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An 'integrated' framework for the comparative analysis of the territorial innovation dynamics of developed and emerging countries

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An 'integrated' framework for the comparative analysis of the territorial innovation dynamics of developed and emerging countries

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Abstract

This paper discusses recent developments in the literature on local and regional innovative performance in order to show how an 'integrated' conceptual framework based on the cross-fertilisation of different theories can serve as a foundation for the comparative analysis of territorial innovation dynamics in both developed and developing countries. The paper outlines a conceptual framework to explain the differences between innovation systems and their geography by drawing on elements of endogenous growth, new economic geography and regional innovation systems. This framework forms the basis of the subsequent analysis of the differences in innovative capacity between the European Union, the Unites States – as the leader system to be challenged – and China and India as emerging competitors for international technological leadership. The systematic analysis of a large body of empirical literature shows important differences between the spatial patterning of 'emerging' (China and India) and 'mature' (EU and US) innovation systems.

Key words: *Innovation systems, geography, endogenous growth, new economic geography, Europe, United States, China, India*

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1. Introduction

The unprecedented pace of the process of technological change and the progressive 'globalisation' of innovation systems are making the territorial dynamics of innovation, on the one hand, more complex to analyse, and, on the other, progressively more interconnected across continents, countries and regions. This changing scenario poses a number of challenges for scholars, practitioners and policy makers alike in order to develop progressively more sophisticated frameworks of understanding able to capture the complexity of the on-going processes. The ultimate aim is to develop adequate policy tools in order to spread the benefits of existing processes and mitigate their potential drawbacks in both developed and developing countries.

In this context, the advancement of both theoretical and empirical literature in a number of fields of the social sciences – not only in economic geography and geographical economics, but also in international business studies and technology studies – has suggested that the insights on the innovation process which that can be produced by a single discipline in isolation are more partial and inconclusive. There is thus an increasing consensus on the need for 'integrated' interdisciplinary eclectic approaches to the genesis of innovation for both positive and normative purposes. In addition, in light of the increasing degree of interconnectedness between regional economies, such a framework should provide consistent insights on the experiences of developed and developing countries, in order to enable mutual learning and policy transfer.

This paper aims to contribute to this debate in two different ways. First, it intends to show how different streams of literature on the genesis of innovation at the territorial level can be productively cross-fertilised into an '*integrated*' and eclectic conceptual framework of understanding. Second, it makes use of this framework to re-interpret a large body of empirical literature in a comparative perspective and investigate in a systematic fashion the similarities and dissimilarities in the territorial innovation dynamics of developed and emerging countries.

The review of the literature in a comparative perspective will show how an integrated framework can contribute to overcome the existing conceptual and empirical barriers that have

limited the capacity of developed and developing countries to learn from each other's experiences, limiting the transfer of successful policy tools. In addition, making use of both quantitative and qualitative information within a theory-driven conceptual framework allows to rise above the limitations of both 'scoreboard' approaches – which rely exclusively on the comparison basic quantitative indicators – and of comparative case studies that remain limited in terms of generality and conceptual foundations. Finally, an integrated comparative analysis facilitates identifying areas where more research is needed to support policy-making in different contexts.

In order to show how different strands of literature on the genesis of innovation at the territorial level can be cross-fertilised into a joint 'meso-level' conceptual framework, the paper is divided into three further sections. Section 2 briefly reviews the existing meso-level innovation literature with the aim of singling out the components of an 'integrated' conceptual framework. The third section discusses the capability of this framework to account for 'real world' regional developmental dynamics in both developed and developing countries more accurately than alternative approaches. The fourth section concludes with some considerations on the 'value added' and implications of this approach.

2. The conceptual foundations of an 'integrated framework' for the comparative analysis of innovative dynamics

The comparative analysis of innovative performance at the territorial level calls for an appropriate analytical framework. Such a framework should possess a number of important features that would make it a suitable foundation for comparative analysis and, eventually, for policy transfer. It should not only be a tool for the detection of the factors of success in leading regions/countries, but a full-embracing conceptualisation of the determinants of regional innovation in both core and peripheral areas, developed and developing countries. Let us briefly review some key contributions to the literature on the territorial determinants of innovation in order to identify

the potential ‘building blocks” of an ‘integrated’ framework for comparative territorial analysis of innovation dynamics.

Link between R&D investments and innovation - By adopting the relationship between innovative efforts and the generation of new ideas/knowledge as its milestone, this conceptual framework would be a suitable foundation for both quantitative and qualitative comparative analyses of regional and local innovative dynamics. The relationship between local innovative efforts and knowledge output is grounded in endogenous growth theory (Romer 1990; Aghion and Howitt 1992; Cheshire and Magrini 2000), the Knowledge Production Function approach (Griliches 1986; Audretsch and Feldman, 1996a and b; Audretsch 2003) and the ‘technology-gap theory’ of technological development (Fagerberg 1988). The latter explicitly assumes the interaction of two ‘conflicting’ forces: innovation (which generates the technology gap) and imitation or diffusion (which tend to reduce it) as the motors of the process long-term technological development. The capability of countries and regions to catch-up with the technological leaders depends on their ‘technological congruence’ and on their indigenous ‘social infrastructure’. It is the capacity to single out these two fundamental forces behind the process of technological development and their explicit link with internal socio-institutional characteristics that makes Fagerberg’s approach particularly suitable for our comparative framework. It fundamentally represents the attempt of the ‘formal analytical’ economic literature to incorporate the Schumpeterian legacy into progressively more sophisticated and comprehensive frameworks that embed innovation into a complex set of other economic processes.

The ‘systems of innovation approach’, on the one hand, and the literature on localised knowledge spillovers and the spatial dimension of the process of innovation, on the other, have tried to move beyond the linear relationship between R&D and innovation by conceptualising the role of more ‘qualitative’/’intangible’ conditioning factors and offering what their proponents deem to be a more realistic view of the process of technological development in time (institutions supportive of

innovative dynamics are seen as the result of long-term processes of social learning) and space. These contributions have flourished outside the economics 'mainstream' and have frequently made use of 'appreciative' approaches and qualitative methods for their empirical analyses. As a consequence, their insights have remained neglected by quantitative comparative exercises involving quantitative indicators, in the same way as the 'generality' of linear approaches has been lacking many in case-study-based analyses.

Systems of innovation conditions - The 'systems of innovation' approach provides fundamental insights into the dynamics of the process of innovation not only by harmoniously 'embedding' innovation into its socio-economic context, but also by effectively integrating proximity, local synergy, and interaction (Camagni 1995; Camagni and Capello 2003) and the importance of "inter-organization networks, financial and legal institutions, technical agencies and research infrastructures, education and training systems, governance structures, innovation policies" (Iammarino 2005, p.499) into the innovative process. A growing number of researchers are also attempting to recalibrate RIS frameworks for emerging country perspectives (Scott and Garofoli 2007; Lundvall et al. 2009; and Padilla-Perez et al. 2009 provide useful overviews). Recalibrating RIS to emerging country conditions is essential as, first, in these countries development in the formal economy partly depends on the performance of the broader, informal innovation system – social capital and networks, institutions and governance capacity (Lundvall et al. 2009). Second, their 'innovation experiences' need to be understood as part of the globalisation of both production and R&D that has been occurring since the 1970s (Mitra 2007; Bruche 2009). As Yeung (2009) points out, the task is to explain innovation under globalization: as Saxenian and Sabel (2008) argue, research needs to explain the specific 'puzzle' of rapid development of high-tech hubs in countries without the consistent quality of institutions generally thought necessary for growth.

These interactions between (local) actors are intrinsically unique and hard to measure and compare across different systems. However, recent developments in the Regional Systems of

Innovation literature have acknowledged the idiosyncratic nature of these factors while, at the same time, placed them into broader frameworks that make them suitable for comparative analysis. This is, for example, the case of the 'evolutionary integrated view of the regional systems of innovation' (Iammarino 2005) which is based on the identification of meso-level "structural regularities from past knowledge accumulation and learning" (Iammarino 2005, p. 503). The macro national-level institutions that provide the broad framework conditions for the genesis of innovation interact with the micro-level behaviour of firms, research centres and universities giving rise to highly localised meso-level conditions: a series of "external conditions in which externalised learning and innovation occur" (Cooke 1997, p.485) which can be identified across innovation systems and on which comparative analysis can be based. This set of localised conditions act as the unique combination "of innovative and conservative components, that is, elements that favour or deter the development of successful regional innovation systems" (Rodríguez-Pose 1999, p. 82) in every space. An important leap in the usability of these concepts for comparative analysis has come from their operational translation into a set of 'measurable' features of the regional realm, directly dealing with concrete constraints in terms of availability of comparable and reliable data. This is the case of the analyses based on 'social filter indices': composite indicators based on the theory-driven selection of proxies for the 'structural pre-conditions' for the establishment of fully functional systems of innovation (Rodríguez-Pose and Crescenzi 2008). The Social Filter Index approach focuses on three main aspects of social structure: educational achievement (Lundvall 1992; Malecki 1997); the productive employment of human resources (Gordon 2001); and demographic structure and dynamism (Rodríguez-Pose 1999).

The use of the 'Social Filter Index' makes it possible to capture such factors in a more parsimonious fashion for comparative analysis, identifying broad regularities in 'innovation-prone' regions across a large number of cases (Crescenzi and Rodríguez-Pose 2009). This approach is particularly helpful when looking at both developed and emerging countries in a comparative perspective, because it cuts through differences that flow from being at different stages in the

development process. However, as it will be discussed below, this literature has also made it clear that the Social Filter Index – although multidimensional in nature – should not be interpreted in isolation, but always considered jointly with other components of an 'integrated framework'.

Localised Knowledge Flows - The third crucial component of such a framework – together with innovative efforts and social filter conditions – comes from the literature on the spatial diffusion of knowledge flows (Storper and Venables 2004; Sonn and Storper 2008). The circulation of economically valuable knowledge is made possible by face-to-face contacts that function as highly localised transmission mechanisms and determine the spatial boundedness of knowledge flows. The transmission of highly valuable non-codifiable knowledge calls for repeated human contacts that are only possible within close geographical proximity. As a consequence, the exposure of regional innovative agents to external sources of innovation in close geographical proximity is a persistent source of competitive advantage for the local economy. The possibility to interact face-to-face with other innovative actors – thanks to physical accessibility / geographical centrality with respect to the technological 'core' – improves (ceteris paribus) local innovative capabilities. The assessment of the impact of accessibility to extra-regional knowledge on local innovative performance, the analyses of the different knowledge circulation patterns and of their geography are all important components of the comparative analysis of the territorial dynamics of innovation. However, comparative analysis should also account for the interaction of knowledge flows with the underlying absorptive conditions, looking at spatial knowledge flows jointly with the factors conditioning their impact on local innovative performance. In this context innovation systems can become catalysts for the absorption of localised knowledge flows and their translation into new knowledge. Hence the comparative analysis should be able to detect not only the influence of local innovative efforts on innovative dynamism, but also capture how 'accessibility to extra-regional innovation' in its turn interacts with the endogenous social filter conditions, determining to what extent such knowledge is translated into innovative dynamism at the local and regional level.

Global networks - The 'drivers' discussed above are all important factors for the comparative analysis of local innovative conditions. However, the analysis would be incomplete without taking into account a set of additional dimensions (cognitive, organizational, social, and institutional proximities) that – together with physical or geographical proximity – make it possible to diffuse and absorb knowledge, shaping the innovative potential of regions and territories (Boschma 2005).

An additional set of proximities is crucial for the generation of innovation by allowing the emergence of complex innovative network relationships, operating between and across different scales (from local to transnational). What matters for the innovative performance of different territories is the combination of intra-local, extra local and transnational network connection which "are not just intra or inter-corporate in nature [as highlighted in Faulconbridge, 2006], but may also encompass other forms of social networks" (Coe and Bunnell 2003, p. 454). These networks generate a complex pattern of winners and losers with an increasing distance between those enjoying the best balance of the various proximities with the most innovative actors and those at the geographical, cognitive, organisational, social, and/or institutional periphery. In developing countries the localisation and degree of territorial embeddedness of such 'global' networks is of paramount importance to internal innovative dynamics. Multinational Firms (Cantwell, 2005; Dunning, 1998; Dunning 1996) and 'lead firms' (Yeung 2009) engage in different types of spatially specific 'strategic coupling' with local firms, influencing cluster formation and producing heterogeneous patterns of spatial development. From a different perspective, migrants and diasporic communities also play important roles in facilitating innovative activity in developing countries by means of 'extra-local' network connections. Not only individual migrants act as mobile carriers of knowledge[1] but cycles of migration and return between developing 'home' countries and developed 'hosts' have helped develop innovative activity in emerging countries. The social capital and trust

[1] For example, in the US, ethnic Indian and Chinese immigrant communities have played a significant role in science and technology innovation (Stephan and Levin 2005), as well as generating large numbers of spin-outs and startups (Wadhwa et al 2007).

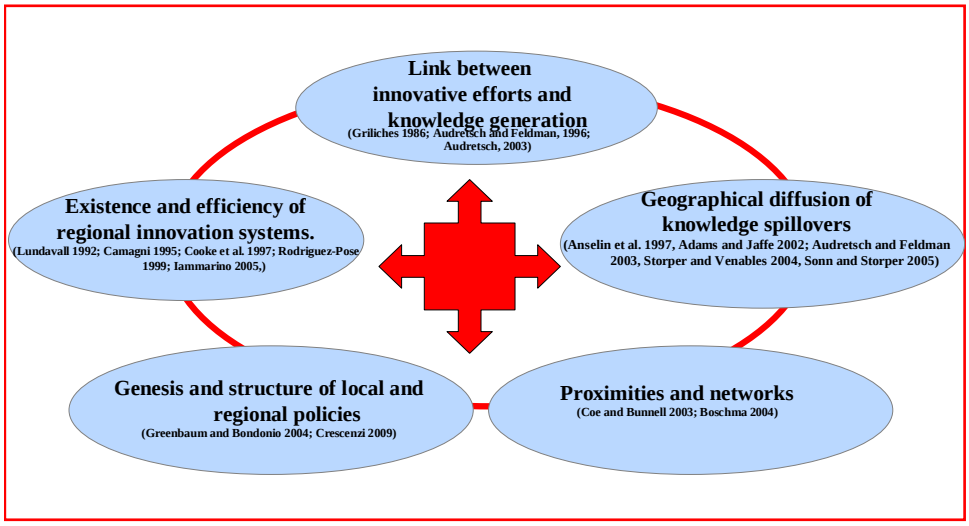
embedded in co-ethnic networks is also crucial in assisting location shifts and lowering transaction costs for network members (Rodríguez-Pose and Storper 2006).

Public Policies - Even if path dependency is very strong in the processes discussed so far, a given course of action is not carved in stone and comparative analyses have to take into account differential evolutionary patterns. External shocks (e.g. in the form of top-down policies) and/or collective action processes (e.g. as bottom-up policies) can change observed trajectories. The systems of innovation perspective, by institutionally embedding the process of innovation, allows us to account for the role of public policies in the comparative analysis of innovation dynamics. The 'a priori' structure and design of public policies may or may not be supportive of the long-term innovative performance of the regional economy. In addition, the literature on the genesis of local and regional innovation policies also suggests that it is necessary to assess the coherence between the policies' 'explicit' objectives and the 'actual' interventions implemented on the ground, as political economy processes may distort not only their design, but also their implementation (Crescenzi 2009 for the EU; Greenbaum and Bondonio 2004 for the USA). Given the role of 'power' factors in the design and implementation of public policies, interventions may be the result of the political equilibria reached in the bargaining process between the national governments, the local governments and various pressure groups. Where these processes generate a fundamental mismatch between the local needs of the innovation systems and the policy targets, the evolutionary trajectory of an innovative area might be hampered. This is of great importance in emerging countries where policy stances have also influenced the spatial patterning of economic and innovative activity. Sun (2003) emphasizes, for example, the Chinese government's persistent role in guiding changes to the national innovation system, while Duflo (2010) highlights the importance of internal restrictions on labour and capital mobility – motivated essentially by political considerations – on the development of the Chinese spatial economy. As will be discussed in the next section such a configuration is not necessarily synergic with the needs of its emerging

'knowledge' economy. As consequence, an effective comparative tool for the analysis of regional innovation needs to incorporate and embed these processes in their dynamic interactions with the key drivers of regional innovative dynamism.

The 'integrated framework' or ' the base-line' scenario for comparative analysis – The conceptual framework discussed in this paper allows us to indentify five key factors shaping the geography of innovation in different territorial contexts: Innovative activities, systems of innovation (social filter) conditions, geographical factors/accessibility/exposure to knowledge spillovers, international (trans-local) linkages and local and regional (innovation) policies. These factors are visualised in Figure 1 where each stream of literature presented in the previous section is translated into the corresponding innovation 'drivers' identified above.

Figure 1 – Territorial drivers of innovation dynamics and streams of literature combined in the integrated framework



Source: Adapted from Crescenzi and Rodríguez-Pose 2011

Local innovative activities are the engines of regional economic performance. In quantitative terms they work as inputs in the Knowledge Production Function for the generation of new ideas. However, in a more qualitative perspective, innovative activities can be pursued in different contexts with different roles being played by private firms, research centres and universities. The impact of innovative activities crucially depends upon two other factors: systems of innovation/social filter conditions and geography. In previous paragraphs we discussed how the concept of social filter – the structural socio-economic pre-conditions for the development of a well-functioning Regional System of Innovation – can been adopted as a quantitative proxy for local institutions supportive/detrimental to the process of innovation, making inter-regional and inter-temporal comparisons and benchmarking possible. However, from a deductive perspective, the assessment of the social filter conditions can be complemented by qualitative considerations capturing its institutional and relational underpinnings. The same line of reasoning applies to geography: different quantitative proxies (accessibility indices and spatially lagged variables respectively) have been developed in the literature to capture the impact of geographical distance from economic and innovative activities on local innovative performance. Exposure to knowledge spillovers is an important predictor for the innovative success of any region. Geography is directly linked to innovative activities and socio-economic conditions in shaping innovation performance. As discussed before, innovation dynamics are not only influenced by physical accessibility: the position of each region in 'global networks' and its exposure to global knowledge flows is also important. The capability of local actors to establish organisational, institutional and social proximity relations with other agents determines the position of the local economy in global networks. Participation in global networks exerts an influence on all the other dimensions mentioned above: it influences the nature and magnitude of local innovative efforts, shapes the local system of innovation and – in particular in emerging countries – impacts upon public policies. Finally, public policies at different levels (from national policies to community-level initiatives), may impinge (directly or indirectly) on local innovative performance.

The comparative analysis of the territorial dynamics of innovation should hence be based on the simultaneous (qualitative and quantitative) assessment of all these five factors and of their reciprocal interactions. The next section will show how these concepts have been applied to both developed and emerging countries, unveiling relevant differences in their geography of innovation.

3. Empirical evidence on regional innovation through the lens of an 'integrated approach'

The cross-fertilisation of linear and non-linear, quantitative and qualitative approaches to the generation of regional innovative dynamism discussed so far, allows our comparative conceptual framework to reconcile the often contradictory views resulting from the adoption of either an inductive or a deductive approach to innovation dynamics. The relative importance of the various determinants of regional innovation varies significantly when assessed from opposite perspectives. Deductive analyses are designed to capture macro knowledge generation dynamics: they are designed, for example, to assess the aggregate average impact of innovative efforts on the patenting performance of a cross-section of regions, highlighting common and 'general' trends (as in the 'standard' Knowledge Production Function approach). In so doing these models treat all specific idiosyncratic factors that differentiate one region/regional innovation system from the other as 'residual'. Conversely, inductive analyses tend to focus their attention on the specificities of a set of regions assessing their unique internal dynamics (as in large part of the Regional Systems of Innovation literature), but overlooking inter-regional trade offs and general trends. While these limitations are logical consequences of the perspective adopted, they significantly hamper the capacity of these models to provide a more accurate picture of the real world and act as foundations for comparative analysis. The conceptual framework presented in this paper effectively bridges deductive and inductive approaches by proposing a meso-level perspective based on the inclusion in a macro framework of processes and factors generally treated as idiosyncratic (and confined into the residual) by mainstream deductive analysis. By placing in a deductive perspective development

drivers grounded into a largely qualitative literature (e.g. systems of innovation) their generality as predictors for innovation can be rigorously tested and compared across space. As a consequence, key qualitative concepts – traditionally addressed by means of case-study analyses – can be treated in a quantitative framework, emphasising their 'non-strictly-idiosyncratic' component and identifying the most appropriate proxies.

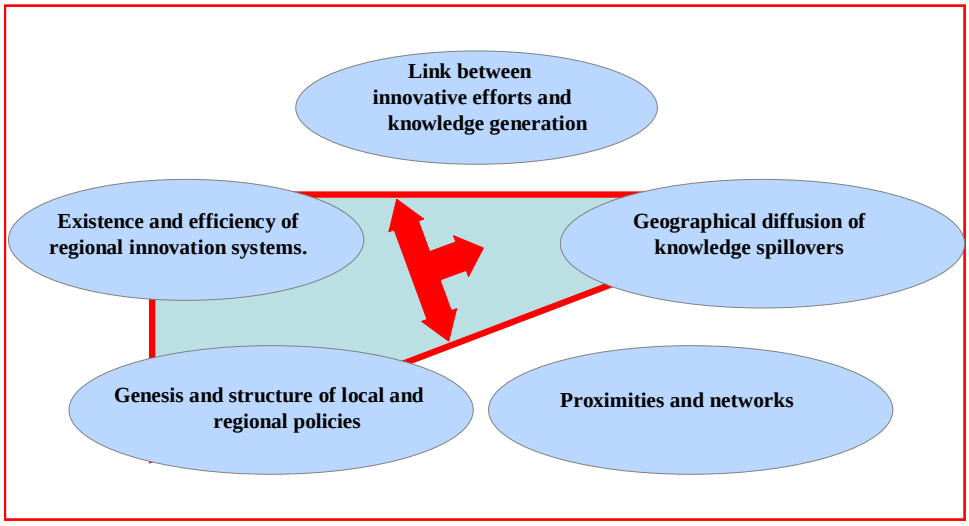
The integrated approach – applied directly or indirectly to the empirical analysis of regional innovation dynamics – can produce interesting insights on both developed and emerging countries. The cross-fertilisation of different theoretical approaches to the analysis of innovation and its economic impact has resulted in the development of empirical models, that, in turn, permit to systematically investigate phenomena hitherto 'confined' to the grey areas between different approaches.

3.1 The territorial determinants of innovation in developed countries

The European Union

In the case of the European Union, a large body of literature has indicated that an increase in innovative efforts has a direct impact on regional-level innovative output (Fagerberg et al. 1997; Cheshire and Magrini, 2000; Bilbao-Osorio and Rodríguez-Pose 2004; Crescenzi 2005). However, the same literature has made explicit that raising the innovative effort does not necessarily produce the same effects in all regions. This is because a variety of local factors influence this process (Rodríguez-Pose 1999; Capello and Faggian 2005; Crescenzi and Rodríguez-Pose 2011). As shown by the red lines in figure 2, the literature suggest that the relationship between local innovative efforts and the localised generation of new knowledge is far from linear. Territorial innovation systems, collective learning processes, relational capital and different social filters have been shown to play a crucial role as determinants of the differentiated 'productivity' of innovative efforts in different regions.

Figure 2 – The territorial drivers of innovation dynamics in the European Union



Source: Authors' elaboration

The uneven impact of R&D investments in the EU regions is further reinforced by a highly differentiated exposure to extra-regional knowledge flows. The limited physical accessibility of certain territories (i.e. their geographical peripherality) often curbs the potential to successfully translate innovation into regional growth due to both a reduced interconnectedness of the local economy to innovative networks and a lower exposure to knowledge flows (upper right-hand-side circle in figure 2). This is a direct consequence of the strong distance-decay of inter-regional knowledge flows in the EU. Greunz (2003) suggests that in Europe only innovative efforts pursued within a 190 miles (or 306 Kms) radius have an impact on regional patenting activity. Other analyses, despite using different methodologies, reach similar results. Bottazzi and Peri (2003) estimate a maximum radius of 200-300 kms for the diffusion of knowledge flows. Moreno et al. (2005) leave it at 250 kms, while for Rodríguez-Pose and Crescenzi (2008) the diffusion of knowledge is bounded to a 180 minute trip-time or 200 kms. These empirical estimates of the degree of spatial boundedness of interregional knowledge flows point in the direction of the

prominent role played by face-to-face interactions and 'temporary' contacts (necessarily constrained by travel-time distance) in the circulation of knowledge among EU regions, where limited labour mobility reduces the probability of long-haul exchanges. In other words, the existing evidence indicates that knowledge flows tend to be driven more by commuting patterns and temporary proximity than by the migration of 'knowledgeable' individuals. The consequence of this is that EU peripheral regions suffer from an intrinsic source of competitive disadvantage, due to the tendency of knowledge to form highly localised pools around innovative centres.

When the evidence outlined above is considered in a 'systemic' way, as the integrated approach allows us to do, the interrelations between the various mechanisms at play are uncovered. As knowledge spillovers are spatially bounded, they create localised pools of knowledge in core areas, where the innovative efforts are also concentrated, leaving only marginal benefits in peripheral areas. However, the impact of such flows crucially depends on a set of localised – largely idiosyncratic but still partially generalizable – meso-level socio-institutional conditions. In this context, territorial-level innovation policies have played a fundamental role in shaping the current territorial dynamics of innovation. The existing literature has shown that the process of economic and political integration and EU policies have profoundly influenced the geography of innovation of European countries and regions (Tsipouri 2004). In the attempt to counterbalance the uneven spatial distribution of innovative activities – on the basis of territorial equity considerations – the EU has systematically supported R&D activities in lagging regions, both by means of the creation of large public research facilities or by incentivising the (re)location of R&D intensive firms. The strong policy emphasis on formal R&D has often resulted in a mismatch between the demand of research centres and private firms for highly skilled labour and the scarcity of local supply (Midelfart-Knarvik and Overman 2002) overlooking the 'systemic' nature of the 'European innovation paradox' (Oughton et al. 2002).

The interlinked drivers of the territorial geography of innovation in Europe are captured by the arrows in figure 2. What remains relatively underexplored (in both conceptual and empirical

terms) by the literature on EU regional innovation dynamics is the role of the fifth pillar: non-geographical 'proximities and networks'. While the impact of the networks generated by both labour (e.g. diasporic communities) and capital (e.g. multinational firms) international/translocal movements on the geography of innovation has been more thoroughly analysed by the literature focused on other geographical areas (as will be discussed later, this is true for the US but also for China and India), for Europe as a whole more research is still needed. Relevant initial insights in this direction come from national-level analyses of the impact of university-industry collaborations (e.g. Ponds, van Oort and Frenken 2010, for the Netherlands; D'Este, Guy and Iammarino 2012, for the UK). Geographical proximity is an important enabling factor for these forms of knowledge exchange, but the existence of trans-local networks is also essential, at least within the borders of the countries considered in these analyses. EU-level evidence shows that networking across regions positively correlates with regional innovative performance (Miguélez and Moreno 2010). But the research challenge is to explicitly disentangle the impact of a differentiated set of 'proximities' (geographical and non-geographical) on regional innovative performance. Marrocu, Paci and Usai (2011) suggest that, although geographical proximity remains an important factor, technological and cognitive proximity might be even more important conditions for the transmission of knowledge, while the role of institutional and organisational proximity seems to be more marginal.

This very dynamic – though still embryonic – strand of literature has still not reached a consensus comparable to that of the other 'pillars' on the relative importance of different non-spatial channels and their impact with respect to the other 'pillars' (such as, for example, systems of innovation conditions) remains to be explored.

The United States

On the other side of the Atlantic, approaching the territorial dynamism of innovation from an integrated comparative framework leads to a remarkably different picture. Not only the linear link between local R&D investments and innovative output (Anselin et al. 1997; Acs et al. 2002) is

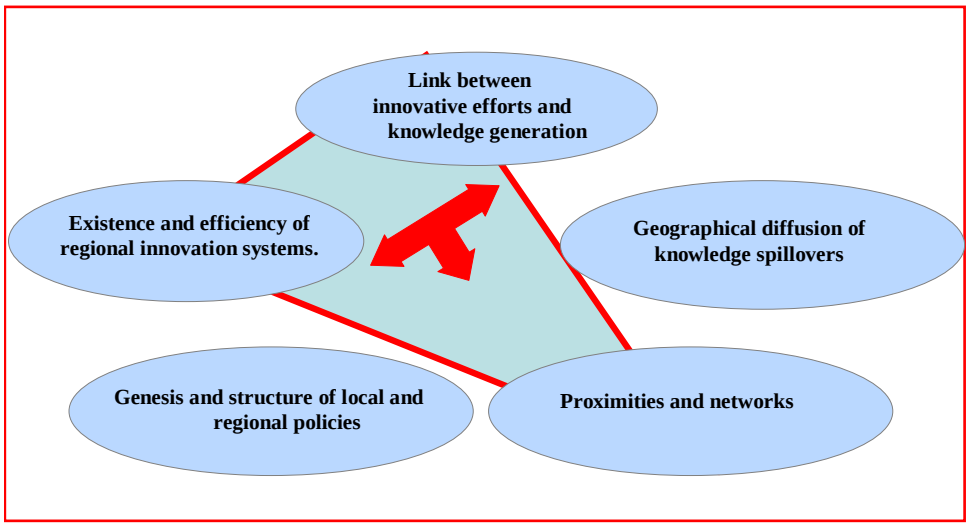
stronger than in Europe, but empirical analyses of the spatial diffusion of spillovers have also highlighted a stronger distance decay effect, with knowledge spillovers, in general, not spreading beyond a 80 to 110 kms radius from the metropolitan standard area (MSA) where they are generated (Jaffe 1989; Varga 2000; Ács 2002). In the US the generation of innovation usually occurs in relatively self-contained geographical areas that rely on their own R&D inputs and maximise the circulation of knowledge within their boundaries. Higher factor mobility allows for this as it makes knowledge and competencies matching more easily achieved locally (Dosi et al. 2006). Mobility of capital, population, and knowledge not only promotes the agglomeration of research activity in specific areas of the country, but also enables the full exploitation of local innovative activities and (informational) synergies. If spatially-bound knowledge flows seem to be confined within the functional borders of the US MSAs, the role of 'global' networks and non-spatial proximities has been shown to be – by a recent, but increasingly consolidated and converging literature – of paramount importance. Bettencourt et al. (2007a, b), Fleming et al. (2007), and Lobo and Strumsky (2008) provide evidence on the positive impact of extra-local connections of different nature on the local innovative performance of US MSAs. The mobility of knowledgeable individuals across space – not constrained by commuting patterns – makes the complex web of their relations stretch across the entire country while remaining highly localised in specific hotspots.

While the knowledge circulation mechanisms differ substantially in the two continents, the institutional conditions that support the process of innovation and reinforce local absorptive capabilities are very similar: in the US, as in Europe, having favourable social filter conditions is key to innovation (Crescenzi et al. 2007).

The red arrows in Figure 3 offer a visual summary of the key pillars of the territorial dynamics of innovation in the US through the lens of the integrated approach: the highly localised impact of R&D investments is reinforced by favourable systems of innovation conditions and 'global' networks. Inter-regional spillovers are less important. The spatial impact of innovation

policies remains limited: spatial equity considerations rarely enter in the science and technology policy-making.

Figure 3 – The territorial drivers of innovation dynamics in the U.S.



Source: Authors' elaboration

3.2 The territorial determinants of innovation in emerging countries

When moving into the analysis of emerging countries, notwithstanding their increasing importance in the international economic arena, the empirical literature becomes more fragmented. In this context, the integrated framework can offer important insights on possible directions for future research.

The link between formal R&D investments and the generation of innovation is of great practical importance for both China and India, given their current and historic emphasis on technology-led national growth (Leadbeater and Wilsdon 2008). Both China and India are investing heavily in 'innovation inputs', such as R&D and human capital, which both feed into and feed from rapid macroeconomic growth (Kjuis and Wang 2006). A systematic analysis of the geography of these investments suggests that their spatial concentration has increased over time both in China

(Sun 2003) and India (Mitra 2007). R&D efforts are heavily concentrated in specific 'host spots' in both countries with a special role being played by R&D departments of multinational firms. However, the link between local R&D and innovative output is highly non-linear in both contexts. The 'productivity' of innovative efforts is much differentiated in space depending on a number of conditioning factors. Figures 4 and 5 highlight – for China and India respectively – similarities and dissimilarities in terms of these territorial-level conditioning factors.

The role of 'global' networks and non-geographical proximities is vital in two countries which have been constantly tapping into the rapidly growing stock of global knowledge through multinational firms and FDI, technology licensing and imported capital goods (Utz and Dahlman 2005). A number of large-scale quantitative studies suggest that global R&D inflows, technology transfer and export-orientation by local firms help improve innovation performance (Liu and Buck 2007; Ying 2008; Fu and Gong 2009; Cheung 2010). Similarly, qualitative analyses suggest that knowledge diffusion from MNEs has helped technological catch-up (Mu and Lee 2005), not least through enabling indigenous innovation and locally developed technologies (Von Zedwitz 2004). Migrants and diasporic communities are also essential in facilitating innovative activity in developing countries as individual migrants act as mobile carriers of knowledge from 'developed' host countries into 'emerging' 'home' economies (Saxenian 2006). This latter channel tends to have stronger impacts in India, where mobility patterns are freer, than in China, but the situation is evolving rapidly (Parthasarathy 2004; Taeube 2004; Saxenian and Sabel 2008).

The contribution of other territorial-level factors is less 'clear-cut' and generally reflects the fundamentally different role of government intervention in the two countries. In particular, the Chinese experience is relatively unique when compared to all other cases. It is certainly true that governments in both countries are actively developing their domestic innovation capacities. But China has developed a very aggressive strategy based on a rapid increase in R&D expenditure (10-15% until 2020) (Lundin and Schwaag Serger 2007), while India's model focuses on developing skilled human capital, clustering activity in science parks, and providing financial instruments such

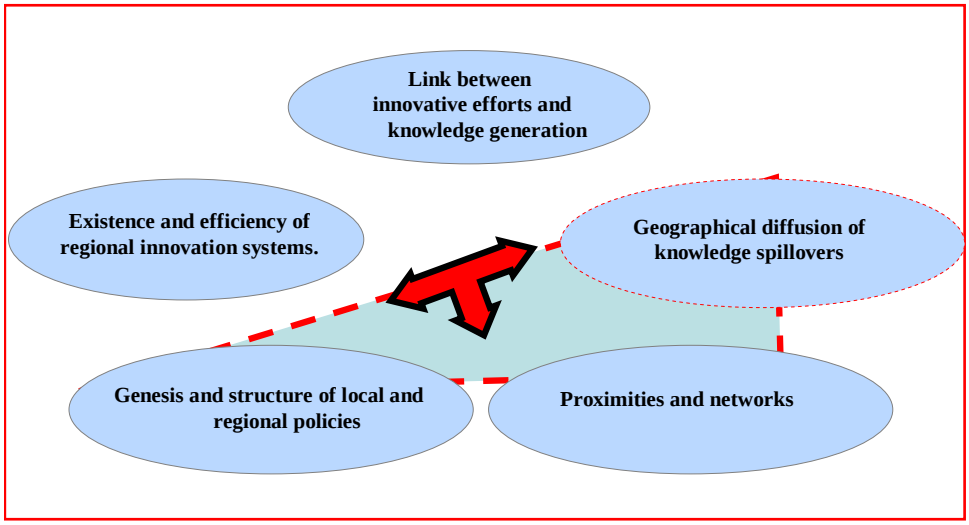
as tax incentives, research grants, concessional loans and venture capital (Mani 2004). Leadbeater and Wilsdon (2008) draw a contrast between the 'open, cosmopolitan' nature of innovative activity and policy in India, reliant on free factor mobility, and the top-down, 'increasingly techno-nationalist' direction that Chinese leaders are taking (aggressively supporting the clustering of innovative activities in designated areas and leveraging on internal capacity rather than external flows.

This has important implications for the geography of spatially-bounded knowledge flows and their localisation patterns in the two countries. A number of studies suggest that the spillover-innovation link also operates in developing country contexts, with strong evidence that the spatial concentration of innovative activities boosts efficiency (Scott and Garofoli 2007; Duranton 2008; Xu 2009). However, these effects may be constrained by institutional and political factors generating differentiated dynamics in different countries. While in India connectivity to innovative neighbouring regions seems, as in the EU case, to benefit the local economy, in China this effect has been shown to be negative (dotted line in Figure 4) with major innovative centres 'sucking' resources from their neighbourhood (Crescenzi, Rodríguez-Pose and Storper 2012).

Long-term differences in public policies have also contributed to substantial differences in the systems of innovation conditions of the two countries. The innovation system in China (Schaaper 2009) is still highly fragmented and not well integrated (Sun 2003), having a more limited impact on the local productivity of innovative efforts, while in India the literature seems to suggest as more directly supportive set of localised systemic institutions (Utz and Dahlman 2005).

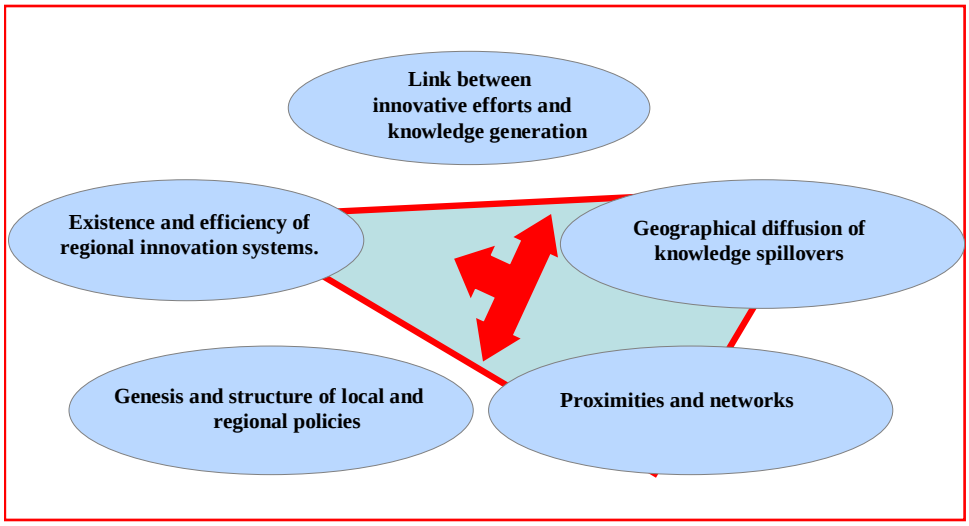
Overall, approaching the territorial dynamics of innovation from an integrated framework indicates that the process of innovation in China appears to be driven by the concentration of substantial R&D resources in specific locations as a result of the interaction of global and (national) state-driven dynamics. Conversely, in India global flows and their impacts are embedded into differentiated local institutional contexts and integrated into localised knowledge-transmission mechanisms.

Figure 4 – The territorial drivers of innovation dynamics in China



Source: Authors' elaboration

Figure 5 – The territorial drivers of innovation dynamics in India



Source: Authors' elaboration

4. Conclusions. What can we learn from territorial comparative analysis? What is the 'value added' of this approach?

Assessing innovation in general, and its territorial dynamics, in particular, using an integrated conceptual framework gives scholars a better opportunity to single out the factors that shape the genesis of innovation and economic dynamism at the territorial level at different stages of the process of technological development. Such an approach provides new and more comprehensive ways to gain a better understanding of these processes for leading and lagging regions at the same time. But is there any general lesson which can be learnt from this framework? The systematic review of the key findings of the existing empirical literature on both developed and emerging countries suggests that innovation processes display very differentiated territorial processes in different contexts. A theory-driven framework makes it possible to generalise and compare some key trends, but regional and local innovation-based policies should carefully take into account local specificities possibly leading to the abandonment of 'best practice' approach to policy-transfer. In the same perspective, a systematic analysis of the literature shows that there is no 'optimal'

geography of innovation. Hence, it does not make sense to call for an 'Americanisation' or 'Europeanization' of the innovation process of countries such as China or India. Instead, public policies should identify the most sustainable models given local conditions and preferences in order to maximise the potential returns of any innovation policy intervention and its sustainability in time.

References

Acs Z.J. (2002) *Innovation and growth in cities.* Edward Elgar, Northampton, MA

Acs Z., Anselin L. and Varga A. (2002) Patents and innovation counts as measures of regional production of new knowledge, *Research Policy* 31, 1069–85;

Aghion P. and Howitt P. (1992) A model of growth through creative destruction, *Econometrica* **60**(2), 323-351.

Anselin L., Varga A. and Acs Z. (1997) Local Geographic Spillovers between University Research and High Technology Innovations, *Journal of Urban Economics*, 42, 422-48;

Audretsch D. B. (2003) Innovation And Spatial Externalities, *International Regional Science Review*, **26**(2), 167 - 174.

Audretsch D.B. and Feldman M.P. (1996a) R&D spillovers and the geography of innovation and production, *American Economic Review* **86**, 630-640.

Audretsch D.B. and Feldman M.P. (1996b) "Innovative clusters and the industry life cycle", *Review of Industrial Organization* **11**, 253-273.

Bettencourt L., Lobo J., Helbing D., Kühnert C., and West G. (2007a) Growth, innovation, scaling, and the pace of life in cities, Proceeding of the National Academy of Sciences 104, 7301-06;

Bettencourt L., Lobo J., and Strumsky D. (2007b) Invention in the city: Increasing returns to patenting as a scaling function of metropolitan size, *Research Policy* 36, 107-20;

Bilbao-Osorio B. and Rodríguez-Pose A. (2004) From R&D to innovation and economic growth in the EU, *Growth and Change* **35**, 434-55.

Boschma R. A. (2005) Competitiveness of regions from an evolutionary perspective. *Regional Studies* **38**(9), 1001-1014.

Bottazzi L. and Peri G. (2003) Innovation and spillovers in regions: evidence from European patent data, *European Economic Review* **47,** 687-710.

Bruche, G. (2009). *A New Geography of Innovation - China and India rising* New York: Vale Columbia Center, Columbia University.

Camagni R. (1995) Global network and local milieu: toward a theory of economic space, in Conti, G., Malecki, E., and Oinas, P. (eds.), *The industrial enterprise and its environment: spatial perspectives*, Aldershot, Avebury.

Camagni R. and Capello R. (2003) La città come "milieu" e i "milieux" urbani: teoria e evidenza empirica in Garofoli G. (ed.) *Impresa e territorio*, Il Mulino, Bologna

Cantwell, J. (2005). MNCs, local clustering and science-technology relationships. In G. Santangelo (Ed.), *Technological Change and Economic Catch-Up: The Role of Science and Multinationals*. Cheltenham: Edward Elgar.

Capello R and Faggian A. (2005) Collective Learning and Relational Capital in Local Innovation Processes, Regional Studies, 39(1), 75-87

Cheshire P.C. and Magrini S. (2000) Endogenous processes in European regional growth: Convergence and policy, *Growth and Change* **31**, 455-479.

Cheung, K. (2010) Spillover Effects of FDI via Exports on Innovation Performance of China's High-Technology Industries, *Journal of Contemporary China* **19**(65): 541-557.

Coe, N.M. and Bunnell, T.G. (2003) 'Spatialising' knowledge communities: towards a conceptualisation of transnational innovation networks, *Global Networks* **3**(4): 437-456.

Cooke P. (1997) Regions in a global market: The experiences of Wales and Baden-Wurttemberg, *Review of International Political Economy* **4**.

Crescenzi R. (2005) Innovation and regional growth in the enlarged Europe: the role of local innovative capabilities, peripherality and education, *Growth and Change* **36**, 471-507.

Crescenzi R. (2009) Undermining the principle of territorial concentration? EU regional policy and the socio-economic disadvantage of European regions, *Regional Studies*, 43(1), 111-133, 2009

Crescenzi R. and Rodríguez-Pose A.(2009) "Systems of innovation and regional growth in the EU: endogenous vs. external innovative efforts and socioeconomic conditions" in Fratesi U. and Senn L. (eds) "Growth and innovation of competitive regions", Springer-Verlag, 167-192, 2009.

Crescenzi R. and Rodríguez-Pose A. (2011) *Innovation and Regional Growth in the European Unio*n, Berlin and New York: Springer-Verlag

Crescenzi, R., Rodríguez-Pose, A., and Storper, M. (2007). "The territorial dynamics of innovation: a Europe-United States Comparative Analysis". *Journal of Economic Geography*, (7:6), pp. 673-709.

Crescenzi, R., Rodríguez-Pose, A., and Storper, M. (2012). "The territorial dynamics of innovation in China and India". Mimeo.

D'Este P., Guy F. and Iammarino S. (2012) Shaping the formation of university-industry research collaborations: what type of proximity does really matter?, Journal of Economic Geography, forthcoming

Dosi G., Llerena P. and Sylos Labini M. (2006) The relationships between science, technologies and their industrial exploitation: An illustration through the myths and realities of the so-called 'European Paradox', *Research Policy*, 35(10), 1450-1464

Duflo, E. (2010) *Transportation Infrastructure and Urban Growth in China*. Presentation to International Growth Centre Conference on Cities and Growth. London, 16 December.

Dunning, J. (1996) The geographical sources of competitiveness in firms: Some results of a new survey. *Transnational Corporations, 5*(3), 1-21.

Dunning, J. (1998). Location and the Multinational Enterprise: a neglected factor? *Journal of International Business Studies, 29*(1), 45-66.

Duranton, G. (2008). Viewpoint: From cities to productivity and growth in developing countries. *Canadian Journal of Economics/Revue canadienne d'économique, 41*, 689–736.

Fageberg, J. (1988) Why growth rates differ, in Dosi, G., Freeman, C., Nelson, R., Silveberg, G., and Soete, L. (eds), *Technological change and economic theory*. Pinter, London

Fagerberg J., Verspagen B. and Caniels M. (1997) Technology, growth and unemployment across European Regions, *Regional Studies*, **31**(5), 457-466

Faulconbridge, J.R. (2006) Stretching tacit knowledge beyond a local fix? Global spaces of learning in advertising professional service firms. *Journal of Economic Geography* 6: 517-540.

Fleming L., King C., and Juda A. (2007) Small worlds and innovation, Organization Science 14, 5, 375-93;

Fu, X. and Y. Gong (2009) International and Intranational Technological Spillovers and Productivity Growth in China, *Asian Economic Papers* **8**(2): 1-23.

Gordon I.R. (2001) Unemployment and spatial labour markets: strong adjustment and persistent concentration in R. Martin and P. Morrison (eds.) *Geographies of Labour Market Inequality*, Routledge, London.

Greenbaum R.T. and Bondonio D. (2004) Losing focus: A comparative evaluation of spatially targeted economic revitalisation programmes in the US and the EU, *Regional Studies*, 38(3): 319-334.

Greunz L. (2003) Geographically and Technologically Mediated Knowledge Spillovers between European Regions, *Annals of Regional Science* **37**, 657-80.

Griliches Z. (1986) Productivity, R&D, and basic research at the firm level in the 1970s, *American Economic Review* **76**, 141–154.

Iammarino S. (2005) An evolutionary Integrated View of Regional Systems of innovation: concepts, measures and historical perspectives, *European Planning Studies* **13**(4), 497-519.

Jaffe A.B. (1989) The Real Effects of Academic Research, *American Economic Review* **79**(5), 984-1001.

Kuijs, L., & Wang, T. (2006). China's Pattern of Growth: Moving to Sustainability and Reducing Inequality. *China and World Economy*, 14(1), 1-14.

Leadbeater, C., & Wilsdon, J. (2007). *The Atlas of Ideas: How Asian innovation can benefit us all*. London: Demos.

Liu, X., & Buck, T. (2007). Innovation performance and channels for international technology spillovers: Evidence from Chinese high-tech industries. *Research Policy, 36*(3), 355-366.

Lobo J. and Strumsky D. (2008) Metropolitan patenting, inventor agglomeration and social networks: A tale of two effects, *Journal of Urban Economics* 63, 871-84.

Lundin, N., & Schwaag Serger, S. (2007). *Globalization of R&D and China – Empirical Observations and Policy Implications*. Stockholm: Research Institute of Industrial Economics.

Lundvall, B.-A., Joseph, K. J., Chaminade, C., & Vang, J. (Eds.). (2009). *Handbook of innovation systems and developing countries : building domestic capabilities in a global setting*. Edward Elgar: Cheltenham.

Lundvall B.Å. (1992) *National systems of innovation: Towards a theory of innovation and interactive learning*. Pinter, London.

Malecki E. (1997) *Technology and Economic Development: The Dynamics of Local, Regional and National Competitiveness*, 2nd edition Addison Wesley Longman, London.

Mani, S. (2004). Institutional support for investment in domestic technologies: An analysis of the role of government in India. *Technological Forecasting and Social Change, 71*(8), 855-863.

Marrocu E., Paci R. and Usai S. (2011) Proximity, Networks and Knowledge Production in Europe, *CRENOS Working Paper* 2011/09.

Midelfart-Knarvik H. and Overman H.G. (2002) Delocation and European integration: is structural spending justified?, *Economic Policy* **17**(35), 322-359

Miguelez E. and Moreno R. (2010) Research Networks and Inventors' Mobility as Drivers of Innovation: Evidence from Europe, IREA Working Papers 201001, University of Barcelona.

Mitra, R. (2007). *India's Emergence as a Global R&D Center - an Overview of the Indian R&D System and Potential*. Ostersund: Swedish Institute for growth Policy Studies

Moreno R., Paci R. and Usai S. (2005) Spatial spillovers and innovation activity in European regions, *Environment and Planning A* **37**, 1793-1812.

Mu, Q. and K. Lee (2005) Knowledge diffusion, market segmentation and technological catch-up: The case of the telecommunication industry in China, *Research Policy* **34**(6): 759-783.

Oughton C., Landabaso M. and Morgan K. (2002) The Regional Innovation Paradox: Innovation Policy and Industrial Policy, *Journal of Technology Transfer*, 27, 97–110.

Padilla-Perez, R., Vang, J., & Chaminade, C. (2009). Regional innovation systems in developing countries: integrating micro and meso-level capabilities In B.-A. Lundvall, J. Vang, K. J. Joseph

& C. Chaminade (Eds.), *Handbook of Innovation Systems and Developing Countries*. Cheltenham: Edward Elgar.

Parthasarathy, B. (2004) India's Silicon Valley or Silicon Valley's India? Socially Embedding the Computer Software Industry in Bangalore, *International Journal of Urban and Regional Research* **28**(3): 664-685.

Ponds R., van Oort F. and Frenken K. (2010) Innovation, spillovers and university-industry collaboration: an extended knowledge production function approach, Journal of Economic Geography, 10(2), 231-255

Rodríguez-Pose A. (1999) Innovation prone and innovation averse societies. Economic performance in Europe, *Growth and Change* **30**, 75-105.

Rodríguez-Pose A. and Crescenzi R. (2008) R&D, spillovers, innovation systems and the genesis of regional growth in Europe" *Regional Studies*, 42(1), 51-67

Rodríguez-Pose, A. and Storper, M.l (2006) Better rules or stronger communities? On the social foundations of institutional change and its economic effects. *Economic geography*, 82 (1). 1-25.

Romer P.M. (1990) Endogenous Technological Change, *Journal of Political Economy*, **98**(5), 97-103.

Saxenian, A.-L. (2006). *The New Argonauts: Regional Advantage in a Global Economy*. Cambridge, MA: Harvard University Press.

Saxenian, A.-L., & Sabel, C. (2008). Venture Capital in the 'Periphery': The New Argonauts, Global Search and Local Institution-Building. [Roepke Lecture in Economic Geography]. *Economic Geography, 84*(4), 379-394.

Schaaper, M. (2009) "Measuring China's Innovation System National Specificities And International Comparisons" *OECD STI WORKING PAPER*, 1.

Scott A. and Storper M. (2003) Regions, globalization, development *Regional Studies* 37, 579-593.

Scott, A., and Garofoli, G. (Eds.). (2007). *Development on the Ground: Clusters, Networks and Regions in Emerging Economies*. Oxford: Routledge.

Sonn J.W. and Storper M. (2008) The increasing importance of geographical proximity in technological innovation: an analysis of U.S. patent citations, 1975-1997. *Environment and Planning A*, **40** (5), 1020-1039 .

Storper M. and Venables A.J. (2004) Buzz: face-to-face contact and the urban economy, *Journal of Economic Geography* **4**, 351-370.

Sun, Y. (2003). Geographic patterns of industrial innovation in China during the 1990s. *Tijdschrift voor Economische En Sociale Geografie, 94*(3), 376-389.

Taeube, F. (2004). Proximities and Innovation Evidence from the Indian IT Industry in Bangalore. *Danish Research Unit for Industrial Economics, Working paper, Nr. 04-10.*

Tsipouri L. (2004) Innovation for European Cometitiveness and cohesion: opportunities and difficulties for co-evolution, *Science and Public Policy* 31(6), 465-474

Utz, A., and C. Dahlman. 2005. *India and the Knowledge Economy: Leveraging Strengths and Opportunities.*Washington, DC: World Bank.

Varga A. (2000) Local academic knowledge spillovers and the concentration of economic activity, *Journal of Regional Science* **40**, 289–309.

Von Zedtwitz, M. (2004). Managing foreign R&D laboratories in China, *R&D Management* **34**(4): 439-452

Yeung, H. (2009). Regional Development and the Competitive Dynamics of Global Production Networks: An East Asian Perspective. *Regional Studies, 43*(3), 325-351.

Ying, L. (2008). The shape of ideas production function in transition and developing economies: Evidence from China. *International Regional Science Review* **31**(2): 185-206.

Xu, Z. (2009). Productivity and Agglomeration Economies in Chinese Cities. *Comparative Economic Studies, 51*(3), 284-301.