Harnessing Asian Capabilities for Transforming the Electronics and IT Sectors:

Recent Trends, Challenges and a Way Forward[1]

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Introduction

Path-breaking changes in electronics technology in general and microelectronics in particular have given birth to the Information Technology (IT) revolution and its related innovations. In the closing decades of last century, the IT revolution facilitated not just technological changes, but also far-reaching institutional changes as seen through deepening globalization processes (Soete 2006).

Perhaps there is no other region like East Asia, which took advantage of the microelectronics revolution and rise of export-oriented production, preludes to today's IT revolution and globalization. A considerable body of work indicates that outward-oriented economic policies, accompanied by a catalytic role for foreign firms and targeting of global production networks, within a context of activist state policy has been at the core of the East Asian Miracle (Ernst and Kim 2002, Rodrik 1992, Sen 1983). Drawing inspiration from the development experience of Southeast Asian countries, many less developed countries, especially in Asia, are striving to promote industrial transformation by developing their electronics and IT production base and promoting the use of IT. The moot question is "How rocky is the road ahead for these countries?"

As globalization processes and the IT revolution gained momentum, there were significant changes in the organization of electronics production that led to the establishment of Global Production Networks (GPN), which later evolved into Global Innovation Networks (UNCTAD 2005). This was facilitated to a great extent by the formation of the World Trade Organization, which led to the widespread dismantling of barriers to trade and investment. For IT goods, this was further accentuated by the Information Technology Agreement (Joseph and Parayil 2008).

These developments also encouraged Outward Foreign Direct Investment (OFDI) from developing nations, such as China, India and other countries, with a view to further strengthening

[1] Francis Hutchinson (2012) *Architects of Growth: Subnational States and Industrial Transformation in Asia*, Institute of Southeast Asian Studies, Singapore.

their technological capabilities and enhancing their market access (Pradhan 2004, Kumar and Chadha 2009). The process of trade and investment liberalization was further accentuated with the etablishment of a multitude of regional trading agreements (UNCTAD 2004). One notable case with regard to electronics has been the e-ASEAN Framework Agreement, which involved liberalized trade and investment on the one hand and capacity-building of the other (Joseph 2006).

All these processes resulted in an unprecedented rate of increase in trade and investment between countries in the South in general and Asia in particular (UNCTAD 2005b). Given that the world economy is now more open and integrated, the international division of labour is now much less constrained than previously. Moreover, for developing countries, an open world economy facilitates the importation of ideas, technologies, and know-how that can be used to establish production capabilities even in high-technology sectors such as electronics.

However, the purchase of technology is not a panacea. As argued by Freeman (2011), the purchaser always receives a more reduced information set than that possessed by the seller. Therefore technologies cannot simply be taken off the shelf and put into use effortlessly. Without a functioning infrastructural base accompanied by investment in education, training, R&D and other scientific and technical activities, very little can be accomplished by way of assimilation of imported technologies. Hence the key issue, and central concern of this paper, relates to the current positioning of those developing countries aspiring to develop their electronics production base, in terms of their ability to offer a conducive institutional environment and infrastructural facilities for achieving their intended goals.

The remainder of this chapter is organized as follows. Section two presents the analytical framework, which articulates the bearing of a country's trade and investment regimes with its institutional architecture and infrastructural facilities (both human and physical). Section three examines the implications for industrially-aspiring sub-national states of recent developments such as the advent of Global Production and Innovation Networks, as well as the emergence of new players from Asia as sources of outward foreign direct investment. The last section presents a perspective wherein, apart from highlighting the need for building an institutional architecture at the sub-national and sectoral level, a call is made for an e-Asia Framework Agreement that involves not only liberalized trade and investment but also built-in provisos for capacity building (technological, physical and human) at the sub-national level within the framework of South-South Cooperation.

1. Analytical Framework

The successful pursuit of industrial transformation assumes key importance given that available information indicates that the returns to globalization and integration with global production and innovation networks have been unevenly distributed. The East Asian 'Tigers' of Singapore, South Korea, and Taiwan have been able to build up their technological capabilities, successfully moving from the status of Original Equipment Manufacturers (OEM) to Original Brand Manufacturers (OBM) (Hobday 1994, 2002). In turn, they have emerged as major sources of OFDI in their own right. Beyond establishing a solid IT hardware production base, they have successfully harnessed information technology for development by ensuring its diffusion to different sectors of their economies and societies.

However, in the cases of Thailand, Malaysia, and Indonesia, their successful entries into various electronics global production networks has not been matched by a commensurate ability to develop a software base or harness IT for Development. Based on a detailed analysis of the electronics industries in Southeast Asia, Ernst (2001) argued that, due to the 'sticky' specialization of exportable commodities, simple export-oriented production can no longer guarantee sustained growth and welfare improvement. Moreover, a narrow domestic knowledge base has led to limited industrial upgrading and limited backward and forward linkages. Evidence also indicates that IT-induced prosperity in general and electronics production in particular has been confined to a few locations, leading to an enclave type of development and contributing towards widening regional and personal inequalities (Joseph 2006).

Based on various studies, Ernst (2001) argues the need for industrial upgrading in most Southeast Asian countries. The issue of industrial upgrading is the most pertinent for countries that remain at the low end of the global production network. However, for a large number of countries, the development of an electronics production base, as well as broader IT-based development, remains a distant dream. In these cases, the key is to identify the strategies that will enable them to make an entry into a global production network.

While addressing recent trends and their implications for industrial transformation at the sub-national level, it is important to have an understanding of the significance of the electronics sector in the ongoing IT revolution. Though the relative share of hardware components has declined over time, as Ernst (2001) rightly remarked, both are complementary and need each other. Hence, it is necessary to have a fair understanding on the ways and means by which electronics contributes to development in general and industrial transformation in particular. This may be viewed broadly at two levels: (a) on account of the growth of electronics sector – the hardware and software; and (b) on account of its contribution towards facilitating IT-induced prosperity. The former refers to the contribution in output, employment and export earnings from electronics which has been well-documented in many East Asian countries. The latter refers to the fact that, without hardware, the IT software alone cannot deliver increased efficiency productivity and competitiveness through facilitating information exchange and reducing transaction costs.

However, in recent literature on IT and Development, the focus of attention has been essentially on IT use and only limited attempts have been made of examining policies towards electronics production and diffusion of IT. As argued by Mytelka and Ohiorhenuan (2000), the often-suggested strategies place developing countries in a situation of perpetual *attente* – waiting for the transfers of technology from the North and focusing their attention on the need to attract multinational corporations to their shore. The studies on technology diffusion, however, have shown that, along with demand-side factors, supply-side factors are also important determinants of diffusion. Hence, the greater domestic availability of electronics goods acts as a catalyst in the process of diffusion. Therefore, enhancing the diffusion of IT need not imply a neglect of electronics production. To the extent that the present levels of income are important determinants of IT use, there is no reason why sub-national states need to forgo the income earning opportunities offered by the production of electronics goods, which could also be instrumental in industrial transformation at the sub-national level.

Production of IT goods and services: Challenges and potential

Studies have shown that in the US, where the macroeconomic benefits of IT revolution are already apparent, the electronics sector accounted for about 8.3 percent of the GDP and nearly a third of GDP growth between 1995 and 1999 (US Department of Commerce 2000). Electronics production also contributed to lowering inflation rates, since a growing proportion of economic output has been in sectors marked by rapidly falling prices.[1] Benefits from electronics production have not been confined to the US alone. As already noted, the electronics sector has shown to be a major source of economic output, exports and job creation in countries like South Korea, Singapore, Taiwan and others. Therefore, it appears that sub-national states in the developing world could gain a great deal by focusing on the production of electronics, instead of the present lop-sided approach towards IT use.

It has, however, been argued that, given the electronics sector's very high entry barriers, it is not necessarily an easy proposition for aspiring sub-national states in the South to enter global production networks. For example, industry segments such as microprocessors and key types of electronic equipment are almost closed because standards are set by leading IT players, mainly US companies such as Intel, Cisco and others. Other segments of the electronics industry are highly capital-intensive, scale-intensive and require specialized skills that only a few countries and regions can hope to achieve (Kraemer and Dedrick 2001). Moreover early entrants such as Singapore, Hong Kong, South Korea, Taiwan, and Ireland have preempted many of these opportunities by securing strategic positions in many GPNs.

While there is some merit in the above argument, a closer look at the characteristics of the electronics sector reveals that the doors are not that firmly closed for newcomers. The electronics sector is a multi-product industry and is characterized by a wide range of GPNs dedicated to each. In broad terms, the sector may be divided into two categories – equipment and components. Electronics equipment may be separated into consumer electronic products and electronic capital goods, although this distinction is increasingly getting blurred. The former comprises audio and video equipment and other consumer equipment. The latter, in turn, comprises the following broad categories: medical equipment; control instruments and industrial electronic equipment; computers; and communication equipment. Each of these broad categories are comprised of a large number of sub-groups and final products. Similarly, the electronic components sub-sector may be broadly divided into: active components; passive components; and electro-mechanical components. In each of these broad categories there are again a large number of products. Thus, there are a wide range of products that come under the electronics sector and they vary in terms of technological sophistication, dynamism and investment requirements (Joseph 2006; 1997). In addition, the demand for electronic goods is likely to increase as the rate of IT diffusion increases both in the developed and developing world. Therefore, the key issue in the context of recent developments is to locate the factors that facilitate the ability of aspiring sub-national states to profitably enter electronic hardware production networks.

Facilitators of Electronics and IT production

Trade and Investment

Analytically, it can be argued that trade policy reforms play a dual role. They are instrumental in promoting both the use and production of IT by operating from both the demand and supply sides. From the demand side, as Kraemer and Dedrick (2001) argue, one of the best ways to promote IT use is to avoid or reduce barriers to use. Needless to say, any government policy that makes electronic goods more expensive, especially in countries where affordability is a crucial issue, will discourage its use and reduce the possible benefits from IT. Thus trade policy reforms, in the form of lowering taxes and tariffs and dismantling non-tariff barriers, can have the effect of promoting demand and use. Trade policy reforms also ease domestic supply constraints and create a more competitive environment, leading to lower prices and better quality products and, thus, promoting the use of IT.

The influence of trade policies on the development of electronic goods production is due to the nature of the production process itself. In an assembly-oriented industry like electronics, production essentially involves assembling a number of components and sub-assemblies based on a design. The production of needed components and sub-assemblies may be highly skill-, capital- and/or scale-intensive such that no country has the capacity to produce all the needed components and other accessories. Hence, there is a need for segmenting the production process across different locations. This is what led to the emergence of global production networks.

Thus, in global production networks, each component or sub-assembly task is made or carried out in different locations, according to their respective comparative advantage. This essentially means that production in any country will call for significant imports and the bulk of the output will have to be exported to other countries rather than sold in the domestic market. Hence, if production and therefore investment in electronics is to take place in a specific country, the trade regime needs to enable the free flow of inputs into and outputs out of the economy. This explains, at least to some extent, why India – which had an electronics industry with production levels higher than South Korea in 1971- lagged behind as it followed a restrictive trade regime (Joseph 1992).

In the case of electronics production, the link between trade and investment notwithstanding, it has been shown that local capabilities are critical for attracting investment and promoting production. In a context where low-cost labour is taken for granted, the ability of developing countries/regions to participate in global production networks is governed by their ability to provide certain specialized capabilities that the TNCs need in order to complement their own core competence (Lall 2001, Ernst and Lundvall 2000). Countries and regions that cannot provide such capabilities are kept out of the circuit of global production networks, regardless of their trade regime.

Cantwell (1995) also argued that MNCs, in recent years, have followed knowledge-based asset-seeking strategies to reinforce their competitive strengths. Hence, from the perspective of developing the electronics industry at the sub-national level, a liberal trade regime constitutes a necessary, but not sufficient, condition. More importantly, to eliminate the risk of getting trapped at the low end of the value chain and to facilitate movement along the continuum of Original Equipment Manufacturer (OEM) to Original Brand Manufacturer (OBM) and finally to Original Design Manufacturer (ODM) (Hobday 1994), there is the need for building up an innovation system while simultaneously pursuing a liberal trade and investment regime.

In a similar vein, a survey by Saggi (2002) concludes that the absorptive capacity of the host country is crucial for obtaining significant benefits from FDI. Without adequate human capital or investment in R&D, spillovers from FDI are unfeasible. This calls for complementing liberalized trade and FDI policies with appropriate policy measures and institutional interventions with respect to education, R&D, and human capital such that learning capabilities are enhanced in all parts of the economy. This is the central concern of studies on innovation systems. In this context, as argued by Bresnahan et al (2001), the initiatives needed to enable an entry into electronics GPNs may be more arduous compared to those needed to upgrade the position of those already in a production network.

Innovation System

It is by now recognized that an economy's ability to bring about industrial transformation, especially by harnessing a knowledge- and skill-intensive sector such as electronics in a sustained manner depends, to a great extent, on its National System of Innovation (NSI). While the historical roots of the concept of NSI can be traced back to the work of List (1841), the modern version of this concept was introduced by Lundvall (1985) in a booklet on user-producer interaction and product innovation.

Freeman (1987), while analyzing the economic performance of Japan, brought the concept to an international audience. He defined a National Innovation System as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (p.1). This definition highlights the processes and outcomes of innovation.

Since then there has been burgeoning literature (Lundvall 1992, Nelson 1993, Freeman 1995, Edquist 1997) focusing on different dimensions of the innovation system.[2] Based on the evolutionary approach to innovation, Nelson and Winter (1977, 1982), Nelson (1981, 1995) Carlsson and Stankiewiez (1995), and Carlsson et al (2002) have advanced the technological systems approach focusing mainly on the generation, diffusion and utilization of technology.

The NSI framework was further enriched by studies on regional systems of innovation (DeBresson, 1989, DeBression and Amesse 1991) and sectoral systems of innovation (Breschi and Malerba 1997, Malebra, 2002). Thus the innovation system may be supranational, national, regional or sectoral. These approaches complement rather than exclude each other and selection of the system of innovation should be sectorally- or spatially-delimited depending on the context and object of study (Edquist 1997).

As regards industrial transformation at the sub-national level, Regional Innovation Systems (RIS) appears to be an appropriate conceptual framework. An RIS is defined as a 'constellation of industrial clusters surrounded by innovation supporting organizations' (Asheim and Coenen, 2005). Viewed in this manner, it goes beyond industrial clusters, which simply refer to the geographic concentration of firms in the same or related industries (Porter, 1998; Pietrobelli and Rabellotti, 2004). Drawing insights from geography, the concept of RIS was developed on the basis of, and inspired by, successful regions and clusters such as Silicon Valley (Cohen and Fields, 1998; Saxenian, 1994), Baden Württemberg (Staber, 1996) and the Third Italy (Beccatini, 1990; Piore and Sabel, 1984). Hence most of the literature on regional innovation systems reflects the traits and characteristics of the developed world.

An RIS according to Andersson and Karlsson (2004), is comprised of two components.

- The regional production structure – comprised of individual firms and their networks.
- The regional supportive infrastructure – comprised of all institutions that support economic activity and innovation such as government agencies, research institutes, technology centres, and so forth.

Thus, across the different interpretations, the RIS approach stresses the systemic dimensions of the innovation process and the dynamic interaction between the different components of the system – individuals, organization and institutions (viewing innovation as an evolutionary, path dependent and interactive process - and not a linear one).

To the extent that the focus of present discussion is on a specific sector, insights from sectoral innovation systems can also be of great utility. A sectoral system of innovation and production is a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products. A sectoral system has a knowledge base, technologies, inputs and an existing, emergent and potential demand. The agents comprising the sectoral system are organizations and individuals (e.g. consumers, entrepreneurs, scientists). Organizations may be firms (e.g. users, producers and input suppliers) and non-firm organizations (e.g. universities, financial institutions, government agencies, trade unions, or technical associations), including sub-units of larger organizations (e.g. R&D or production departments) and groups of organizations (e.g. industry associations). Agents are characterized by specific learning processes, competencies, beliefs, objectives, organizational structures and behaviors. They interact through processes of communication, exchange, cooperation, competition and command, and their interactions are shaped by institutions (rules and regulations). Over time, a sectoral system undergoes processes of change and transformation through the co-evolution of its various elements (Malerba, 2002).

Empirical evidence across countries in the South also indicates that the elements of a sectoral system that were instrumental varied from sector to sector and country to country. While the crucial factor behind technological progress in sectors like electronics in Taiwan has been the learning and capabilities of domestic firms under the weak patent regime (Amsden and Chu 2003), the role of the government has been highlighted in the case of telecommunications and aircraft in Brazil (Mani, 2004, Dahlman and Frischtak 1993, Viotti 2002) and software in India (Joseph 2002, 2006).

In several sectors, Mazzoleni and Nelson (2006) have shown that universities and public research laboratories performed advanced research and trained human capital, which were important as the experience of several countries indicate. The catch-up process of countries in different sectoral systems has also been affected by the specific types of networks. In some sectoral systems like electronics, as argued by Lundvall (1992), vertical networks with suppliers have provided new inputs and shared relevant information for production and innovation, and led to learning and capability development by domestic firms. In the context of global production networks, studies have also shown that specialization in different stages of the global value chain has been another way to catch up (Gereffi et al. 2005, Ernst, 2002, Morrison, Pietrobelli and Rabellotti, 2006). While the large and growing domestic demand has been relevant to catch-up for most sectors in countries like China, exporting for the world market has played a major role in catch-up in small or medium size countries. These differences, as argued by Malerba (2006), need to be seen against the fact that sectors are not homogenous and are characterized by different technologies, actors, networks and institutions.

These are important insights in understanding sectoral dynamics in terms of their innovation and production processes. However, from the perspective of developing countries, one also needs to reckon with the new international environment in which they operate. With the removal of trade barriers, domestic firms, regardless of the sector in which they operate, are exposed to international competition. Thus, the infant industry protection and government subsidies widespread in most of the earlier catch-up episodes have a very limited role at best today. The unprecedented exposure to international competition in turn has had influence on their innovative behaviour and competitive strategies of local firms. This has been manifested in the increasing incidence of joint ventures and takeover of local firms by foreign firms.

Similarly, the strong intellectual property right regime being imposed on the developing countries of today entails an environment significantly different from the one in which the East Asian Tigers developed. Today, there is little scope for reverse engineering and duplicative imitation-based innovation strategies widespread in the earlier regime.

In addition, the role of university-industry interaction that was significant in prior episodes of catch-up is likely to be more limited due to recent cuts in social sector expenditure. In this new environment, the observation that countries that are technologically backward have the potential for generating growth more rapidly than more advanced countries (Abramovitz 1986) may not be as applicable as it was earlier. Therefore, under the new disposition, the basic building blocks of the sectoral system, as articulated by Malerba, while remaining intact, might exert their influence in a distinct way from the earlier catch-up episodes. Hence, any attempt at developing sectoral/regional systems of innovation in developing countries needs to take note of the existing context and devise appropriate strategies to address them.

2. Recent Trends and Challenges

There is hardly any country in the developing world today that has not initiated policy measures and institutional interventions to harness IT for Development. But the development of an electronics production base seems to have not received the attention that it deserves, presumably because various agencies, including multilaterals, consider the promotion of IT use as their key agenda. In this context, the experience of ASEAN newcomers appears instructive. Induced by the development experience of the first ASEAN member countries wherein electronics production played a significant role in catching-up, the policy framework of these countries underscores the need for developing an electronics production base as means of pursuing industrial transformation. Despite their best efforts, the production bases for electronics production in these countries remain, with the plausible exception of Vietnam, rudimentary. This needs to be seen within a context of successful trade and investment liberalization, but rather more modest success in developing vibrant innovation systems (Joseph 2006).

Industrial transformation at the sub-national level has also become an issue of immense policy relevance for emerging countries like India and China. Of late, China and India have joined the globalization bandwagon, not only through their active engagement in the production and export of IT and electronics, but also by harnessing the power of new technology for addressing their varied developmental problems. Moreover, both China and India have emerged as attractive locations for FDI in R&D and are active participants in Global Innovation Networks. In the sphere of OFDI, these countries today are no less significant players. At the same time, it has been shown that their impressive economic performance has hardly been inclusive and that there has been widening interpersonal and interregional disparity in development. This, in turn, casts doubt on the effectiveness of the hitherto followed strategies in achieving industrial transformation at the sub-national level and bringing about more regionally inclusive development outcomes.

ITA and Global Networks in Production and Innovation

Although outsourcing and sub-contracting has a long history in the electronics sector (Boswell, 1993), outsourcing gained momentum during the 1990s, largely due to the emergence of contract manufacturers. While analyzing the development of the electronics industry and its competitive dynamics along with patterns of industrial organization, Ernst (2002b) observed that globalization in the electronics industry is characterized by the international dispersal of the value chain to highly concentrated locations. This has been an outcome of an organizational innovation that resulted in the formation of global production networks induced by MNCs' increased outsourcing requirements in the context of heightened international competition. In their effort to achieve cost minimization, they search for low cost foreign capabilities that are complementary to their own competencies. The creation of GPNs reflects increasing pressures to exploit complementarities that result from the interactive nature of knowledge creation (Antonelli, 1998). A peculiar character of GPNs is that manufacturing is de-coupled from product development and is dispersed across firm and national boundaries.

GPNs, while being global, are characterized by a heavy concentration between and within countries. To the extent that GPNs call for free inflow of inputs and outputs from the country, the countries that followed a liberal trade regime were those who secured entry into GPNs. There has also been concentration in a few specialized local clusters because the specialized capabilities that the MNCs seek are confined to select locations. By the same logic, the concentration of dispersal increases as we move towards more complex capital-intensive equipment and components.

However, most of these countries are found specialized in the mass production of a few products mainly for the export market. This has led to a kind of sticky specialization, with limited backward and forward linkages especially for materials and production equipment. This gives rise to a very high level of import dependence and limited value addition. In the case of Thailand, Mephokee (2003) noted that Thai IT firms play a small subcontracting role by supplying minor components for foreign firms in the IT industry. However, the production of these components is largely import-dependent, due to four reasons. First, the production technology belongs to foreign parent companies. Secondly, there are no domestic components, because the production technology is not available in Thailand. Thirdly, the quality of domestic components cannot meet the requirements of foreign companies. Finally, it is easier to deal with foreign suppliers with whom a long-term relationship has already been established. Thus, the study concludes that Thai firms have little room to play in their local IT industry.

A striking feature, which can partly be attributed to the strategy being adopted, is the mismatch between local production and consumption both at the component and equipment level. To illustrate, in the case of telecommunication equipment, Thailand exports almost 70 per cent of its production and at the same time imports more than 70 per cent of its domestic demand (Joseph 2006). The case with semiconductor devices appears to be similar. The narrow production base with export orientation also has the effect making the industry highly susceptible to international market fluctuations. In such a context, the need for upgrading of East Asia's electronic industry has been underlined. The key issue is to what extent recent developments like the Information Technology Agreement (ITA) of WTO and the emergence of Global Innovation Networks facilitate the much-needed upgrading of Asia's electronics industry.

Since the Information Technology Agreement of WTO came into force in 1997, tariffs and other duties and charges on the goods covered by the Agreement have been abolished. This, in turn, has made some countries that were conventionally considered to be unattractive for GPNs due to their restrictive trade regimes to emerge as attractive locations. Thus, China and India have emerged as priority investment targets for leading global electronics companies. Having abundant stocks of low-cost manpower and a liberal trade and investment regime, these countries pose a serious challenge to established manufacturing locations with a similar competitive advantage.

Between 1995 and 2004, the share of R&D spent outside by Western European multinationals outside their home countries increased from 26 per cent to 44 per cent, by Japanese multinationals from 5 per cent to 11 percent, and by North American multinationals from 23 per cent to 32 per cent. Since then, there has been a substantial increase in investment by these multinationals in developing economies like Brazil, India, and China. According to a survey of the world's largest R&D spenders (UNCTAD, 2005), China has been considered as the third most important offshore R&D location (after the USA and UK), followed by India (6th) and Singapore (9th). A more recent survey by the Economic Intelligence Unit in 2006 showed that India and China are the second and the third most important offshore R&D locations (after the USA and ahead of the UK). Leading global corporations thus consider India, the USA and China to be the next overseas locations for future R&D.

The unprecedented growth in global innovation networks on the one hand and increasing participation of developing countries on the other, has attracted significant scholarly attention. Drawing from the received wisdom, it is possible to locate a host of “centripetal forces”[3] which induce the firms to centralize R&D activities in headquarters and “centrifugal forces”[4] that work towards the dispersal of R&D activities across different locations beyond the home country. The unprecedented increase in the pace at which GINs are being formed (UNCTAD 1995; Ernst 2011), however, suggests the presence of certain factors that reduce uncertainty as well as the costs of coordination and transaction and thus undermine the power of centripetal forces. There are two important factors for this rebalancing and resultant increase in the mobility of knowledge as argued by Albuquerque et al (2011). The first relates to the improvement in the information communication infrastructure and its extensions around the world. The second refers to policies to liberalize trade and investment, which helped firms exploit the benefit of technological change. To this, we may add the emergence of new locations that are perceived as capable of providing complementary capabilities, especially human capital, at lower cost. For instance, it has been predicted that, by 2010 China would have more science and engineering doctorates than United States (Freeman 2005; National Science Board 2008).

OFDI from the South: China and India

As is evident from Table 1, leading Asian countries have been major investors in Asia. Rajan (et al 2011) have shown that, during the period 1990-2004, Japan has been the largest investor into emerging Asia, accounting for 17-18 per cent of the total inflows and showing an increase from 13-14 from 1990-94. According to UNCTAD (2008), OFDI from developing countries increased

Table 1: Top Bilateral FDI Flows between Asian Countries (1997-2005)[#]
(Millions of US$)

		Average		In percent to Asia	
Donor	**Host**	**1997-2000**	**2001-5**	**1997-2000**	**2001-5**
Hong Kong	China	17,750.8	17819.1	16.0	16.8
China	Hong Kong	7266.9	5459.4	6.5	5.2
Japan	China	3276.2	5194.5	3.0	4.9
Taiwan	China	2774.8	3361.3	2.5	3.2
Singapore	China	2706.3	2136.7	2.4	2.0
Japan	Thailand	1347.0	2324.9	1.2	2.2
Japan	Hong Kong	1417.6	2044.6	1.3	1.9
Singapore	Hong Kong	2835.3	353.1	2.6	0.3
Japan	Singapore	1281.5	1276.6	1.2	1.2
Singapore	Malaysia	844.1	1133.8	0.8	1.1
Singapore	Thailand	441.7	1381.9	0.4	1.3
Japan	Korea	607.8	717.3	0.5	0.7
Taiwan	Hong Kong	268.9	446.6	0.2	0.4
Japan	Philippines	232.9	377.5	0.2	0.4
Malaysia	China	290.8	316.7	0.3	0.3
Hong Kong	Malaysia	272.3	296.5	0.2	0.3
Hong Kong	Thailand	360.1	160.8	0.3	0.2

Japan	India	249.3	244.7	0.2	0.2

[#]This data is based on FDI inflow data to the host economy.
Source: Rajan, R. S. with Gopalan S. and Hattari, R. (2011)

from US$ 6 billion between 1989 and 1991 to US $ 225 billion in 2007, which indicated an increase in their share in global outflows from 2.7 per cent to nearly 13 per cent. But a recent development with implications for industrial upgrading and industrial transformation has been the emergence of selected developing countries, especially from Asia, as major sources of OFDI.

While OFDI from some of the major economies in Asia slowed down in early 2009 in the wake of the global financial crisis, OFDI from China maintained an upward trend and that from India showed only a marginal decline (UNCTAD 2009). Despite the global financial crisis, FDI from China reached USD 53.8 billion in 2008, an increase of over 100 per cent from USD 26.5 billion in 2007, and its outflows continued to grow in 2009 (Hong 2011). China currently ranks 13th in the world as a source of FDI and third among all developing and transition economies. The FDI outflow from India was USD 18.8 billion in 2008, slightly less than the USD 21.4 billion seen in 2007. As a result, the share of China and India in total East, South and Southeast Asian outflows increased from 23 per cent in 2007 to 37 per cent in 2008 (Hong 2011). It is important to note that about 75 per cent of China's OFDI was directed towards Asia. Though Chinese OFDI in Asia is highly concentrated at present in Hong Kong (88%), with the signing of China-ASEAN free trade area in 2010 and ASEAN China Investment Agreement in 2009, Chinese investment is likely to become regionally more dispersed. Similarly, India also has signed the Free Trade agreement with ASEAN and the discussion on services and invest is in progress.

The Challenges

Given the opportunities provided by GINs, GPNs and FDI from the South for industrial upgrading, the often-followed strategy has been to attract more FDI through various incentives. This has resulted in intense competition not only between developing countries but also between different regions within them to provide incentives. The final outcome of such wasteful incentive competition is bound to be detrimental to the interests of developing countries. In a context wherein incentives and cheap labour are taken for granted by MNCs, the policies of regional governments aspiring to enter into GPNs need to satisfy very demanding requirements.

In this context, drawing from Bresnahan et.al (2001) it can be argued that the factors that enabled national entities to enter into global production networks could be different from those that enable industrial upgrading of those who have already entered them. Agglomeration economies, external effects and social increasing returns from any source may arise naturally once the regions have successfully entered GPNs.

But, the most difficult and risky part is to negotiate entry in the first place. At this stage, factors such as linkages with a sizable and growing demand, along with technological capabilities in the firm-level supply of manpower at all levels including production, R&D, managerial, adequate infrastructure, venture financing and, above all, an enabling policy environment accompanied by an uncorrupt bureaucracy are crucial.

For countries with limited markets, government procurement policies, especially at the early stage can be of great help. All these fall into what we have discussed as vibrant innovation systems which include: high-quality but low-cost infrastructure and information communication systems; streamlined administrative procedures that facilitate smooth supply chain management and quick adjustments to change in markets and technology; and an efficient support industry and services with certified procedures that guarantee world class quality standards and short time-to-market cycles (Ernst, 2008). There is also the need to evolve an interlinked system of research centers, universities, firms and other organizations that can tap into the growing stock of global knowledge, assimilate and adapt it to local needs and create new knowledge. While we underline the need for qualified skilled manpower there could be different sources for skill for different regions. Here the role of universities is important. Yet it could also be accomplished through training imparted by industry (like the large IT forms in India), or repatriates from other countries as shown by the experience of Taiwan.

Segal and Thun (2001) have shown that although national institutional characteristics provide the overall framework for growth and regulate the overall process, variation in developmental outcomes is the result of the specifics, characteristics and abilities of local institutions. Even at the local level, different industrial sectors have different developmental needs, and a policy that work for one sector will not necessarily work for another. To the extent that the needs of one sector vary from another and the institutional structures that are required to meet firm-level needs are local more often than national, there is a need for focusing on local institutions and farms within a particular sector. Hence, the focus of policy makers needs to be on judiciously building an appropriate institutional architecture at the regional level (regional innovation system) complemented by a focus on sectors that are part of their comparative advantage (sectoral innovation system).

However, as noted earlier, given the changed environment in which developing countries operate there are serious constraints today as compared to yesteryear. Here the emergence of India and China could be a blessing in disguise. The huge potential markets in these countries for electronic products and services provide new trade and investment opportunities for Asian firms. In addition, Asian electronic firms could also exploit the low-cost and high-skilled manpower available in these countries. Here we need to take note of the presence of accumulated capabilities by select developing countries in the South in the sphere of electronics. Also, the international context for building innovation systems is less friendly than ever before while innovation systems are no longer limited by national boundaries. Hence, it is pertinent to explore ways by which Southern capabilities can be harnessed for building up an appropriate institutional architecture to bring about industrial transformation.

3. Towards a Perspective

During the 1970s and 80s, South-South cooperation was much debated among developing countries.[5] The issue seems to have taken a back seat during the last decades as developing countries were increasingly experimenting with trade and investment liberalization under globalization. But today, with increasing disenchantment among developing countries with globalization, the topic is re-gaining momentum.[6]

In a sense, the potential for Electronics and IT-based industrial transformation of the developing world through South-south cooperation is due to the fact that while the Western world held a monopoly over earlier GPNs, in case of IT, the capabilities are more diffused with substantial capabilities in Asia. While Japan and developing Southeast Asian countries (Ernst 1993) hold a leading position in the production of IT goods and services, and China recently entered the league of IT goods production, in the field of IT software and services India has emerged as a major player in the world market (Schware 1987, 1992, Heeks 1996, Kumar 2001, Arora et.al 2001, Joseph and Harilal 2001, Joseph 2009). In addition, there are a number of IT-based solutions developed by the South that address South-specific issues like last mile connectivity and affordability (Joseph and Parayil 2008). More importantly, Asia is the home of the highly-skilled manpower much-needed for IT in general and electronics in particular. The challenge therefore, is to harness the synergy between IT hardware, software and human capabilities of Asian countries to help industrial transformation by promoting both the production and use of IT.

While South-South Cooperation in the field of information technology is in its incipience, there are a number of regional and bilateral arrangements for harnessing IT for Development.[7] Perhaps, the most notable one is the e-ASEAN Framework Agreement. The e-ASEAN initiative has to be seen against the background of the economic and digital divide between the new ASEAN (Cambodia, Lao PDR, Myanmar and Vietnam) and old ASEAN member countries (Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore and Thailand). The e-ASEAN initiative, among others, is an integral part of the Initiative for ASEAN integration. Unlike the Information Technology Agreement of WTO, which is essentially a tariff-cutting mechanism agreed upon mostly by developed countries, the e-ASEAN Agreement aims at tariff cutting along with facilitating capacity-building. Thus the underlying strategy is one of "ASEAN helping ASEAN".

Here it is pertinent to highlight the limits of such a regional arrangement as compared to the benefits of broad-based cooperation. To be more specific, we may examine to what extent the old ASEAN could help in capacity building, both physical and human, in the new ASEAN countries. This in turn depends on the capabilities of the old ASEAN in the field of IT, which could be viewed in terms of capabilities in IT hardware and IT software and human resources. In the case of IT hardware capability, the countries of ASEAN-6 such as Singapore, Malaysia Thailand are known for their IT manufacturing and export base. But already noted, in most of these countries, IT hardware investment and production is dominated by the MNCs with a limited role for domestic firms.

The issue is more acute in the case of IT manpower, because the old ASEAN countries are also faced with an excess demand situation, both in terms of quality and quantity, with respect to IT manpower. For example, an estimate for Thailand, despite its concerted efforts to build up human capital, has shown that, by 2006, the excess demand for IT manpower would be of the order of 26,000 (Durungawarol et.al. (1995), Puntasen et al. (2001) as quoted in Somchai Suksiriserekul (2003)). Even in the case of Singapore, which is highly developed, there is an acute shortage of IT manpower.[8] Thus in achieving the declared objective of bridging the development divide between the old and new ASEAN members by harnessing IT, cooperation among the ASEAN countries may be complemented with more broad-based cooperation involving other countries in Asia.

Thus the scope for cooperation among countries in Asia is obvious. But, what is at present missing is an institutional arrangement for promoting it as well as research backed by theory and empirics to sustain it. Here lies the need for an e-Asia Framework Agreement aiming at the establishment of a more regionally-diversified production base for IT and electronics and promotion of IT use across different sectors of the economy and segments of society. Towards achieving this objective, the Agreement, in tune with the Information Technology Agreement of WTO should focus on liberalizing the trade in IT goods and services. At the same time, drawing from the e-ASEAN Framework Agreement, the e-Asia Framework Agreement should be instrumental in the creation of an institutional architecture at the sub-national and sectoral level *inter alia* by harnessing Asia's capabilities in both hardware and software. Given the paramount importance of human capital in developing IT production and promoting IT use, a special focus may be given to developing the IT manpower base. In general, the Agreement should facilitate an integrated development of the IT sector by promoting both production and use instead of the ongoing lop-sided approach wherein developing countries are often considered as passive adopters of technology.

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[1] The report argues that actual inflation fell by 0.5 per cent points a year from 1994 to 1998 due the effect of declining prices of IT (electronic) goods. Also the electronic sector, including telecommunications, employed 7.4 million workers in 1998 and this accounted for 6.1 per cent of the total employment with an annual wage rate more than 1.5 times that for all private employees. A cynic may argue that to sustain such growth in employment, output and wages in developed countries, the diffusion – and not production – of IT in developing countries needs to grow at higher rate.

[2] Here the readers are referred to the large number of papers presented in the GLOBELICS conferences held in Rio in 2003, Beijing in 2004 and Pretoria in 2004. The papers are available at www.globelics.com.

[3] The centripetal forces included the need to protect firm-specific technology to avoid R&D leakage (Rugman, 1981) due to the tacit nature of technological knowledge, need for closer coordination in decision making in the face of uncertainty of innovation Patel and Pavitt (1991); take advantage of scale economies in R&D high cost of co-ordination and control (Eg. Vernon, 1974).

[4] The centrifugal forces include demand oriented factors that emanate from the need to be nearer to the export market to exploit regions' differential advantage in production and in R&D Cantwell (1995); supply side factors operating as centrifugal forces most important one appears to be the access to scientific and technological skill including scientific infrastructure that are available in the host countries at a more advantageous terms than in the home market (Ernst 2008).

[5] See in this context among others, RIS (1987) and South Commission (1990).

[6] The High-level Conference on South-South Cooperation held at Marrakech on 18, December 2003 at the instance of G-77 had a special Round Table on IT for Development. The Round Table underlined the role of ITs in enhancing the capacity of enterprises of developing countries and called for concrete actions to help countries improve the use of IT, including through e-commerce, e-finance, e-governance and e- tourism. The Round Table also highlighted the need for South-South Cooperation in ITs See for details: http://www.g77.org/marrakech/RT-IT.htm Also see, Ojo et al (2008).

[7] Kumar and Chadha (2002) made the case for IT cooperation among SAARC countries. In all the bilateral cooperation between India and other countries, IT is an important element.

[8] In an interview in New Delhi in 2004, Singapore's Infocom Development Authority (IDA) Chairman Lam Chuan Leong said that Singapore had an Infocom resource pool of 93,000, which is significantly short of projected demand. They, therefore, would like to outsource 25,000 professionals from India over the next five years to meet the growing demand.