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# **Globalisation of Knowledge Production and Regional Innovation Policy: Supporting Specialized Hubs in Developing Countries**

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**Abstract**

This paper sheds light on the role of the regional innovation system facilitating the transition from competing on low cost activities/services towards competing in innovation, using Bangalore software industry as an example. Recent research has documented that Bangalore has become one of the most important IT clusters outside the US. According to this stream of literature a combination of easy access to qualified and relatively cheap technical human capital has attracted a number of transnational corporations (TNCs) during the nineties (eg. IBM, Motorola, Hewlett-Packard, Siemens, 3M, Texas). The TNCs have stimulated a tremendous development of the IT software industry either through outsourcing of routine activities or through establishing offshore subsidiaries. This literature however has not yet paid much attention to the evolutionary aspects of the system of innovation, that is, how the system of innovation emerges and evolves encompassing the changes in the strategies of the indigenous firms. This chapter attempts to contribute to reducing these omissions by paying specific attention to the evolutionary aspects of the system of innovation, analyzing the emergence and evolution of the regional system of innovation of the software industry in Bangalore, India.

The case clearly illustrates that the move from cost competition to innovation base competition of the Bangalore firms is seriously compromised by the existing weaknesses in systemic aspects of the regional system of innovation. The interactions with Universities are weak and so are the interactions among the indigenous firms. Furthermore, the connections with the final users and lead users are also quite limited. The paper concludes suggesting some policy measures that take the specific systemic propensities of the Bangalore cluster into account.

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# Globalisation of Knowledge Production and Regional Innovation Policy: Supporting Specialized Hubs in Developing Countries

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# **Globalisation of Knowledge Production and Regional Innovation Policy: Supporting Specialized Hubs in Developing Countries**

## **1. Introduction**

In recent years there has been a blossoming interest in the rapid growth of certain regions in developing countries, particularly in China and India. These regions have become specialized hubs in global value chains providing, in some cases, knowledge-intensive goods and services whilst they appear to be rapidly moving up the global value chain. Most of the literature has focused on the strategy of particular firms, the vertical and horizontal links in the clusters or the determinants of the successful growth of these regions in terms of human capital endowment or export-led growth model. Yet not much attention has been paid to the role of the regional innovation system and the regional policy supporting this rapid growth. And even less attention has been paid to the link between regional innovation systems and global value chains.

This paper is concerned with analysing the changing role of regional innovation systems and regional policies in supporting the transition of indigenous firms in developing countries from competing on low costs towards becoming knowledge providers in global value chains. Special attention is paid to policies supporting the emergence and development of the regional innovation system in this transition process. Among policy-makers and academics consensus has long suggested that innovation is a crucial factor in generating economic growth and development (Lundvall, 1992; von Hippel, 1988; Kaplinsky, 2006; Schmitz, 2006). Innovation systems research has acknowledged this and has placed innovation at the heart of discussion on upgrading and growth in developing countries (Giuliani and Bell, 2005; Lee and Tunzelmann, 2004; Lundvall et al, 2006; Lundvall et al.; 2005). Most work on innovation systems suggests that the region is a key level at which innovative capacity is shaped and economic processes coordinated and governed (Carlsson, 2004; Chaminade and Vang, 2006; Gu and Lundvall, 2006; Schmitz, 2006; Vang and Asheim, 2006) and, as a consequence, research focused initially on the endogenous-led growth of the region, where the regions were conceptualised as self-organizing and self-containing systems. The consequence on the policy sphere was a strong focus on constructing or building self-containing regional innovation systems. While this model was initially useful to explain the growth of certain regions in the developed world (Third Italy, Silicon Valley, Hollywood and Baden-

Württemberg), developing countries experiences with self-contained systems have seldom resulted in the desired outcomes, requiring strategies combining internal and external sources of capital, technology and knowledge (Loebis and Schmitz, 2005; Pietrobelli and Rabellotti, forthcoming; Schmitz 2006). Instead regions are to be understood as open nodes in global value chains, which are constituted through dynamic relations and interactions with local and trans-local organizations and firms (Amin, 2004).

Thus regional innovation systems in developing countries have very recently started to be conceptualised as specialized hubs in global innovation and production networks – henceforth, global value chains - (Asheim et al, forthcoming; Chaminade and Vang, 2006a; Maggi forthcoming). A specialized hub refers to a node in a global value chain that mainly undertakes one or few of the activities required for the production and development of a given good or service or serves a particular segment of the global market. In global value chains, firms in developing countries have traditionally been responsible for the lowest added value activities<sup>1</sup>. This does not pose great demands on the need of a well-functioning regional innovation system as competition is primarily based on exploring low cost factor endowments. However, a few emerging regional innovation systems in developing countries are beginning to challenge this scenario by rapidly moving up the global value chain (traditional upgrading) and/or using the competences built in the initial phases of development for shifting into related industries (functional upgrading)<sup>2</sup>. There is, however, still only a poorly developed understanding of the *systemic propensities of the transition process* (Lundvall et al, 2006), that is, how the system of innovation emerges and evolves to support this transition process and what the role of regional innovation policy is in building the regional conditions that support the indigenous small and medium size enterprises (SMEs) in this transition process.

This paper aims at reducing this omission by linking the upgrading strategy of the indigenous SMEs to the emergence and evolution of the regional innovation system. Particularly, we will analyse how the move towards becoming knowledge providers requires the support of a well-functioning regional innovation system, how the system of innovation emerges and evolves with the changing

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<sup>1</sup> In IT, for example, testing of software, standard programming, etc..

<sup>2</sup> India, for example has become a global hub for IT services and is gradually moving up the global value chains within pharmaceutical and biomedical research. Pakistan is starting to out-compete German manufacturers of surgical instruments, while China is rapidly accumulating competences to upgrade in global value chains in different industries ranging from textiles to automotive and to IT-hardware.

strategy of the firms and discuss the implications of this transition process for the design of regional innovation policies in developing countries. For attaining this goal the transition of Bangalore's software innovation system is analysed. Bangalore's – together with Shanghai's – regional innovation system is among the most notable successes in reaching the goal of moving up towards the higher end of the global value chain (albeit still far from having succeed in this upgrading process, as we will argue in this paper). Recent research has documented that Bangalore has become one of the most important IT clusters outside the OECD-countries - though Japan, Germany and Ireland software exports are larger than India's (Arora and Gambardella, 2004, 2005). Bangalore is also interesting as a case since it has grown basically from scratch without local (lead) users pulling the demand of technologies, almost without cooperation among indigenous firms and with weak support from the national and regional governments. But Bangalore has nevertheless managed to sustain the world's highest growth rates within the industry (Arora and Gambardella, 2004) for a decade. The combination of local high quality education institutions and the large presence of multinationals with strong linkages with the indigenous firms – including SMEs - has supported the accumulation of competences in the indigenous firms, thus setting the grounds for the emergence of an (immature) regional innovation system. While the industrial organization of Bangalore has been dealt with in several papers, there is not yet any analysis on how the regional innovation system has evolved (and needs to evolve) to support the (further) upgrading process of the indigenous SMEs, what the caveats are for such transition and how the government can stimulate the development of such a system.

The structure of the reminder of the paper is as follows. First, we introduce the theoretical framework – regional innovation systems. Special attention is paid to the systemic propensities of the RIS, that is, the critical interactive learning that takes place at regional level and how this can be adapted to the context of developing countries. The importance of these dimensions of RIS is examined for the emergent Bangalore's innovation system. This is followed by a section tearing out some case-contingent policy lessons on constructing RIS as specialized hubs in developing countries in the context of globally distributed industries. The paper is rounded of with concluding remarks.

## **2. RIS, interactive learning and upgrading in global value chains**

The purpose of this section is to introduce the concept of regional system of innovation and the particularities of RIS in developing countries, paying special attention to its evolutionary aspects, that is, how the system of innovation emerges and evolves over time to a well-functioning RIS. The later is characterised by the intensity of the interactions between the organizations located in the RIS. The nature of those interactions is discussed in detail, particularly the user-producer interaction (TNC-SME) and the linkages between SMEs and the knowledge providers.

### **2.1. Regional innovation systems**

The main argument of the paper suggests that upgrading to higher value activities in global value chains is possible when there is an environment that supports interactive learning and innovation. Firms' isolated efforts to make this transition tend to fail in the longer term. Activities in the higher end of the value chain involve a high degree of innovation and interaction with the customer, other firms and organisations. In the case of SMEs, the literature argues that the interaction best takes place with other firms and organisations co-located in the same regional area (Lundvall and Borras, 1999). The importance of the local interactions for SMEs holds for developed (Asheim et al., 2003; Cooke and Morgan, 1998; Cooke and Will, 1999; Schmitz, 1992) as well as developing countries (Albu, 1997; Giuliani, 2004; Giuliani and Bell, 2005; Pietrobelli and Rabellotti, forthcoming; UNIDO, 1997 and 2004). Moreover, this literature explicitly finds that SMEs external relations are more confined to the region than those of large firms (Asheim et al., 2003; Cooke and Morgan, 1998). One of the reasons for this is that SMEs are more dependent on complex, tacit knowledge and less capable of searching for and using codified knowledge. This forces them to rely more on personal ways of transferring (tacit) knowledge and on learning-by-doing and interacting as opposed to relying on globalized (and more codified) modes for knowledge acquisition.

For this reason, the paper departs from the so-called regional innovation systems (RIS) approach. Regional innovation systems can be seen as a “constellation of industrial clusters surrounded by innovation supporting organizations” (Asheim and Coenen, 2005). Thereby, the regional innovation system is boiled down to two main types of actors and the interactions between them. The first type of actors concerns the companies in a region's main industrial clusters, including their customers

and suppliers. In this sense, industrial clusters represent the production component of the regional innovation system. In the RIS approach, industrial clusters are defined as the geographic concentration of firms in the same or related industries (Porter, 1998; Pietrobelli and Rabellotti, 2004; for a critique, see Martin and Sunley, 2003). The second type of actors, backing up the innovative performance of the first type of actors, include research and higher education institutes (universities, technical colleges, and R&D institutes), technology transfer agencies, vocational training organizations, business associations, finance institutions, etc (Asheim and Coenen, 2005). The knowledge creating and diffusing organizations provide the resources and services (knowledge, capital, etc.) to support innovation among the local firms.<sup>3</sup>

In well-functioning RIS, proximity facilitates the circulation of knowledge and information needed for innovation. Contrary to more traditional approaches to innovation and upgrading (that focus on the acquisition of technology), a RIS approach stresses that supporting SMEs in their innovation-oriented upgrading process is a matter of not only facilitating the access to technology, but of supporting interactive learning<sup>4</sup>. Innovation is the result of an interactive learning process stretching across firm borders (Lundvall, 1992). Interactive learning is defined as the acquisition of knowledge and competences through interactive collaboration with firms and knowledge providers. Interactive learning is considered a function of the *soft infrastructure* (increase qualification of the human resources, organizational capital and inclusive social capital) (Chaminade and Vang 2006a and 2006b, Lundvall et al 2006). In contrast to other approaches stressing these variables, the RIS approach puts the emphasis on the *systemic dimension* of the innovation process; being the dynamic interaction between the different nodes in the system and the impact of the system's weak nodes on the dynamic efficiency of the system as a whole.

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<sup>3</sup> The inclusion of the second type of actors represents a main difference from traditional cluster studies in developing countries. Universities and other knowledge providers are considered crucial in correcting or changing systemic failures in clusters which might prevent them from upgrading or engaging in radical innovations (Asheim, forthcoming). Traditional industrial districts and clusters research is more concerned with the propensities in local systems that support incremental innovations, thus 'Schumpeterian' systems failures are not theorized.

<sup>4</sup> This is different from Porter's cluster theory that mainly focuses on rivalry as the engine for competitiveness and growth in the cluster. It also runs against Malmberg and Maskell (2006) whose cluster theory mainly focuses on observability



## **2.2. The systemic aspects of RIS. Critical interactive learning paths and building blocks**

Well-functioning RIS are characterised by the intensity of the interactions between the different building blocks of the system. The extent to which SMEs can learn through the interaction with the local environment is a function of their absorptive capacity (Cohen and Levinthal, 1990) i.e. the ability to utilise the information and knowledge that comes from the interaction with users, other firms and/or with knowledge providers (i.e. research institutions). Central to building absorptive capacity is the accumulation of human capital and other forms of knowledge. Firms need to have the necessary human capital to identify, acquire and transform the internal and external knowledge required for developing innovations<sup>5</sup>, especially innovations of a more radical character.

Interactive learning is considered to be dependent on social capital (Fukuyama 1995, Bourdieu 1983, Coleman 1988). “Social capital refers to the institutions, relationships, and norms that shape the quality and quantity of a society's social interactions. Social capital is not just the sum of the institutions which underpin a society – it is the glue that holds them together” (World Bank 1998). Social capital refers both to “structural social capital” and “cognitive social capital” (World Bank 2002). Structural social capital refers to “relatively objective and externally observable social structures, such as networks, associations, and institutions, and the rules and procedures they embody. Cognitive social capital comprises “more subjective and intangible elements such as generally accepted attitudes and norms of behaviour, shared values, reciprocity, and trust<sup>6</sup>. Unless there is a high degree of generalized social capital (i.e. non-discriminating social capital) and a high degree of absorptive capacity cooperation, communication and thus interactive learning is usually limited (Nooteboom, 2000). In the absence of trust, the fear of opportunistic behavior will prevent the exchange of valuable knowledge and mutual learning (Fukuyama 1995, Putnam 1993, 1997, 2000, Maskell, 2000, Lundvall 2002). Hence unless there is a high degree of generalized social capital-based interactive learning is likely to be limited or at least confined to the ‘in-groups’ which greatly reduces the localized knowledge spillovers (Putnam 1993, Vang and Asheim, 2006).

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<sup>5</sup> Moreover, as Kaufmann and Tödtling (2002) point out, SMEs need to use the human resources more intensively than large firms in their innovation process. However, in general terms SMEs face difficulties to attract and retain qualified human resources, especially when they are competing with TNCs as in developing countries.

<sup>6</sup> Although these two forms of social capital are mutually reinforcing, one can exist without the other. Government-mandated organizations represent structural social capital in which the cognitive element is not necessarily present.

Interactive learning benefits from physical proximity (Gertler 1995; Morgan 2004) as physical proximity is considered pivotal in the emergence of the cognitive social capital (for a critique, see Amin and Cohendet 2005). Physical proximity implies that the firms are embedded in the same institutional setting and thus share certain norms, conventions and mindsets. Hence, a shared institutional setting facilitates the transmission of complex tacit knowledge needed for innovation.

Interactive learning and thus innovation will most probably take place when both human capital and social capital are in place as the comparison of a number of cases has shown (Chaminade and Vang, 2006). Furthermore, physical proximity might in some cases support the emergence of social capital thus setting the grounds for interactive learning. Interactive learning can take place in the interaction with the users, with other firms in the industrial clusters or with the knowledge providers of the regional innovation system.

Innovation systems research has long emphasized the importance of **user-producer interaction** for upgrading and innovation (Castellacci, 2006; Fagerberg, 2004; Lundvall, 1988; Jeppesen and Molin, 2003; Luthje et al, 2005). The emphasis of the user-producer interaction stems from the fact that innovations often occur in response to specific problems that emerge from the interaction between the user and the producer. Recently, focus has shifted towards lead users (Franke and von Hippel 2003; Franke and Shan 2003; Franke et al 2005). Lead users defined as users that perceived needs well ahead the mass market and that, often, have developed their own innovative adaptive solutions (Jeppesen and Frederiksen 2006).<sup>7</sup> Interaction with users might provide incremental innovations while interaction with lead users might be more important for more radical innovations and thus more valuable for the innovative firm. The user-producer model relies on the assumption that the user and the producer have 'equal' incentives for sharing the knowledge required for successful collaboration and that the both have sufficient in-house human capital to absorb and use the exchanged information and knowledge or at least that the interaction constitutes a win-win situation<sup>8</sup>.

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<sup>7</sup> It is beyond the scope of this paper to engage in a detailed discussion of limits to the lead-user approach but it should be stressed that lead users might suggest investments in R&D projects aimed at goals not shared by the majority of consumers; not even in the future.

<sup>8</sup> Additionally, the research on user-producer interaction tends to ignore that the importance and morphology of user-producer interaction is contingent on the specificities and particularities of the indigenous firms' position in the global value chain. Production of 'low end' goods and services mainly requires a limited interaction with the users but can nevertheless serve as a competence-building phase. Production of 'higher' end goods and services require a high degree of user-producer interaction. The move from production of low end goods and services to high end services are thus

Users are not the only source of knowledge and technology for firms, although empirical research asserts that it is the most common source (Fagerberg, 2005). Interactions at local level with other firms or knowledge providers also constitute other important sources of innovation and can facilitate the acquisition of knowledge and competences needed for upgrading in global value chains. The vast literature on clusters has long acknowledged the advantages of engaging **in interactive learning with other firms** located in the cluster (Malmberg and Maskell, 2004; Maskell, 2004; Marshall, 1920; Piore and Sabel, 1984). As opposed to the externalities that might emerge by the simple co-location of firms in related activities in one region (Marshall, 1920), the deliberate cooperation between actors leads to increasing innovation (Nadvi and Schmitz, 1999; Schmitz, 1995).<sup>9</sup> In the case of SMEs, collaboration might be facilitated by bridging institutions such as entrepreneurial associations or even specialized research institutes (Chaminade, 2004).

Interactive learning might also take place when firms collaborate **with the knowledge creating and diffusing organizations** of the regional innovation system such as universities and research centres and other institutions like business services, entrepreneurial associations, etc particularly for certain industries. Universities are often described as engines of growth, particularly at regional level. Yet despite the large amount of research on university-industry interactions (Mansfield 1991, 1998; Meyer-Krahmer and Schmoch, 1998; Salter and Martin, 2001) the direct effects of the universities and research centres on the innovative performance of firms has proved difficult to trace (Fagerberg 2005; Laursen and Salter, 2004). Universities play a double role as the providers of qualified human resources<sup>10</sup> (needed to build absorptive capacity) and as the providers of R&D. As R&D providers, universities and research centres are believed to be especially relevant for certain sectors (Pavitt, 1984), such as the pharmaceutical industry (Mansfield, 1995) or biotechnology (Asheim and Coenen 2005) while it appears to be almost irrelevant for some others such as furniture (Klevorick et al. cf Laursen and Salter, 2004). As in any form of interactive learning the absence of absorptive capacity among the firms, organizations or limited generalized social capital might seriously hamper the collaboration between the different institutions.

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constrained by the lack of localised lead users in developing countries; especially for indigenous SMEs. Indigenous TNCs can compensate for this by establishing subsidiaries in close proximity to their lead users (Infosys, for example, has 14 subsidiaries in different countries).

<sup>9</sup> The literature also emphasizes Marshall's 'atmosphere' or Buzz (Storper and Venables 2005) but as illustrated by Asheim et al (forthcoming) this is less important than initially claimed.

<sup>10</sup> In the cluster vocabulary this is referred to as specialized labour markets (Marshall 1920, Storper 1997).

### **2.3. Understanding RIS in developing countries: Adopting an evolutionary perspective**

Well-functioning RIS based on intense interactive learning are typically found in developed countries but seldom in the developing world. RIS in developing countries are characterized a low degree of institutional thickness thus weak interactive learning (Amin and Thrift, 1995; D'Costa, 2006).

As opposed to dynamic clusters in the developed world that 'are characterized both by dense local social interaction and knowledge circulation, as well as strong inter-regional and international connections to outside knowledge sources and partners' (Gertler and Levitte, 2005:487), clusters in developing countries are often simply local agglomerations of firms within the same industry without localised interactive learning (UNIDO 2001) or 'casual' agglomerations with occasional horizontal linkages, limited cooperation and weak local institutions (Guerrieri and Pietrobelli, 2006) which, in turn, implies weak interactive learning. Additionally, the lack of local knowledge resources in RIS in developing countries forces the indigenous firms to rely much more on TNCs as providers of knowledge and capital (Pietrobelli and Rabellotti, forthcoming; Schmitz 2006; Vang and Asheim, 2006). Thus for the indigenous SMEs, the users tend to be TNCs and the relationship between users and producers are normally highly asymmetrical in terms of power, knowledge and incentives to collaborate. SMEs in developing countries are often specialized in activities at the bottom of the global value chain which implies in most of the cases hierarchical or quasi-hierarchical relationships with the TNCs (Schmitz, 2006). Typically the TNCs are reluctant to engage in interactive learning with the indigenous firms due to their low absorptive capacity, the lack of differentiation between firms and the goods that they supply and the fear of losing knowledge (D'Costa, 2006), as the vast literature on direct and indirect spillovers from TNC's to indigenous firms has demonstrated (Dunning, 1993; Dunning and Narula 2004; Lall and Narula 2004; Narula and Marin 2005,)<sup>11</sup>.

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<sup>11</sup> Nevertheless Schmitz's (2006) recent survey illustrates that the interaction between TNCs and indigenous firms can lead to upgrading for the indigenous firms. Schmitz points to that upgrading and innovation especially happens in relation to product and process improvements but only seldom for functional upgrading.

Good educational and research institutions are scarce, their administrative capacity limited, their competences usually meagre and their governance is often problematic. The consequence is that the quality of the knowledge providers might be far below from what SMEs need to move from being low end to high-end provider of goods and services in the global value chains.

Taking all the above into account, if we consider that a RIS exists only when all the systemic aspects of the RIS are in place, it will be impossible to trace and identify any RIS in developing countries. Rather, RIS in developing countries are better conceptualized in an evolutionary perspective. RIS in developing countries should be understood as emerging RIS where some of the building blocks of the RIS are in place but where the interactions among the elements of the RIS are still in formation and thus appear fragmented as Figure 1 shows<sup>12</sup>.

- Insert Figure 1 around here -

In the emergent RIS we might expect that market transactions dominate the interactions between the building blocks of the system (firms, universities and other knowledge providers and users), the weak intersectoral links, absence of interface units and universities specialized mainly in the supply of manpower (Galli and Teubal, 1997) which is broadly speaking paradigmatic of RIS in developing countries. In emergent RISs firms and other building blocks of the system are accumulating the competences that are needed to engage in different forms of interactive learning. Emergent RIS might gradually evolve to mature RIS. In mature RIS interactions between the building blocks of the RIS take place through market and non-market mechanisms such as informational links, interactions and other forms of formal and informal networks. Firms and other organizations in the system have developed their absorptive capacity and are engaged in continuous interactive learning with other firms, users, universities and other organizations in the system. It follows that the university-industry linkages are strong and involve various forms of knowledge transfer (Galli and Teubal, 1997).

In this paper we refer to regional innovation systems in the first phase as *emerging RISs* and to systems in the second phase as *mature RISs*. We focus on the co-evolution between the upgrading strategy of the firms and the evolution of the RIS. Considering that innovation is based on

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<sup>12</sup> We are aware of the limitations of these graphical representations of an innovation system. In this sense, the figure should be considered only as an illustration of the differences between the different phases of a RIS.

interactive learning and that this takes place in mature RISs, the firms' transition from pure cost-based competition to competing on the basis of knowledge provision needs to co-evolve with the move from an emerging RIS to a mature RIS. To understand how this transformation takes place we will analyse the emerging RIS in Bangalore, India. Special attention is paid to the different types of interactive learning, their emergence over time and the derived policy requirements. Particularly the impact of the export-led growth model on the strength of local linkages which is a dimension not normally considered in the RIS-literature in developing countries is investigated. This is central for understanding the possibilities for upgrading in RIS aiming at becoming specialised hubs in global value chains.

### **3. Evolution of Bangalore as a specialized hub in the provision of software services**

Bangalore has emerged as one of the largest and fastest growing software clusters outside the US (Nadvi, 1995; Parthasarathy, 2004a). Bangalore is not only a hub for software-related industries but also houses several high-tech clusters (e.g. defence, aeronautics) and is considered to be the scientific and engineering centre of India in terms of research and training and partly manufacturing. Despite the weight of the TNC in the Bangalore IT sector, the large majority of firms are SMEs (NASSCOM, 2005).

Bangalore has attracted the attention of scholars around the world for its impressive software growth export rates, superior to those of competing IT hubs such as Israel, Brazil or China (Arora and Gambardella, 2004, Athreye, 2005). The value of export, for example, typically grows more than 30% annually while revenues grow at 30-40% ([www.bangaloreit.in](http://www.bangaloreit.in)). The growth of the software industry in India is based on exports to global markets, mainly to the US. This export-led development trajectory or model has important implications for the industrial structure of the RIS and the possibilities for upgrading of the indigenous firms, as we will discuss later. India has an estimated share of 65 percent within the global IT services off-shoring segment and around 46 percent of the global BPO market (NASSCOM-McKinsey Study, 2005).

However the majority of the exports are from software services in the low-end of the value chain. The value added of those activities is low and the contact with the end-user is not necessary (Chaminade and Vang, 2006). Figure 2 plots the software development value chain. The routine

activities basically draw on codified programming skills while the sophisticated tasks draw on a combination of codified programming competencies, and firm specific – tacit and quasi-codified - competencies developed through creating customized programs (in the best cases through interaction with users) (Parthasarathi, 2004a).

- insert figure 2 around here –

Until recently Indian firms have been competing in the global value chain on the basis of the low cost of qualified human resources (e.g. mainly cheap engineers), the timezone difference with the US (which allows the provision of round the clock tasks) and their English skills (Arora et al., 1999; 2001; Parthasarathy 2004; Saxenian, 2001). However, this growth model is now in danger because of raising salaries in India and the emergence of competing countries such as China. The alternative for the indigenous firms seems to be to move to activities with higher added value and start competing on the basis of innovation (D'Costa, 2006), as the pioneer example of the embedded software has shown (Parthasarathy and Aoyama, forthcoming). The question is how the system of innovation emerges and evolves to support this transition process and what the role of the regional government is in facilitating this transition. The development of Bangalore innovation system will illustrate this transition process

### **3.1. The emergence of the RIS**

As many authors have acknowledged (Arora and Gambardella, 2004, Athreye, 2005) the early development of Bangalore as a specialized hub in the software industry was due to the location in the region of some of the best educational institutions in the region such as the world renown Indian Institute of Information Technology, the Indian Institute of Science, Raman Research Institute, National Institute of Mental Health and Neuro-Sciences, Central Food Technological Research Institute, Indian Space Research Organisation, National Aeronautical Laboratory, etc. The high concentration of knowledge providers in the region resulted in critical mass of highly qualified yet cheap labour force which could explain the initial interest of the US firms in locating their outsource activities in the region.

The type of interaction between the indigenous firms and the TNCs has changed significantly over time. In the initial phase many SMEs specialized in the provision of low-end services, often based on body-shopping<sup>13</sup> - that is sending software programmers to the (US) clients to provide maintenance services (Arora et al, 1999, 2001). Despite the critics that this strategy has received over time (see Parthasarathy 2004), it seems clear that it helped to reduce the institutional distance between the firms in the two countries. The indigenous firms became more familiar with the work organization and requirements of the US firms (delivery times, quality, reliability) while the US firms started to gradually outsource tasks to be performed entirely in Bangalore. Cooperation was facilitated by the role of the Indian transnational community in the US (Saxenian, 2001), particularly those that held important positions in US firms (Vang and Oberby, 2006)<sup>14</sup>.

As the Bangalore software RIS matured both Bangalore and US firms improved their competences in managing outsourcing and off-shoring, build up inter-cultural competencies and created their own local networks. Employee attrition and wage increases forced the firms to introduce advanced management techniques (Arora et al, 1999; Athreye, 2003). This, together with a tendency to codify procedures and improve the transfer of knowledge has increased the organizational capital of some firms (hence their absorptive capacity) (Saxenian, 2001). The broader knowledge base combined with the existence and gradually building of reputation as reliable suppliers in the US market plus an aggressive certifying strategy among most Indian firms have permitted some firms to move up the global value chain (to the provision of R&D services for multinational firms) and, even in some cases, develop their own innovation strategy and enter new niche markets with their own final product as Figure 3 shows<sup>15</sup> (Parthasarathy and Aoyama, forthcoming).

- insert figure 3 around here -

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<sup>13</sup> Bodyshopping was explicitly recognised in the Computer Policy of 1984 (Saxenian, 2001).

<sup>14</sup> Clearly the Indian community played a significant role in the establishment of subsidiaries in Bangalore of Motorola and Texas Instruments (Vang and Overby, 2006).

<sup>15</sup> It should be noted that what will be described next should be interpreted as an emerging trend rather than a consolidated tendency or general move in the cluster. It is however important to discuss the implications of such an emerging trend in the very early stages as policy makers could play a very significant role supporting this transition to higher added value activities through innovation and interactive learning embedded in an effective regional system of innovation. For doing so, we will take as an example the provision of R&D services in embedded software (Parthasarathy and Aoyama, forthcoming). Embedded software is a particular branch of the industry which combines hardware and software. It is design to perform tasks without human intervention. Upgrading in this segment of the software industry is possible because the firms have acquired new capabilities, comply with international standards and have gain a reputation internationally while intensifying their local networks.



### 3.2. The transition to knowledge providers. Caveats for the development of the RIS

Higher-added value activities involve the design and prototyping of new products or systems, which are considered as R&D software services (Barr and Tessler, 1996) (see Figure 2, activities 1 & 2). According to the National Association of Software and Service Companies (NASSCOM), the main industry association, R&D service exports accounted for US\$1.21 billion, or 15.8% of India's software exports, in 2001-02. The figures grew to US\$1.66 billion and 17.4% respectively in 2002-03, and is estimated to grow to US\$9.2 billion by 2010" (NASSCOM, 2005)

Off-shoring or outsourcing R&D-projects to India/Bangalore involve larger challenges than outsourcing/off-shoring standardized and routine activities as in the past. The former activities are sequential, can be decomposed and codified. This is less the case for the R&D activities as markets for information, knowledge and technology (Arora et al, 2002) are riddled with imperfections derived from the culturally-specific, embedded, complex tacit and firms specific knowledge associated with R&D activities. The outcome of an R&D service is often a final product, almost ready to be commercialized (Barr and Tessler, 1996). However, **IP rights for software** are virtually non-existing in India apart for embedded software, which makes it highly risky to outsource or off-shore innovative and/or R&D activities.

As acknowledged by the extensive literature of innovation systems, innovation activities require a well-functioning RIS – mature RIS - based on interactive learning with users, other firms and knowledge providers. The question here is whether the emerging Bangalore RIS is evolving to a mature RIS that can provide the kind of support needed by the firms upgrading in the global value chain.

A closer look at the interaction between SMEs and TNCs documents that only a small group of firms has benefited from the interaction with the TNCs. As acknowledged by D'Costa "the top 20 Indian software exporters still account for about 60 % of total exports, leaving more than 800 firms with the remaining 40% of the software market" (2006). Competition between those 800 firms is fierce which translates into almost **no cooperation among the indigenous SMEs** (no generalized social capital and thus no interactive learning). Most of the SMEs located in Bangalore provide

standardized services, therefore, the incentives for the TNC to create long-term arrangements with the indigenous SMEs maintain to be low. Their absorptive capacity also remains low. Only the small group of firms that has been able to build an absorptive capacity and create distinctive capabilities are benefiting from the interaction with TNCs. The growth model that the indigenous firms have adopted (i.e. export- and TNC-driven) has created a fragmented industry with very weak local linkages (D'Costa, 2006).

Apart from formal competencies developed by several Indian firms the high end activities in the global value chain require **interactive learning with the end-users** (and often lead users); firms need to interact closely with the end-user and this requires developed technical capabilities and a deep knowledge on the business processes of the client (Arora et al., 1999). But those clients are mostly located in the OECD-countries and therefore are not easy to reach by the Bangalore companies unless it is in collaboration with TNCs or with members of the trans-national community located in those OECD countries<sup>16</sup>. Local markets are also not well developed and the tax system clearly disincentives firms to target the local market in favour of the export market.

Undoubtedly, the co-location of a great number of educational and research institutions and high-tech clusters sets the grounds for the emergence of the RIS. However, if one eliminates the handful of world-class technical institutions, the picture is one of shortages of high quality staff (Arora and Gambardella, 2006; NASSCOM-McKinsey 2005), and under-investment in research facilities. With few exceptions universities are almost exclusively devoted to the provision of (qualified) manpower to the local firms. Research is often more basic research and, as a consequence, universities are not playing a significant role in supporting innovation and generating research results for the local firms. This explains why TNCs have increasingly started to build their own training centres in Bangalore as the recent examples of Infosys show. **Interactive learning with universities** is thus weak (D'Costa, 2006) although there have been some valuable results from the collaboration between universities and industry. D'Costa, for example, mentions that the collaboration between the Indian firm Encore and the Indian Institute of Science has led to a low cost computer named Simputer.

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<sup>16</sup> It should be mentioned here that most of the production of the software sector in India goes to external markets (According to Arora et al., 1999), exports account for 65% of the software revenue) and this numbers are growing.

The analysis of the emerging Bangalore RIS shows that none of the *systemic aspects* of the RIS is strong in the system yet. Interactive learning with other firms, with the final user or with the universities is far from sufficient developed. In this sense, there is a great opportunity for policy makers to put in place the conditions necessary for building Bangalore's future in collaboration with private firms.

#### **4. Supporting the emergence and the transition of the RIS: the growing role of regional innovation policies**

Many authors have argued that the move up the global value chain of some Bangalore firms is the result of a deliberate strategy of the TNCs to locate in Bangalore and of the indigenous firms to build up their absorptive capacity and to a lesser extent as a consequence of any policy intervention (Parthasarathy, 2004b; Van Dijk, 2003). While this might be true for regional policies, it might be debatable for national policies particularly if one considers the initial role played by the central government in the location of high quality education and research institutions in Bangalore. The extensive, export-based model characteristic of the Bangalore software firms was also only possible after the central government dismantled the rather counter-productive ISI-strategy<sup>17</sup>. But with the exception of these two major policies and the provision of research institutes in the area (Parthasarathy and Aoyama, forthcoming), the role of the government in building the industrial and innovation capacity of the region has been very limited (Parthasarathy, 2004b; Van Dijk, 2003).

However, the move from an *emerging RIS* to a *mature RIS* that can support the transition of some firms from competing on low costs to competing on the provision of knowledge might require a much active role of the regional government as the Bangalorian case is paradigmatic of systemic failures of problems (Chaminade and Edquist, 2006; Edquist and Chaminade, 2006) that call for policy intervention<sup>18</sup>. Systemic problems include, among others, the lack of capabilities of the firms, the lack of institutional framework or the existence of network problems derived from too weak or too strong linkages with other organizations in the system. This corresponds to the situation in the emerging Bangalore RIS, particular with regard to the SMEs.

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<sup>17</sup> Though it should be remembered that TATA and other indigenous firms were established during the ISI-phase.

<sup>18</sup> Chaminade and Edquist (2006) refer to problems instead of failures to indicate that there is no notion of optimality in systems of innovation, therefore one should not talk about systemic failures but systemic problems.

The regional government could pursue different initiatives to stimulate the development of systemic propensities in Bangalore's RIS, focusing specifically on the weak links in the system<sup>19</sup>. A natural starting point would be policies aiming at *stimulating vertical collaborations among indigenous SMEs*. This could be done by giving financial support (e.g. via R&D subsidies) only to consortia of SMEs or of SMEs and research institutions or by supporting the creation of organizations that bring together local producers, researchers, service providers and even the government with the objective of solving collectively a problem that is affecting the system. Additionally, the last couple of months have witnessed the emergence of a number of hybrid organizations that bring together research and educational institutions, government and local firms to discuss how to drive the regional growth through improving the *systemicness* of the RIS (D'Costa, 2006; NASSCOM-McKinsey 2005). NASSCOM is also quite active in promoting the development of local entrepreneurial networks (Parthasarathy and Aoyama, forthcoming) and could play a coordinating role.

The regional government might play a role stimulating the *collaboration between knowledge providers (i.e. universities) and SMEs*. This would require additional - and earmarked - resources for these activities, additional financial resources to knowledge providers and also a change of mindset among researchers who tend to favour collaboration with the large firms. It is important to increase the research capacity of the existing universities and research centres, leveraging the average quality of the centres and the number of researchers in the universities though focus should be on applied research. This is major hurdle as the incentives for the researchers to leave the university and create their own company (or be employed by a company) are high due to the higher salaries offered by the industry (Arora and Gambardella, 2006).

The strong dependency on TNCs of the indigenous SMEs and the limited *access to the final customer* (i.e. (lead) users), the experiences in Ireland, Israel and China (Breznitz, 2005; Sands, 2005; Tschang and Xue, 2005) suggest that the government could play an important role by using public procurement as an instrument to stimulate experimentation and innovation in the local firms (i.e. the government as a lead customer) (Arora and Gambardella, 2004, 2005). This has been done in India to a very limited scale (Kumar and Joseph, 2006). Public procurement might be very

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<sup>19</sup> What follows should not be considered as an exhaustive list of all possible instruments that the regional government might use to support the systemic propensities of the Bangalore RIS. Rather our intention is to illustrate with some examples that the regional government has an increasing role to play in the development of the RIS.

important to create local markets and give the right incentives to the indigenous SMEs to use their competences for innovation<sup>20</sup>. However, public procurement might also steer the local innovation towards products or services that have relatively low value in international markets. In this sense, a well-informed government is a pre-requisite for the success of public procurement. The public procurement should explicitly build on the areas of potential specialization advantages (i.e. potential competitive advantages) that are within Bangalore's reach. One crucial pillar in this specialization strategy is Bangalore's unique ability to be competitive in services that combine low cost labour intensive activities and high-end activities, especially those that require face-to-face collaboration between the high and low end activities. This is a unique position in the global value chains for software products and IT-services in general which cannot be copied by competing regions outside India, hence policies should target areas where Bangalore holds a potentially unique position in the global value chain. Additionally, there is a need for developing policy measures and evaluating tools that take into account the position of the RIS in the global value chain. Policies could focus, for example, on competency-specialization, on the match between competition, coordination and interactive learning and the structure of the value chain.

#### **4. Emergence and development of RIS in developing countries: some lessons from the Bangalore case**

The notion of systems of innovation carries the idea of interaction and mutual dependency among the different elements of the system. What the Bangalore case clearly shows is that systems in developing countries can be developed over time, in close interaction with the strategies of the indigenous firms, the government and the TNCs, as Figure 2 shows. The figure shows *one possible* development trajectory – that of Bangalore - and does not suggest that this path can be uncritically replicated by other regions nor that there is *one* only possible way for building a RIS as a specialized hubs in global value chains, as all regions display specificities and contingencies (Peng and Zhou, 2005). Nevertheless Bangalore's development does shed some light on some general issues that apply to a large number of specialized emerging RIS in developing countries.

The study documents that a RIS can emerge when the region starts accumulating competences and organisations. This includes a critical mass of indigenous firms involved in a similar activity

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<sup>20</sup> Many scholars argue that Indian SMEs have already the design capabilities

(cluster), qualified human resources and good training institutions, organizational capabilities and research facilities. They constitute the backbone of an emerging RIS. In the initial phases those building blocks are hardly connected, that is, the systemicness of the local system is still very low and rather relies on the external linkages (i.e. TNCs). Contrary to suggested by traditional cluster studies, local social capital is not needed to upgrade and start accumulating competences and the need for extra-firm interactive learning is limited. However, international social capital - links between Diaspora-members and entrepreneurs, indigenous incumbents, educational institutions and government officials in their home country is a valuable asset (see below).

The competences accumulated in the RIS and the firms located in the region during the first stages (from the interaction with the TNCs or the provision of human capital from the local educational institutions) can be used as a platform for upgrading in the global value chain. However, this is not sufficient for firms to move further up in the value chain. The upgrading strategy can take two forms (Izushi and Aoyama, forthcoming): indigenous firms – mainly SMEs - can move up to higher value added activities in the value chain or firms can diversify and enter into higher value market niches. The first of the two strategies might be problematic as the value chain is usually dominated by lead firms with a strong market and bargaining power. The second strategy might also be feasible, but requires a sound knowledge of the market and the competencies needed to move to a different market segment (diversify). In any of the two strategies, the systemic propensities of the RIS becomes critical factors as innovation requires interactive learning with other nodes in the system and a match with the strategies being applied by other agents (Lundvall, 1992).

The type of interaction is different than the one concerned with in the low-end activities as innovative and R&D activities involve a high degree of uncertainty, complex tacit knowledge and – potentially – highly valuable knowledge which is difficult to write complete contracts about, thus requires a stronger reliance on trust. Strong local social capital is pivotal in this phase (Chaminade and Vang, 2006a) as it facilitates trust relations between subjects within the firm and between different firms (Nielsen, 2003). It decreases transaction costs, increase quantity and quality of information, facilitates coordination and diminishes interactive learning problems and thus facilitates the transfer of knowledge.

Interaction with the final customer (i.e. user) is also crucial. However, with few exceptions (Brazil and China) local markets for software in developing countries are weak. Instead, indigenous firms tend to target the external markets, usually working for a TNC as the Bangalore case illustrates and in some case the access to final international customers can be facilitated by trans-national communities. Trans-national communities reduce the institutional distance between the home and the host country. It diminishes the transaction costs by providing access to external markets but there are still several aspects that cannot be bridged – such as the development of a reliable IP system.

In sum, it is necessary to think about RIS as evolutionary (open) entities, especially in developing countries where well-functioning RIS are far from being set in place. Contrary to what is argued in the cluster and RIS literature, it seems that the systemic propensity of the systems is not necessary in the first phases, where the objective is to attract foreign investment and accumulate competences. However, it becomes a crucial factor when the firms attempt to move up the value chain with activities that involve a higher degree of innovation. In this phase, the absence of networks between the different nodes in the system might seriously hamper the development of the RIS and thus the region and the indigenous firms.

## 5. Policy implications

From a policy perspective, one of the clearest conclusions is that the role of the regional and central government also changes over time (and should do so in parallel with the transformation of the strategies of the firms and the RIS), see table 1 for a summary of the main findings of the case.

In the **initial phase** of the emergence of the RIS the regional government bodies do not play an important role as the factors for attracting TNCs usually fall within the domain of the central government, apart from ensuring a well-functioning infrastructure and bureaucracy (i.e. limited corruption and red tape). The countries compete on the traditional measures associated with comparative advantages (i.e. low costs) in developing countries, thus the ability to attract the standard and routine activities, and so forth. The central state however should ensure sound macro economic policies (i.e. low inflation), non-discrimination of export and import; possible with selective measure protecting infant industries. Central state policies benefit from focusing on the

supply-side<sup>21</sup>, on reducing the transaction costs of for TNCs to outsource or off-shore<sup>22</sup> among other issues. The latter can be done mainly by reinforcing the national and regional institutions (regulations, IP and other patent laws, etc) or training the indigenous firms in the management of inter-cultural differences and possible targeting the members of the trans-national community. The Bangalore case also suggests that national and regional governments can play a significant role supporting the emergence of high quality educational and research institutions in the region.

The role of the regional government is more prominent during the **second phase** when the firms start moving up the value chain and a well-functioning (i.e. more mature) RIS is needed. Then a sound knowledge of the different actors in the system, their competences and their interaction is needed; especially for policies targeting SMEs. The regional governments ought to stimulate the construction of local networks and eventually even the local markets through public procurement. This calls for a decentralized territorial decision making structure as regional government – given the developed competencies and capacity - possess the local stock of knowledge, especially on ‘emerging’ needs. In other words, regional governments are likely to play a more conducive role in facilitating the upgrading process as they have the incentives for being dedicated to the needs of their particular region (though even a region as Bangalore has its own ‘twisted’ incentives that lead to occasional discrimination of the software industry). National government bodies might have competing development agendas (growth versus regional equality, for example) and thus not equally dedicated to one particular region needs. Additionally, if regional government bodies are directly involved in setting up and managing education and research institutions they are better able to tailor it to the specific needs of the (firms in the) region. And probably the regional government bodies will be more sensitive to the SMEs particular needs in this context. However, it is crucial that the regional government bodies collaborate with the central government bodies to support a global positioning of the RIS.

- insert table 1 over here –

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<sup>21</sup> In contexts where education is within the domain of the regions this changes the division of labour between the central state and the regions.

<sup>22</sup> We do not suggest that there is only one way to attain the growth in the initial phase, and research analysing the contrasting experiences of the home-market centered experiences of China and Brazil is called for (Arora and Gambardella, 2004).



## 6. Conclusions

While the study cannot be generalized it nevertheless provides suggests that the RIS ‘policy-template’ needs to be modified and more sensitivity to evolutionary aspects should be emphasised<sup>23</sup> and that these aspects need to be understood in a global-local context. On a general level markets based development strategies in the initial phase might prove more efficient than assumed by RIS-theorist and thus there might be less need for regional innovation policies as such (apart from more indirect policies stressing the supply side). Devolutions is also less required than assumed by the RIS-literature though the systemic propensities of the totality of the systems needs to be emphasized in the sense that RIS polices without a complementary macro-policy will not result in regional development. In addition there seems to be lees need for emphasising policies underpinning social capital formation and interactive learning in the initial phase; interactive learning starts to be relevant when the indigenous firms have built competencies at a certain level (before this there will be diminishing return to collaboration with other indigenous firms as opposed to TNCs). In other words, markets have at least in this case proven to stimulate adequately the appropriate specialization in the global value chain. However, in the second phase reliance on markets seems less convincing as the market imperfections constrains distance collaborations – additional the incentives for distance collaboration are smaller as cost differences are minor. Thus while there is a need for upgrading the human capital (maintain focus on supply side) the government public procurement policies become central for compensating for market imprecations and lack of localised lead customers and for stimulating interactive learning. The policies should emphasise and redevelop the areas within which the regions hold specialisation advantages in the global value chains. A decentralized territorial decision making structure becomes crucial in the latter phase but contrary to normally suggested by RIS-policies collaboration with central government is crucial for gathering the information needed for designing and evaluating the policy-measures to support the global positioning.

The case illustrates the dynamic nature of the regional innovation system. It highlights the need to adopt a flexible and accommodative policy that takes into account the changes in the needs of the indigenous firms, the endowments of the regional innovation system and the international networks and that places them in a dynamic global context. As Saxenian (2001) suggests, upgrading in the

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<sup>23</sup> For a discussion on how to make regional policy sensitive to industrial differences, see Chaminade and Vang, forthcoming 2006.

global value chain requires moving away from “replication” of successful models (i.e. Silicon Valley) to new pathways that respond to the specific conditions of each of the regions and their potential to become specialized hubs in global value chains. The RIS approach allows policy makers to identify the systemic problems of the RIS where policy interventions are most urgently needed. In the case of Bangalore, it highlights the lights and shadows of the future of the IT Bangalore cluster in the global value chain. We argue that, unless there is a clear investment in the systemic propensities of the RIS, the possibilities of the indigenous SMEs to upgrade are seriously limited. The suggested policy measures and tools are to be considered illustrative only as it is beyond the scope of the paper to include all possibilities. However, having said this there is also an urgent need for additional research on innovation policy in developing countries – and the developed world too – on designing, measuring/evaluating and implementing policies that bring together local or regional dynamics with global positioning analyses.

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## FIGURES

Figure 1. Transition of RIS

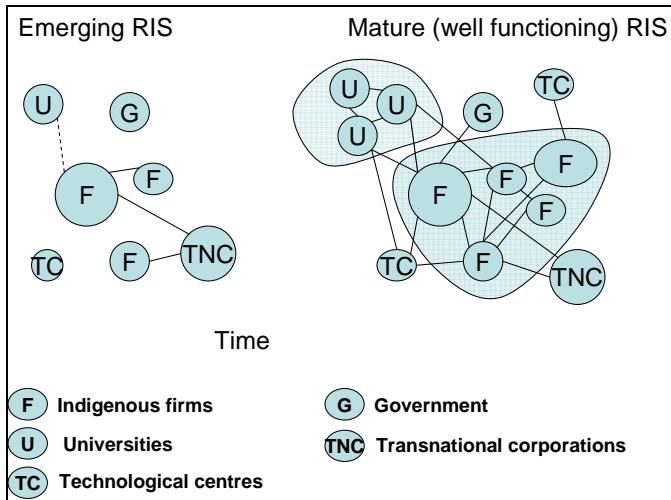
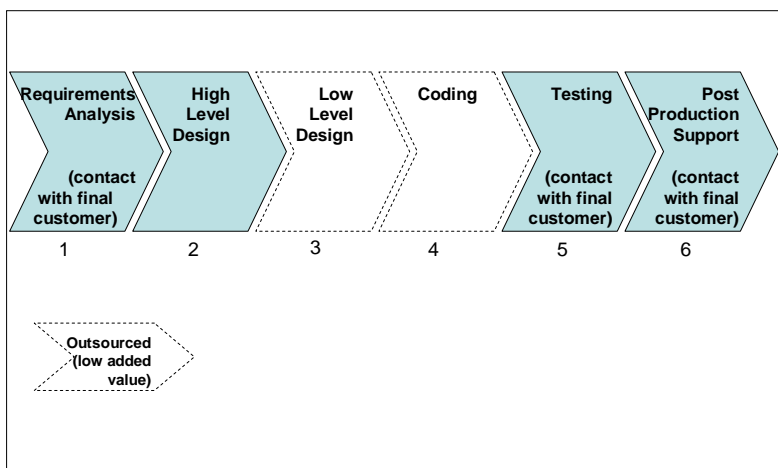


Figure 2. The software development value chain



Source. Adapted from Arora 1999.



**Figure 3. Upgrading in Bangalore and the role of the RIS**

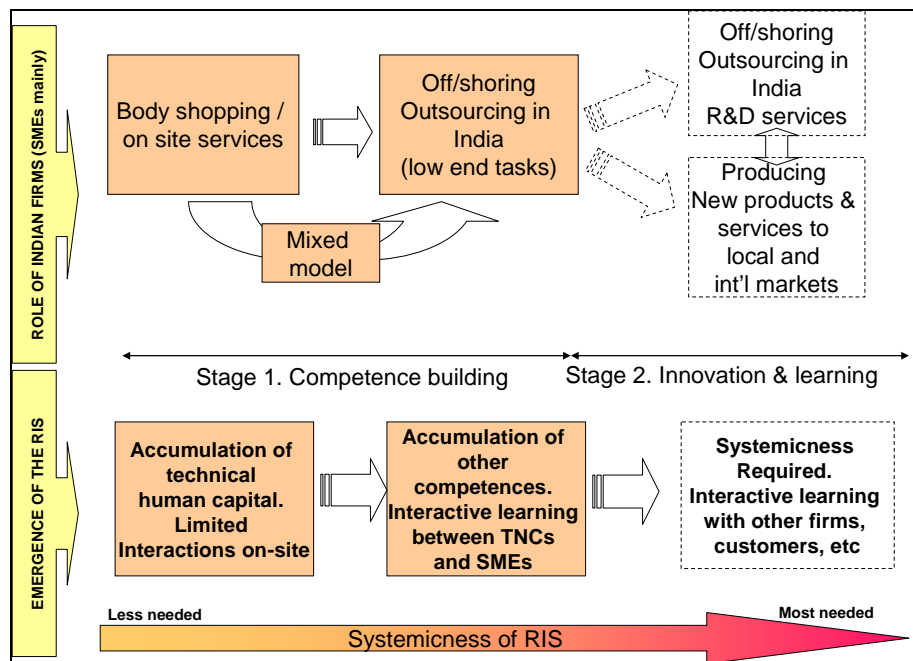


Table 1. The emergence of the Bangalore Regional Innovation System

		<b>Stage 1. Competence building</b>	<b>Stage 2. Innovation and interactive learning</b>
	Content of work	Multinationals outsource specific tasks to the indigenous SMEs. TNCs are responsible for assembling the different modules into the final product. Competitiveness of the local SMEs is mainly based on costs	Indigenous firms start providing final products to specific market niches. In some cases, some cooperation between SMEs is needed to combine complementary competences. Indigenous firms start using their integration skills to integrate modules that are being developed in different firms.
Local endowments of the RIS	Human Capital	In this first stage the focus is on the accumulation of technical human capital. Bangalore provides enough technical human capital. There are good technical schools located in the area although the managerial skills that are needed for the transformation are lacking.	In this second stage new skills are needed beyond technical skills. Indigenous firms need to be able to integrate the different modules into the final product.
	Social capital and networks	The main linkages are those established between the TNC and the local indigenous SME. Few SMEs collaborate with other SMEs. Social capital seems not to be relevant in this first stage.	Social capital starts to play a crucial role stimulating and supporting interactive learning between the indigenous SMEs. In the Bangalore case, a new set of horizontal relationships seems to be emerging, both formal and informal (particularly in embedded software)
International links	Transnational corporations	The focus in this first phase is to attract transnational corporations. In this first phase TNCs play a significant role in the RIS, as they link the indigenous SMEs with the international markets. They may also transfer some competences to the local SMEs as well as (and mainly) stimulating the introduction of standards (acquisition of organizational competences) in the local SMEs.	SMEs and TNCs could collaborate on the provision R&D services (traded externalities leading to spillovers) and offshore R&D labs => untraded spillovers.
	Transnational communities	Transnational communities are also crucial in this first stage. They contribute to the development of the RIS and the indigenous SMEs by reducing institutional distance which in turn reduces transaction costs.	the role of transnational communities in this phase has not yet been studied. However, we expect them to continue to be relevant as they reduce the institutional distance and facilitate the direct access of the indigenous firms to the final markets .

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