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THE RISE OF THE SOUTH AND NEW PATHS OF DEVELOPMENT IN THE 21ST CENTURY

BACKGROUND PAPER

FOREIGN DIRECT INVESTMENT, INTELLECTUAL PROPERTY RIGHTS AND TECHNOLOGY TRANSFER

THE NORTH-SOUTH AND THE SOUTH-SOUTH DIMENSION

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Foreign Direct Investment, Intellectual Property Rights and Technology Transfer

The North-South and the South-South Dimensions

Biswajit Dhar and Reji Joseph

Technology flows from the advanced to the developing countries and the factors influencing such flows have generated attention of development economists during most part of the past half a century. With developing countries aspiring to emulate the development experience of the advanced countries, acquisition of technologies from the latter assumed critical importance. Although most of the studies have described this process as transfer of technology, the reality of the technology acquisition was aptly described by Constantine Vaitsos as one of "technology commercialization" or technology trade, which brought into focus the nature of the market through which technology is "transferred" to the developing countries[1]*. Vaitsos argued that technology transfer is governed by a bargaining relationship between the suppliers and the recipients. In this relationship, purchasers are at an inherent disadvantage, owing to two factors: (i) the oligopolistic or even monopolistic nature of the international market for technology; and (ii) the nature of technology itself, which is highly complex and cannot be evaluated thoroughly by buyers before a particular transaction*[2]*. The relevance of the above characterisation of the process of technology stems from the fact that technology generation is, in turn, influenced by two factors that have been extensively discussed in a large body of literature, viz. intellectual property rights and foreign direct investment. While several generations of*

[1] Vaitsos (1974).
[2] Rath, A. and Herbert-Copley, B. (1993).

economists have recognised the role that intellectual property rights (IPRs) can play in overcoming the problem of market failure in the process of generation and diffusion of new knowledge, studies have also commented critically about the control exercised by the owners of IPRs over the market for technology. The focus on foreign direct investment (FDI) as a factor determining technology transfer owes to the domination of transnational corporations (TNCs) in the market for technologies. Viewed from the developing countries perspective, FDI has been seen as provider of technologies and managerial skills essential for these countries to achieve rapid economic development.

In recent years, technology transfer is acquiring a new dimension with the advent of the emerging economies on the world stage, particularly over the past decade. These countries have initiated several ventures with their partners in the developing world that involve transfer of technologies covering a wide variety of sectors. Although the evidence regarding South-South technology transfer is still scattered, these models need to be examined to understand their dynamics and their differences with respect to North-South models of technology transfer.

This paper examines the two facets of technology transfer mentioned above in two parts. The first part of the paper will examine the nature of North-South technology transfer as has been discussed in the literature by elaborating on the nature of influence of intellectual property rights and foreign direct investment on technology transfer. The second part of the paper will discuss a few cases of South-South technology transfer, highlighting the key features of this phenomenon.

Part I

I. Foreign Direct Investment and Technology Transfer

A technology may be defined as “the information necessary to achieve a certain production outcome from a particular means of combining or processing selected inputs” (Maskus 2004: P9). Technology may be codified (formulas, blueprints, patent applications, etc.) or un-codified as well as embodied (capital equipment) or disembodied (pure know-how). There is wide variation in embodiment across products and services and products like pharmaceuticals are relatively very easy to be copied as compared to complex machineries. Technology transfer is the process by which one party gains access to the knowledge of another party and becomes able to adapt successfully the knowledge in the production processes. Technology transfer may take place through market based and non-market based mechanism. Market based channels include trade in goods and services, foreign direct investment (FDI), licensing, joint ventures and cross border movement of personnel whereas major channels in the non market based system are imitation, departure of employees (who later join in other firms/institutions or begin their own business) and data in patent applications and test data (Maskus 1997; Maskus 2004).

Import of capital goods and technological inputs like chemicals can directly improve the productivity when they are employed in the production process. In FDI, the ownership of knowledge based assets of MNCs provides them with cost or quality advantage that can be adapted in multiple locations (Markusen 1995). Licenses involve purchase of production and distribution rights (protected by IPRs) and the know-how required to enable the exercise of production and distribution rights. Licenses may involve subsidiaries or unrelated firms. In intra-firm licensing, the MNC retains the control over IPRs and know how whereas in licensing involving unrelated firms, access is provided to the licensee of the IPRs and know-how (Maskus 2004). Joint ventures are arrangements between two or more firms where each one provide some advantage that results in reduced cost of operations. In joint ventures generally MNCs provide superior knowledge based assets whereas the local firms provide locational advantages like distribution networks, brand recognition, etc. Movement of skilled personnel also plays an important role in the process of transfer of technology. Adaptation of certain technologies requires the transfer of complementary services of engineers and technicians to do onsite jobs. MNCs are better equipped to transfer such personnel to their subsidiaries. Transfer of skilled personnel to unrelated firms may be more restrictive and less flexible, which may raise the transfer and adaptation costs (Maskus 2004). [3]

Among the different channels of technology transfer, FDI is the most significant one. FDI is defined as "act of establishing or acquiring a foreign subsidiary over which the investing firm has substantial management control" (Maskus 1997: P7). By definition firms engaging in FDI are multinational companies (MNCs). MNCs engage in FDI when they have advantages either in terms of capital or technology or both as compared to the firms in the host country to overcome the disadvantages it might face in terms of language and cultural barriers, jurisdiction-specific tax treatments, distance from headquarters, and monitoring local operations. FDI is generally viewed less as a source of finance and more as a source of technology or knowledge based assets. Because the capital required in the investment may be raised from host country or global financial markets or even from local capital markets of the home country (Maskus 1997).

In order to understand the link between FDI and transfer of technology, it is important to know the factors influencing decisions on FDI vis-à-vis other options for serving a particular market. A firm can: (i) export directly the good, (ii) produce locally by undertaking FDI and controlling the production process, (iii) license or franchise its technology to an unrelated firm in the particular country, and (iv) undertake a joint venture involving joint production or technology-sharing agreement. These decisions would depend on characteristics of particular market, called location advantages. Location advantages include market size and growth, local demand patterns, distance and transport costs, wage costs, endowments of natural resources, trade protectionism that could encourage "tariff-jumping" FDI investment, modern infrastructure and

[3] Maskus (2004) suggests that the bulk of the international technology transfer takes place through market based mechanisms or within multinational firms.

transparent and predictable government procedures (Maskus 1997). Exports may be the preferred mode of supply when transport costs and tariffs are low in comparison to the costs of FDI and licensing. The volume of exports may depend also on the strength of local IPRs. The study of Maskus and Penubarti (1998) based on OECD countries' exports in 28 manufacturing sectors to 25 developing countries in 1984, found that exporting firms discriminate in their sales decisions, taking account of local patent laws: exports to countries with stronger patent laws were on average larger than exports to countries with poor patent protection. A later study by Smith (1999) based on more disaggregated industry data[4] confirmed the view that export decisions of firms are influenced by the strength of patent rights in the importing countries. The study was based on US exports (of all manufacturing industries at two digit level) to 92 countries in 1992. The study found that US exports has been significantly influenced by patent rights in the importing countries, but the direction of the relationship i.e., market expansion and market power effect,[5] depended on the threat of imitation. Strengthening of patent rights in those countries posing a strong threat of imitation would enhance the expansion of exports whereas strong patent rights would enhance market power in countries where the threat of imitation is week.[6]

When undertaking FDI involving knowledge based assets firms need to be sure that their advantages will not be undermined. MNCs have the advantage of using their knowledge produced in several plants in different countries (Markusen, 1984) whereas a local firm, in similar circumstances, would operate at a cost disadvantage. The knowledge is embodied in blueprints, software, chemical formulas, and managerial or engineering manuals and MNCs are able to use the knowledge numerous times at low marginal cost (Maskus 1997). Thus, FDI is more likely to be important in industries in which intangible, knowledge-based assets (KBAs)

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[4] The study was based on United States' exports (of all manufacturing industries at two digit level) to 92 countries in 1992.

[5] The *market power effect* would reduce the elasticity of demand facing the foreign firm and would ordinarily induce the firm to export less of its patentable product and *market expansion effect* would increase the elasticity of demand and firms would export more.

[6] The study had classified countries into four groups depending on their strength of patent rights and imitative capabilities: (1) countries with weak patent rights and weak imitative abilities, (2) countries with strong patent rights and weak imitative abilities, (3) countries with weak patent rights and strong imitative abilities and (4) countries with strong patent rights and strong imitative abilities.

specific to each firm are significant. IPRs play a crucial role where FDI involves knowledge based assets; protection of IPRs provides assurance that the knowledge will not be copied. Firms in industries with high R&D investments are likely to undertake FDI when IPRs are weak and are likely to license when IPRs are strong (Nicholson 2007). Mansfield (1994) found that US based MNCs were sensitive to IPRs in major developing countries while deciding on facilities abroad. The study also found that that lagging technologies were transferred under licenses and R&D facilities were less likely to be established in those countries where enforcement of IPRs is weak. Similar conclusions were reached by Blyde and Acea (2002) and Yang and Maskus (2001). With improvement in the strength of IPRs the risks associated with licensing gets reduced, resulting in FDI paving way for licensing. And the likelihood that the most advanced technologies are transferred rises with the improvement in the strength of IPRs (Maskus 1997).

Although IPRs can have impact on FDI, their relationship needs careful analysis. This relationship is influenced also by the size of the market. Maskus has pointed out that if strong patents alone are sufficient to attract FDI inflows, recent FDI flows to developing countries would have gone mainly to Sub-Saharan Africa and Eastern Europe (Maskus, 2000). FDI can also be dependent on the science and technology (S&T) base of the host country, depending on the motive of the TNC. Firms might invest in R&D abroad to gain access to local knowledge (Florida 1997). In the FDI aimed at augmenting firm's knowledge base, the S&T base of the target country become the deciding factor. For augmenting purposes, the FDI is directed to countries with relatively well developed science base (Walter 1998). A firm's decision on investing in R&D abroad for augmenting purposes would depend on the relative commitment to R&D by private and public sector in the host country as well the quality of the "mental capital" and level of scientific achievement (Walter 1999). Such FDI will create spillovers for the local environment because R&D sites provide employment and learning opportunities for the local researchers. The characteristics of national innovation system, which includes higher education, public funding for R&D, IPRs, venture capital, etc.), would determine the nature of spillovers (Walter 1999). Maskus argues that developing countries' attempts to use FDI as a means for technology transfer must be accompanied by programmes to build local skills and ensure that the benefits and ensure that the benefits of competition emerges (Maskus 2000). Firms might also engage in

FDI in R&D to adapt the technology to the local markets (Hakanson and Nobel 1993). As the local demand gets more sophisticated, local R&D facilities become useful in helping a firm to adapt its products better to the local needs (Bartlett and Ghoshal 1990; Hakanson 1990; Vernon 1966). In the latter case also the innovation system of the host country would play a crucial role in determining the quality and quantity of FDI as well as its spillover.

Though the impact of FDI and licensing on transfer of technology vary across developing countries, it holds promise for improving productivity and growth in developing countries. These flows provide access to the technological and managerial assets of MNCs, which provide both a direct spur to productivity and significant spillover benefits as they diffuse throughout the economy. The spillover takes place through numerous channels like the movement of trained labor among enterprises, the laying out of patents, product innovation, and the adoption of newer and more efficient specialized inputs that reduce production costs (Maskus, 1997). It might also result in increased competition. These beneficial impacts of inward FDI and technology transfer would come true only if the ground is ready for that. This calls for linkages with other relevant economic sectors, failing of which might result in enclave FDI. In enclave FDI, MNCs engage only in exports and there is only limited spillover into technologies adopted by local firms. The host country also needs to ensure that the MNCs do not engage in abusive practices of their protected market positions in exploiting stronger IPRs. The host country needs to in put in place a policy system that promotes the maximum gains from FDI.

The experience of the Republic of Korea illustrates the importance of domestic policy in using FDI for the catching up process. Korea chose the FDI and foreign collaboration route for technology development. Original Equipment manufacturing (OEM) was a specific form of subcontracting that evolved out of the joint operations of TNC buyers and NIE suppliers. Under OEM, finished products are manufactured following the specifications of the TNC which then markets the products under its own brand name. In Korea OEM accounted for a significant share of electronics exports in 1970s, 80s and 90s. OEM has undergone changes over the years. Initially OEM partners helped in selection of capital equipment, the training of managers, engineers and technicians and advice on production, financing and management. Today OEM overlaps with ODM (own design manufacture); local firms usually carry out most of (or all) the production design tasks according to the general design layout given by the partner TNC. Though ODM indicates some advancement in technology capability it applies mainly to incremental or follower designs rather than leadership product innovations based on R&D (Michael 2000). Samsung began making electronics in 1969 in joint collaboration with Sanyo of Japan. In 1981 Toshiba licensed microwave oven technology to Samsung. In 1982 Philips supplied colour TV technology and videocassette recorder technology was licensed from JVC and Sony in 1983. One in five microwave ovens sold in US in 1992 was made by Samsung mostly under OEM with GTE. Later it emphasized on own brand sales and its brand sales increased to 55% in 1992, to 56% in 1993 and to 57% in 1994. In the 1980s the Korean majors had become dominant producers and exporters. Japanese firms such as Matsushita, Sanyo and NCE withdrew from joint ventures as tax advantages were cancelled and firms were encouraged by the government to leave (Michael 2000). The Korean industrialization process may be divided into three phases. Phase one (late 1950s to 1969), was dominated by FDI. In the 1960s the US and Japanese firms invested in cheap labour assembly activities in Korea. US firms – Motorola, Signetics and Fairchild began to assemble chips during the mid 1960s followed by Japanese-Korean joint ventures such as Samsung-Sanyo, crown radio corporation, Thoshiba and LG-Alps electronics. The second phase (1970-79) witnessed the emergence of more local firms and joint ventures. Exports included semi-finished, low technology parts and components, shipped into Korea for final assembly by foreign firms. Finally, in the third Phase (1980s) Chaebols became dominant force for production and exports. Japanese firms such as Matsushita, Sanyo and NCE withdrew from joint ventures as tax advantages were cancelled and firms were encouraged by the government to leave (Michael 2000).

II. Intellectual Property Rights and Technology Transfer

Knowledge has the characteristics of a public good that is non rival and non excludable. The knowledge/technology can be shared among multiple users without diminishing its productivity for any particular user and without affecting the availability of any one user. The non-excludability demands the developer not to prevent other users from using it without compensating. Competitors might use the technology to develop cost effective production processes, affecting the business interests of the innovator. As the generation of technology involves costs, the developer will be inclined not to share the technology or not to develop the technology at all if some kind of protection is not provided against unauthorised use of the technology. This is a market failure situation and the governments often need to subsidise innovators until the costs of the subsidies equalize the benefits to society and then allow dissemination of technology at free of cost. Although this is the optimal solution to address the market failure, many practical problems arise in the implementation implementing phase. This in turn suggests the adoption of a more practical second best solution: the IPRs.

An IPR is a "government protected right granted to an inventor or creator to exclude others from using the technology or product" in question (Maskus 2004: P22). Granting temporary monopoly to innovators enables them to reap rents to recoup their investments in R&D. The scope these rights refer generally to the ability of the inventor to exclude others from the use, production, sale and import the product or technology for the specific period of time. The IPR system aims to serve three purposes: it provides legal means to ensure exclusivity rents to the inventor; it facilitates the disclosure of the knowledge especially in IPRs like patents (Article 29 of TRIPS); and it provides a platform for the creation of markets in technology (Arora, Fosfuri and Gambardella 2001). The third aspect is crucial in the discussion on IPR and technology transfer. IPRs provide the legal basis for the innovator to agree on a contract with its subsidiaries (or licensees) in order to transfer proprietary technologies (Arora 1996).

Among different kinds of IPRs, patenting is crucial when it comes to transfer of technology. The study of Mansfield (1994), which surveyed 100 major US firms found that the influence of IPRs on transfer of technology vary across nature of industrial activities. All those firms engaged in R&D activities reported that their decisions on R&D investment would be influenced by strength of IPRs. An earlier study of Mansfield (1985) found that patents are very significant in promoting innovations in R&D intensive industries. The study points out that 65% and 30% of innovations in pharmaceuticals and chemicals respectively would not have been possible without patents. The study of Levin et.al (1987) showed that patents are most important to protect the process and product innovation in R&D intensive industries like pharmaceuticals. It was found that the process patents were 40 % and product patent 51 % more effective as a means of protecting the returns from industrial innovations as compared to other industries.

Does a strong IPR regime mean more inbound transfer of technology? If it was true, bulk of the technology transfer would have occurred in the African region. Country experience shows that IPRs alone are not sufficient to attract inward movement of technology. Studies have shown that MNCs are not interested even in filing for patents in those countries where the market is not attractive. A study conducted in 53 African countries for 15 antiretroviral drugs found that patenting prevalence was only 21.6% (Attaran and Gillespie, 2001). The study of Blyde and Acea (2002), which looked into imports and FDI into Latin American countries found that imports and FDI are sensitive to patent index only for the higher income countries and insensitive to patents in poorer countries.

A strong IPR regime will result in better transfer of technology only if certain conditions are met. In the absence of such conditions a strong IPR regime may result in a mere market power effect which would simply raise the cost of transfer of technology. The framework for initial conditions for a national "catching-up" strategy was first presented in a cogent manner by List (1838). This grew out of his concern about the relative technological backwardness of Germany in the first half of the 19th century and its inability to bridge the technology gap with Britain. Apart from advocating the policy of infant industry protection to promote industrialisation in the lesser developed Germany, for which he is better known, List proposed a broad set of policies aimed at developing a domestic technological base through the interaction between "mental capital" and "material capital", which in the present day context may be referred to as software and hardware. From the above, it has been inferred that List had clearly recognised the importance of both new investment embodying the latest technology and the importance of "learning by doing" from the experiences of production with the equipment.[7] Besides giving the framework of policy in this regard, List presented his views on the institutional mechanism, which should support the technology generation efforts. The crucial element was the link between the industry and the formal institution of science and education. List stated thus: "There scarcely exist a manufacturing business, which has no relation to physics, mechanics,

[7] Freeman (1987), p. 99.

chemistry, mathematics or to the art of design etc. No progress, no new discoveries and invention can be made in these sciences by which a hundred industries and processes could not be improved or altered. In the manufacturing state, therefore, sciences and arts must necessarily become popular"[8]. It was not only in the absence of access to technology from the technologically advanced Britain that List saw the relevance of developing an indigenous system of innovation. He insisted that even if technologies were made available to the underdeveloped countries by the leading nations, the former would have to make attempts to assimilate them, depending essentially on the local capabilities that they were able to put in place. And, it was precisely this complementarity between imported technologies and development of domestic skills which characterized the past 150 years of economic history.

A number of advanced countries such as US, Japan, the Republic of Korea and Taiwan have taken advantage, in their development process, of the foreign knowledge by tailor-making their respective IP regimes. During their development phase, these countries provided only the minimum IPR protection (Maskus 2004). Japan’s patent system was designed for facilitating innovation and diffusion (Ordover 1991). It provided for utility patents, permitted only single claims in a patent application and required pre-grant disclosure. Japan’s patent system also instilled an active opposition regime. All these features of Japanese patent system encouraged incremental and adaptive innovation. Japan also strongly encouraged innovative foreign firms to license their technologies to Japanese firms. The Ministry of Trade and Industry (MITI) was actively involved in the technology licensing process by examining the terms of the technology licensing contracts (Maskus 2004). Japan revised its patent regime under pressure from the US during the period between 1988 and 1993.

In Japan, the IPR system was a part of the broader innovation system. Japan rejected FDI as a means of technology transfer and encouraged local firms to assimilate imported technology. This led to improvements in the total system (Freeman 1987).They had a systems approach to design, which recognizes the integrative, coupling role of innovation management, relating to the product design and process design to world technology. The ‘quality circles’ were a social innovation designed to maximize the contribution of the lower levels of the workforce and to

[8] Freeman (1997), p. 25.

assign to lower management levels a responsibility for technical change. The government adopted an 'integration strategy' which brought together the best available resources from universities, government research and industry to solve the most important design and development problems (Peck and Goto 1981). In order to cater to the innovation strategy, Japan reformed the education and training system. As a result the rate of enrolment especially in S&T education increased steeply. In S&R education, industrial training was carried out at enterprise level. The aim is to build up all-round capability at lower levels in work force so that break down and maintenance are far more rapidly dealt with and there is a smoother assimilation and readier acceptance of new process technology (Gregory 1985). Further, the Japanese system of 'decentralized management' permitted greater horizontal integration in design, development and production (Aoki 1986). Technology forecasting was carried out to decide on focus of technology. This orchestration of strategy was achieved by a combination of central government coordination (mainly by MITI) and Keiretsy (large conglomerate groupings in Japanese industries) initiatives.

The gains from IPR policies in terms of transfer of technology also depend on the industrial policy of the IPR granting country. The MNC may engage in FDI, joint venture or licensing depending on its motives. If the objective is to market its products, licensing may become the predominant strategy. Whereas an MNC seeks to adapt its products to local conditions, FDI or joint ventures may likely become the dominant strategies. Similarly if the MNC wants to gain from the advantages of the country, for example the scientific talent at lower costs, FDI might become the strategy. All these modes would result in some diffusion of technology through the movement of personnel. However, more significant spillover will occur if forward and backward linkages are in place, and industrial policy plays a crucial role precisely in the establishment of such linkages. A forward linkage exists where the firm produces inputs that reduce the costs of its customer firms or raises the quality of its products and a backward linkage arises where the firm's operations increase demand for inputs from its local supplier companies and work to improve the technologies and standards used by those companies (Maskus 2004).

With the strengthening of IPRs, licensing might become the dominant mode of transfer of technology. Yang and Maskus (2001) came to the conclusion after analysing the pattern of license fee payment to US by 26 countries that payment of license fees were positively and significantly affected by the strength of patent laws. An increase of one percentage in the strength of patent index (Ginarte Park Patent Index) would increase the licensing volume by 2.3 %. The study also points to the probability of enhanced market power contributing to increased licensee fees. The licensing contracts were not available to the authors to examine the terms of the contract. Studies have shown that licensing deals may contain restrictive provisions such as no-compete and grant back which would impede the spill over effects of the transfer of technology. Hence it is important to have an effective competition policy that checks anti-competitive effects of the licensing deals. The study of Taylor (1994) observed that technology transfer expands with stronger patents when there is competition between a foreign innovator and a domestic innovator. Interestingly Smith (2001) found that the positive relationship between patent enforcement and license fee payments is true only in the case of countries with strong imitative capabilities.

Very high IPR standards at the same time might prevent global innovation and technology transfer. The global innovative firms would expect slower loss of their technology advantages and would earn higher profits per innovation, reducing the need to engage in R&D (Helpman 1993; Glass and Saggi 1995). Where the imitation is based on licensed technology, the licensor may provide low quality technologies and this in turn reduced the licensee's incentive to imitate (Rocket 1990). In order to counter the abusive powers arising out of IPRs, the industrial policy should also have provisions for compulsory licensing when the innovator fails to transfer the latest technology or fails to transfer in the required manner. Without such provisions, patent laws may become a tool merely for preventing others from using the technology. Blocking patents and patent thickets can come in the way of both transfer and diffusion of technology. The blocking patents are in the nature of complementary patents which are essential for the development of new products or processes, implying thereby that these patents must be licensed out in order to successfully launch products or processes in the market. [9] Patent thickets pose a serious problem in technology transfer arrangements as they

[9] A more formal characterisation of a blocking patent was provided by Merges and Nelson thus: "Two patents are said to block each other when one patentee has a broad patent on an invention and another has a narrower patent on some improved feature of that invention. The broad patent is said to "dominate" the

can affect the possibilities of arms length transfers. This problem affects developing countries, in particular, as technology transfer opens up the possibilities of strengthening their domestic production capabilities. Compulsory licensing is a very effective policy instrument widely used in the advanced countries to check anti-competitive practices. Compulsory licensing provisions were introduced into the British patent law as early as 1623 and into the US patent law in 1790 (Penrose 1951).

In recent times, China provides a very good example to use of industrial policy to gain from IPR-technology transfer linkage. A study conducted by United States International Trade Commission (USITC 2011) showed that the indigenous innovation policy in China has crucial provisions to effect international transfer of technology, its local adaptation and dissemination. The study identified six policy areas as relevant to indigenous innovation in China: (1) Government procurement – this has been used both by the central and provincial governments as an early market to encourage the new technology products manufactured by Chinese companies. A catalogue is prepared every year of the products of indigenous innovation and products in the catalogue gets preference in the government procurement; (2) Chinese standards – China has introduced its own technical standards different from international standards. Such standards encourage local adaptation of foreign technology as well as Chinese made products; (3) China has introduced a strong anti-monopoly law; (4) tax incentives on R&D in China – Chinese firms are entitled for tax benefits if R&D in undertaken within China and IP is owned locally; (5) Technology transfer policies and joint-venture requirements - in a number of high-technology industries, including aviation and automotive, foreign firms' access to Chinese market has often been contingent on the requirement of the transfer of specified technology to a Chinese firm, generally a joint-venture partner; and (6) local content requirement for FDI firms. This would create backward linkages.

With the support extended to Chinese firms and indigenous innovation the share of residents in total patents granted in the country is steadily growing. Figure 1 gives the details.

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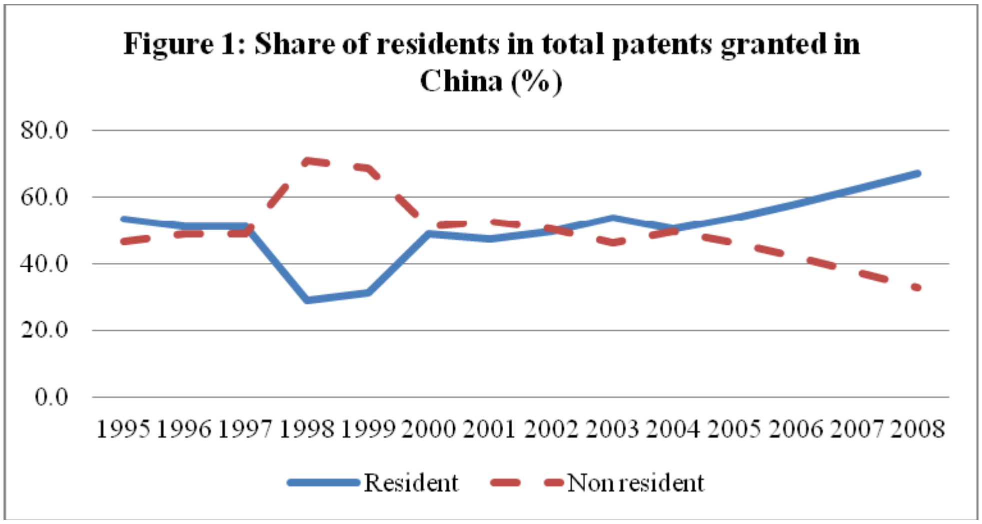
narrower one. In such a situation, the holder of the narrower ("subservient") patent cannot practice her invention without a license from the holder of the dominant patent. At the same time, the holder of the dominant patent cannot practice the particular improved feature claimed in the narrower patent without a license", see Merges and Nelson (1990), p. 860-61.



Source: WIPO database

IPRs are important for the international transfer of technology. But certain initial conditions in the IPR granting country are needed. Experience from advanced and emerging economies shows that these initial conditions include the existence of forward and backward linkages, competent domestic industry, skilled personnel, strong policies to check anti-competitive practices and to support indigenous innovation. In other words, IPRs should be seen as a part of the indigenous innovation system and has to be adequately linked to other components of the innovation system in order to maximize gains from international transfer of technology. Studies have shown that in the absence of such conditions, market power effect emerges resulting in no effective transfer of technology or transfer of lagging technologies.

III. Lessons learnt

The literature surveyed in this section provides few clear messages regarding the North-South experience of technology transfer. The role of intellectual property rights in determining technology transfer appears somewhat ambiguous. The strong case made in favour of a strong regime of intellectual property protection for enabling developing countries to get access to new technologies does not find adequate empirical support. The studies reviewed in this paper have pointed out that the owners of patented technologies were inclined to enter into licensing agreements only if the recipients have adequate domestic capabilities to assimilate the technologies. Most developing countries have weak local innovation systems and hence they do not have very much gain from the strengthening of the intellectual property regime. Again, while several studies have argued that a strong intellectual property regime will result in technology spillover, which would, in turn, have a positive impact on the R&D systems of the recipient countries, the empirical support for this argument appears rather weak. In fact, there is now evidence emerging from the developed countries like the United States that have historically been supporting strong intellectual property regimes, that the impact of such a regime can be detrimental for its own innovation system.[10]

Evidence linking foreign direct investment regime and technology transfer is equally inconclusive. Like in the case of intellectual property rights, studies reviewed in this paper have indicated that the foreign firm usually exercises its superior bargaining power to refuse technology transfer to the host countries. Interestingly, technology transfer via foreign investors seems to be more successful only where the host country governments impose conditions on the investors. China, more recently, and India, in an earlier period, provides ample examples of what may be termed as "policy-induced" technology transfer.

[10] Federal Trade Commission (2003).

Part II

One of the key features of the evolution of the global economy over the past decade and a half has been the prominent role that some of the emerging economies have been playing. This has given a perceptible fillip to cooperation between the countries in the South – in fact, South-South cooperation has become a significant component of many development programmes. In recent years, a steady stream of new aid providers has emerged. While China's significant presence in Africa, besides in a number of other low-income and least developed countries has been widely discussed, India has been steadily expanding its role as a development partner beyond the South Asian region in which it has provided assistance for more than five decades.[11]

The available evidence on development assistance between southern partners indicates that the beefing up of soft infrastructure has dominated this form of cooperation. While this has mostly taken the form of capacity building programmes, initiatives that can have larger pay-offs, such as collaboration in the area of science and technology, are only beginning to emerge.

This part of the paper discusses three cases of successful technology and knowledge sharing involving India and its partner countries. We are deliberately not using the term "technology transfer" for the partnerships are built on a much wider "knowledge platform". The cases that we will discuss are the following: (i) sharing of technologies for production of antiretroviral drugs in Uganda; (ii) development of the Pan Africa E-Network through technology and knowledge sharing; and (iii) sharing of knowledge on human genome sequencing with Sri Lanka. While the first of the cases involves one of the leading generic pharmaceutical firms, viz. Cipla, the two other cases involve publicly financed institutions. These cases are interesting for they have at least two significant features. One, they cover areas that represent frontiers in technology, and two, they are critical for the development of the partner countries.

[11] India began providing assistance to Nepal in the 1950s, and through the Indian Technical and Economic Co-operation (ITEC) scheme from the mid-1960s, there has been a clear emphasis on unconditional technical, project-based co-operation. For details see, Price (2005).

IV. India-Uganda Joint Venture for Production of Anti-AIDS Retrovirals

The largest Indian-owned generic pharmaceutical producer in India, Cipla Ltd is among the largest producers of antiretroviral drugs (ARVs) in the world. Cipla's involvement in the supply of cost effective treatment for AIDS patients began in 2001 when the firm made an offer to South Africa to give it the right to sell eight AIDS drugs that were then available at high prices only from the firms that held patents on these drugs.[12] Cipla offered to sell generic versions of these drugs to South Africa and other governments for $600 a year per patient, which was about $400 below the price of the patented variants.

With its market for ARVs expanding in several other African countries during the next few years, Cipla received the offer to take its commercial involvement in the continent to the next higher level in 2004 when it received an offer from the Government of Uganda to start a joint venture with one of the local firms, Quality Chemicals Ltd (QCL), which was a local distributor of imported medicines in the country.

The Cipla-QCL joint venture, the Quality Chemical Industries Ltd (QCIL), represented strategic thinking on the part of the Government of Uganda that was struggling to provide adequate supplies of cost effective ARVs and anti-malarial drugs to its population. While India was the largest supplier of the generic drugs in Africa, the Ugandan government was concerned about its ability to be a reliable source of affordable the ARVs and anti-malarial products following the amendment of India's patent laws in keeping with its commitments under the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). Through this amendment, which was effected in 2005, India introduced product patents in pharmaceutical, replacing the process patent regime that existed since the early 1990s. The process patent regime allowed domestic enterprises to reverse engineer patented products and was therefore credited with the emergence and the subsequent strengthening of the generic pharmaceutical industry in India. With the introduction of the product patent regime in India, generic pharmaceutical producers would be constrained to engage in reverse engineering and this became the basis for the Ugandan government's offer to Cipla.

[12] Swarns (2001).

The Ugandan government's decision was also conditioned by the fact that the WTO Members had agreed to extend the transition period for introduction of product patents in pharmaceuticals for the least developed countries until 2016 as a part of the decision which addressed issues relating to the TRIPS Agreement and public health concerns. Thus, as a least developed country, Uganda would be in a position to continue producing generic substitutes of patented medicines without infringing the rights of the patent owners until product patents were introduced in 2016. QCIL was therefore seen as a steady source of supply of the much needed medicines satisfying the demand not only in Uganda, but also in the countries belonging to the East Asia Community.

QCIL was an important step for it was engaged in the production of a vital range of drugs, the full triple therapy combination of antiretroviral (ARV) drugs, something that was done in Africa before. Before QCIL began production, South Africa had a plant for producing ARVs, but it did not produce triple therapy combinations. Likewise, a few African countries such as Egypt and Nigeria have ARV factories, but none of them produce the full range of three drugs required for treatment of HIV/AIDS.

When the two partners, QCL and Cipla entered into the agreement in 2005 for the establishment of QCIL, Cipla's share in the equity holding of the joint venture was 38.55%, while QCL held the remaining shares. However, the two partners agreed to equally share the profits. Subsequently, the shareholding pattern was altered with Cipla increasing its stake to 41.8%, with the QCL holding a similar share. Two private equity firms, TLG Capital of UK and Capitalworks Investment Partners of South Africa equally shared the rest of the equity holding.[13]

The design specifications of the production facility were provided by Cipla. The firm also transferred intrinsic technology; a range of hardware technologies, including the know-how for manufacturing of the active ingredients required for producing the ARVs and anti-malarial drugs. And Cipla also provided the information on the sourcing of raw materials, packaging technologies and production plant design.

[13] This is the shareholding pattern as of February 2011.

Cipla was responsible for engaging the technical expertise for building the state-of-the art production facility that was designed to meet the latest global standards. Initially, expatriates were recruited to perform the technical work. Subsequently, Cipla drew upon the expertise skills available in Uganda, including mechanical and electrical engineers, biochemists, pharmacists, and other skills. As a result, the number of expatriates was reduced from about 40 to 12. [14]

The most prominent feature of the joint venture is the focus on the tacit know-how and skills training that Cipla is expected to provide. [15] The joint venture partner also provided the know-how related to the day-to-day running of the plant, including quality assurance and quality control. In addition, Cipla provides training not only for scientists, chemists and other management personnel, but also training in organizational issues. In particular, skills and know-how that have been transferred over the past 2 years relate to (i) plant design and installation, (ii) product and process know-how, (iii) good laboratory practices, (iv) engineering for plant maintenance and (v) sourcing of raw materials. [16]

The joint venture began the production of two ARV combinations (containing zidovudine, lamivudine, stavudine and nevirapine) and one antimalarial drug (an artemisinin lumefantrine preparation) in February 2009, after obtaining a manufacturing License from National Drug Authority (NDA). In January 2010, the production facility was declared to be in compliance with WHO Good Manufacturing Practices (GMP). Later, in July 2010, In July, it received the WHO pre-qualification for its production, thus paving the way for the firm to participate in the donor-driven programmes on HIV/AIDS and malaria.

Although the Government of Uganda did not participate directly in the joint venture, it played a prominent role, first in the realisation of the joint venture, and then by helping it to remain economically viable. In the initial phases of the project, the Ugandan government provided a variety of incentives to attract the initial investment, which included an agreement to invest a 23% stake as part of Quality Chemical's local equity to allow the plant to be completed as

[14] Economic Policy Research Centre (2010), p. 21.
[15] Sampath (2011), p. 266.
[16] Sampath (2011), p. 267.

intended in 2008. Yet another decision taken by Government, to procure 100% of the joint venture's output of ARVs, will play a crucial role in ensuring that the joint venture will overcome its teething troubles, thus contributing to greater access to medicines in Uganda. This dimension becomes even more important given that QCIL is unable to reduce the prices at which it is able to sell its products. Herein lays the key challenge: from an access-to-medicines perspective, QCIL will have to reduce the price of its final product to a level where its products are no more than 5–7% higher than the internationally competitive generic prices in these therapeutic segments. Quite clearly, Cipla's would have to play a much larger role now – to improve the commercial viability of the joint venture.

V. Human Genome Sequencing: Generating and transferring a state-of-the-art technology[17]

Human genome sequencing opened the possibility of introducing personalised health regime based on the specific genetic make-up. Pharmacogenomics, the branch of pharmacology which deals with the influence of genetic variation on drug response in patients by correlating gene expression or single-nucleotide polymorphisms (SNP) with a drug's efficacy or toxicity, is expected to play a critical role in clinical medicine in the near future. Although pharmacogenomics-based-drug and dosage management is very expensive and unaffordable to most of the potential candidates in developing countries, a recent breakthrough shows that it has a potential for making drugs affordable by keeping old and cheap drugs in the market and reviving drugs withdrawn from the market because of side effects.

The development of drug response biomarkers has provided opportunities for better targeting of the drugs. The response of individuals to specific drugs would then become the critical factor in determining the bouquet of drugs that should be retained in the market. More importantly, drug response biomarkers will enable low-cost drugs to be retained in the market for therapeutic use, instead of being replaced by the relatively more expensive new generation

[17] This case study was developed by interviewing scientists at the Institute for Genomics and Integrated Biology (IGIB), a research laboratory established under the Council of Scientific and Industrial Research, Government of India.

medicines. By using this technology, only a small percentage of patients that do not respond or show low tolerance to existing low cost drugs need to be prescribed the more expensive new generation drugs, thereby reducing the overall public health care cost without compromising the quality of treatment. Thus, the discovery of potential drug response biomarkers suitable for a large fraction of a country's population is seen as the key to effective disease and drug dosage management. The key to the discovery of such biomarkers is the identification of units of genetic homogeneity amidst the diversity of populations. This in turn necessitates the building up of a map that would define the genetic structure of a given country's population and enable the comparison with other populations.

In 2003, India emerged as one of the first developing countries to have undertaken the task of developing a database on human genome sequencing. The initiative was taken by the public-funded Institute for Genomics and Integrated Biology (IGIB) under the Council of Scientific and Industrial Research (CSIR) to establish a network of institutions, Indian Genome Variation (IGV) consortium. The importance of this initiative stems from the fact that this was entirely driven by the domestic science and technology institutions in India.

The primary objective Indian Genome Variation (IGV) consortium was to provide data on validated SNPs and repeats, both novel and reported, along with gene duplications, in over a thousand genes, in 15,000 individuals drawn from Indian subpopulations. These genes were been selected on the basis of their relevance as functional and positional candidates in many common diseases including genes relevant to pharmacogenomics. This was the first large-scale comprehensive study of the structure of the Indian population with wide-reaching implications. A comprehensive platform for Indian Genome Variation (IGV) data management, analysis and creation of IGVdb portal was also developed. The ultimate goal was to create a DNA variation database of the people of India and make it available to researchers for understanding human biology with respect to disease predisposition, adverse drug reaction, population migration etc. IGVdb is being perceived as a resource that catalogues the common patterns of genetic variation in important complex disease candidate genes. There is provision for incorporating or widening the scope of the project as more and more information on the human genome variations is being made available with additional information.

The first results of the studies undertaken by Indian Genome Variation (IGV) consortium was obtained after six years when the research project yielded the complete human genome sequencing. India had thus joined China as the only other developing country to have undertaken human genome sequencing.

Knowledge Dissemination in Sri Lanka

The knowledge generated by Indian Genome Variation (IGV) consortium was put to immediate use in a collaborative venture in Sri Lanka. [18] This project was initiated by the Specialty Board in Biomedical Informatics of the Postgraduate Institute of Medicine, University of Colombo, Sri Lanka. The feature of this project was that it yielded resulted far more quickly than in India. Within a year of the sequencing of the human genome in India, the first Sri Lankan Personal Genome was successfully sequenced by scientists and bioinformaticians from the University of Colombo, Sri Lanka and the Institute of Genomics and Integrative Biology, New Delhi, India.

As in the case of India, the Sri Lankan Genome Variation Database has been developed, which is a database of SNPs found in Sinhalese, Sri Lankan Tamils and Moors - the three major ethnic groups in Sri Lanka. The database presently contains information including genotype frequencies of 34 genomic variations encompassing 14 medically important genes from the Sri Lanka's point of view. Here again, the database was made accessible to all and it also accepts submissions from the research community and thus offers a standard access point to the spectrum of genetic variations in the population to researchers and clinicians.

In the future, the project expects to unravel the genetic diversity of Sri Lankan populations by sequencing more individuals from different racial groups by building on the collaborations that had helped in its development. The next steps contemplated by the Sri Lankan research team suggest that it has climbed the learning curve quite efficiently. The project is preparing to assimilate knowledge and expertise and possibly co-create resources which would enable the interpretation of data and its application in healthcare. This includes participation in co-creating open resources for interpreting genomic variations and participation in collaborative initiatives

[18] Interview with the IGIB Scientists revealed that a similar project "Malay Genome Re-Sequencing" has already been initiated with Universiti Teknologi MARA (UiTM), Selangor, Malaysia

aimed at understanding the diversity of Asian populations. The researchers also recognise that application of genomics in healthcare would not be possible without educating and involving medical professionals in genomics research and that this would include educating medical professionals on analysing and interpreting genomic information and using such information in their clinical practice.

VI. The Pan-African E-Network: Technical cooperation and knowledge sharing with African Union[19]

The most ambitious of the technical assistance projects undertaken by the Government of India is the Pan-African E-Network Project, undertaken in partnership with the 53 members of the African Union. The objective of the E-Network Project, which was launched in 2007, is to empower the resource-rich Africa through tele-medicine and tele-education. Launched initially for a period of five years, this project is among the largest programmes of distance education and tele-medicine ever undertaken and it stands out as one of the first examples of a large South-South development cooperation.

The project seeks to provide adequate educational facilities and affordable healthcare, the two prominent concerns of many developing countries. Besides providing the essential connectivity for enhancing development programmes in the above-mentioned areas, the E-Network Project would eventually provide real-time connectivity among the Heads of States of African Union.

Improvements in communication infrastructure for delivering quality education and healthcare across length and breadth of the country are vital for the progress of any country. Efforts in delivering education and healthcare from resourceful urban areas/developed countries to inaccessible remote/rural areas have yielded fruitful results in terms of success to the quality services in time and a cost effective manner.

India and Africa share a lot in common in the development challenges they face. India has had some early successes in Information Technologies and as a partner of Africa took the leadership

[19] Information obtained from Ministry of External Affairs, Government of India.

to share its technological know-how in partnering with countries of Africa to bridge the digital divide.

This landmark initiative was designed to share India's expertise in the educational and medical fields for improving health and education services in the African continent. The project covered supply, installation, testing and commissioning of hardware and software, end to end connectivity, satellite bandwidth, providing the tele-education and tele-medicine services to the members of the African Union. India has thus undertaken to provide critical knowledge and training in the areas of education and health as well as the technological expertise essential for setting and maintenance of the infrastructure necessary delivering for the services.

The Critical Deliverables

As mentioned above, the primary objective of the Pan-African E-Network project is contribute to capacity building in partner countries in Africa by imparting quality education to students, through the best Indian Universities and Educational Institutions and to provide tele-medicine services by way of on-line medical consultations to the medical practitioners in the patient-end locations from Indian medical specialists in various disciplines, specialties and sub-specialties.

By undertaking this project, India committed itself to providing pedagogical skills that would be imparted to the participating countries through the e-learning mode by the Indian Universities. Over a period of 5 years, 10,000 students of Africa will be benefiting from the educational programmes that are put in place.

The advances in medical science, bio-medical engineering together with telecommunications and Information Technology (ICT) have led to the development of Tele-Medicine solution in India. This has contributed to providing affordable healthcare facilities to the population settled in remote areas. Through the E-Network Project, India's healthcare sector would be able to provide its services to partner countries in Africa.

Indian Super Specialty Hospitals will provide tele-medicine services to the participating countries, which will consist in on-line medical consultation for an hour per day to each country and off-line medical advice for 5 patients per day per country. The project also covers

Continuing Medical Education (CME) to practicing doctors and the paramedical staff with a view to updating and enhancing their knowledge and skills.

Telecommunications Consultants India Limited (TCIL), a publicly funded organisation, is turnkey implementing agency of the project. Thus, TCIL is responsible for setting up the necessary infrastructure for the project and organise training programmes at the regional centres in Africa to familiarize their Telecom, IT and Paramedical staff who are required to operate the equipments/network on day-to-day basis.

In addition to linking up the institutions in India and Africa, the infrastructure that TCIL will build will facilitate connectivity with the centres of excellence in education and health existing in Africa. Five regional leading universities and five regional super specialty hospitals in Africa will also provide tele-education and tele-medicine services in the respective region.

The first phase of the Pan African e-Network Project in being implemented since 2009 in 11 countries.[20] In this phase of the Project, tele-medicine patient end locations have already been set up in 11 Indian Super Specialty Hospitals. These have been connected to 33 Patient-End Hospitals in African countries. Regular tele-medicine Consultations have already started in some of the African countries.

Tele-education teaching centres have also been set-up in 5 Indian Universities and 3 Regional Leading University Centres in Africa. More than 1700 students from several African countries have already registered with Indian universities and they are being imparted tele-education by Indian Universities.

The second phase of the project has also commenced in 2011, wherein 12 more countries have been included in the project.[21]

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[20] The countries included are Benin, Burkina Faso, Gabon, The Gambia, Ghana, Ethiopia, Mauritius, Nigeria, Rwanda, Senegal and Seychelles.

[21] Botswana, Burundi, Cote d'Ivoire, Djibouti, Egypt, Eritrea, Libya, Malawi, Mozambique, Somalia, Uganda and Zambia, are the countries included in this phase.

VII. Lessons learnt

The evidence of South-South technology and knowledge sharing that were provided through the cases discussed above clearly indicates that the spirit of *partnership* permeates through each of them. These cases stand in contrast with the North-South technology transfer in at least two ways. First, it is the development dimension on which these projects are conceived, and secondly, there are no conditions attached by the technology and knowledge provider before entering into the partnership.

Interestingly, the development dimension is evident even in the case of a joint venture between two commercial enterprises, viz. the Cipla-QCIL joint venture in Uganda. In this case, the technology providing entity responded to the need of the recipient to set up a production facility for some of the more critical drugs, even when the establishment of the joint venture would have affected Cipla's export market. Although available evidence shows that the joint venture faces considerable challenges before it can be commercially viable, this case illustrates clearly that South-South Cooperation has the potential to make a difference in critical areas.

The second case, the development and sharing of knowledge in the frontier area of human genome sequencing provides evidence that science and technology in countries of the South are in the process of getting decoupled from those in the North. The collaboration between India and Sri Lanka in the latter's project on human genome sequencing was thus considerably more valuable – it provided a validation of the technology that the Indian scientists had generated and had used in the Indian Genome Variation consortium.

The third case illustrates the fact that South-South Cooperation can execute broad spectrum projects that typically consist of a wide range of participants. This case provides evidence that South-South Cooperation can help in strengthening institutions that are essential for realising the development objectives. This contribution, in our view, is particularly significant because developing countries are often saddled with weak institutions unable to provide the needed impetus.

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