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Building RIS in Developing Countries: Policy Lessons from Bangalore, India

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Abstract

This paper sheds light on the role of the regional innovation system in facilitating the Bangalore Software cluster's transition from a development model based on offering low cost activities/services towards a model based on an independent innovation profile. Recent research has documented that Bangalore has become one of the most important IT clusters outside the US. With noble exceptions the literature addressing the recent transformation of the IT cluster in Bangalore has either interpreted the transformative potentials though a pre-determined 'negative' political economy template or through a firm-level analysis. Both types of research tend to ignore the systemic propensities of the cluster within which the firms are embedded and the derived need for policy intervention. This chapter attempts to contribute to reducing these omissions by discussing the role of policy interventions in supporting innovation in the software cluster and, more specifically, the innovation based upgrading strategies of the indigenous SMEs. To attain this goal the chapter applies the so-called regional innovation systems approach. Regional Innovation systems can be seen as a "constellation of industrial clusters surrounded by innovation supporting organizations" (Asheim and Coenen 2005) where focus is on the systemic propensities of the institutional setting and possibilities for selective policy intervention. The recent adaptation of the RIS approach to the Asian context (Asheim and Vang, forthcoming and Chaminade and Vang, forthcoming) is used as a departure point in the discussion. In the context of RIS two important aspects need to be highlighted. Contrary to more traditional approaches to innovation and upgrading a RIS approach stresses that supporting SMEs in their innovation-oriented upgrading process is not only a matter of facilitating the access to technology but of providing what we refer to as soft infrastructure (increase qualification of the human resources, provision of knowledge supportive social capital). In this sense, we critically use the RIS framework to discuss how the hard and soft infrastructure of the RIS and their systemic propensities might influence the innovative performance of the software SMEs located in the Bangalore cluster; and how can the government selectively invest can in the weak and critical nodes of the local infrastructure to support SMEs innovative capabilities and upgrading in general.

Keywords: Sweden; paradox; R&D; growth; entrepreneurship.

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1. Introduction

The purpose of this paper is to unpack the transition of firms and regional innovation systems in developing countries from competing on costs to competing by providing unique knowledge and discuss the related policy consequences. Special attention is paid to policies supporting the innovative potential of the indigenous SMEs 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 in the developed world (Lundvall, 1992; von Hippel, 1988). Innovation systems research has acknowledged this and has placed innovation at the centre of the upgrading/ growth and development process. 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 (Gu and Lundvall, forthcoming, Asheim and Vang, forthcoming, Carlsson, 2004) and, as a consequence, strong focus was made on the endogenous-led growth of the region. Initially, 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. However, developing countries experiences with so-called self-contained systems (albeit on national level) represented by Import Substitutions Industrialization strategies (ISI) have shown that self-contained systems have seldom been relevant in a developing country context, hence alluded to a need for strategies combining internal and external sources of capital technology and knowledge.

Thus regional innovation systems in developing countries have increasingly been conceptualised as specialized hubs in a globalized innovation and production network (Asheim et al, forthcoming). In this global innovation and production network, RIS in developing countries have then been traditionally allocated the lowest activities in the value chain[1]. However, a few regional innovation systems in developing countries are beginning to challenge this conceptualisation by moving up the value chain (traditional upgrading) and/or using the competences built in the initial phases of development for shifting into related industries (diversifying upgrading). There is still only a poorly developed understanding of the *systemic propensities in the transition process* (Lundvall et al, forthcoming), that is, how the system of innovation evolves to support this transition process and what is the role of public policy (i.e. procurement) building the regional conditions to support the needs of the SMEs in this transition process. This paper aims at reducing this omission.

This paper attempts to shed some light on systemic propensities of the transition process from providing low-end services towards becoming knowledge providers in the 'high-end' and discuss the implications of this transition process for the design of regional innovation policies in developing countries. For doing so, we focus on the transition of the Bangalore's software innovation system. Bangalore's – together with Shanghai's – regional innovation system is among the most notable successes in attaining the goal of moving up the 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, Germanys and Irelands software exports are larger than India's (Arora and Gambardella,

[1] In IT, for example, testing of software, standard programming, and so forth.

2004). Bangalore is also interesting as a case since it grew basically from scratch without localised lead users pulling the demand of technologies and has managed to sustain the world's highest growth rates within the industry (Arora and Gambardella, 2004). 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 eighties and nineties (e.g. 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 though establishing offshore subsidiaries. This literature however has not yet paid much attention to a) how this TNCs contributed to building competences in the region, b) how these competences are being used by the SMEs (and other larger firms) to upgrade and c) what are the policies needed for supporting the indigenous firms' attempts to move further up the value chain. Furthermore, our main concern is to understand how the regional innovation system has evolved (and needs to evolve) to support the upgrading process of the indigenous SMEs and how the government can stimulate the development of such a system.

The structure of the reminder of the paper is as follows. First, the theoretical framework – regional innovation systems – is introduced; special attention is paid to the importance of regional decentralization, social capital and collective learning. The importance of these dimensions of RIS is examined in the context of Bangalore and the implications for RIS literature discussed. This is followed by a section trying to tear out some case-specific policy lessons on building RIS in developing countries. Then we highlight central conclusions.

2. RIS, SMEs, TNCs and the Transition Process

The main argument of the paper is that upgrading to higher value activities is only possible when there is an environment that supports interactive learning and innovation. Isolated efforts to make this transition will be fated to fail. Activities in the higher end of the value chain involve a high degree of innovation and interaction with the customer and other firms and organisation. In the case of SMEs, this interaction takes place at best at regional level, with other firms and organisations located in the same regional area.

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 support industries (e.g. 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 Rabelotti, 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, includes research and higher education institutes (universities, technical colleges, and R&D institutes), technology transfer agencies, vocational training organizations, business associations, finance institutions, etc. They can be created and governed by the central or regional government – or private organizations – the importance in a RIS perspective is their physical presence in the region. These knowledge creating and diffusing organizations provide the resources and services (knowledge, capital, etc.) to support regional innovativeness.

In well-functioning RIS, proximity facilitates the knowledge and information circulation needed in the particular industry in a particular context. In the context of RIS, two important aspects need to be highlighted (Chaminade and Vang, forthcoming 2006). 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 also providing what we have referred before to as *soft infrastructure* (increase qualification of the human resources, facilitate organizational change, support social capital). In contrast to other approaches stressing these variables, the RIS approach puts the emphasis on the systemic dimension of the innovation process. In innovation systems research, innovation is the result of an interactive learning process stretching across firm borders (Lundvall, 1992). RIS are especially relevant for SMEs as their

interaction takes place mainly at the local level and this holds for developed (Asheim et al., 2003; Cooke and Morgan, 1998; Cooke and Will, 1999; Schmitz, 1992) as well as developing countries (Albu, 1997; Bitran, 2004; Giuliani, 2004; Pietrobelli and Rabellotti, 2004; UNIDO, 1997 and 2004; Giuliani and Bell, 2005). Moreover, this literature explicitly finds that mostly SMEs extra/firm relations are more confined to the region than those of large firms (Cooke and Morgan, 1998; Asheim et al., 2003). One of the reasons for this is that SMEs are more dependent on 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.

The soft infrastructure of the RIS (human capital and social capital) is crucial to explain innovation in the SMEs localized in the region as we have argued before (Chaminade and Vang, forthcoming 2006). Interactive learning, particularly among indigenous SMEs might be facilitated by **social networks or social capita**l. Following the World Bank "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). Unless there is a high degree of social capital cooperation, communication and thus interactive learning is limited (Nooteboom, 2000). 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[2]. Cognitive social capital explains the raise of ethnical based networks of SMEs in Asian countries (of Indians, Chinese, etc) which provide the resources needed for the firm.

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 available information and the information and knowledge that comes from the interaction

[2] 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.

with users 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 knowledge required for innovation. 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.

In developing countries there is an extensive stream of literature discussing the **role of TNCs** in the provision of competences (human and organizational) to the indigenous SMEs. It is argued that the impact of the TNCs on the regional economic development is dependent on the strategic coupling between the regional assets and the TNCs assets (Coe et al, 2004 cf Vang and Asheim RIS in Asian countries). However, this coupling is problematic when the TNC is only approaching the developing region to access their cheap labour force. The result is that the developing countries enter the race to the bottom competing only on the basis of low cost labour, low taxes, poor environmental and labour market regulations and so forth. But, when regions offer some knowledge-based competitive advantage (such as qualified human resources) TNCs can function as an important source of capital and knowledge, leading to competence building and the generation of positive externalities in the region. As Mathews argues (2002) in the long run it is even possible that these firms start to move up the value chain (upgrade) (Vang and Asheim, forthcoming). As we will discuss later, attracting and retaining TNCs is a matter of (among other issues) being able to reduce the institutional differences between the two countries (home and host). Transnational communities might play an important role in facilitating the interaction between the TNC and the local SMEs (Vang and Overby, forthcoming; Saxenian, 1994, 2001)

Interactive learning and thus innovation (stimulated by TNCs or not) only takes place when both human capital and social capital (or networks) are present in the system of innovation but how are these two components built over time and what is the impact in the firms located in the region remains a question to be answered. Furthermore, we know very little

about how the system of innovation evolves over time and in relation to the upgrading strategies of the firms located in the region[3]. To understand how this transformation takes place we will now turn to the cluster/regional innovation system in Bangalore, India. We will pay special attention to how competences are accumulated in the region (particularly we will investigate the role of the external linkages of the region and the cluster, that is, the role of TNCs and transnational corporations in building competences in the indigenous firms). In that respect, we will stress the importance of institutional distances between regional innovation systems which is a dimension not normally touched upon in the RIS-literature for understanding the transnational interaction across RIS boundaries. This is central to understand the globalisation of innovation-processes.

3. Bangalore – India's leading software cluster

Situated 1000 km from Bombay, in the Karnataka State, Bangalore has become one of the most important IT clusters outside the US to the extent that it is known as "India's Silicon Valley" (Nadvi, 1995) and certainly the most important in India. Bangalore city, a city of around 1 million inhabitants, is the centre of the city-region spread out around Bangalore. Bangalore is not only the hub for IT-related industries but also houses several high-tech clusters (defence, aeronautics) and is considered to be the scientific and engineering centre of India in terms of research, training and manufacturing. India's best research university- Indian Institute of Science is based in Bangalore. Despite the weight of the TNC in the Bangalore IT sector, the large majority of firms are small and medium sized enterprises (NASSCOM, 2005).

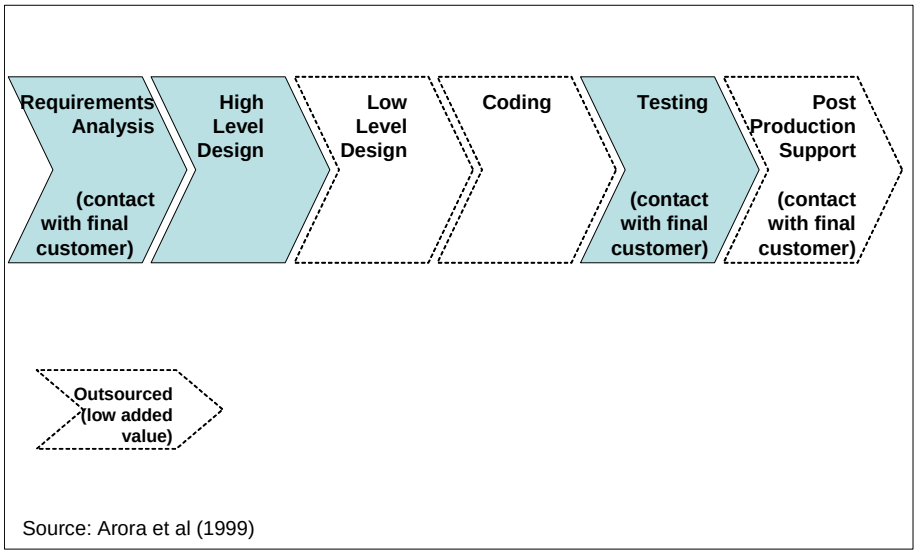
Bangalore has attracted the attention of scholars around the world for its impressive software growth export rates, superior to those of competing IT hubs such as Ireland, Israel, Brazil or China (Arora and Gambardella, 2004). The value of export, for example, typically growth more than 30% annually while revenues growth a 30-40%. Bangalore/India is also still highly attractive to TNCs. According to NASSCOM-McKinsey

[3] There is an emerging literature alluding to the transition process of systems of innovation, particularly in Asia (Lundvall et al, forthcoming 2006 compiles several studies of innovation systems in transition in Asia) but very few theoretical works unfolding how this transition takes place (Galli and Teubal, 1997 is one of these few attempts)

Study 2005 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 (see appendix 1). The main reason for choosing India is to be found in a cumulative causation process based on high quality of the human capital, growth in the number of officially certified firms and possible herd behaviour among TNCs.

However a closer look at the statistics shows that most of the exports are due to software services in the low-end of the value chain. Figure 1 plots the software development value chain. The process of developing software starts with the identification of the needs of the end-user (Requirements Analysis) and the high level design of the application for the end user. These two activities are considered the software R&D part. These two activities require deep knowledge of the customer's business, close interaction with the customer as well as high level design skills. These activities are in the higher end of the value chain. Once the product specifications are designed, it follows a series of routine activities of coding, low level design and maintenance. These are typically the activities that have traditionally being outsourced to other countries such as India. The value added of those activities is low and the contact with the end-user not necessary. 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).

Figure 1. The software development value chain



Source: Arora et al (1999)

Until very recently Indian firms have been competing in the global value chain on the basis of the low cost of their qualified human resources, the time zone difference with the US (which allows the provision of round the clock tasks) and their English skills (Arora et al, 1999, 2001; Saxenian, 2001). The question that many researchers are asking now is to what extent is this growth model sustainable over time (considering the raising salaries in India and the emergence of competing countries such as China) and what can be the alternatives to the existing growth pattern. The large majority of researchers have focused on the strategy of the firms and their competitive advantage in terms of qualification of the human resources and costs. However, little attention has been paid to the role of the regional system of innovation in supplying the resources (hard and soft) needed to sustain the growth of the industry and support the transformation of the cluster. Roughly speaking, we can talk about two different phases in the development of the IT cluster in Bangalore: an initial phase of accumulation of competences and move from body-shopping to more advanced forms of outsourcing and an emerging phase that seems to be relying on interactive learning and innovation as a mean to upgrade in the value chain. Both phases will be described with more detail next.

3.1. The competence-building phase

3.1.1. Industry and learning dynamics during this first phase

The software industry has since its emergence been dominated by US firms as it was driven by interaction between national US security institutions and universities. Until the 1980s, production of IT-services was still predominantly a US phenomenon (subsequently OECD country phenomenon) and outsourcing of IT-service mainly occurred in Silicon Valley, while the East Coast IT-firms were vertically integrated.

From the late 1980s and onwards, the industry gradually globalizes. In the developing world the vast majority of the IT-based business was located in India. The main reasons for choosing India was cost reduction, the existence of excess capacity of engineers, time zone difference, and widespread English skills. The local Indian capacity within the field was limited as few Indian firms at that time had significant IT competences. Rather the majority of firms were situated in the low end of IT-service industry; the red tape still overwhelming. At the same time, most US firms only had limited experience with outsourcing to developing countries. To phrase it differently this combination of few high skilled Indian firms and little experience in transacting within developing countries generated a high degree of uncertainty for the US firms around issues such as which subcontractors had the appropriate competences, which subcontractors were trustworthy and which bureaucratic and cultural obstacles they would face (Vang and Overby, forthcoming).

The institutional differences between the US and India were noticeable[4] as Box 1 summarises. Due to the high institutional distance the US firms experienced a high degree of uncertainty which created non-trivial cost and difficulties of transacting. The institutional differences hereby initially constrained US firms' propensity to outsource to and establish subsidiaries in India. The multinationals appreciating the opportunities in India arguably tried to lower these transaction costs. Two critical issues explain the final decision of the US firms to locate in Bangalore: First, the approach to the Indian firms was made gradually to test the reliability of the Indian subcontractor, before any significant task was finally

[4] Institutions refer to "the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction" (North, 1990: 3). Institutional distance refers to the perceived differences in institutional frameworks (often associated with problems) between the firms' home and 'host' country (Vang and Overby, forthcoming 2006). Peng explains that ' … no firm can be immune from the institutional frameworks in which it is embedded ..' and "… that when organizations [TNCs] attempt to expand beyond their national boundaries they implicitly take with them their nation's history of socioeconomic choices". (Peng, 2002: 251)

outsourced (learning between TNCs and SMEs). Second, the transnational community played a significant role in reducing the institutional difference between the two countries.

Box 1. Institutional distance between US-India

The differences between Western economies and India are well established in the sociological literature. Weber pointed to the radical differences between Hinduism and Christianity. Some of the concrete challenges firm off shoring to India face are related to the caste system (whom to hire, what it means if you hire a low cast in a higher position), language (Indians speak English fast and their body language is significantly different from westerners body language), clarity of arguments (Indians tend not to give straight answers in meetings with bosses), that the US is a low context culture (i.e. low degree of specifications) and India is a high context culture (i.e. requiring a high degree of specifications), among others things. The business psychologist Geert Hofstede has tried to systematize cultural differences and measured the difference between India and the US. He divides culture into five dimensions: Power Distance, Individualism, Uncertainty Avoidance, Masculinity and Long term orientation.

Cultural Differences between India and the US

		PD	I	U	M	LT
India	77	48	40	56	61	
USA	40	91	46	62	29	

Source: www.spectrum.troyst.edu/~vorism/hofstede.htm

According to Hofstede the major differences between India and the US are in the degree of power distance where India is a society characterized by a high degree of power distance, which is only moderate in the US. US is a very individualistic country, which is not the case for India. Finally, Indians tend to favour long-term commitments as opposed to short-term commitments in the US. Together these findings indicate a large institutional distance.

Interactive learning between TNCs and indigenous SMEs

Initially the US firms only moved rather simple and trivial activities to India such as maintenance of existing code or reengineering code from one programming language. US firms recognized three reasons for Indian firms not to engage in opportunistic behaviour during these initial contacts; first the value of future collaboration might exceed the value of reneging on current contracts, second the need for reaching minimum efficient scale, and finally the importance of reputation in the industry. The activities that were initially moved did not involve any high degree of asset specificity, and hence they did not expose the firms to great hold-up risks.

Moreover, in the initial phase many small new firms specialized at that time in providing body-shopping services[5] - that is sending software programmers to the (US) client to provide maintenance services - (Arora et al, 1999, 2001). Despite the critics that this strategy has received over time, it seems clear that it helped to reduce the institutional distance between 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 firm started to gradually outsource tasks to be performed entirely in Bangalore. In a sense, this build-up of trust between the partners was the result of the interaction and mutual learning between the TNC and the indigenous firm providing the software service. As acknowledged by Parthsarathy and Aoyama (forthcoming) the TNCs induced both process and functional upgrading in the indigenous SMEs.

Yet this is not enough to explain the initial uptake in outsourcing and foreign subsidiary establishment in India. As co-founder of Infosys, one of India's leading technology firms with revenues of $754 in 2002-2003, explains:

> "In the early '90s, when we went to the United States to sell our services, most chief information officers, didn't believe that an Indian company could build the large applications they needed… We realized that there was a huge gap between, on the one hand, how prospective Western clients perceived Indian companies and, on the other, our own perception of our strengths".

To adequately explain the increase in outsourcing and off-shoring from the US to India it is necessary to understand the role of members of the Indian transnational community in the US.

The role of the transnational community

The importance of the Indian community is indicated by the stylized fact that in Silicon Valley alone more than 750 IT firms have a CEO with Indian background (2001 numbers), Indians received around half of the H1-B visas (special visas for experts) and half of them

[5] Bodyshopping was explicitly recognised in the Computer Policy of 1984 (Saxenian, 2001).

(135.000 in 2001) work in the IT industry (www.northsouth.org). Moreover, members of transnational communities are also returning to India. This trend has been reinforced after 9/11, where a hostile US environment has amplified the number of Indian IT professionals returning from US to India to 35.000-40.000 (Businessworld India 2003). Several members of this community held important positions in US firms. These members played a significant role in shaping the outsourcing and off shoring decisions in the US firms as the following examples illustrate. Large institutional distance and significant uncertainty prevented US-based Motorola from utilizing the advantages of India. In 1991, Motorola established MIEL, a software subsidiary in Bangalore. Despite the obvious cost advantages no product sector within Motorola was willing to risk sourcing its software needs from MIEL. Ramachandran and Dikshit (XXX) explain: “The first breakthrough came when Arun Sobti, an Indian who was a senior manager in Motorola’s Land Mobile Product Sector in Florida, USA, decided to give MIEL a chance”. They also did some internal marketing with other divisions in their companies even though this was not part of their formal roles. According to Ramachandran and Dikshit, although the first project from Sobti was successful, Sobti was unable to give any more projects to MIEL, because he faced budgetary cuts in his division. However, Sobti continued to help: He put Shrikant Inamdar, the then General Manager (Operations) in MIEL on to the Cellular sector, and he personally lobbied with the sector’s management and helped MIEL get its second contract for a Motorola product called CT2. Since the work was in the cellular domain, it afforded MIEL an opportunity to learn about the wireless technology that Motorola was famous for.

International social capital (in the structural sense) were also important when Texas Instruments (TI) set up its first international IT-subsidiary in Bangalore, India in 1985. The establishment was made possible, because the Indian TI vice president Mohan Rao utilized his professional position in the US and his knowledge of the Indian political bureaucratic system to facilitate TI’s entrance into India. Rao used this combination to get access to top-level people in the Indian government, which in turn allowed him to push the ideas of building an Indian IT industry and to establish a TI plant in India. In other words, his knowledge of the Indian political culture allowed him to reduce the bureaucratic uncertainties and deal directly with top-level politicians in the Indian government. The bureaucracy also ran more smoothly because TI bought the most modern IT equipment and gave it to the Indian government.

Hence, in line with Saxenian, we argue that , “As they [Indians in the US] gained seniority in US companies in the 1990s, many non-resident Indians (NRIs) were instrumental in convincing senior management to source software or establish operations in India to take advantage of the substantial wage differentials for software skill”. Hereby the Indian transnational community in the US played a crucial role in the development phase of the Indian software industry.

3.1.2. What it takes from the RIS to support this strategy

As Figure 3 shows, the most important role of the regional innovation system during this first phase was the supply of highly qualified yet very cheap labour force for the provision of software services for the TNCs. In other words, Bangalore became the dominant location for the outsourced and off shored TNC activities because of the concentration of highly skilled labour in Bangalore. This attracted the indigenous firms and TNCs. The attractiveness of Bangalore was determined by its dominant position within the educational and research systems in India where Bangalore had a privileged position in comparison with other Indian regions. Today Karnataka state has a total of more than 65 engineering colleges (albeit of varied quality).

Bangalore was ‘blessed’ with the central government choice of locating some of the best educational institutions in the region such as the world renown Indian Institute of Information Technology and other research centres such as 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, and others. Additionally, as a result of military research strategies Bangalore was/is the centre for advanced science and military research. Bangalore was mainly chosen for physical geographical reasons such as air without dust which was needed for military testing.

Phrased differently the co-location of education and research institutions created the conditions behind a cumulative causation process that allowed Bangalore to become the dominant centre of IT. However, the supply-side aspects only became efficient when combined with an export-oriented development strategy which ”put the resources to work”. The provision of highly qualified human resources together with the co-location of a great number of educational and research institutions set the grounds for the emergence of the regional system of innovation. The regional advantages provided by Bangalore could explain the initial interest of the US firms in locating their outsource activities in the region. But, what has been the role of the government in creating the regional conditions that facilitate the emergence of the Bangalore RIS?

3.1.3. The role of the Government in the accumulation of competences

After the initial policy failures the central state’s policies did play an important role of creating the conditions making India an attractive location; the initial support from the central government was dismantling the rather counter-productive ISI-strategy[6]. This resulted in the development of a more pro-export ‘hand-off’-policy where the central state reduced the import duties and created incentives for exporting;

Secondly, the Indian central government has been most successful in providing the required human capital in the region and in sustaining the educational effort over time. As Arora and Gambardella acknowledge the:

> “Accredited engineering capacity in India increased from around 60,000 in 1987-88 to around 340,000 in 2003, and IT capacity has increased from around 25,000 to nearly 250,000. .. NASSCOM figures indicate that in India the number of number of IT graduates increased from 42,800 in 1997 to 71,000 in 2001. By comparison, the number of IT graduates in the U.S. increased from 37,000 in 1998 to 52,900 in 2000. During this period the IT workforce (which does not directly correspond to IT degree holders) in the U.S. was probably eight to ten fold larger than the IT workforce in India”

[6] Though it should be remembered that TATA and other indigenous firms were established during the ISI-phase.

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 (Van Dijk, 2003). “Until 1991-92, there was virtually no policy support at all for the software sector. Even the term `benign neglect' would be a too positive phrase to use in this connection’ writes the former head of Department of Electronics (DOE) DoE dr. Sen (quoted from Parthasarathy, 2004a).

That the Bangalorian firms have to some extent been capable of moving up the global value chain is thus the result of a deliberate strategy of the transnational firms to locate in Bangalore and of the indigenous firms for building up their absorptive capacity and to a lesser extent as a consequence of any policy intervention. The change in the strategy away from ‘body shopping’ - used in the initial phase - to distance work was also facilitated partly by the advances of ICT technologies as well as deliberate strategies among the TNC’s to modularise and standardize some of their IT processes. This provided the background for the distance work which in turn allowed the Bangalorian firms to maintain a broader knowledge base at home (Parthasarathy, 2004a, 2004b) and improve the career opportunities (and subsequent reduce the turnover rate with its negative implications for the firms ability to build firms specific knowledge), hence secure better absorptive capacity. The question now is how these accumulated competences in the firm and in the region can be used to move further on in the global value chain.

3.2. Towards an innovation phase?

Very recently we are witnessing an upsurge of literature claiming that there is a move towards higher added value activities in software production in Bangalore and an increasing number foreign companies have established or are in the process of setting software centres in India from where they export to other countries (Arora et al. 1999, 2001)[7]. Higher activities involve the design and prototyping of new products or systems, which is considered as R&D software services (Barr and Tessler, 1996). Despite we acknowledge that most of the firms still are operating in the low-end of the value chain, we

[7] Saxenian (2001) claims that there is little more than anecdotal evidence of this move towards more sophisticated design and programming projects.

want to investigate what are the implications of such an upgrading strategy for the regional innovation systems of Bangalore, as well as the policy implications.

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[8]. 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 a 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 (Parthsarathy and Aoyama, forthcoming) which is summarised in Box 2. Furthermore, it seems that the "low cost" road (i.e. competing on the basis of low costs) can not endure too long as the salaries of the Indian engineers are rapidly increasing (Saxenian, 2001, Parthsarathy and Aoyama (forthcoming), with growth rates far superior to those of the US.

Box 2. Upgrading to the provision of software services in the embedded software industry in Bangalore

Embedded software is a particular branch of the industry which combines hardware and software. It is design to perform tasks without human intervention. The best example is the chip. In the embedded software industry there is an increasing number of firms that have started to provide intellectual property blocks (R&D) that are integrated in various embedded systems. 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. According to the CEO of Sasken Communication Technologies "companies go to Bangalore for complete solutions, based on the expertise, knowledge base and credibility of the local firms, and no longer for cost reasons". Innovation has been stimulated by a growing number of start-ups that specialized

8 The majority of Bangalorian and Indian firms – especially SMEs - however remain in the lower end of the software industry which indicates that the upgrading strategy is still limitedly successful; an indicator of this is that value of sales/employment is 50 (slightly higher than China and Brazil on respectively 37,6 and 45,5) which is significantly lower than in US (195,3), Japan (159,2) and Germany (132,7) (Arora and Gambardella, 2004). This is inline with NASSCOM-McKinsey Study 2005 that suggests that cost advantages is still the main reason for choosing Bangalore/India (despite that India is slightly more expensive than competing countries).

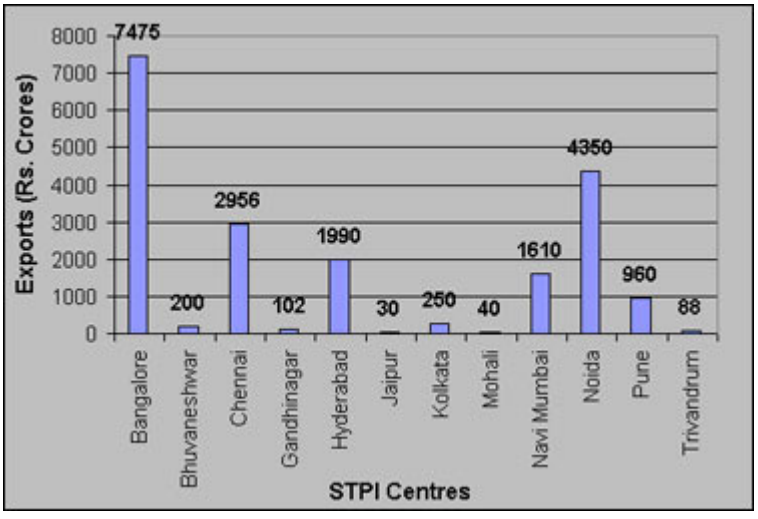
exclusively in R&D services targeting niche markets (combination of upgrading in the value chain and diversification). Interaction with other local firms is also increasing, to be able to assemble IP blocks and sell a complete solution to a TNC, both based on formal and informal networks. Parthsarathy and Aoyama indicate that "local networks are being developed among domestic firms in Bangalore, in part because of the emergence of local business opportunities and in part because of a greater interest among firms to exploit new opportunities" (p. 23).

Source: Parthsarathy and Aoyama, forthcoming.

3.2.1. Industry and learning dynamics during the second phase

Bangalore has maintained its position as the dominant software cluster in India well ahead other regions in the country, as figure 2 shows. Bangalore is probably the cluster now capable of providing the most advanced IT-services and indigenous firms have started to outsource to other cheaper emerging clusters. Bangalore dominant position can be explained as a cumulative causation process where Bangalore now attracts the most talented software workers from all over India and by the fact that Bangalore has become the 'brand' of software in India.

Figure 2. Exports of IT related products by region

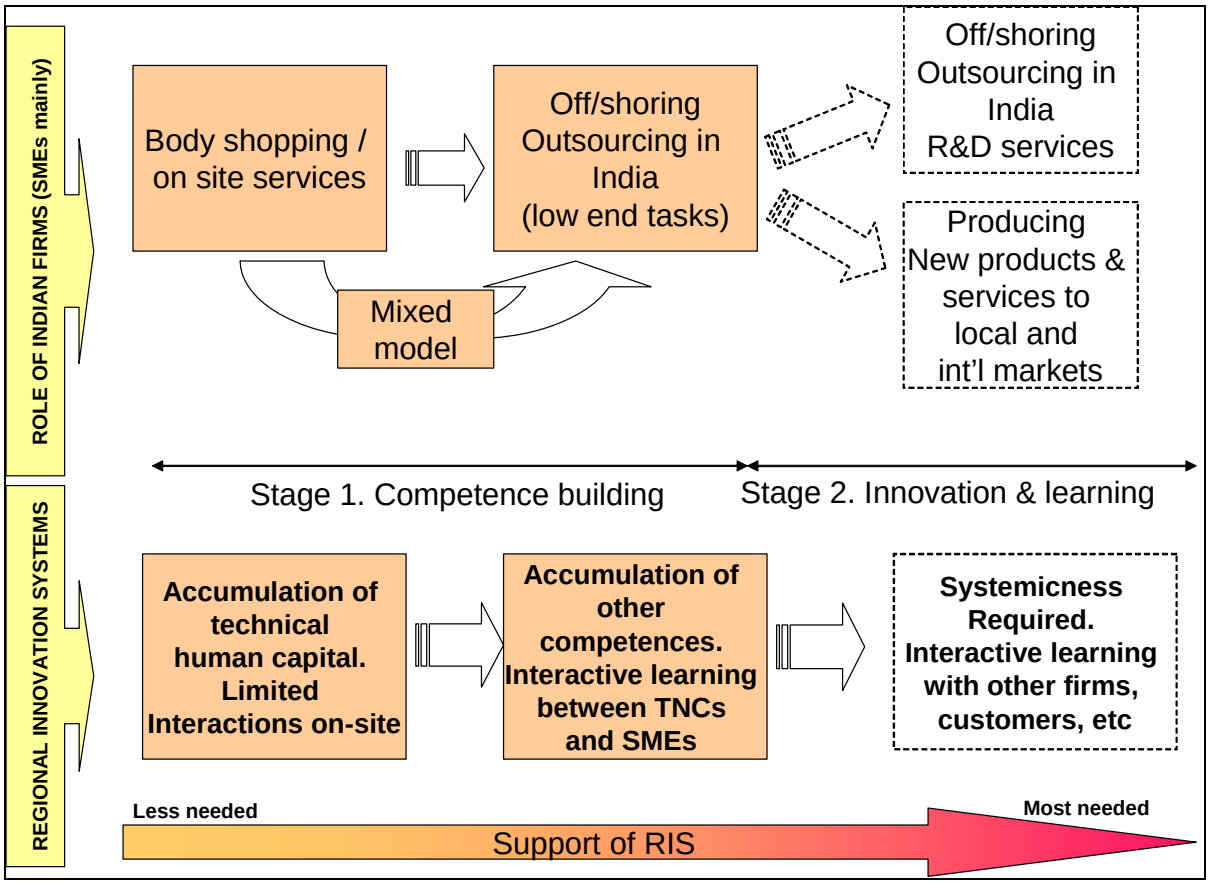


Source: www.bangaloreit.in 2006.

As the industry has matured both Bangalorian and US firms have improved their competences in handling offshore outsourcing to and off-shoring, build up cultural competencies and created their own local networks. Employee attrition and wage increases has forced the firms to introduce human capital management and other advanced management techniques in the firm (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 the firm (hence their absorptive capacity). They have also invested in development of management competencies (Saxenian, 2001)which constituted an important constraint for Bangalorian firms aiming at moving up the value chain (still there is a tendency in the firms to promote people to managers before they have the appropriate experience; often only two or three years). The broader knowledge base combined with the existence and gradually building of reputation in the US marked plus an aggressive certifying strategy among most Indian firms is allowing 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 in new niche markets with their own final product[9]. The two possible upgrading strategies are plotted in Figure 3.

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

[9] However the diversification strategy is still very scarce, with just a few anecdotal evidence of a limited amount of firms that have adopted this strategy. For this reason, we will thereon focus mainly on the traditional upgrading strategy (moving up the value chain to the provision of R&D services).



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; PTI, 2004), quoted from Parthasarathy and Aoyama, forthcoming).

Off-shoring or outsourcing R&D-projects to India/Bangalore involve larger challenges than outsourcing/off-shoring standardized and routine activities. The former activities are sequential, can be decomposed and codified. This is not the case for the R&D activities (Nelson and Winter 1982) and the literature on innovations – outside the innovation systems-literature – has typically associated these activities with in-house activities (near the headquarters) as markets for information, knowledge and technology (Arora et al, 2000) are riddled with imperfections derived from the culturally-specific, embedded, tacit and firms specific knowledge associated with R&D activities.

3.2.2. What it takes from the RIS to support this strategy

Three central challenges, related to institutional distance, constrain the outsourcing or off-shoring of innovative activities (i.e. R&D):

- First, innovative activities do require face-to-face communication as they involve a high degree of tacit knowledge. Tacit knowledge is embedded in the cultural and geographical context and hence difficult to translate from one geographical context to another (even for members of the transnational community). In the context of the US-Indian it implies a high frequency of meeting between the two parties, thus diminishing the cost advantages that working with Indian firms report to US firms.
- Second, the cost advantages for the US of locating R&D activities in India is considerable lower than with routinized activities as they carry additional transaction costs, communication costs as well as a higher risk (in a context where the is not a lack of supply of competent employees in the US). The higher costs are a function of the need to increase face-to-face interaction (thus involving a lot of travelling), the scarcity of research staff in India, especially those that can think 'out of the box'.
- Finally, one needs to add that IP rights for software are virtually non-existing apart for embedded software which makes it highly risky to outsource or offshore innovative and/or R&D activities. As Barr and Tessler (1996) point out, the outcome of the R&D software services is a finished product that can be easily copied and distributed at no cost. In this sense, off-shoring of software R&D is riskier than any other form of R&S outsourcing. IP rights are a crucial element here.

Additionally, one of the crucial factors is that – apart form formal competencies which several Indian firms have by how – the activities up the value chain requires **learning from the end-users** (and lead users) which in turn demands a close interaction with them; firms need to interact closely with the end-user and posses great technical capability and deep knowledge on the business processes of the client (Arora et al 1999). But those clients are mostly located in the OECD-countries[10]. This again places the TNCs in a central role, as

[10] It should be mentioned here that most of the production of the software sector in India goes to external markets (According to Aroral et al, exports account for 65% or the software revenue) and this numbers are growing.

they are located in the OECD-countries. And The transnational community has been an active player in 'pushing' the Indian firms up the value chain, especially as venture capitalisms, by reducing the dimensions of institutional distance relevant when talking about R&D projects between the US and India. They typically funded ventures that have a front-end (sales and marketing) in the US and a back end (software development) in India. Other members of the Indian transnational community have become intermediaries/sales people for software companies, either as consultants or employees. A few have also opened companies in India leveraging their relationships in the US (e.g. Pradeep Singh of Aditi, a former Microsoft employee). Firms such as TiE (The IndUS Entrepreneurs) started spanning both the US and India and creating a global network. This raised the image of India as a source of high technology and indirectly promoted software contracts to Indian firms. Also, managers, who have worked for other multinationals in India, play a key role. E.g. Raman Roy, who set up GE Capital's back-office in Gurgaon (near Delhi), was later persuaded by a leading venture capital firm to set up his own company to provide third-party services. His company, Spectramind, was subsequently acquired by Wipro, a large Indian IT services company.

Additionally, the upgrading strategies of indigenous firms have been constrained by the lack of **interactive learning and cooperation between the indigenous firms in Bangalore**; there has continued to be interactive learning along vertical dimensions (between SMEs and TNCs) but horizontal or collective learning has not developed much in the software industry in general. In other words the Indian firms did only to a limited extent engage in interactive learning compared to more bustling IT cluster such as Silicon Valley. By collaborating SMEs can generate economies of scale and scope, which are necessary to accumulate competences and move up the value chain. Economies of scale refer to the capacity of SMEs to respond to larger orders coming from the TNCs or the final markets by pooling their resources. Economies of scope refer to the capacity of SMEs to provide jointly a larger variety of products or services to the final customer. Economies of scope are important for the second type of upgrading through diversification and they are only possible when the firms have accumulated unique competences and knowledge in specific market segments, technology or even managerial capabilities (such as integrating different

modules). The successful case of the embedded software industry (see box 2) is a clear example of the advantages of collective action and learning among groups of SMEs. SMEs have been able to provide final products to the TNC by assembling different modules that were developed by other firms (Parthsarathy and Aoyama, forthcoming). That is, a group of SMEs, each of them specialized in one part of the final product, gained economies of scale and scope by collaborating in the provision of a R&D service. Furthermore, informal social networks are also quite frequent in the embedded software segment.

However, this type of interaction is not yet frequent in the software industry in general. The lack of collective learning can partly be explained by formal constraints imposed on the Indian subcontractors (i.e. security concerns and lack of appropriate IP rights) as well as the high degree of competition among the indigenous SMEs. As we have argued before (Chaminade and Vang, forthcoming) social capital in the cluster is very weak and (at most) limited to the networks of alumni associations. The lack of local social capital has prevented collective learning, the transfer of knowledge and best practices among the indigenous SMEs and thus constrained the bargaining power of the indigenous firms – especially the SMEs - vis-à-vis the TNCs. SMEs fail to see that Bangalore will only become attractive for TNCs to off-shore their R&D activities is there is a critical mass of research and innovative activity in the cluster, as the paradigm of Silicon Valley shows where even entrepreneurship is a collective activity (Saxenian, 2001).

In contrast with the previous phase where the focus was on the accumulation of competences in the system of innovation and not that much on the interaction between the different elements of the system, innovation is based on interactive learning among firms, and between firms and the final customer. The analysis of the Bangalorian RIS shows that none of the two types of interactions is really strong in the system. In this sense, there is a great opportunity for policy makers to put in place the conditions necessary for building Bangalore's future. However, some interesting initiatives seem to be taking place. NASSCOM is quite active in promoting the development of local entrepreneurial networks (Parthsarathy and Aoyama, forthcoming). Entrepreneurial organizations and bridging

institutions have been traditionally very good vehicles to stimulate the collaboration between SMEs, even when no prior collaboration existed (Chaminade, 2004).

3.2.3. The role of the government in supporting innovation and interactive learning

The role of the government supporting interactive learning and innovation albeit critical in this phase is almost absent in the Bangalorian case. The idiosyncratic character of the R&D activities as opposed to more routine activities pleas for a more decentralized governmental intervention (i.e. increasing role of the regional government). From our perspective, at least two policy instruments could be initially used to stimulate the systemic propensities of the Bangalorian RIS.

As we have mentioned, joint-action is particularly relevant for SMEs in this phase. By collaborating, and diversifying combining the acquired competences, firms can experiment with path shifts (Kim XXX) that might allow them to trespass the lead firms that dominate every value chain, as the case on embedded software suggests. Thus policies should stimulate collaborations exploiting scale and scope. This has been traditionally done in the developed world by allocating financial support (e.g. via R&D subsidies) only to consortia of SMEs or of SMEs and research institutions. Policies, particularly at regional level, can also facilitate associational activities that bring together local producers, researchers, service providers and even the government with the objective of solving collectively a problem that is affecting all the system, such as the need for better communication infrastructures in the region (Saxenian, 2001)

Additionally, the experiences in Ireland, Israel and China suggest that the government might 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 lead customers) (Arora and Gambardella, 2004). This has done in India to a very limited scale (Kumar and Joseph, forthcoming). Public procurement might be very important to create local markets and give the right incentives to the indigenous SMEs to use their competences for innovation[11]. However, public procurement might also steer the local innovation towards

[11] Many scholars argue that Indian SMEs have already the design capabilities

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. Additionally, there is a need to levelling the playing field so that IT products and services sold in the domestic market enjoy the same tax benefits as those currently enjoyed by export goods and services (Saxenian, 2001).

4. The transition of the system of innovation: some lessons from the Bangalore case

The notion of systems of innovation carries implicitly the idea of interaction and mutual dependency among the different elements of the system. What the Bangalore case clearly show is that systems in developing countries are developed over time, in close interaction with the strategies of the indigenous firms, the government and the trans-national corporation, as Figure 3 clearly shows.

The Regional System of Innovation emerges when the region starts accumulating competences and organisations: a critical mass of local firms involved in a similar activity (cluster), qualified human resources and good training institutions, organizational capabilities and research facilities. In the initial phases those competences are hardly connected to each other, that is, the systemicness of the local system is still very low. However, the external linkages of the RIS are fundamental. Local social capital is weak while international social capital (i.e.) links between Diaspora-members and entrepreneurs, indigenous incumbents, educational institutions and government officials in their home country is central (see below). Established RIS can to a large extent maintain their position by a continued focus on supply-side factors (i.e. human capital) due to the cumulative causation-process. Focus on supply-side allows for maintaining cost advantages in combination with incremental minor movements up the value chain.

The competences accumulated in the RIS and the firms located in the region during the first stages (from the interaction with the TNC or the provision of human capital from the region) start to be used to upgrade in the value chain. However this is not sufficient for firms to move further up in the value chain. 'Radical' upgrading can take two forms (Izushi and Aoyama, forthcoming). a) Indigenous firms – including SMEs - can move up to higher

value added activities in the value chain or b) 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 power. The second strategy might be more feasible, but requires a sound knowledge of the market and the competencies to move to a different market segment (diversify).

The systemic propensity of the RIS becomes now a critical factor. Innovation is a socially embedded interactive process (Lundvall, 1992). Firms and individuals do not innovate in isolation but in continuous interaction with other individuals and other organizations and with the users.

If during the first phase interaction was mainly limited to the relationship between the TNCs and the local SMEs, during this second phase the formal and informal networks among SMEs are of utmost importance to support innovation and upgrading. Interaction is not only important as a form of “pooling resources” that are limited for SMEs but as a vehicle to exchange information, knowledge and practices which are needed for the upgrading. By interacting with each other SMEs learn about new markets, new products, techniques etc. And it is this interactive learning what supports innovation and upgrading.
The type of interaction is different than when concerned with in the low-end activities as innovative and R&D activities involve a high degree of uncertainty, tacit knowledge and – potentially – highly valuable knowledge which is difficult to write complete contracts about, thus a stronger reliance on social capital. Strong local social capital is extremely important in this phase (Chaminade, 2004, Chaminade and Vang, forthcoming) as it facilitates trusting 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 collective action problems and thus facilitates the transfer of knowledge. Knowledge is highly embedded in the context.
Interaction with the customer is also crucial. User producer interaction is one of the most important forms of innovation (Lundvall, 1988) especially for certain sectors such as software (Pavitt, 1984). The RIS need to provide the links with the markets (local or international). With few exceptions (Brazil and China) local markets of software in the developing countries are weak. Instead, local firms tend to target the external markets,

usually working for a TNC as the Bangalorian case illustrates. To some extent the access to final international customers can be facilitated by transnational communities. Transnational communities reduce the institutional distance between the home and the host country. It diminishes the transaction costs derived by the access to external markets but there are still several aspects that cannot be bridged. The IP system, for example, still needs to be developed and implemented for software. Additionally, the school system increasingly needs to focus on the requirement of innovations (i.e. thinking out of the box, creativity as opposed to focus on the transmission of technical knowledge.

In sum, it is necessary to think about RIS as dynamic entities, especially in developing countries where well functioning RIS are far from being there. Contrary to what is argued in the 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 absent of a networks between the different components of the system might seriously hamper the development of the region and the local firms.

5. Policy implications – regional vs. central government intervention

Table 1 summarises the main findings of the case. From a policy perspective, one of the clearest conclusions is that the role of the regional and central government also changes over time (and in parallel with the transformation of the strategies of the firms and the RIS). In the initial phases the regional government bodies do not play an important role initially 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

should focus on the supply-side[12], on reducing the transaction costs of for TNCs to outsource or offshore to developing countries[13] and on providing reasonable intellectual property controls:

- On the supply side especially important is a need for an integrated approach stressing the provision of highly qualified human capital with practical skills. It is however not enough to stress the importance of creating a well educated workforce (which includes higher education, but also primary and secondary education systems)
- As discussed earlier the main constraints preventing TNCs to take advantages of the supply of human capital is the transaction costs associated with institutional distances between the home country of the TNC and the host country of the activity (outsourced or off shored activity). In the initial phases, where the objective is to attract TNCs to the region and link them to the local SMEs, reducing this institutional distance is an important policy objective. From a policy perspective, this can be done mainly by reinforcing the national and regional institutions (regulations, patent laws, etc) or training the local firms in the management of inter-cultural differences and targeting the members of the transnational community.
- Finally, the central government needs to develop reliable intellectual property rights that allow the companies outsourcing R&D services to protect their outcome from non-desired copies and other negative spillovers of information. The outcome of an R&D service is a final product, almost ready to be commercialized. In this sense NASSCOM has been crucial in ensuring the intellectual property protection for the Indian software firms (Parthsarathy and Aoyama, forthcoming).

From a knowledge perspective the type of activities involved in software are standardized, hence there is not a strong need for decentralizing the decision power structure. But regional government might play a role in creating incentives to attract the educational and research institutions and the TNCs to their region. In this sense, there are good reasons to

[12] In contexts where education is within the domain of the regions this changes the division of labour between the central state and the regions.

[13] 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 cantered experiences of China and Brazil is called for (Arora and Gambardella, 2004).

allow the regional governments freedom to build education and research institutions (this however can result in increased inequality within the country).

The role of the regional government is more prominent during the second phase where a sound knowledge of the different actors in the system, their competences and their interaction is needed. The regional governments needs to stimulate local networks and the local markets. This calls for a decentralized decision making structure as regional government – given the developed competencies and capacity - possess the local stock of knowledge, especially the 'emerging' needs. In other words, regional governments are likely to play are 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 it 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). Additionally, if regional government bodies are directly involved in setting up and managing education and research institutions they can better be tailored to the need of the (firms in the) region. And probably the regional government bodies will be more sensitive to the SMEs particular needs in this context.

- insert table 1 over here –

6. Conclusions

While the study cannot be generalized it nevertheless provides insights that suggests that the RIS 'policy-template' needs to be modified and more sensitivity to evolutionary aspects should be emphasised[14]. On a general level markets in the initial phase might prove more efficient than assumed by RIS-theorist and thus there might be less need for regional policies as such (apart from those stressing the supply side); and certainly 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 collective learning in the initial phase; collective learning mainly becomes relevant at a time where the indigenous firms have built competencies until a certain level and diversity

[14] For a discussion on how to make regional policy sensitive to industrial differences, see Chaminade and Vang, forthcoming 2006.

(before this there will be diminishing return to collaboration with other indigenous firms as opposed to TNCs). Decentralization is also less urgently called for that suggested by RIS theorists. 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 collective learning. A decentralized decision making structure becomes crucial in the latter phase.

The case clearly 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 local firms, the endowments of the regional innovation system and the international networks. As Saxenian (2001) suggests, upgrading in the 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. The RIS approach allows policy makers to foresee what are the systemic failures of the RIS where policy intervention is most 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.

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Table 1. The transition of a Regional Innovation System

		Stage 1. Competence building	**Stage 2. Innovation and interactive learning**
	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 (integrating 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)
	Entrepreneurship	Not relevant in this initial phase where SMEs are only performing the tasks commissioned by the TNC.	The search and access of new market niches requires strong entrepreneurial services. Entrepreneurship is increasing in embedded software.
	Markets (as main sources of information for innovation)	The majority indigenous SMEs do not have direct access to international markets. Their customer is the TNC who sets the standards of the product & had the contact with the final customers.	The direct access to the final customer becomes critical. Local markets can stimulate innovation in the indigenous companies. In this sense, public procurement could be a good instrument to stimulate the SMEs to use their competencies and create incentives for investing more in these competences.
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 .

Appendix 1

A.T. Kearney Global Services Location Index 2005

Rank	Country	Financial structure	People and skills availability	Business environment	Total score
1	India	3.47	2.14	1.26	6.87
2	China	3.21	1.76	1.17	6.17
3	Malaysia	2.95	1.12	2.00	6.07
4	Philippines	3.58	1.16	1.05	5.78
5	Singapore	1.62	1.44	2.67	5.73
6	Thailand	3.27	0.94	1.51	5.72
7	Czech Republic	2.57	1.12	1.90	5.58
8	Chile	2.73	0.97	1.87	5.58
9	Canada	1.10	2.03	2.40	5.52
10	Brazil	2.91	1.36	1.23	5.50
11	United States	0.54	2.74	2.22	5.49
12	Egypt	3.55	0.96	0.98	5.47
13	Indonesia	3.51	1.08	0.89	5.47
14	Jordan	3.02	0.91	1.43	5.35
15	Bulgaria	3.29	0.86	1.11	5.27
16	Slovakia	2.72	0.96	1.55	5.24
17	Mexico	2.87	1.16	1.19	5.22
18	Poland	2.67	1.06	1.44	5.16
19	Hungary	2.61	0.88	1.63	5.13
20	United Arab Emirates	2.66	0.61	1.85	5.12
21	Costa Rica	2.96	0.97	1.34	5.09
22	Ghana	3.57	0.58	0.93	5.08
23	Argentina	3.14	0.93	0.98	5.05
24	Romania	3.07	0.92	1.05	5.03
25	Jamaica	2.92	1.01	1.10	5.03
26	Vietnam	3.55	0.69	0.76	5.00
27	Russia	2.83	1.31	0.85	4.99
28	United Kingdom	0.46	2.12	2.41	4.99
29	Australia	0.97	1.66	2.29	4.91
30	Tunisia	2.97	0.69	1.20	4.86
31	Germany	0.50	2.10	2.23	4.84
32	South Africa	2.76	0.81	1.24	4.81
33	Israel	1.86	1.22	1.67	4.75
34	New Zealand	1.28	1.19	2.28	4.74
35	France	0.40	2.34	2.05	4.69
36	Panama	2.90	0.65	1.10	4.65
37	Portugal	1.60	0.83	1.80	4.28
38	Spain	0.96	1.50	1.67	4.12
39	Ireland	0.42	1.41	2.25	4.07
40	Turkey	2.14	0.91	0.92	3.97

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