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Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options

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Summary. — This paper analyzes national and international policy options to encourage the international transfer of technology, distinguishing between four major channels of such transfer: trade in products, trade in knowledge and technology, foreign direct investment, and intranational and international movement of people. A typology of countries and appropriate policy rules of thumb are developed as a guide to both national policymakers and multilateral rule making in the WTO. We argue that the optimal policy mix varies across countries and that there is a need for differentiation in the design and application of rules in trade agreements as well as for a more explicit focus on evaluation of the impacts of policies.

Key words — technology transfer, multilateral trade negotiations, WTO

1. INTRODUCTION

The importance of international technology transfer (ITT) for economic development can hardly be overstated. Both the acquisition of technology and its diffusion foster productivity growth. Developing countries have long sought to use both national policies and international agreements to stimulate ITT. *National* policies range from the general, such as education and intellectual property rights (IPR) protection, to the specific, such as tax incentives for purchase of certain types of capital equipment. A prominent episode of *international* efforts to encourage ITT came in the late 1970s, when many developing countries sought a Code of Conduct to regulate technology transfer under United Nations (UN) auspices.

Given the incentives of owners not to transfer technology without an adequate return and the problem of monitoring compliance with international regulations, it is not surprising that ITT is predominately mediated by national policies. Existing multilateral rules on, for example, subsidies, trade policy, and IPR regimes, define limits on what is permissible. In contrast, agreements regarding actions that governments should pursue to encourage ITT are largely of a best-endeavor nature.

Starting in the mid-1990s, multilateral disciplines on ITT-related policies began to deepen. The WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), adopted in 1995, calls on countries to enforce

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comprehensive minimum standards of IPR protection on a nondiscriminatory basis. It also has provisions relating to ITT, as discussed later in this article. In 2001, WTO members established a Working Group on Trade and Technology Transfer to examine the relationship between trade and ITT and explore ways to increase technology flows to developing countries.

This paper discusses options that could be pursued by countries to promote ITT and the implications for international rule making and development assistance. Three dimensions are highlighted: safeguarding national "policy space" to address market failures; identifying actions by source countries to encourage ITT; and multilateral initiatives to address international externalities associated with technology markets or national policies. Section 2 reviews the major channels of technology transfer and the main policy instruments that could be used to enhance ITT. In Sections 3–5, our discussion turns to normative policy implications, focusing on policies of host (importing) countries, source (exporting) countries, and multilateral cooperation in the WTO, respectively. In Section 6, we summarize the discussion by means of suggested policy rules of thumb for countries at different stages of development. In Section 7, we conclude with a brief discussion of how trade agreements can help improve ITT policies.

2. CHANNELS OF TECHNOLOGY TRANSFER

We start with a brief discussion of the main avenues through which ITT occurs: trade in goods, direct investment and licensing, and movement of people.

(a) *Trade in goods*

Economic growth centrally relies on technological change through the creation of new products and processes (Grossman & Helpman, 1991). New products embody novel ideas and international trade can transmit knowledge across borders. Indeed, barriers to technology adoption are a key determinant of international differences in per-capita income (Parente & Prescott, 1994) and greater trade openness can increase growth by lowering such barriers. Trade contributes to ITT by allowing local reverse engineering and access to new machinery and equipment. Coe, Helpman, and Hoffmaister (1997) found that foreign R&D embodied in imported capital goods has a significantly positive impact on total factor productivity (TFP) of importing countries. [1] Later studies noted that this impact is greater, the more open the countries are, the more skilled is their labor force, and, in the case of developing countries, the more their trade is with developed countries (Schiff, Wang, & Olarreaga, 2002). Further, variations in capital-goods trade explain cross-country differences in productivity better than does overall trade (Eaton & Kortum, 1999).

These results suggest that open trade policies are crucial for developing countries to be able to attract technology. But openness alone is not sufficient, for strong absorptive capacity and the ability to adapt foreign technology are important for ITT to effect local technical change. In developing countries, technology acquisition often amounts to adapting existing methods to local circumstances (Evenson & Westphal, 1995). Gradual adoption of new techniques or inputs may be optimal for risk-averse producers in the face of costly investment and uncertain returns. Producers need to learn how to apply the new technology and improve it gradually over time (Tybout, 2000). Countries tend to acquire international technology more readily if domestic firms have R&D programs, there are domestic research laboratories and universities, and there exists a sound basis of technical skills and human capital (Maskus, 2000). These factors reduce the costs of imitation, adaptation, and follow-on innovation.

(b) *Foreign direct investment and licensing*

Investment by multinational enterprises (MNEs) may provide developing countries with more efficient foreign technologies and result in technological spillovers. In addition to demonstration effects, spillovers may arise because of labor turnover and vertical linkages. Case studies suggest that substantial technology diffusion occurs due to FDI (Blomstrom & Kokko, 1997). However, econometric studies support a more diverse set of conclusions. Some found that firms in sectors with a relatively high MNE presence tend to be more productive (Kokko, Tansini, & Zejan, 1997), while others noted that competing domestic firms do worse as the foreign presence in their industry increases (Aitken & Harrison, 1999). Such negative horizontal spillover effects may occur if MNEs siphon off

domestic demand or bid away high-quality labor. Similarly, there is a risk that imports of technology may reduce R&D efforts of local firms, which may have happened in some sectors in China in the 1990s (OECD, 2002).

Moran (2004) argued that there is a substantial difference in operating characteristics between subsidiaries that are integrated into the international sourcing networks of the parent MNEs and those that are prevented from such integration by policy barriers such as mandatory joint venture and domestic content requirements. These different characteristics include size of the plant, proximity of technology and quality-control procedures to global best practices, speed with which production processes are brought to the frontier, and cost of output. Integrated subsidiaries have a more positive impact on the host country, often accompanied by vertical backward linkages and externalities. Isolated affiliates have a less positive, and sometimes negative, impact on the local economy.

Drawing upon case studies and econometric evidence, Moran claimed that this contrast in performance holds across different industries, countries, and time periods. He noted that failure to differentiate between export-oriented FDI and import-substitution FDI, or between foreign investors free to source from any location and those operating under domestic content requirements, or between foreign investors obliged to operate as minority shareholders and those with complete or majority ownership, accounts for the inability of earlier studies to isolate the influences of FDI on host-country welfare.

Studies focused on spillovers to local competitors of MNEs miss the fact that such firms typically transfer technology to local suppliers. Mexico's *maquiladora* sector is a recent example of vertical ITT. Most maquiladoras began as subsidiaries of US firms that shifted labor-intensive assembly operations to Mexico. However, over time, the maquiladoras adopted more sophisticated imported production techniques (Saggi, 2002). [2] A recent case study of the effects of Intel's investment in Costa Rica by Larrain, Lopez-Calva, and Rodriguez-Clare (2000) found that local suppliers benefited substantially from Intel's investment. Similar evidence exists for other sectors and countries (Moran, 1998, 2001). For example, in the electronics sector, foreign investors helped their local subcontractors keep pace with modern technologies by assigning technicians to the suppliers' plants to help set up and supervise automated production and testing procedures.

Javorcik (2004) examined backward linkages and technology spillovers using data from Lithuanian manufacturing firms over 1996–2000 and found that productivity is positively affected by a sector's contacts with multinational customers but not by the presence of MNEs in the same industry. Thus, her results supported the existence of vertical spillovers from FDI. Blalock (2001) used panel data from Indonesian manufacturing establishments to check for similar effects. He found a strong positive impact of FDI on productivity growth of local suppliers, suggesting that effective technology transfer does occur. He also plausibly suggested that, since MNEs tend to source inputs that require relatively simple technologies, local intermediate suppliers are in a good position to learn from affiliates.

Licensing is an important source of ITT for developing countries (Correa, forthcoming). Contracts typically involve the purchase of production or distribution rights and the underlying technical information and know-how. [3] The general determinants of decisions to license are similar to those involving FDI, including market size and policy certainty and transparency. An important additional factor is the confidence of licensor firms that proprietary technologies will not leak into the host economy through copying or defection of personnel. If this is likely, foreign firms may prefer FDI, may not engage in licensing at all, or may transfer lagging technologies (Maskus, 2000).

Successful transfer typically requires capacity to learn and investments to apply technologies into local production processes. This factor explains why countries with substantial engineering skills and R&D programs for adaptation and learning are greater recipients of licensing flows than others (Yang & Maskus, 2001).

(c) *Labor turnover and movement of people*

Little attention has been given to the role of labor flows as a channel for ITT. Some studies have found that domestic labor turnover from MNEs to local firms is limited, while others claimed the opposite (Rhee, 1990). An explanation is that in countries where local firms are not far behind MNEs in technical terms, labor turnover is more likely. Thus, the ability of local firms to absorb new technologies is a determinant of whether labor turnover is a means of diffusion.

International movement of people, associated with nationals studying or working abroad for a limited period, or the inward movement of foreign citizens, is another potential channel for ITT. The recent experience of India in developing a software and related services industry illustrates that payoffs from such movements may take time to materialize but can be large. A policy challenge for developing countries is to facilitate temporary movement abroad and encourage returnees to undertake local research and business development.

(d) *Market failures and the need for policy*

Markets within which ITTs take place are subject to at least three major problems. The first is asymmetric information (Arora, Fosfuri, & Gambardella, 2001; Horstmann & Markusen, 1987). Technology suppliers cannot fully reveal their knowledge without destroying the basis for trade, while buyers cannot fully determine the value of the information before buying it. This problem can lead to large transaction costs and stifle technology flows. In the international context, information and contract enforcement problems may be severe. A second problem is that owners of new technologies typically have substantial market power resulting from lead time and IPR (Maskus, 2000). Thus, the price of technology will exceed its marginal cost. While this exclusivity allows developers to profit from innovation, it reduces the static national welfare of those importing technologies. A third problem is that externalities arise if the costs and benefits of technology exchange are not internalized by participants (Saggi, 2004). A major share of benefits to recipient countries of ITT is likely to arise from uncompensated spillovers, wherein technological information is diffused into the wider economy and the technology provider cannot extract the associated economic value.

These market failures support the potential for policies to increase welfare by altering the incentives of private agents to engage in ITT. This task is complex, and it is difficult for policymakers to identify optimal policies or even to rank order them according to effectiveness. [4] However, the problematic characteristics of knowledge markets noted above suggest that policy should aim at three targets: First, increase access of local buyers to the international stock of knowledge and improve the ability of technology owners to signal the true value of their inventions to buyers. Second, reduce the costs of acquiring and absorbing existing technologies. Third, increase incentives for domestic innovation. We next turn to policy options for host countries, source countries, and international cooperation.

3. NATIONAL POLICIES

A basic challenge for host developing countries is to improve the local environment for ITT and its diffusion. Both FDI and licensing respond to such factors as an effective infrastructure, transparency and stability in government, and a reasonably open trade and investment regime (World Bank, 2004). Also important is an entrepreneurial environment that attracts skilled workers home from developed countries. Given that vertical spillovers are strongest in countries where MNEs work with competitive suppliers, reducing entry barriers in upstream industries can also assist ITT.

An important determinant of the ability to absorb and adapt technology is the return to investing in at least simple R&D capacity. If existing technology policies, capital market regulations, and taxes discourage such investments, they could be reformed to encourage innovation. Similarly, absorption and competitive deployment of ITT depend on an adequate supply of engineering and management skills, making domestic education and training policies important. Governments can reduce the technological distance between local and foreign firms by establishing innovation systems that encourage R&D, transfer knowledge from universities and public laboratories to domestic firms, and promote use of cost-saving technologies.

Host-country governments also need to recognize the risk taking involved in adopting foreign technologies. Suppose domestic firms are considering the costly adoption of some foreign technology, and that significant uncertainty exists regarding the degree to which it can be used effectively. Firms adopting the technology first generate positive spillovers for others who can watch and learn. In the presence of such informational externalities, it makes sense to subsidize the adoption of foreign technologies. Hausmann and Rodrik (2003) have emphasized that in many developing countries, the market undersupplies investment by firms in new activities because of appropriability problems. If so, a subsidy or similar incentive can expand innovation and risk taking. [5]

(a) *Trade and FDI policies*

Available evidence suggests that diffusion of knowledge is facilitated by an open trade regime (Saggi, 2002). Firms need access to capital equipment and imported inputs that embody foreign knowledge. At the same time, the existence of market failures makes questionable any unconditional arguments against trade protection.

An important question is the scope of knowledge spillovers. International spillovers, for which there is considerable evidence (Eaton & Kortum, 1996), tilt the balance in favor of free trade. In contrast, intranational spillovers create a role for policy intervention, though trade policies would be neither efficient nor effective. Instead, general policies encouraging agents to undertake activities that generate social benefits exceeding private returns, without simultaneously creating additional distortions, are more appropriate.

Historically, restrictive trade policies were complemented by restrictions on FDI. Thus, Japan, the Republic of Korea, and Taiwan imposed restrictions on FDI, whereas policies were more welcoming toward other modes of ITT. Moran (1998) summarized the approach taken by Korea and Japan as a combination of import barriers coupled with export promotion; fiscal subsidies to create national champions in certain sectors; and restrictions on FDI coupled with insistence upon licensing and other arrangements. More recently, national FDI policies have become more liberal, but policies may differentiate between joint ventures and majority-owned FDI. For example, the Chinese policy has encouraged joint ventures more than inward FDI. Whether this approach is beneficial depends on the incentives MNEs have to transfer technologies to recipient firms and there is evidence that joint ventures obtain less advanced technology (Mansfield & Romeo, 1980; Moran, 1998).

While the magnitude of ITT undertaken by MNEs may not be socially optimal, evidence exists that they are keen to transfer technology to local suppliers (Moran, 1998). Policies that facilitate this process, rather than insisting that MNEs engage in ITT to local competitors, are more likely to succeed. In practice, many countries seek to attract foreign investors through special economic zones, subsidies, tax holidays, and other grants. Such investment incentives can be justified only if host countries enjoy positive learning and productivity externalities from inward FDI.

The prevalence of "follow the leader" behavior among MNEs provides a potential case for FDI incentives. One new entrant may attract investments by both other firms and upstream suppliers. If so, competition at multiple stages of production may increase, thereby improving both efficiency and overall output. An implication is that a host country may be able to unleash a sequence of investments by successfully inducing FDI from one or two major firms.

If the local economy lacks a well-developed network of potential suppliers, however, MNEs might not invest and suppliers may not develop. In such cases, growth is constrained by coordination problems that can partially be resolved by initiating investments from key firms. Such problems cannot be tackled solely through investment incentives, however. Policy efforts need to improve the investment climate and reduce the costs of absorbing technology. The latter task is complex and involves improving property rights, expanding innovation systems, and investing in efficient infrastructure. Thus, for incentives to be effective, important preconditions relating to the investment climate and absorptive capacity must be satisfied. Once upstream capacity exists, there may be a case for programs that help potential suppliers meet the needs of MNEs as customers. Such programs have been successfully implemented in a number of middle-income countries.

One set of policies often justified on the basis of regulating ITT are trade-related investment measures (TRIMs), such as local content rules and technology transfer requirements. However, TRIMs are implicit taxes on intermediate goods imports because manufacturers are forced to use higher-cost local inputs. They provide little incentive for the protected producers of intermediate goods to acquire knowledge and improve productivity. If the constraints imposed by TRIMs are too strict, MNEs may refrain from investing.

(b) *General versus specific technology-related policies*

Many studies indicate that absorptive capacity is crucial for obtaining significant spillover benefits from trade or FDI. For example, Borensztein, De Gregorio, and Lee (1998) tested the effects of inward FDI on growth in 69 developing countries. They found that it

contributes *more* to domestic growth than does domestic investment but only where the host country has a minimum threshold stock of human capital. Similarly, Keller (1996) argued that access to foreign technologies alone does not increase growth rates of developing countries.

Consider the role that subsidies can play in facilitating learning and technology acquisition when returns to such investments cannot be appropriated by private agents. Such commentators as Amsden (1989) argued that policy interventions, including implicit or explicit subsidies, lay behind the economic miracles in Korea and Taiwan. Their case is that carefully targeted subsidies allowed these governments to stimulate key sectors that became efficient and provided positive spillovers. It is important, however, to differentiate between sector-specific subsidies and general policies facilitating learning and enterprise development. In a recent retrospective on the East Asian development experience, Noland and Pack (2003) argued that sector-specific policies did not result in high rates of TFP growth for manufacturing. In Korea and Taiwan, TFP growth was not much higher than in OECD countries. In India, selective interventionist policies were associated with declining TFP growth rates, while the opening of the economy led to an increase in TFP growth (Krishna & Mitra, 1998).

The case for general policy supports for innovation, education, transport infrastructure, and similar public goods is uncontroversial. Regarding more commercial activities, however, the efficient use of support policies requires that governments can both identify cases that justify intervention and implement it appropriately. In practice, governments may fail to avoid potential problems, including subsidies that support inefficiency and strategic subsidy seeking by firms. Because these problems become difficult to control, credible exit strategies are needed to weed out successes from failures.

(c) *IPR and technology transfer*

IPR can support markets in technology, including ITT (Arora *et al.*, 2001). Patents and trade secrets provide a legal basis for revealing the proprietary characteristics of technologies to subsidiaries and licensees, supporting the formation of licensing contracts. [6] Patent protection both increases flows of ITT to countries with sufficient technological capacity and shifts incentives for investors between FDI and licensing.

The empirical literature supports several observations. First, patent applications from foreign firms are associated with productivity growth in recipient countries (Eaton & Kortum, 1996). Thus, "trade in ideas" is a significant factor in world economic growth. Second, information from patent citations suggests that the most significant patents are widely diffused, as is knowledge in highly technological sectors (Peri, 2003). Knowledge flows have a positive impact on international innovation.

Third, international trade flows, especially in patent-sensitive industries, respond positively to increases in patent rights among middle-income and large developing countries but not among poor countries (Smith, 2001). Next, the evidence on patent laws and inward FDI is mixed but recent studies find positive impacts among middle-income and large developing countries. However, in poor countries, patents do not expand FDI (Blyde & Acea, 2002; Smith, 2001). Fourth, strengthening IPR tends to shift ITT from exports and FDI toward licensing and also increases R&D expenditures undertaken on behalf of affiliates in recipient countries with strong imitative abilities (Smith, 2001). Fifth, the sophistication of technologies transferred rises with the strength of IPR protection and domestic capacities to absorb and improve technology.

A common finding is that the poorest countries are unlikely to benefit from strong IPR (McCalman, 2001). Stronger patent rights may be expected to raise monopoly rents earned by international firms as such rights become more valuable, obliging developing countries to pay more for protected technology. These are also countries where ITT-related spillovers are likely to be small. Thus, in poor countries policy should aim at lowering costs of imports of IPR-intensive goods and raising the capacity to absorb and adapt technologies.

(d) *Summary: Theory and experience*

Economic theory does not provide unambiguous guidance regarding the relative social payoff to alternative channels of ITT. Much depends on whether spillovers are international or intranational, the capacities to absorb and improve technologies, and other factors. A "one size fits all" approach to policy is inappropriate. Consider, for example, the choice be-

tween licensing and FDI from a host-country's viewpoint. If the relevant market is imperfectly competitive, the choice is not simple. The alternative to suffering market power at the hands of MNEs might be sustaining domestic incumbents with significant market power. While the profits of the latter add to national income, such incumbents will generally possess inferior technologies. If there exists a strong domestic incumbent, limiting FDI and encouraging technology licensing to that firm can increase its market power *vis-à-vis* weaker domestic rivals (Saggi, 1996). On the other hand, if FDI were restricted and open technology licensing encouraged, licensing would be preferable to FDI if the technology owner agreed to transfer the technology.

Given the limited guidance offered by theory, it is helpful to revisit briefly the history of successful efforts to move up the technology ladder. One reason for Japan's rapid growth and industrialization after World War II was that its patent system was designed for both small-scale innovation and diffusion. The system encouraged incremental innovation by Japanese firms and promoted the diffusion of knowledge into the economy (Maskus, 2000). Japan also encouraged foreign firms to license to Japanese firms, in part through restrictions on FDI.

Korea encouraged learning *via* "duplicative imitation" of mature technologies that were in the public domain or available cheaply (Kim, 2002). IPR protection was weak and encouraged imitation and adaptation. In the 1970s, Korea specialized in labor-intensive goods, with firms importing "off the shelf" technologies and adapting them to produce differentiated goods. Government promoted the development of technical skills through education and workplace training and significantly reduced antiexport bias. In the 1980s, Korean firms shifted to "creative imitation," involving more significant transformation of imported technologies. This shift required domestic R&D and in-house research capabilities. The government also became more welcoming to formal channels of ITT and strengthened the IPR regime.

Brazil, Mexico, Malaysia, and the export-intensive regions of China and India are other examples of movement from "pure" to "creative" imitation. In these cases, IPR protection was limited and firms took advantage of available foreign technologies. As the technological sophistication of production processes matured and the depth and complexity of knowledge for effective absorption grew, firms resorted more to formal means of ITT and governments strengthened the IPR regime.

These experiences suggest that the nature of ITT and appropriate policies follow a technology ladder. Many middle-income developing countries are at the duplicative imitation stage, hoping to absorb foreign technologies into labor-intensive export production and evolve into higher value-added strategies over time. The poorest countries have barely stepped onto this rung. Thus, a differentiated approach is needed for national policy and multilateral rulemaking. Specifically, the priority in poor countries with weak institutions and limited R&D capacity is to improve the business environment, with liberal trade policies to encourage imports of technology. Such countries should be exempt from strong IPR obligations and have access to mechanisms to reduce the cost of imports of IPR-protected goods. This could be achieved, for example, through either subsidies or differential pricing schemes.

Because absorptive capacity is weak in low-income countries, the emphasis should be on using trade to benefit from foreign knowledge and acquiring technology through FDI. Licensing is not a realistic option for least-developed countries (LDCs), given weak business environments and absorptive capacity. In poor countries, there is a greater need for FDI because the incentives for licensing or joint ventures are weaker. Indeed, this situation may provide a case for outward FDI investment incentives by high-income countries as part of their development assistance.

As countries move up the income and technology ladder, they gain more from IPR, which becomes important for licensing and benefits home entrepreneurs and innovators. Based on the experience of Asian economies, developing countries should adopt standards for patentability, novelty, and utility that are stricter (raising a higher bar to patenting) than those found in the United States and the European Union. This approach is consistent with WTO rules, which do not specify substantive criteria on the basis of which IPR grants are awarded. Upper-middle-income countries would benefit less from subsidy schemes to lower the price of technology.

4. SOURCE-COUNTRY POLICIES

Perhaps the most powerful indirect incentive for ITT that source countries could provide is

to grant greater market access for products in which poor countries have a comparative advantage, including agricultural products and labor-intensive goods. The linkage is that better assurance of foreign market access would expand incentives to transfer new technologies to producers in developing countries.

Turning to specific measures aimed at ITT, fiscal incentives or subsidies are the most obvious candidates. Subcentral governments in OECD countries often offer tax incentives to induce firms to establish facilities or to remain in their own countries, especially in low-income areas. One option is for central governments to offer the same fiscal benefits to firms transferring technologies to developing countries as are available for domestic activities. Developed countries could also offer the same tax advantages for R&D performed abroad as for R&D done at home.

In designing such incentives, home countries could tailor interventions toward channels appropriate for countries at different stages of development. Given the foregoing arguments in favor of FDI over licensing in low-income countries, for example, policies that subsidize direct ITT through licensing may not be beneficial to poor countries. A better approach would be to ensure that incentives target (or minimally do not discriminate against) outward FDI. Source countries should also differentiate between countries in initiatives to lower the cost of technology-intensive imports through promotion of differential pricing schemes. Although not a direct ITT policy, such price segmentation would avoid undesirable reverse transfers from South to North through arbitrage. [7]

Several other options to increase ITT incentives exist. First, permit tax deductions for contributions of technology to nonprofit entities engaged in ITT, taking the form of grants, technical assistance, or mature patent rights. Second, offer fiscal incentives to encourage enterprises temporarily to employ recent graduates from developing countries. Here there are potential synergies with efforts to expand the temporary movement of natural service suppliers under mode 4 of the General Agreement on Trade and Services (GATS). Third, public resources, such as those from the US National Science Foundation, could be used to support research into the technology needs of developing countries. Technologies developed under such programs could be made publicly available.

Fourth, universities could be encouraged to recruit and train students from LDCs. Financial incentives that tap into development aid funding for setting up degree programs through distance learning or even foreign establishments may be particularly effective. Finally, additional initiatives could center on increasing information flows. For example, technical standards play a role in diffusing production and certification technologies. Thus, developed countries could finance participation by experts from developing countries in their standards-setting bodies.

Convincing OECD governments to offer incentives for transferring technology is a challenge, but could be part of their overall development assistance efforts.

5. INTERNATIONAL COOPERATION

Many of the suggestions in the previous section will come at a cost to source countries. Similarly, a number of the developing country policy options discussed in Section 3 will require financing. Moreover, their effectiveness will depend importantly on design, discipline, and monitoring. These considerations provide rationales for using international agreements as commitment devices and enforcement mechanisms to increase the credibility and impacts of ITT policies. Safeguarding the ability of countries to pursue beneficial policies is also important. Certain avenues that were used in the past to achieve industrialization have been narrowed as a result of the WTO, suggesting a need to ensure that policy space exists to encourage ITT.

Helleiner (2000), Finger (2002), and Sabel and Reddy (2002), among others, emphasized that countries need the freedom to experiment with regulatory policies. Thus, detailed international policy harmonization is inappropriate. As argued by Hoekman (2005), multilateral monitoring and information exchange mechanisms can play a useful role in preventing capture and identifying effective policies. Such institutions as the OECD, UNCTAD, and UNIDO have provided a forum for exchanging experiences and discussing appropriate policies. The WTO Working Group on Trade and Technology Transfer provides a forum for dialogue that could be used more effectively.

There is a close connection between ITT discussions in the WTO and the concept of special and differential treatment (SDT) of developing countries. The argument that needs (market failures) differ depending on the type of country

suggests that ITT policies should be differentiated. The same is arguably true of SDT more generally, although differentiation is resisted by many developing countries. [8] Similar questions arise in regional trade and investment integration agreements. Most such agreements do not address technology transfer explicitly in the form of binding commitments, instead imposing disciplines on the ability to use specific instruments such as subsidies or TRIMs. However, some North–South agreements put substantial emphasis on financial and technical assistance to be granted by the high-income partner(s). The best example is the European Union, which has included such provisions in its partnership agreements with Mediterranean and other countries and has provided assistance for improving both absorptive and innovation capacity in its partners. To date, no such links have been made in the WTO and we now discuss areas where actions could be considered in that forum.

(a) *Subsidies*

The WTO Agreement on Subsidies and Countervailing Measures (ASCM) divides subsidies into three categories: prohibited, actionable, and nonactionable. R&D and related technology subsidies are nonactionable if they are not specific, or, if specific, satisfy certain conditions. These conditions cover ''assistance for research activities conducted by firms or by higher education or research establishments on a contract basis with firms.'' Fundamental research, defined as ''an enlargement of general scientific and technical knowledge not linked to industrial or commercial objectives'' is not subject to disciplines. [9] However, the provisions on nonactionability of R&D subsidies lapsed in 1999 and should be reinstated to permit developing countries to use them. In defining what is permitted, scope should exist to adopt measures that can be justified on the basis of externalities of the type identified by Hausmann and Rodrik (2003), discussed above. This does not mean complete freedom, for there is an important role for multilateral disciplines to help governments control subsidy policies and prevent capture. One approach would be to develop monitoring and surveillance mechanisms in the WTO aimed at increasing information on the effectiveness of policies to encourage innovation.

The current focus of the WTO is disciplines on national use of subsidies. A complementary approach would seek commitments by high-income countries to provide financing for risk-reducing entrepreneurial programs that promote entry into new activities. Such funding should be nondiscriminatory, made available to both foreign and domestic firms, because the nationality of innovating firms does not matter for realizing knowledge spillovers. The possibility of funding foreign entry through FDI or joint ventures might also enhance the support for such aid programs by creating a constituency in its favor in source countries.

(b) *Temporary movement of people and labor turnover*

Learning by doing, and subsequent labor turnover, are important channels of ITT. While most of the literature has focused on within-country labor turnover associated with FDI, international movement of people has a potentially larger role to play in fostering ITT. In order to be most beneficial to developing countries, policies should encourage temporary movement of people. The classic problems with international migration are that it is often long-term and can give rise to a ''brain drain'' with potentially negative impacts on home-country welfare. Such problems would not arise if labor movements were temporary and returnees applied new skills and knowledge at home.

Negotiations over the temporary cross-border movement of people have been launched in the WTO. These discussions arise in the GATS, for one mode of supplying services is through the temporary movement of suppliers. While GATS is limited to people providing services, its approach could be extended to a category of personnel that relocate temporarily in order to increase their human capital and acquire new skills (''training services''). In effect, such movements could be regarded as a mechanism for host countries to export knowledge to developing countries. While it may not be feasible to incorporate this idea into the GATS, the mode 4 precedent might be used to negotiate a stand-alone arrangement under which developing countries would be granted additional temporary visa allocations for working in OECD countries, motivated by ITT objectives. This would also be a way to provide concrete SDT to developing countries. [10] The visa allocation mechanism could be similar to the ''GATS visa'' regime that has been suggested by a number of WTO members (Mattoo & Carzaniga, 2003).

Donor countries and organizations could also consider establishing special trust funds for training scientific and technical personnel, facilitating the transfer of technologies that are particularly sensitive for the provision of public goods, and encouraging research in developing countries (Roffe, 2002). To the extent that data and research results must be purchased, differential pricing schemes for governments and institutions in poor countries could be encouraged. At the margin, visa allocations could be aimed at students and researchers from poor countries. More generally, developed countries could help developing countries build capacity for improving education and science, including their ability to access international information and the Internet.

(c) *IPR and TRIPS*

TRIPS Article 66.2 imposes an obligation on developed economies to find means of increasing ITT to the LDCs. One option would be for governments in developed countries to increase technical and financial assistance for improving the ability of poor countries to absorb technology and engage in trade. Examples of such assistance include capacity building in IPR management and technical standards, establishing public and public–private research facilities, and facilitating trade in technology-related services. The terms of TRIPS Article 66.2 could also be expanded to include all developing countries without a significant domestic science and technology base. In addition, a special fee on international patent applications could be considered, through the Patent Cooperation Treaty, with revenues earmarked for improving IPR administrative systems in developing countries. Given different interests of developing countries regarding criteria for patentability, novelty, and utility, efforts toward harmonization of criteria or tests could be limited to the regional level, through, for example, cooperative examination offices that apply regional standards (Maskus, 2003).

Poor countries face major shortages in expertise for developing and enforcing antimonopoly laws. One way for their governments to gain confidence in the system would be for authorities in developed countries to undertake enforcement actions against firms headquartered or located in their jurisdictions. A committed effort on the part of rich countries to prevent market-power abuses in developing-country markets by their sellers of technology could help achieve the goals of TRIPS Article 66.

(d) *Protecting and expanding the global commons for knowledge*

Another proposal that has considerable potential to expand ITT to poor countries is to negotiate a WTO Agreement on Access to Basic Science and Technology (ABST) (Barton & Maskus, 2004). This would place into the public domain the results of publicly funded research. The idea is to preserve and enhance the global commons in science and technology without unduly restricting private rights in commercial technologies. The agreement could encourage researchers from other countries to participate in, or compete with, local research teams for grants and subsidies, possibly combined with increased opportunities for temporary migration. It could also give researchers in other countries access to nationally generated science and data. It may be necessary to adopt a GATS-like approach to the ABST, permitting governments to reserve sensitive areas of technology and to designate different levels of commitment to open access. Safeguards for security-related regulation would be required as well.

(e) *Information exchange and multilateral monitoring*

To reduce problems of asymmetric information, international organizations such as the WTO could serve as an intermediary conduit for knowledge about successful technology-acquisition programs of national and subnational governments. Firms in many developing countries may have little knowledge about the structure of international ITT contracts. What are reasonable royalty rates? What conditions have sellers of technology been willing to negotiate? Which contract clauses have proved helpful in encouraging local technological development? Answers to such questions exist but their dissemination requires efforts by both the private and public sectors of developed countries. Privacy concerns should not be a major obstacle, as summarizing expired licensing contracts would not reveal confidential data.

More emphasis on information exchange and multilateral monitoring would also be beneficial. This effort should focus on the success of various policies in achieving particular objectives. Rather than only seeking to regulate what

countries may do to encourage ITT and innovation, a more productive approach could be to establish a broad framework that requires countries to engage in a regular exchange of information and policy assessments. Sabel and Reddy (2002) provided a conceptual sketch of such a "learning to learn" framework that could be applied to the ITT arena. The framework could also be devised to monitor the operation of subsidy programs supported by high-income countries.

6. RULES OF THUMB

Determining optimal policies to maximize ITT is difficult. ITT depends on many factors, including proximity to markets, size, growth, competition conditions, human capital basis, governance, and infrastructure. Significant uncertainty remains regarding the extent of market failures and spillovers, complicating the identification of good policies. Nonetheless, the foregoing analysis identified some rules of thumb for policy intervention as well as a number of specific proposals. We summarize the main policy implications in Table 1, distinguishing between low-income, lower-middle-income, and upper-middle-income countries. These categories are illustrative only and are useful primarily in distinguishing between the types of general policies that are most appropriate for countries at different levels of development. We also suggest a rank ordering of polices on the basis of likely social benefits.

A main priority in all types of developing countries is effective general technology policies, including improving basic education, building appropriate infrastructure, and reducing entry barriers for local firms that could be suppliers for MNEs. For local economies to gain productivity from ITT, such broader policy initiatives are important. This is a complex task that involves building human capital, expanding national innovation systems, and appropriately protecting IPR. Lower-income and middle-income economies could gain from investing in R&D support, especially as regards collaborations between public research entities and private enterprises, as part of their innovation systems. Source (donor) countries should support such investments.

Turning to specific policies, the evidence suggests that countries pursuing relatively closed trade policies fail to achieve the benefits from technology implicit in international trade. We therefore argue for liberal trade policies as a key priority, as important as sound general technology policies. As noted earlier, R&D-intensive capital-goods imports from high-income countries are associated with higher TFP in developing economies. Further, spillovers from technology-intensive imports can encourage exports because exporters need to deploy technologies that support international quality levels and standards.

Again, there is compelling evidence of vertical spillovers from FDI (Javorcik, 2004; Saggi, 2002). FDI is likely to be particularly important for low-income and lower-middle-income countries. The weak investment climates in many of these countries may justify a temporary case for encouraging FDI inflows, which we would rank second behind open trade policies. Such incentives should avoid discrimination across both sectors and foreign origins. Governments are not good at picking winners and should focus on encouragement of new activities. Given the possibility of coordination failures and learning externalities, any incentives for new "nontraditional" activities should apply to both domestic and foreign firms. Ideally, such support would be financed by development assistance.

A third specific priority for developing economies, especially poorer countries, is temporary international movement of technical workers abroad for education and training. Upper-middle-income countries could see growing two-way movements in skilled personnel. Such movements are an important source of learning, and will also lead to establishment of networks in foreign countries that are potential markets as well as sources of knowledge. China, India, and other emerging economies illustrate the importance of having a significant and sustained outflow of people who, upon their return, raise productivity. Even if they stay abroad for an extended period of time, they can be part of networks supporting trade and investment flows.

While licensing is an important source of technical transformation, successful transfer generally requires capacity to learn and adaptive investments by local firms. Poor countries are most likely to achieve these gains by taking advantage of mature technologies in the public domain or available cheaply. Thus, specific policies here are not as likely to be a high priority. They could aim at improving information flows about such technologies, as well as building skills and R&D capacity. Middle-income countries, in which firms have engineering skills and

Table 1. *A rule-of-thumb typology and examples of ITT policies*

	Trade in goods	FDI	Temporary movement of natural persons	Trade in knowledge (licensing)	IPR	General technology policies
Own policies						
Low-income countries	(1) Liberal access	(2) Nondiscriminatory investment promotion	(3) Incentives for education abroad and training-related movement	(4) Improve information flows about public domain and mature technologies	(5) Basic protection and minimum standards only	(1) Basic education; improve infrastructure; reduce entry barriers
Lower-middle-income countries	(1) Liberal access	(2) Nondiscriminatory investment promotion	(4) Incentives for education abroad and training-related movement	(3) Improve information; limited incentives for licensing	(5) Wider scope of IPR protection; employ flexibilities	(1) R&D support policies; improve infrastructure; reduce entry barriers
Upper-middle-income countries	(1) Liberal access	(3) Upstream supplier support programs	(2) Encourage two-way mobility	No active policy	(4) Apply full TRIPS	(1) R&D support policies; improve infrastructure; reduce entry barriers
OECD policies toward						
Low-income countries	(1) Subsidize public-good-type imports; free trade	(2) Incentives for outward flows exceeding those for FDI to LMICs (see below)	(3) Preferential access; subsidies for education; incentives for universities to accept DC students in STI disciplines and temporary employment	(5) Subsidize transfer of public domain and mature technologies	(4) Forbearance in disputes; differential pricing for exports of IPR products; assistance in competition policy	(1) Support for general DC technology policies (see above); public and public–private research facilities
Lower-middle-income countries	(1) Free trade; no controls	(2) Incentives equal to those granted for own disadvantaged regions	(3) Wider access for education and training; temporary employment of DC scientific personnel/ engineers	(4) Assistance in establishment of joint venture partnerships; matching grants	(5) Differential pricing of public-good type IPR protected goods; assistance in competition policy	(1) Support for general DC technology policies (see above); fiscal incentives for R&D performed in DCs
Upper-middle-income countries	Free trade; no controls	No incentives	Encourage mode 4 type mobility	No active policy	No active policy	No active policy

Notes: Numbers in parentheses indicate authors' rank ordering of policy on basis of economic importance or anticipated payoff. DC: developing country; LMIC: lower-middle-income country.

active R&D programs, are more likely to be the recipients of significant licensing flows. To enhance these flows, policy efforts could focus on reducing the costs of absorbing technology. The upper-middle-income economies require no active intervention in licensing, where technology markets may be expected to operate effectively. Note that our analysis in no case supports extensive government involvement in selecting technologies or placing restrictions on the use of technical information.

Despite the intense focus on IPR in the literature, we would argue that this is a relatively less important area for policy, so long as IPR regimes are tailored to levels of development and technological capacities. In Table 1, we hint at the issues and far more detail could be added. [11] Thus, low-income countries would find it advantageous to enforce basic protection of trademarks, trade secrets, utility models, and industrial designs in order to encourage both local small-scale innovation and inward FDI in labor-intensive technologies. However, it is inadvisable to move beyond minimum TRIPS standards, while requirements for patents, plant variety rights, and copyrights should be as pro-competitive as possible. The LDCs may be expected to do relatively little in terms of enforcing foreign patent rights in any case. There is a strong case for forbearance by OECD governments in pursuing enforcement-related dispute settlement at the WTO. For their part, lower-middle-income countries should take advantage of TRIPS flexibilities while offering somewhat wider scope of protection.

The bottom half of Table 1 encapsulates policy recommendations for high-income source economies that desire to encourage ITT to poor countries. Here again, market access for goods and services produced in developing countries is a priority. Fiscal incentives may be an effective means for overcoming market failures in ITT. As mentioned, such financial support should be directed at the general technology policies that are a top priority in most developing countries.

In terms of specific support policies, FDI is most important for low-income countries as they have the most to gain from investments in "new" activities and from entry by efficient foreign firms. Such incentives should be at least equal to those offered for investments in OECD countries, and, as argued above, could extend to entry by local firms into new markets and activities, including as suppliers to MNEs.

Liberal policies toward, and explicit encouragement of, labor movement through improved access to educational establishments, scholarships, and temporary employment of graduates and professionals is a third priority area for source-country action. This idea is politically sensitive and thus may be less feasible than the other areas. Finally, OECD governments could improve flows of public-domain technologies with appropriate subsidies and support the establishment of extensive price differentiation for exports of IPR products to low-income developing economies.

7. LEVERAGING TRADE AGREEMENTS FOR ITT

Many of the suggestions made in this paper can be implemented unilaterally. However, some require action in the WTO and many can be made more credible by incorporating them as specific commitments. This idea could be achieved as part of a new approach to SDT in the WTO that provides greater scope for policy flexibility on the part of developing countries. Alternatively, various ITT-related policy initiatives could be embedded in a mix of existing and new WTO agreements.

Although binding disciplines help ensure policy certainty, there is a rationale for flexible government tools to encourage ITT and address externalities in information markets. Thus, a key option is to negotiate clear criteria that differentiate among beneficiary countries. Broad, transparent categories would minimize transaction costs and uncertainty, but would not do much to help countries achieve ITT objectives. An alternative suggested by Hoekman (2005) is to provide for greater flexibility in the enforcement of multilateral disciplines in specific areas, such as ITT-related policies, but to accompany this with multilateral monitoring and periodic discussions among WTO members about the incidence and effectiveness of the policies pursued.

A related issue is whether the proactive ITT measures we have suggested for source countries should take the form of binding and enforceable commitments in the WTO or regional trade agreements. In some cases, such as the suggested implicit exemption from enforcement of TRIPS for low-income countries, a change in the relevant WTO rules is needed. However, in areas that are not now covered by the WTO a "soft law" approach that establishes broad

guidelines and relies on ensuring transparency and accountability *via* regular multilateral monitoring of performance is likely to be more effective at increasing cooperation and compliance. What matters most is that "demandeur" developing countries elucidate the need for specific policies and engage in a process of analysis to identify the most appropriate instruments. Insofar as these are subsidies, proposals should be put forward in development assistance allocation discussions. The extent to which such requests are met should be part of the proposed multilateral monitoring mechanism. The same is true with regard to allowing developing countries to pursue general technology-related policies and to encourage the use of specific channels of ITT.

NOTES

1. See Keller (1998) for a criticism of earlier work by Coe and Helpman (1995), the results of which may have been spurious. However, that trade embodies technical information is evident in numerous studies, including Eaton and Kortum (1996) and Keller (2002). Keller (2002) noted that information diffusion declines with distance but recognized that one channel must be trade.

2. Similar findings apply to transition economies; see, for example, Javorcik (2004).

3. With intrafirm ITT, the MNE retains proprietary control of the know-how, while in the arm's-length case, it must be provided the licensee.

4. In practice, the potential for beneficial policy may be frustrated by mistakes or rent seeking.

5. In such cases, IPRs may not be effective, for often the technology would already have been invented elsewhere. The objective is to encourage imitation of "revealed successes" through entry into what are new productive activities for the country concerned.

6. See Correa (forthcoming) for the counterargument that IPR stifle ITT as firms exploit market power.

7. A recent example was the August 2003 decision by WTO members to permit poor countries to issue compulsory import licenses for essential medicines, in return for effective means to prevent the backflow of medicines to higher-price countries.

8. Hoekman, Michalopoulos, and Winters (2004) offered an extensive discussion of the need for moving toward greater differentiation in SDT in the WTO.

9. A distinction is made between industrial research and pre-competitive development activity. For the former, the maximum amount of government participation is 75%; for the latter it is 50%.

10. A proposal by the LDC Group in the WTO, that they be given preferential access to a mode 4 "quota" as part of the GATS negotiations, goes in this direction.

11. World Bank (2001) offers extensive discussion.

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