TRANSFER OF TECHNOLOGY AND TECHNOLOGICAL CAPACITY BUILDING

I. INTRODUCTION

The importance of technological change in raising productivity and living standards is well-known. Productivity increases are associated with lower-cost production processes, higher-quality intermediate inputs and outputs, and greater product variety, all of which require innovation. Invention and creation processes remain overwhelmingly the province of the OECD countries, who continue to undertake the great majority of R&D and to register the bulk of patents. Developing countries largely must rely on imported technologies as sources of new information about management, production techniques, and innovative products and services. However, considerable amounts of follow-on innovation and adaptation occur in those countries and, indeed, this process drives effective technological change in follower nations.[1] Thus, both the acquisition of technology and its diffusion into the economy are central for productivity change and growth.

Global policies regarding international technology transfer (ITT), especially intellectual property rights (IPRs), have been controversial for a long time. A prominent episode came in the late 1970s when efforts were made by many developing countries to revise the Paris Convention and establish a Code of Conduct on technology transfer.[2] Those efforts were widely reviled by technology developers and multinational firms as poorly considered and antithetical to the market processes within which ITT largely occurs.

Since that time policymakers in most developing countries have become more amenable to reliance on markets for spurring inward ITT. Technology transfer is generally a complex and costly process and both sellers and buyers need some assurances that they will recover the costs of their investment in moving information across borders. Moreover, as discussed below, ITT depends on many factors in addition to IPRs. Countries increasingly recognize that they need to fit their IPR regimes appropriately within a broader policy context, including a substantial reliance on market forces.

In this regard, the primary recent policy change is the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) at the WTO. TRIPS commits countries to establishing and enforcing comprehensive minimum standards of IPR protection, without discrimination between domestic and foreign creators. The presumed benefits include greater incentives for both creating new technologies and selling them through more orderly markets. Indeed, the Agreement elevates technology transfer to a basic objective of the international trading system. Specifically, Article 7 states as a fundamental goal that:

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[1] Evenson and Westphal (1997) and Evenson (2003).

[2] Sell (1998) describes the politics involved and Patel, Roffe and Yusuf (2000) analyze the nature of the negotiations and their aftermath.

> *The protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations.*

Article 7 is an objective for the global system. Thus, the regimes adopted not only by developing countries but also those by developed countries and those reached in bilateral and multilateral consultations should promote technology transfer and diffusion. For its part, Article 8.2 recognizes that countries may wish to adopt policies "…to prevent the abuse of intellectual property rights by rights holders or the resort to practices which unreasonably restrain trade or adversely affect the international transfer of technology."

These two articles reflect the fundamental tensions inherent in protecting technology developers in order to induce more invention and ITT. In principle, stronger protection could improve the business climate within which technology markets operate, expanding both innovation and (compensated) diffusion. However, exclusive rights provide developers the opportunity not to transfer technologies to particular markets and raise the costs of (uncompensated) imitation. Where a refusal to transfer technology becomes an abuse of IPRs, countries are empowered to offset this abuse.

Evidently negotiators believed that simply agreeing to TRIPS, and even enforcing its provisions, likely would not suffice to expand information flows to the poorest countries. Thus, the most direct language on technology transfer arises in Article 66.2, which states:

> *Developed country Members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least-developed country Members in order to enable them to create a sound and viable technological base.*

There are several noteworthy aspects of this article. First, it requires only developed countries to provide such incentives, and only on behalf of the LDCs. No obligations or rights are created for the developing and transition countries. Second, it is a positive obligation, as affirmed by the Doha Declaration. Third, there is presumably an "effectiveness test" implicit in this article. Although the language does not say the incentives must actually achieve increases in ITT, a failure to be effective would reduce the meaningfulness of both Article 66.2 and Article 7. However, the final phrase implies that such incentives should be carried out in order to enable LDCs to create a technological base. Thus, "effectiveness" should be read as an expectation placed on both sides. Finally, Article 66.2 does not mention IPRs specifically. Thus, developed countries could establish whatever incentives they find appropriate. Such incentives could include limitations on the scope of IP protection that do not otherwise conflict with provisions of TRIPS.

In this note I consider various economic issues raised by the technology transfer concerns implicit in TRIPS. In the next section I analyze the available evidence about the role of IPRs in transferring technologies to developing countries. In the third section I offer suggestions about policies that both developed and developing countries could undertake to promote ITT. Implicit in those suggestions are comments about IPR negotiations and the work programme of the WTO Working Group on Trade and Technology.

II. EVIDENCE ON IPRS AND TECHNOLOGY TRANSFER

One question posed for this paper is whether there is any valid evidence that the IPR regime, presumably in recipient countries, has any impacts on ITT. This question is not straightforward to answer because the processes involved are so complex and dependent on circumstances. Nevertheless, it is possible to gain insights from a relatively brief overview of the nature and determinants of ITT.[3]

2A. Concepts

Technology transfer refers to any process by which one party gains access to another's technical information and successfully learns and absorbs it into his production process. Technology may be codified (e.g., in blueprints) or uncodified (e.g., know-how of engineers). It may be embodied in products or disembodied in ideas. Technology ranges from choosing input mixes and output quality to organization of intermediate production stages, management, means of finance, and other elements.

Much technology transfer occurs between willing partners in voluntary transactions. Thus, there are demanders and suppliers of technology and information is traded in technology markets. Markets for information are peculiarly subject to failures and there is justification for addressing these with public policy. However, not all technologies are transferred in private markets between unrelated parties. Much information flows within the boundaries of firms and joint ventures. Further, knowledge about production and management processes may be gained from reverse engineering, reading published materials, training within firms and laboratories, and attending professional conferences. Finally, much information may be in the public domain. Note that the public domain is filled both by public research outcomes and by the decisions of firms not to seek protection or to permit their intellectual property protection to lapse.

Technology transfer is generally a costly process and these costs are central to how information is traded. Indeed, managing such costs is an essential component of both private technology markets and other forms of learning. For many developing countries policy must aim at reducing costs if more ITT is to be induced.

There are numerous channels through which technology may be transferred across international boundaries. One major channel is trade in goods and services. All exports bear some potential for transmitting technological information for they may be studied and reverse engineered. However, trade in capital goods and technological inputs can directly improve productivity by being placed into production processes. A second is foreign direct investment (FDI) through multinational enterprises (MNEs). MNEs generally may be expected to transfer to their subsidiaries technological information that is newer or more productive than those used by local firms. This is because their primary advantage is some knowledge-based asset that can be adapted and employed in multiple locations. This process may require the cross-border movement of technical and managerial personnel, in itself a significant conduit for ITT.

A third major channel is technology licensing, which may be done either within firms, among joint ventures, or between unrelated firms. Licenses typically involve the purchase of production

[3] Recent reviews are offered in OECD (2003), Saggi (2003a), and Maskus (2003).

or distribution rights and the underlying technical information and know-how. There are important differences between intra-firm ITT and market-mediated licensing. In the first case the MNE retains proprietary control of the intellectual property and know-how, while in the second case access to these assets must be provided the licensee. Thus, patents, trade secrets, copyrights, and trademarks can serve as direct facilitators of knowledge transfers.

The processes describe so far may be characterized as market transactions. Thus, markets for information play the major role in ITT and expanding the scope for transfers requires reducing imperfections and impediments in such markets.

There are also important non-market channels of ITT. Perhaps most significant is imitation, in which a rival firm learns the technological or design secrets of another firm's formula or products. Imitation may be achieved through product inspection, reverse engineering, decompilation of software, and trial and error. Whether imitation is legal or illegal depends on the scope of intellectual property protection and unfair competition laws. Because imitation bears no compensation to the technology owner it is an attractive form of learning and diffusion for developing economies. However, imitation is costly and may divert attention from local innovation.

A related form of learning is turnover of technical and managerial personnel, who take knowledge of one firm's technologies and join or start a rival firm. Such competition can be a significant form of information diffusion. Again, the scope for this activity depends on the legal treatment of labor mobility and "non-compete clauses" in contracts.

Another means of acquiring technology is to study patent applications. In principle, firms can read such applications, learn the underlying technologies, and develop competing processes and products that do not infringe the original claims. However, there is considerable debate over whether such patent disclosures provide sufficient information that rival engineers can understand the technologies, especially in poor countries.

Finally, much knowledge is transferred through the temporary migration of students, scientists, and managerial and technical personnel to universities, laboratories, and conferences located mainly in the developed economies. Note that in-depth training in science and engineering may be gained this way, making it a long-lasting form of ITT. The challenge for developing countries in this context is to encourage expatriate students and scientists to return home and undertake local research, educational, and business development.

A final general observation is that while ITT in various forms provide direct increases in productivity, a major share of benefits to recipient countries arise from uncompensated spillovers. Positive spillovers exist whenever technological information is diffused into the wider economy and the technology provider cannot extract the economic value of that diffusion. Spillovers are clear in the case of imitation. However, they arise also through imports, exports, licensing, and FDI. This may be most evident from FDI because the operations of multinationals may generate labor turnover, demonstration effects, and vertical (backward and forward linkages).[4]

[4] FDI might also generate negative pecuniary externalities if it drives local firms out of business and causes increased market concentration.

2B. Evidence on ITT

Technology transfer flows are not easily measured for several reasons. Much ITT is implicit in international trade in goods and services and it is impossible to break out the proportion of product price reflecting technology content. Similarly, available FDI data rarely measure implicit knowledge flows. Formal licensing contracts involve royalties and fees, which are the most direct measure of ITT, but these may be distorted for various reasons. Almost by definition, imitation goes unreported and spillovers cannot be directly measured. Finally, virtually no analysis has covered the poorest countries because the data available are extremely sketchy.

Thus, as an empirical matter analysts generally must take an indirect approach to assessing ITT. One strategy is simply to report trends in high-technology trade, FDI, and licensing fees, despite the fact that such flows overstate the underlying direct ITT. By any measure these flows have increased sharply to developing countries in the last 15 years.[5] However, these increases were not distributed evenly across destinations and FDI in particular went overwhelmingly to a small number of large developing nations. The LDCs failed to attract much expansion in this technology trade.

A second strategy is to measure the spillover impacts of such flows into higher (or lower) domestic productivity. The following points crudely summarize a complex literature.

- There is considerable evidence that commodity imports, especially in capital goods from R&D-intensive countries, is associated with higher total factor productivity and labor productivity in importing countries. These spillovers exist at the aggregate, intra-industry, and inter-industry levels. Exports to developed countries also are associated with higher domestic productivity, largely because exporters need to deploy technologies that support international quality levels and standards. On this point there is compelling firm-level evidence.
- The evidence on spillovers in developing countries from FDI is mixed at best. In terms of horizontal (within-industry) externalities, there is little evidence of higher domestic productivity or wages in firm-level studies from Morocco, Mexico, and Venezuela. However, in China and the Czech Republic there was within-industry evidence that firms undertaking in-house R&D programs benefited from the existence of competing MNEs.
- The evidence of vertical spillovers from FDI, especially through sharing technical specifications and blueprints with supplier firms, is compelling. Studies in Korea, Lithuania, Malaysia, and Indonesia all have found strong firm-level indications of powerful backward linkages to higher productivity.
- Licensing is an important source of innovation and technical transformation for developing countries.[6] However, technology is not just information that can readily be learned by passive buyers. Rather, successful transfer typically requires some capacity to learn and investments to introduce technologies into production processes. Thus, countries in which enterprises have substantial engineering skills and active R&D programs for adaptation and learning are more likely to be the recipients of licensing flows than others and to benefit

[5] Maskus (2000) and UNCTAD (2002) provide representative data.

[6] See Correa (2003).

from spillovers. To my knowledge, there are no compelling cross-country studies of the impacts of licensing on productivity.

- Much technology exists in the public domain and is, in principle, free for the taking or available at nominal charge. However, there can be significant costs in absorbing these technologies.

In interpreting such conclusions it needs to be recognized that ITT flows depend strongly on other factors, including proximity to markets, size, growth, competition conditions, human capital basis, governance, and infrastructure.

2C. How Do IPRs Matter?

Intellectual property rights are granted for three purposes. First, they are society's legal means of providing exclusivity rents to inventors as compensation for their investment costs. Without IPRs, inventive and creative activity would be diminished. This argument commands wide political support in developed economies but remains under debate among economists. Second, because some forms of IPRs, particularly the patent, require public disclosure of the technical nature of what is protected, they advance the stock of publicly available knowledge.

The third purpose is most relevant here. A major reason for protecting IPRs is that they can serve as an important support for markets in technology, including ITT.[7] Without protection from leakage of new technical information, firms would be less willing to provide it on open technology markets. Further, patents and trade secrets provide the legal basis for revealing the proprietary characteristics of technologies to subsidiaries and licensees, supporting the formation of contracts. Trademarks serve a useful complementary role in this context.

To put it differently, firms offering technologies to potential partners in foreign countries will account for the likelihood of losing control of the information in setting contract terms. In an environment of weak IPRs, they may choose not to transact at all, to offer older-generation technologies, to keep the information within the firm, or accept reduced fees from licensees to induce them not to defect with the information. These problems may be expected to reduce overall volumes of ITT.

However, the fact that weak IPRs reduce inward ITT is not certain; nor is the idea accepted by all observers.[8] Limited patent protection and weak trade secrets offer local firms some scope for imitating foreign technologies and reverse engineering products. The essence of intellectual property protection is to award to inventors the right to decide when, where, and under what terms information will be transacted. Thus, foreign firms may choose not to have any physical presence in a country, preferring to satisfy a market through exports. Similarly, strengthened IPRs provide foreign inventors greater market power in setting licensing fees, distribution territories, and grant-back provisions.

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7 See Arora, Fosfuri, and Gambardella, 2001.

8 For example, Correa (2003) argues that strong intellectual property protection is liable to stifle ITT as firms exploit their market power.

Thus, there are complex tradeoffs that must be answered with empirical research. The evidence overall is reasonably persuasive that patent protection both increases flows of ITT and shifts incentives for investors between FDI and licensing. However, this work is based largely on aggregate data and therefore is not definitive. Further, there is little suggestion of this positive impact in the least developed countries. Again, I offer here a crude summary of the evidence.

- There is strong evidence that patent applications serve as a conduit for learning among OECD economies. Patent applications from foreign nations are strongly associated with productivity growth in recipient countries.[9] Specifically, every country other than the United States obtained more than 50 percent of its productivity growth by importing technologies (patents) from abroad and this proportion was far higher for small economies. Thus, "trade in ideas" is a major factor in world economic growth.
- Patent citations reflect "knowledge flows" across borders in the sense that local inventors learn from them. One study found that about 15 percent of average knowledge within a region is learned outside the region of origin.[10] Thus, there is a limited amount of diffusion overall, owing to distance, borders, and differences across regions in technological specialization. However, the most significant patents are widely diffused, as is knowledge in the highly technological sectors. Most significantly, there is a strongly positive impact of knowledge flows on international innovation.
- Stronger patent rights may be expected to raise considerably the rents earned by international firms as patents become more valuable, obliging developing countries to pay more for the average inward protected technology.[11]
- International trade flows, especially in patent-sensitive industries, respond positively to increases in patent rights among middle-income and large developing countries. An important reason is that these countries represent a competitive imitation threat with weak IPRs and stronger patents expand the market for foreign exporters.[12] However, trade flows to poor countries are not responsive to patent rights.
- The evidence on patents and inward FDI is mixed but recent studies, armed with better models and data, uniformly find positive impacts among middle-income and large developing countries.[13] Again, poor countries with stronger patents do not attract FDI on this basis. It seems likely that important threshold effects are at work and these need to be studied more carefully.
- There is an identifiable "internalization effect" whereby strengthening of patent rights shifts ITT from exports and FDI toward licensing. Further, patent protection positively affects inflows of knowledge, measured as R&D expenditures undertaken on behalf of affiliates. Again, these findings apply only to recipient countries with strong imitative abilities; the impact was zero in countries with weak imitative abilities.[14]

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[9] See Eaton and Kortum (1996).

[10] See Peri (2003).

[11] See McCalman (2001) and World Bank (2001).

[12] See Smith (2001).

[13] See Smith (2001) and Blyde and Acea (2002).

[14] See Smith (2001) and Nicholson (2002).

- The sophistication of technologies transferred rises with the strength of intellectual property protection. That is, as countries strengthen their regimes and offer domestic capacities to absorb and improve upon technology, foreign firms become more willing to transact more advanced products and processes.

We need not rely solely on such econometric studies for insights. Important evidence is available also from individual country experiences with attracting ITT and diffusing it into the economy. Unfortunately, relatively few countries have been studied and, to my knowledge, none of the LDCs. Again, therefore, the histories should be considered largely suggestive.

Japan is often described as a country that acquired much technology without IPRs in place. This is misleading, for Japan had an active patent law since the early 1900s at least. A fairer characterization is that in the period of Japan's rapid growth and industrialization after World War II, its patent system was designed for both small-scale innovation and diffusion. Thus, the regime recognized utility models, permitted single claims only within the patent application, required early (pre-grant) disclosure, and had an active opposition system. This approach encouraged incremental and adaptive innovation by Japanese firms and promoted the diffusion of knowledge, including foreign technologies, into the wider economy. It also encouraged inventive foreign firms to license their technologies to Japanese concerns, in part because of the difficulties of establishing FDI. Extensive econometric analysis suggested that this system encouraged the filing of large numbers of utility model applications for incremental innovations that were based partly on laid-open patent applications.[15] Statistically, utility model filings had a positive and significant impact on Japanese TFP growth from 1969-1993, suggesting that they were a source of technical change and information diffusion.

Korea represents another case of a "technology follower" that has transformed itself into an increasingly innovative and high-technology economy. In its early stages of industrialization, through the 1970s, Korean firms undertook learning via "duplicative imitation" of mature technologies that foreign firms had permitted to enter the public domain or were willing to provide cheaply.[16] Industrial property rights were weak and encouraged imitation and adaptation. In this context, Korea was a low-wage economy producing labor-intensive goods at the end of the product life cycle. For this purpose, however, its firms had to import "off the shelf" technologies successfully and adapt them for developing slightly differentiated products. The role of the government essentially was to promote exports and encourage the development of technical and engineering skills through education and workplace training.

Korea's success moved it up the product cycle to an economy undertaking "creative imitation" in the 1980s and 1990s. This process involved more significant transformation of imported technologies, increasing domestic R&D, and additional production differentiation. It also required increasing use and development of knowledge-intensive intermediate inputs. Thus, the need for in-house research capabilities became central for technology acquisition. Under pressure from the United States (and with increasing support from innovative domestic firms) the government undertook major upgrades of the intellectual property system from 1987 to

[15] See Maskus and McDaniel (1999).

[16] See Kim (2002) and Maskus (2000).

1993. It also became more welcoming to formal channels of ITT and there were major increases in royalty payments, capital goods imports, and FDI in the 1980s and 1990s.

Brazil, Mexico, Malaysia, and the export-intensive regions of China and India are among other countries that graduated from the imitative stage to that of creative imitation and implementation of knowledge-intensive inputs. In each of these cases IP protection was limited and firms took advantage of available foreign technologies. But as the technological sophistication of production processes matured and the depth and complexity of knowledge for effective absorption grew, firms increasingly have resorted to formal means of ITT and governments have strengthened the IP regime.

From this history it is fair to conclude that both the nature of ITT and interests in IPRs follow a form of "technology ladder" related to basic product-cycle ideas. Many middle-income developing and transition countries are essentially at the duplicative imitation stage, hoping to absorb free or cheap foreign technologies into labor-intensive export production and evolve higher value-added strategies over time. The poorest countries have barely stepped onto this stage of the ladder at best.

In this regard, a strong argument exists that the global system of stronger protection required by TRIPS amounts to a significant entry barrier for firms in poor countries. While this pessimism can be overstated, it does seem that certain avenues to industrialization have been narrowed by the new regime. It is, therefore, important to consider policies that countries and the system might undertake to offset this trend.

III. POLICY SUGGESTIONS

An initial question to address is whether there are positive arguments for governments intervening to regulate and encourage ITT. In fact, there are inherent difficulties with technology markets that justify policy interventions.

1. Because technical information is partially non-excludable inventors are likely to transfer (place on the market) fewer technologies than would be optimal, or to raise imitation costs that limit transfers. In terms of policy, governments need to balance the needs of follow-on competition from spillovers (i.e., limit excludability) against the costs arising from restricted technology transfer. In some degree, IPRs accomplish this objective.

2. Transfers of technology are subject to asymmetric information problems that can significantly reduce incentives for trade. The essential problem is that the owner of a technology may have complete knowledge about its effectiveness and associated know-how, while the buyer has far less information about it. The buyer would be unwilling to offer a price that would cover all of these claimed benefits before he is sure that such information is correct. But the seller would be unwilling to reveal the information without a contract in place at an acceptable price. Accordingly, many otherwise mutually beneficial technology transactions may break down. It follows that policy should aim at two objectives. First, reduce this information asymmetry by increasing access of local buyers to the international stock of knowledge about available technologies. Second, increase the certainty with which technology owners can signal the true value and characteristics of their inventions to buyers without excessive concerns about losing that value without compensation.

3. Owners of new technical information are likely to have market power because of lead times, brand loyalty, or the exercise of intellectual property rights. Thus, inventors may be expected to sell technologies at a price higher than marginal cost, which is socially less than optimal for the recipient country. This wedge between price and cost raises some scope for policy intervention to restrain prices. It should be acknowledged that it is very difficult to implement the kinds of precise intervention that would expand technology transfers at lower cost, rather than simply induce technology developers to exit particular markets. An important variant of this problem is that inventors might transfer technologies under terms that monopolize output markets rather simply extracting rents on the transfer itself. In such cases the exercise of anti-monopoly policies may be in order.

4. More controversially, inadequate flows of ITT associated with these market imperfections can impede the ability of nations to acquire public goods, the provision of which depends on access to international technologies. Prominent examples include technologies to improve environmental use, medical technologies to enhance public health, and scientific and educational materials. In analytical terms, the economic here reflects an externality across distorted input markets (e.g., a patent-protected environmental technology and the poorly regulated use of environmental resources) or between input and output markets (e.g., vague ownership of genetic resources and IP protection on extracted medicines). Optimal policy would aim to use multiple instruments to deal with these multiple distortions, accounting for interactions between instruments.

These market problems provide the essential justification for intervention, assuming that government regulatory failures can be avoided. As noted, IPRs themselves offer a partial solution to each problem but typically fall short of a full remedy. With this in mind, I offer the following list of policy suggestions.

3A. Host-Country Policies

Developing countries could do much on their own to encourage inflows and adoption of ITT. In short, their challenge is to improve the local environment for ITT and its diffusion.

- An important determinant of the ability of domestic firms to absorb foreign technologies is the return to investing in at least simple R&D capacity. To the extent that technology policies, restrictions on capital markets, and tax policies restrict this return or discourage such investments, they could be reformed to encourage more innovation.
- Similarly, absorption of ITT and its translation into greater competition depend on having an adequate supply of engineering and management skills. In this regard, domestic education and training policies are important. Equally important, however, is establishing a domestic entrepreneurial environment that attracts skilled workers who reside in developed countries to repatriate.
- Backward spillovers from ITT appear to be strongest in countries where multinational firms are capable of working with competitive suppliers in order to increase their productivity and standards. Reducing entry barriers in supplier industries can assist ITT.
- Evidence suggests that FDI and licensing respond to an adequate business environment. Important factors include, among others, an effective infrastructure, transparency and stability in government, and a reasonably open trade and investment regime.

- Governments may be able to do little about geographical distance but they can take steps to reduce the "technological distance" between their firms and foreign firms in order to encourage ITT. This is the main argument for establishing national or regional innovation systems that encourage local R&D, transfer knowledge from universities and public laboratories to domestic firms, and promote use of telecommunications, e-commerce, biotechnologies, and other cost-saving technologies.
- The intellectual property system is integral to efforts to promote learning from ITT and follow-on innovation. In this regard, attention should be paid to selecting IP standards that recognize the rights of inventors but encourage dynamic competition.

This list offers little new to policymakers in developing countries and may be of limited relevance to the poor and least-developed countries because some of them require resources that might be better spent on other development needs. Therefore, the more relevant lists are those following.

3B. Source-Country Policies

Under Article 66.2, developed countries have a positive obligation to provide incentives for ITT to LDCs. To date the reports issued offer little room for optimism that effective new programs are under consideration. These reports, while useful for increasing transparency about available benefits, are hardly sufficient for expanding technology flows. The following suggestions for a more positive approach may be considered.

- Nothing in Article 66.2 prevents developed countries from providing indirect incentives for ITT. The most powerful incentive would be to provide significant market access in the developed economies for products in which poor countries have a comparative advantage. The linkage between ITT and market access could be easily made by recognizing the role that market size and growth play in attracting trade and FDI, while recognizing that both international enterprises and domestic firms in developing countries would be more willing to invest in new technologies if export markets were more assured.
- In recognition of the role that technical standards play in diffusing production and certification technologies, developed countries could commit to greater access to experts from developing countries in deliberations of their own standards-setting bodies.
- Governments in developed countries could increase their technical and financial assistance for improving the ability of poor countries to absorb technology and trade. Among the key issues here would be capacity building in IPRs and technical regulations and standards, establishing public and public-private research facilities, facilitating technology-related services, and enhancing competition policy. Training programs in how technology is transferred through modern technology markets would be beneficial.
- It would be difficult for governments to envision fiscal incentives for transferring technology without offering similar incentives to firms to locate in or provide technologies to lower-income areas within their own countries. However, such discrimination typically works in the other direction. Thus, governments could agree to offer identical fiscal benefits to firms transferring technologies to developing countries as to developing home regions.
- Similarly, in the spirit of non-discrimination at the WTO, developed countries could offer the same tax advantages for R&D performed abroad as for R&D done at home.

To meet the terms of Article 66.2, there might be somewhat greater advantages offered for R&D performed in poor countries.

- Governments could ensure that tax deductions are available for contributions of technology to non-profit entities engaged in ITT. Such contributions could be in the form of money, technical assistance, or mature patent rights.
- Fiscal incentives could be offered to encourage enterprises to employ, at least temporarily, recent scientific and engineering and management graduates from developing countries. If such employment were to happen in the donor countries, some coordination with immigration policies would be required, including presumably requirements for the personnel to return to their countries for some time period.
- Public resources, such as those from the National Science Foundation or National Institutes for Health in the United States, could be used to support research into the technology development and technology transfer needs of developing countries. Further, grant programs could be established for research into technologies that would be of greatest productivity in poor countries for social needs, such as water treatment, energy, and the environment. Technologies developed under such programs could be made publicly available if transferred through public resources.
- In a similar vein, grant programs could be devised that offer support to research proposals that meaningfully involve research teams in developing countries, presumably in partnership with research groups in donor countries.
- Universities could be encouraged to recruit and train students from LDCs in science, technology, and management. Incentives for setting up degree programs through distance learning or even foreign establishments may be particularly effective in this context.

3C. Multilateral Policy Options

There are essentially two roles that international organizations can play in encouraging ITT. One is to serve as a coordinating mechanism for overcoming problems in private technology markets. The second is to serve as a forum for negotiating additional rights and obligations at the international level in order to reduce impediments to ITT. Neither of these roles necessarily involves the WTO, though that institution is likely to be important. Following are a series of suggestions that might be pursued at the multilateral level.

- The terms of Article 66.2 could be expanded to include all developing countries, or at least those without a significant domestic science and technology base and extensive university training. Incentives provided for ITT presumably would be more productive in countries that have a stronger ability to absorb information than do the LDCs currently.
- There may be scope for linking Article 66.2 and Article 67 to Article 7 in terms of obligations. Specifically, developing countries can argue that building a "sound and viable technological base" (Article 7) requires institutional reforms (including implementing and enforcing IPRs), infrastructure, and an effective science and technology policy, all of which are costly. Thus, developing countries could commit to making a good faith effort to improving the environment for ITT if developed countries were prepared to offer much more technical assistance and sustainable funding for such reforms.

- In this regard, a particular suggestion worth exploring would be to establish a special fee on applications through the Patent Cooperation Treaty, the revenues of which would be earmarked for improving IP administrative systems in developing countries. The primary beneficiaries of stronger patents in the developing world will be firms in developed economies. The poor countries have little incentive to fund these institutions. Thus, to resolve the collective-interest problem here (ie, that beneficiaries do not pay the costs), a special administrative fee at the PCT (or other international patent organizations) is sensible.
- Through negotiations the WTO could increase the scope for monitoring developed-country efforts in ITT and could add an evaluative mechanism for the effectiveness and extent of technology transferred. Over time this approach should compile important information about problems and effective practices in transferring technologies.
- To reduce information problems, the WTO and technology-related organizations could serve as an intermediary conduit for knowledge about successful technology-acquisition programs that have been undertaken by national and sub-national governments in the past.[17] That is, the WTO could serve a useful role in encouraging collaboration and information sharing among member governments. Once enough information of this type has been compiled and studied, the WTO (in conjunction perhaps with WIPO and technology-related organizations) could attempt to develop a model technology transfer contract that could serve as a guideline for ITT and would represent the legitimate interests of both buyers and sellers.
- Poor countries face major difficulties in developing the appropriate expertise for developing and enforcing anti-monopoly laws. Thus, one way for governments in developing countries to feel more confident about the system would be for authorities in the developed countries to undertake enforcement actions against firms headquartered or located in their jurisdictions.[18] Developed countries would agree to issue sanctions in home markets on the basis of malfeasance in poor countries, until that malfeasance is remedied. There would need to be considerable cooperation between competition authorities in the developed and developing economies for purposes of defining and recognizing licensing abuses.
- In future negotiations over Mode 4 in the GATS (temporary movement of personnel), developing countries could push for additional visa allocations for attending conferences and for professional researchers and students.
- Donor countries and organizations could consider establishing special trust funds for the training of scientific and technical personnel, for facilitating the transfer of technologies that are particularly sensitive for the provision of public goods, and for encouraging research in developing countries.[19]
- Countries are engaged in negotiating a Patent Harmonization Treaty through the auspices of WIPO. Developing countries should not agree to protection standards as they exist in the United States and the European Union regarding patentability, novelty, and utility. At a minimum there need to be regional examination offices with standards that reflect the needs of developing countries.

[17] See Saggi (2003b).

[18] See Saggi (2003b).

[19] See Roffe (2002).

- As regards TRIPS itself, there will be strong pressures to expand protection for geographical indications and to require patentability for biotechnological inventions. Each of these changes would pose some additional potential for increasing ITT flows to developing countries as the relevant technologies are deployed there. However, they also may raise costs and for some countries could be harmful in the intermediate term. Accordingly, developing countries could tie such changes to significant agricultural liberalization in developed countries. The linkages are direct in any case.
- Going beyond TRIPS, it is possible to argue that technical standards and regulations act not only as non-tariff barriers to trade but have the effect of limiting technology transfers to poor countries.[20] In this context, some relief (perhaps for a defined period) from the need for the poorest countries to meet minimum technical standards could help them acquire mature technologies.

3D. A New Treaty?

I would like to discuss briefly a final proposal for multilateral action, which bears considerable potential for expanding technology flows to poor countries but would be politically difficult to achieve. The proposal is for a multilateral Agreement on Access to Basic Science and Technology (ABST).[21] An agreement at the WTO would be negotiated in which all signatories would place into the public domain, or find other means of sharing at modest cost, the results of publicly funded research. The idea is to preserve and enhance the global commons in science and technology, while setting out a public mechanism for increasing the international flow of technical information, especially to developing countries, without unduly restricting private rights in commercial technologies.

The agreement could cover "input liberalization," which would permit researchers from other countries to participate in, or compete with, local research teams for grants and subsidies. This could be combined with increased opportunities for temporary migration of scientific personnel and additional student visas. However, governments could choose to reserve their research results for preferential use by local firms and the registration of intellectual property rights. While this approach could expand research efficiency and transfer more skills abroad, its scope for raising access to new information would be limited.

Alternatively, "output liberalization" would entail offering researchers in other countries access to nationally generated science and data, without increasing their ability to use underlying funding or research facilities. This approach would usefully expand the public commons and increase knowledge transfers but would not directly expand efficiency or transfer research skills. A key provision here would promote access to scientific databases and would ensure that intellectual property regulations not limit access to basic scientific knowledge.

Finally, "full liberalization" would combine these regimes, both expanding international flows of research contracts and personnel and increasing global access to outcomes. This would be thee most effective approach if it is all politically feasible. In getting there, however, it may be necessary to adopt something like a GATS approach, permitting governments to reserve

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[20] See Maskus and Wilson (2001).

[21] This proposal was first discussed by Barton (2003) and expanded in Barton and Maskus (2003).

sensitive areas of technology and to designate different levels of commitment to open access. Safeguards for security regulation would be required as well.

In recognition of the need for encouraging a "sound and viable technological base," it would be possible to build in preferences for the developing economies. For example, to the extent that data and research results are to be made available at some cost, differential pricing schemes for governments and institutions in poor countries could be encouraged. Efforts to encourage research participation by scientists and engineers from developing countries could be written into proposals. Marginal visa allocations could be aimed at students and researchers from poor countries. More generally, developed countries could commit themselves to help developing nations build capacity for improving educational and scientific processes, including their ability to benefit from available international information and the internet.

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