JRC Technical Notes

East Asian Growth:
Policy Lessons from Bangalore, India

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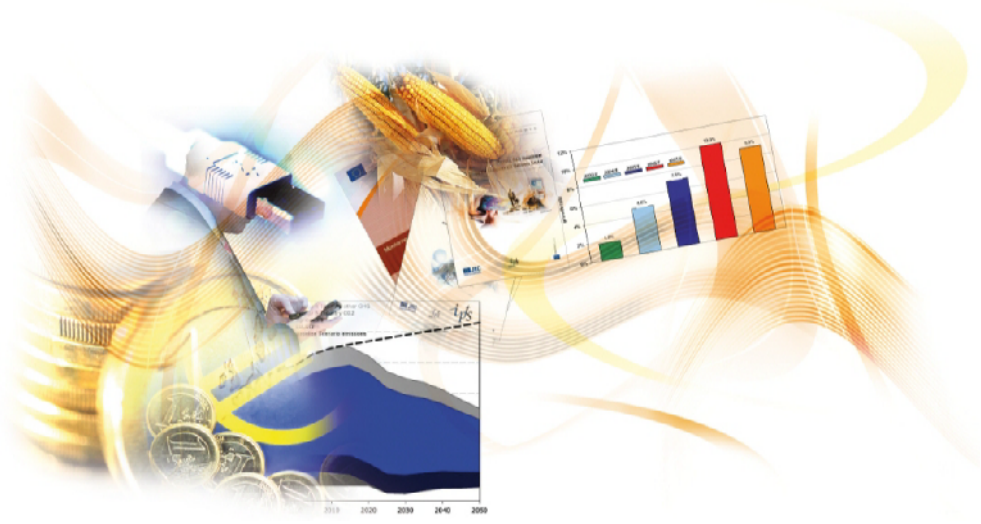

JRC 63989 - 2011

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JRC 63989

Technical Note

Luxembourg: Publications Office of the European Union

Preface

R&D activity in the Information and Communication Technologies (ICT) industrial sectors is an important factor in boosting the competitiveness of the European economy. The ICT industry and ICT-enabled innovation in non-ICT industries and services is making an increasingly important contribution to economic growth in advanced economies. The ICT sector was highlighted in the EU Lisbon Objectives, and has retained its prominence in the recently proposed **Europe 2020 Strategy**.

The Information Society Unit at IPTS[1] is carrying out a research project on Prospective Insights on R&D in ICT (PREDICT)[2] and has produced a series of annual reports. PREDICT combines, in a unique way, three complementary perspectives: national statistics (covering both private and public R&D expenditures), company data, and technology-based indicators. PREDICT relies on the latest available official statistics delivered by Member States, Eurostat and the OECD.

The first part of each annual PREDICT report gathers the most recent quantitative information on ICT R&D investments in the EU and worldwide. It presents the data by countries, sub-sectors and companies. The second part of each report is dedicated to a specific thematic analysis. In 2010, it focused on the internationalisation of ICT R&D.

This thematic analysis is based, in part, on an earlier study which focused on the ICT sector and R&D in East Asian countries in order to gain a better understanding of major ICT capabilities in those parts of the world.[3] The present report provides a synthesis of one of those studies.

This overall research exercise on internationalisation led to a series of further reports. All of them are available on the IS Units website of the IPTS.[4]

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1 IPTS (the Institute for Prospective Technological Studies) is one of the 7 research institutes of the European Commission's Joint Research Centre.

2 PREDICT is co-financed by JRC-IPTS and the Information Society & Media Directorate General of the European Commission.

3 This report was commissioned during the period 2005-2007 by JRC-IPTS as part of the study "Towards Knowledge-based Societies. ICT for Growth and Cohesion in a Global Knowledge-based Economy: Lessons from East Asian Growth Areas". The research consortium included Frans van der Zee (TNO), Simone Kimperle and Thomas Stahlecker (Fraunhofer ISI) and several non-European PhD grantholders. It was coordinated by Professor G.N. Von Tunzelmann from SPRU, University of Sussex, UK to whom JRC-IPTS is very grateful.

4 Available on our website under the link http://is.jrc.es/pages/ISG/PREDICT.html

Table of Contents

1. Introduction[5]

The purpose of this study is to investigate the hypothesis that firms and regional innovation systems (RISs) in Asia are moving from competing on costs to competing by providing unique knowledge and to discuss the related policy consequences. Regional Innovation Systems (RISs) in developing countries have increasingly been conceptualised as specialized hubs in globalized innovation and production networks (Asheim et al. forthcoming). In these global networks, RISs in developing countries have then been traditionally associated with the lowest value-added producing activities.[6] However, a few RISs in developing countries are beginning to challenge this interpretation by raising the kinds of value-added (functional upgrading) and/or using the competencies acquired in the initial phases of development for moving into related industries (intersectoral upgrading). There is still only a poorly developed understanding of how the system of innovation evolves to support this transition process and how public policy could build the necessary regional conditions to support the needs of the SMEs in this transition process. This study aims to improve this understanding.

This study applies the regional innovation systems approach. RISs can be seen as a "constellation of industrial clusters surrounded by innovation supporting organizations" (Asheim and Coenen 2005). 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 recent adaptation of the RIS approach to the Asian context (Vang and Asheim 2006) will be used as a departure point in the discussion.

The study focuses on the transition of the Bangalore's software regional innovation system (RIS). Bangalore has become one of the most important IT clusters outside the OECD countries (Arora and Gambardella 2004). Bangalore is an interesting case since it has grown up from scratch without localised lead users pulling the demand for technologies and has managed to sustain the world's highest growth rates within the industry (ibid.). During the 1980s and 90s, the combination of easy access to qualified and relatively cheap technical human capital attracted a number of transnational corporations (TNCs), which have stimulated very strong development in the IT software industry, either through outsourcing of routine activities or though establishing offshore subsidiaries. Our main concern is to

5 Acknowledgements: We thank Hubert Schmitz, Carlo Pietrobelli and Parthasarathi Banerjee for their comments and suggestions on earlier versions of this study.

6 In IT, for example, testing of software, standard programming, and so forth.

understand how this RIS has evolved (and needs to evolve) to support the upgrading process of indigenous SMEs and, as regards the policy implications, how the government can stimulate the development of such a system.

The main argument of the study is that upgrading to higher value-adding activities is only possible when there is an environment that supports interactive learning and innovation. 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 (Chaminade and Vang 2006a, b). How these two components are built over time and what is the impact on the firms located in the region remains a question to be answered. Furthermore, little is known about how the system of innovation evolves over time and in relation to the upgrading strategies of the firms located in the region.[7]

The structure of the paper is as follows. First the Bangalore RIS is described, paying particular attention to the role of Bangalore in the global value network. Then the evolution of the RIS is examined in the context of Bangalore and the implications for RIS literature discussed. We will pay special attention to how competences are accumulated in the region (in particular, we will investigate the role of the external linkages of the region and the cluster, that is, the role of TNCs and transnational communities in building competences in the indigenous firms). This is followed by a section which tries to tease out some case-specific policy lessons on building RIS in developing countries. Then we highlight some central conclusions.[8]

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

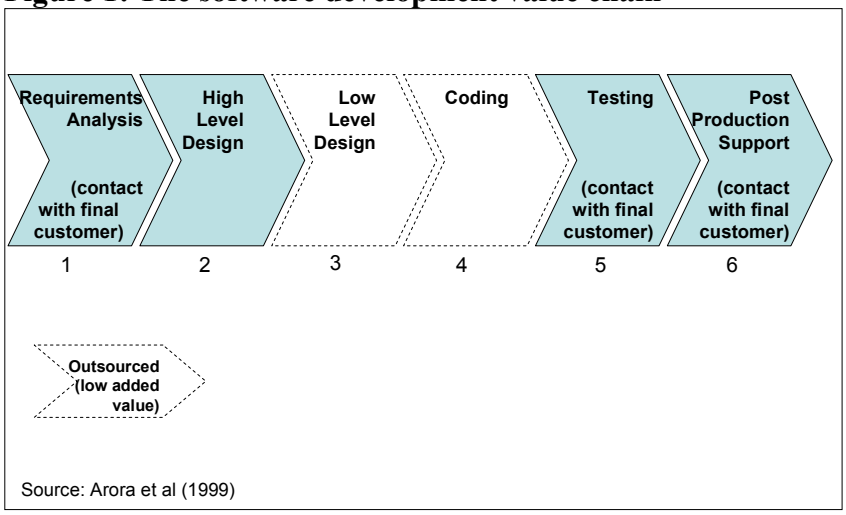
[8] Due to restrictions on the length of the study, the theoretical discussion has been significantly reduced. The complete theoretical framework can be found in Vang and Chaminade (2006) available at: www.circle.lu.se

2. Bangalore – India's leading software cluster

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). Exports have typically grown by more than 30% annually while revenues have grown at 30-40%. According to the NASSCOM-McKinsey Study (2005), India has an estimated share of 65% of the global IT services offshoring segment and around 46% of the global BPO market.

Bangalore has maintained its position as the dominant software cluster in India well ahead other regions in the country (www.bangalore.it). Bangalore software firms are now capable of providing the most advanced IT services, and some indigenous firms have started to outsource to other cheaper emerging clusters. Bangalore's 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. However a closer look at the statistics shows that most of the exports are due to software services toward the low end in terms of value-added. Figure 1 plots the software development value chain.

Figure 1: The software development value chain



Source: Arora et al (1999)

3. The two phases of development in software services

Until very recently, Indian firms have been competing in global value networks 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 rising 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 levels of the human resources and costs. However, little attention has been paid to the role of the RIS in supplying the resources (hard and soft) needed to sustain the growth of the industry and support the transformation of the firms located there. In this study we will focus on the formation and evolution of the RIS in Bangalore and its role in providing the (hard and) soft resources needed by the indigenous firms.

Roughly speaking, we can talk about two different phases in the development of the software 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 means to upgrade value.

3.1 Phase 1: Offshoring and outsourcing - the competence-building phase

The software industry has since its emergence been dominated by US firms although the type of interaction between the indigenous firms and the TNCs has changed significantly over time.

In the initial phase many small new firms specialized in the provision of body-shopping services[9] – that is sending software programmers to the (US) client to provide maintenance services (Arora et al. 1999, 2001). Despite the criticisms that this strategy has received over time, 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 gradually started to 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

[9] Body-shopping was explicitly recognised in the Computer Policy of 1984 (Saxenian 2001).

between the TNC and the indigenous firm providing the software services, as Figure 2 shows. To explain adequately how trust was built (therefore allowing the critical transfer of competencies) it is necessary to understand the role of members of the Indian transnational community in the US.[10]

Several members of the Indian community held important positions in US firms. These members played a significant role in shaping the outsourcing and offshoring decisions in the US firms as the following examples illustrate (Vang and Overby 2006).

Large institutional distances 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 division within Motorola was willing to risk sourcing its software needs from MIEL. Ramachandran and Dikshit (2002, cf Vang and Overby 2006) 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". Although the first project 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 for which Motorola was famous. International social capital (in the structural sense) was 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.

Hence, the Indian transnational community in the US played a crucial role in the development phase of the Indian software industry. It reduced the institutional distance between India and

[10] 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 granted by the US government (special visas for experts) and half of them (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).

the US, building trust and supporting outsourcing and offshoring strategies to Bangalore. As acknowledged by Parthsarathy and Aoyama (forthcoming) the cooperation with the TNCs induced both process and functional upgrading in the indigenous SMEs.

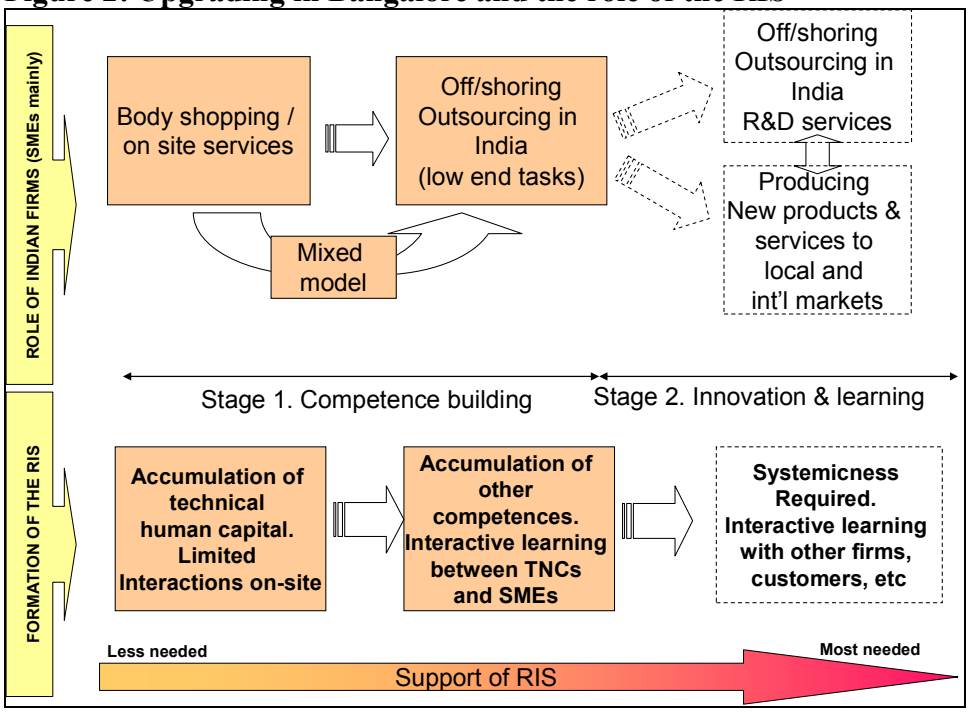
During this first phase the RIS of Bangalore started its formation. Basic blocks such as universities, business sectors and local and international linkages (Galli and Teubal 1997), as well as strong linkages between the indigenous SMEs and the TNCs, emerged and developed during this initial phase setting the grounds of the RIS.

One of the most important building blocks of the Bangalore RIS was the high number of educational and research institutions located in Bangalore. Bangalore is considered to be the scientific and engineering centre of India in terms of research, training and manufacturing. India's best research university, the Indian Institute of Technology, is based in Bangalore and today Karnataka state has a total of more than 65 engineering colleges (albeit of varied quality). So there was a concentration of education and research institutions in the region.[11]

When the development of the software industry in Bangalore started, Bangalore already had a dense organizational setting; Bangalore was the centre for advanced science and military research – this was mainly for physical geographical reasons such as unpolluted air that which was needed for military testing. Even the government had located the public telephone company in Bangalore as well as other large state enterprises in high-tech sectors (Chaminade and Vang 2006). So Bangalore became the dominant location for outsourced and offshored software-related activities because of the existence of an emerging RIS based on the concentration of highly skilled labour and specialized firms in the region.

[11] As Arora and Gambardella (2004) acknowledge, "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 US 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 US was probably eight to ten times larger than the IT workforce in India."

Figure 2: Upgrading in Bangalore and the role of the RIS



The provision of highly qualified human resources together with the co-location of a great number of educational and research institutions and high-tech clusters set the grounds for the emergence of the RIS. Although the local interactions among the indigenous firms were almost absent, SMEs developed strong linkages with the TNCs located in the region, particularly during the offshoring and outsourcing phase. The regional advantages provided by Bangalore could explain the initial interest of the US firms in locating their outsource activities in the region.

What has been the role of the government in creating the regional conditions that facilitate the emergence of the Bangalore RIS? After the initial policy failures the central state's policies did play an important role of creating the conditions making India and particularly Bangalore an attractive location; the initial support from the central government was dismantling the rather counterproductive ISI strategy.[12] This resulted in the development of a more pro-export 'hands-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.

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

[12] Though it should be remembered that Tata and other indigenous firms were established during the ISI phase.

industrial and innovation capacity of the region has been very limited (Van Dijk 2003; Parthasarathy 2004a). That the Bangalore firms have to some extent been capable of raising their contribution to global value networks is thus the result of a deliberate strategy of the transnational firms 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 (i.e. it is the result of private initiatives rather than public). The question now is how these accumulated competences in the firm and in the region can be used to upgrade further in global value networks.

3.2 Phase 2: Towards an innovation phase?

As the Bangalore software RIS has matured, both Bangalore and US firms have improved their competences in handling outsourcing and offshoring, built 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).

The broader knowledge base combined with the existence and gradual build-up of reputation in the US market plus an aggressive certifying strategy among most Indian firms is allowing some firms to move into 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. 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.[13]

[13]. 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 value-adding 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). Embedded software is a particular branch of the industry which combines hardware and software. It is designed 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 gained a reputation internationally. Innovation has been stimulated by a growing number of start-ups that specialized exclusively in R&D services targeting niche markets (combining upgrading of value-added 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 (p.23) indicate that "local networks are being developed among domestic firms in Bangalore, in

Higher 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 1, 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 are estimated to grow to US$9.2 billion by 2010" (NASSCOM 2005; PTI 2004; quoted from Parthasarathy and Aoyama forthcoming).

Offshoring or outsourcing R&D projects to India/Bangalore involves larger challenges than outsourcing/offshoring standardized and routine activities as in the past. The former activities are sequential, can be decomposed and codified. This is not the case for the R&D activities (Nelson and Winter 1982) as markets for information, knowledge and technology (Arora et al. 2000) are riddled with imperfections derived from the culturally specific, embedded, tacit and firm-specific knowledge associated with R&D activities. Three central challenges, related to institutional distance, constrain the outsourcing or offshoring 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 US-Indian context 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 are considerably lower than of routine activities as they carry additional transaction costs, communication costs as well as higher risks (in a context where there 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) and 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-existent in India apart from 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

part because of the emergence of local business opportunities and in part because of a greater interest among firms to exploit new opportunities".

at no cost. In this sense, offshoring of software R&D is riskier than any other forms of outsourcing.

3.2.1 A well functioning RIS supporting innovation?

The question here is whether the existing RIS based on strong educational institutions, high concentration of firms, and strong interactions between TNCs and SMEs but weak horizontal linkages among SMEs and with the users can support this emerging trend.

Apart from formal competencies which several Indian firms have by now – the activities to the left end of the software development value chain require *interactive learning from the end-users* (and lead users); firms need to interact closely with the end-user and possess great technical capability and deep knowledge of 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 in collaboration with TNCs or with members of the transnational community located in those OECD countries.[14] Thus, TNCs and trans-national communities can continue playing an important role in this second phase. Additionally, the upgrading strategies of indigenous firms have been constrained by the lack of *interactive learning and cooperation between the indigenous firms in Bangalore* (Parthasarathy 2004b); by collaborating SMEs can generate economies of scale and scope, which are necessary to accumulate competences and increase the value-added.[15] In the successful case of the embedded software industry SMEs have been able to provide final products to the TNC by assembling different modules that were developed by other firms (Parthasarathy 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 an R&D service.

Furthermore, informal social networks are also quite frequent in the embedded software segment. However, this type of interaction observed in the embedded software segment is not yet frequent in the software industry in general, compared to a more bustling IT cluster such as Silicon Valley. The lack of collective learning can partly be explained by formal

[14] 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., exports account for 65% of the software revenues) and these numbers are growing.

[15] 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).

constraints imposed on the Indian subcontractors (e.g. 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 2006), social capital in the cluster is very weak and (at most) limited to the networks of alumni associations. SMEs fail to see that Bangalore will only become attractive for TNCs to offshore their R&D activities if 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).

Innovation is based on interactive learning among firms, and between firms and the final customer. The analysis of the emerging Bangalore RIS shows that none of the two types of interactions is really strong in the system yet. 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 the private initiatives. Some interesting initiatives seem to be taking place in this direction. NASSCOM is quite active in promoting the development of local entrepreneurial networks (Parthasarathy and Aoyama forthcoming) which is promising as entrepreneurial organizations and bridging institutions have traditionally been very good vehicles to stimulate the collaboration between SMEs, even when no prior collaboration existed (Chaminade 2004).

3.2.2 The role of the government in supporting innovation and interactive learning

The role of the government in supporting interactive learning and innovation, albeit critical in this phase, is almost absent in the Bangalore case. The idiosyncratic character of the R&D activities as opposed to routine activities pleads 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 Bangalore RIS.

Policies could stimulate collaborations by, for example, 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 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 a lead customer) (Arora and Gambardella 2004). This has been done in India on 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.[16] 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. Furthermore, there is a need to reconsider the playing field so that IT products and services sold in the domestic market enjoy the same tax benefits as those currently enjoyed by exported goods and services (Saxenian 2001). Otherwise there will be fewer incentives for the independent firms to sell in the local markets.

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

4. Building RIS in developing countries: 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 shows is that systems in developing countries are developed over time, in close interaction with the strategies of the indigenous firms, the government and the transnational corporation.
The RIS emerges when the region starts accumulating competences and key organisations (universities, research centres, and businesses). In the initial phases those competences are hardly connected to each other, that is, the systemic-ness 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 is central. Focus on the supply side (human capital) allows for maintaining cost advantages in combination with incremental minor upgrading of value-added.

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. However this is not sufficient for firms to move further to the left along the software development value chain. The systemic propensity of the RIS (interactions) now becomes a critical factor.

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. R&D activities involve a high degree of uncertainty, tacit knowledge and – potentially – highly valuable knowledge for which is difficult to write complete contracts, thus needing 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, decreases transaction costs, increases the quantity and quality of information, facilitates coordination and diminishes collective action problems facilitating the transfer of knowledge (Vang and Overby 2006).

Interaction with the customer in the innovation phase 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). With few exceptions (like 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 Bangalore case illustrates. To some extent the access to final international customers can be facilitated by transnational communities 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 and creativity as opposed to focusing on the transmission of technical knowledge).

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 formation of the RIS). In the *initial phase* the regional government bodies do not play an important role at first 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 central state however should ensure sound macro-economic policies (e.g. low inflation) and non-discrimination of exports and imports, possibly with selective measures protecting infant industries. Central state policies should focus on the supply side,[17] on reducing the transaction costs for TNCs to outsource or offshore to developing countries, and on providing reasonable intellectual property controls.[18]

- On the supply side, there is a need to adopt an integrated approach, stressing the provision of highly qualified human capital with technical and managerial skills. However creating a well-educated workforce (which includes higher education, but also primary and secondary education systems) is not enough.
- As discussed earlier the main constraints preventing TNCs from taking advantage of the supply of human capital are the transaction costs associated with institutional distances between the home country of the TNC and the host country of the activity (outsourced or offshored activity). In the initial phases, when 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.

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

[18] We do not suggest that there is only one way grow in the initial phase. Further research is needed on analysing the contrasting experiences of the home-market centred experiences of China and Brazil (Arora and Gambardella 2004).

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 of indigenous SMEs do not have direct access to international markets. Their customer is the TNC who sets the standards of the product & has the contacts 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 them.
International links	Transnational corporations	The focus in this first phase is to attract transnational corporations. TNCs play a significant role in the RIS, as they link the indigenous SMEs with 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 competencies) in the local SMEs.	SMEs and TNCs could collaborate in the provision of 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.

- Finally, the central government needs to develop reliable intellectual property rights that allow companies outsourcing R&D services to protect their outcome from non-desired copies and other negative spillovers of information. In this sense NASSCOM is very active in promoting the intellectual property protection of the software produced in India (Parthasarathy and Aoyama forthcoming).

From a knowledge perspective the type of activities involved in software are standardized, hence there is no strong need for decentralizing the decision power structure. But regional government might play a role in creating incentives to attract and maintain high quality educational and research institutions, and to attract TNCs to their region. In this sense, there are good reasons to give the regional governments enough autonomy to build education and

research institutions in their region (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 interactions is needed. The regional government 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 capacities – possesses the local stock of knowledge, especially the 'emerging' needs.

In other words, regional governments are likely to play a more conducive role facilitating the upgrading process as they have the incentives for dedicating themselves to the needs of their particular region (though even a region like 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 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.

6. Concluding remarks

While generalisations cannot be made from this study, it nevertheless provides insights that suggest that the RIS 'policy-template' needs to be modified to emphasise the evolutionary aspects and the interaction between RIS formation and development and the strategies of the indigenous firms.[19] On a general level, markets in the initial phase may prove to be more efficient than is assumed by RIS theorists and thus there may 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 less need for policies which emphasise social capital formation and collective learning in the initial phase. Collective learning mainly becomes relevant when the indigenous firms have built competencies to the level where they require upgrading (before this point, there will be diminishing returns from collaborating with other indigenous firms as opposed to TNCs). Decentralization is also less urgent than is often suggested by RIS theorists – at least, in the initial phases. However, in the second phase, reliance on markets seems less convincing as market imperfections constrain distance collaborations. Additionally, the incentives for distance collaboration are smaller as cost differences are minor. Thus while there is a need to upgrade human capital (maintaining focus on the supply side), government public procurement policies become central for compensating for market imperfections 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 RIS. 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 RIS and the international networks. As Saxenian (2001) suggests, upgrading requires moving away from 'replication' of successful models (e.g. Silicon Valley) to new pathways that respond to the specific conditions of each region. The RIS approach allows policy makers to foresee where policy intervention is most needed. In the case of Bangalore, it highlights the future of the IT Bangalore cluster in global value networks. We argue that if there is no clear investment in the systemic propensities of the RIS, the possibilities of the indigenous SMEs to upgrade may be seriously limited.

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

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European Commission

JRC 63989 – Joint Research Centre – Institute for Prospective Technological Studies

Title: East Asian Growth: Policy Lessons from Bangalore, India

Authors: Jan Vang and Cristina Chaminade

Luxembourg: Publications Office of the European Union
2011
Technical Note

Abstract

This study aims to investigate the hypothesis that firms and regional innovation systems (RISs) in Asia are moving from competing on costs to competing by providing unique knowledge. RISs in developing countries have been traditionally associated with the lowest activities in terms of value-added. However, a few RISs in developing countries are beginning to challenge this, by carrying out functional upgrading and/or intersectoral upgrading. The study addresses the poorly understood issues of how the system of innovation evolves to support this transition process and what is the role of public policy.

Bangalore has become one of the most important IT clusters outside the OECD countries. It is in the process of evolving from a low-cost supplier of outsourced and offshored software, an old growth model that appears less sustainable over time, considering the rising salaries in India and the emergence of competing countries such as China. Bangalore is thus trying to support the upgrading of indigenous SMEs, where higher value-adding activities are possible only when there is an environment that supports interactive learning and innovation, which in turn require both human capital and social capital (or networks) to be present in the regional system of innovation. Higher-value activities involve the design and prototyping of new products or systems, which are considered as R&D software services. Strong local social capital is extremely important in this second phase.

With some important exceptions and the provision of research institutes in the area, the role of the government in building the industrial and innovation capacity of the region has been very limited. The analysis of the emerging Bangalore RIS shows that interactive learning is not really strong in the system yet, either among firms or between firms and the final customer. 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 the private initiatives. Some interesting initiatives seem to be taking place in this direction. A more decentralized governmental intervention (i.e. increasing role of the regional government) seems warranted. More use might also be made of public procurement as an instrument to stimulate experimentation and innovation in the local firms (i.e. the government as a lead customer). Upgrading requires moving away from 'replication' of successful models (e.g. Silicon Valley) to new pathways that respond to the specific and systemic conditions of the individual region.

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