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Volume 1, Issue 3, September 2004

Economic Perspectives on a Multilateral Agreement on Open Access to Basic Science and Technology

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Abstract

In this essay the authors set out a general proposal for a multilateral agreement on "open access" in basic science and technology. The authors discuss the economic foundations for such an accord, which they call an Agreement for Access to Basic Science and Technology (ABST), and analyse the principal issues that would emerge in establishing it.

DOI: 10.2966/scrip.010304.369

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Revision: May 2004

Prepared for presentation at The World Trade Forum, held at World Trade Institute, Berne, June 16-17 2003. The authors are grateful to Richard Baldwin, Bernard Hoekman, and other participants of the Forum.

1. Introduction

In this essay we set out a general proposal for a multilateral agreement, most appropriately reached at the World Trade Organization (WTO), on "free trade" (more accurately, "open access") in basic science and technology. The idea for this agreement was advanced earlier by one author (Barton 2003b). We discuss the economic foundations for such an accord, which we call an Agreement for Access to Basic Science and Technology (ABST), and analyze the principal issues that would emerge in establishing it. The agreement could be structured around open access for inputs (coordination and movement of research projects and scientific personnel), open access to outputs (basic research results) or both, and be founded on basic WTO principles. Moreover, the agreement could include provisions for preferential treatment for developing countries. Its central purposes would be to ensure widespread access to essential scientific results and to enhance the transfer of basic technological information to the developing world at reasonable cost.

We propose such an agreement for three essential reasons, which we explain further in the following sections. First, we share the increasingly widespread concern that government restrictions on access to data and research results could harm the pace of global scientific advance and the diffusion of knowledge, particularly to the detriment of transition and developing countries (Maskus and Reichman 2004; David 2003). Put simply, there has been a sharp policy shift toward making knowledge a private commodity, despite its inherent character as a public good, raising fundamental questions for science, education, and the diffusion of information.

Second, issues of technology transfer are at the center of the contentious debate about how the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) might affect developing countries. There is a common perception that, despite the promise held out by TRIPS that stronger technology protection would expand flows of knowledge to poor countries, very little gains have emerged in this regard. At the same time, the exclusive rights offered by TRIPS bear the potential for limiting access of developing countries to even publicly generated basic research that might otherwise enable greater competition and local innovation.

Finally, the economics of knowledge creation and the non-rival nature of information implies that global investments in basic science and technology are surely under-funded in comparison with a global optimum. Knowledge is a prime example of a global public good that can be more effectively provided by cooperative multilateral actions.

Thus, in our view it is important 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 without unduly restricting private rights in commercial technologies. The agreement we describe in this paper bears promise for meeting these objectives. There are precedents for an ABST. The United States is

party to numerous bilateral scientific exchange accords, some as treaties and some as arrangements between counterpart institutions. However, they apply solely to designated cooperative public sector programs. Recently scholars have proposed an agreement among universities and research institutions on free exchange in scientific data and in coordinating licensing arrangements (Reichman and Uhlir 2003).

In the following section we set out our concerns underlying the need for the proposed agreement. In the third section we discuss the economic principles justifying coordinated intervention in the diffusion of basic research. In the fourth section we describe the essentials of the proposal for an ABST and analyze both its structure and political viability. We offer concluding remarks in the fifth section.

2. The Proliferation of Proprietary Rights in Basic Research

As noted above, an essential reason for proposing an ABST is to offset the imbalances in access to knowledge arising from two fundamental policy changes. First, governments are increasingly imposing restraints on the use of knowledge generated by public research or through public funding. Such restrictions arise in part from regulations designed to protect national competitiveness, as in the following examples. Under the U.S. Bayh-Dole Act, a license to use technology developed from federally funded research must be awarded preferentially to national firms. In 2002 The European Union established a European Research Area, with several reservations for EU firms as regards use of publicly funded research results.

Other restrictive regulations emerge from the increasing scope of intellectual property protection for basic scientific results in the United States and the EU, which remain the primary generators of knowledge. This protection is expanding beyond products and applied technologies to basic ideas, procedures and materials, which had not been the subjects of proprietary rights under traditional intellectual property norms. For example, the United States grants patents on basic research tools and scientific methods of discovery in genetic sciences. In doing so the classical utility standard, under which an invention had to be reduced to a commercially useful product or process (as opposed to a scientific method), has been diminished significantly as a bar to gaining exclusive proprietary rights to basic knowledge. At the same time, the United States permits patents on research tools with broad reach-through claims, extending property rights on basic inventions to applied innovation. This policy raises fundamental concerns about "anti-commons" effects in biotechnology and materials sciences as the transactions costs of acquiring licenses rise (Heller and Eisenberg 1998; David, 2003). Furthermore, a recent U.S. court decision greatly narrowed the research exemption in patent law that was long permitted as a means of legitimate science and competition.[1]

In its 1996 Directive on the Legal Protection of Databases, the European Commission established a *sui generis* regime for the protection of data compilations (David 2004; Reichman and Uhlir 2003). Exclusive rights are available for the developers of commercially useful databases, even where those data are compiled from public research results and information already in the public domain. Thus, the regime offers proprietary rights on creations of limited inventiveness and, because the protection is renewable, it effectively is stronger than limited-duration patent grants.

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[1] Madey v. Duke University, 307 F. 3d 1351 (CAFC 2002).

These restrictions on data use in the EU offer little scope for fair use procedures that hitherto permitted reasonable access by researchers and educational institutions. Certainly those rights are considerably stronger than the global standard (as established by the WTO Agreement on Trade-Related Aspects of Intellectual Property rights, or TRIPS) of protecting databases solely with copyrights. For our purposes the primary concern is that such protection may reduce access to publicly generated, basic research results. For example, meteorological data generated by government research stations are now sold frequently under private rights. The European Commission's Directive may soon be emulated in U.S. law, as legislation to protect databases on a similar standard has repeatedly been brought forward in Congress.

Finally, we are concerned that excessively restrictive standards for granting proprietary rights to basic knowledge may be extended globally through various negotiated initiatives. For example, under the auspices of the World Intellectual Property Organization (WIPO) deliberations are underway regarding a global Substantive Patent Law Treaty. The essential objective of these negotiations is to harmonize standards for patent eligibility and examination procedures in order to minimize transactions costs. It is possible that recently evolved standards in the United States, including minimal utility, low inventiveness and novelty, and broad claim coverage, could be established in this treaty, thereby significantly limiting access of researchers and competing innovators on a global scale.[2]

A second concern relates to the effects of IPRs on international technology transfer. Governments in many countries place great importance on the ability of local firms and researchers to acquire technological information on reasonable terms. Economic evidence suggests that, in the long run, the stronger technology protection standards required by TRIPS should provide firms in developing economies significantly larger private technology inflows, mediated through imports, foreign direct investment (FDI), and licensing.[3] However, the likelihood of these increases depends on such national characteristics as size, proximity to markets, infrastructure quality, local imitative capacity, and the ability to absorb, modify, and deploy new technologies. Indeed, much of the additional technology transfer on offer may be from parents to affiliates within a multinational enterprise, with diminished capacities for spillovers to local firms. More directly, strengthened proprietary rights to knowledge raise the likelihood that firms may act more monopolistically in setting prices for information. Thus, increases in technology flows are not guaranteed and may not emerge at all in the poorest economies (Smith, 2001).

While there is considerable small-scale innovation in developing countries, they remain net importers of new technological information, which is the primary source of technical change and an important determinant of productivity growth (Hoekman, Maskus, and Saggi 2004). In this context, access to general knowledge emanating from basic research in the technologically advanced economies, no less for developing countries than for the developed nations themselves, is central to the processes of experimentation, adaptive innovation, and product development. Put differently, fundamental science generates the enabling technologies from which

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[2] Barton (2004) analyzes prospects for this treaty and argues for more competitive and development-regarding standards.

[3] Maskus (2000) provides a comprehensive review of such evidence and Smith (2001) offers recent empirical evidence.

dynamic competition springs (David, 2003). Significant restraints on access to such scientific results could pose difficulties for competition, particularly in developing countries.

Such concerns about technology transfer surfaced in TRIPS itself. Thus, Article 7 lists as a primary objective of the Agreement that intellectual property rights should contribute "…to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge…" To give content to this objective and to promote technology transfer to poor countries, negotiators agreed in Article 66.2 that "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."

Authorities in many developing countries are disappointed in the evidently meager response of technology flows to these indirect and direct incentives.[4] For this reason, WTO Members affirmed in Paragraph 11.2 of the Doha Ministerial Declaration that the provisions of Article 66.2 are mandatory. The Declaration calls for a mechanism for ensuring full implementation of that obligation and also set up a Working Group on Trade and Technology Transfer. To date the Working Group has collected submissions from developed countries describing the incentives they have in place to encourage technology transfer to poor countries. While these submissions are many and detailed, the programs described tend to be small, focused on specific projects, and not specific to the needs of the least developed countries. Moreover, the Article is restricted to the "least-developed countries," which is a subset of the developing countries and, indeed, a subset in which the private sector technology transfer envisioned by the Article is particularly difficult.

That supply responses in technology transfer have been meager to date is not surprising in economic terms. "Technology transfer" refers to a host of complex transactions that depend on a variety of factors, only one of which is the intellectual property system. New intellectual property regimes are only recently in place in many countries and have yet to achieve strong enforcement support. Most significantly, international technology transactions are undertaken primarily in private markets. While governments can provide some subsidies, tax advantages, research subventions, and credit guarantees, ultimately "…they cannot force the private sector to transfer its technologies" in the words of the EU submission to the Working Group.[5]

Though the issue surfaces most directly in TRIPS, the need to enhance technology transfer appears in several other WTO Agreements, suggesting that it is a broader concern than may be reflected in intellectual property rights. Such language exists also in GATS, the TRIMS Agreement, the Agreement on Technical Barriers to Trade, and the Agreement on Sanitary and Phytosanitary Measures. Further, any prospective

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[4] The assertion that technology transfer has not increased much since TRIPS is not based on systematic evidence, a study of which is needed. There is some evidence, reviewed in Barton (2003a), that the world's move toward stronger intellectual property rights contributes to greater foreign direct investment in some sectors, and may favor direct foreign investment over development through indigenous technology-based enterprises.

[5] "Implementation of Article 66.2: Information from Developed Country Members: European Communities and Their Member States," 2002.

agreement on competition policy presumably would address various aspects of technology markets.

Despite this coverage, many developing countries believe that the WTO Agreements do not adequately address means for facilitating effective technology transfers to their markets (Roffe 2002). In some degree this reflects a preference that the transfer of private commercial technologies be subsidized or made available without private property rights attached (Becker 2002). Neither possibility is likely, for fiscal subsidies to transfer commercial technologies would run into political opposition in home countries, while eliminating intellectual property rights in commercial information (through patent buyouts, compulsory licensing, and the like) would run counter to the nature of TRIPS itself.

3. Economic Perspectives

To advocate a multilateral policy intervention on behalf of open access to basic science and technology, we must demonstrate that the approach would help resolve market failures in the private generation of knowledge and its use, would provide advantages over a system based extensively on proprietary rights to basic science and technology, and would improve multilateral policy coordination in this area. To this end we begin by considering the economic nature of basic technological knowledge.

Economics of Knowledge Creation and Diffusion

Generations of writers have explained the fundamental characteristics of knowledge as a public good. Thomas Jefferson, for example, compared an idea to the flame of a candle, which could be used to light other candles without diminishing the original light.[6] Thus, the defining feature of knowledge is its non-rivalry: access distributes the gains from its use widely without reducing the ability of developers to use it. In turn, the social value to multiple uses is the sum of all the individual valuations, a sum potentially far larger than its value to an individual user. However, this same characteristic immediately generates a free-rider problem because anyone who can gain access to an existing idea would rationally refuse to offer to bear any of the initial costs of developing it. Non-rivalry is a technical characteristic suggesting non-convexities in the use of ideas and optimal social policy would call for the widest possible use of existing knowledge, assuming the marginal cost of additional provision is small.

A second feature of knowledge is that it may be difficult to maintain it in exclusive possession while putting it to some useful purpose. Attempts at secrecy often fail and, in the extreme, some technologies, such as medicines and software, bear their technical properties "on their face" and are easily learned through simple imitation. There may be technical and legal solutions that aim at generating exclusivity but the stronger these are the more costly is access to use of information.

Taken together, these characteristics imply that the returns to investing in ideas often may not be captured by an original creator. This non-appropriability problem necessarily implies that knowledge is a public good; indeed, in Arrow's (1962) classic conception it is the purest form of public good. Accordingly, market actors would not

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[6] David (1993) describes Jefferson's writings in this context.

undertake costly investments in developing new information and society would suffer from a diminished rate of technical progress.

This essential market failure calls for public intervention, which has by tradition taken place through a mix of two canonical policies. Numerous governments provide substantial direct funding to research in order to solve the underinvestment problem. Thus, in the United States annual federal government spending on research grants to universities, government laboratories, and private research centers amounts to tens of billions of dollars. There are also subsidies through tax incentives for private firms to undertake research and development. Systems in Europe and Japan are similar, if not as large. These supports have directly accounted for the development of massive amounts of basic technology that supported extensive commercial invention.

The second approach is to safeguard the ability to earn returns to investment in research by providing exclusive intellectual property rights. Patents, copyrights, trademarks, trade secrets and related devices protect different forms of innovation and operate in different fashions but all offer exclusivity in the production, use, sale, and licensing of designated subject matter. These are essentially market-based inducements to R&D, for firms are free to invest in whatever programs they think will achieve market success. They are also incentives for placing new products and ideas on the market, the ultimate source of welfare gains from innovation. In contrast, government direction or funding of commercial research is generally ineffective for the public sector may have limited information about dynamic market prospects and is liable to make politically motivated and inefficient allocations of research funds. To be sure, IPRs can in some circumstances support substantial market power and induce wasteful duplication of R&D spending. Nevertheless, they seem to be an integral support for technological competition, at least in innovative economies, and typically do not constitute significant barriers to entry.

There are no definitive principles for deciding the appropriate mix of public funding for research and proprietary rights to research outcomes. The conventional solution in most societies has been to draw a fuzzy line between investments in basic scientific knowledge and applied research in specific processes and products with commercial applicability. The former might be considered true public goods in that they are both non-rival and offer general knowledge that can support multiple uses. Thus, private markets would fail to invest sufficient resources in their generation, requiring a public solution. The latter are more properly construed as quasi-private goods because of their specificity and relative ease of technical or legal excludability. Regulatory instruments typically should be sufficient to ensure their market provision.

This distinction is central both to conventional research policy and IPRs. The bulk of U.S. government-performed research findings and data, save that reserved for security purposes, traditionally has been placed into the public domain. University scientists operate in a vigorous "open source" mode in which their findings are thoroughly vetted and published for wider use. The gains to successful scientists in this environment stem from building reputation assets rather than property rights, though reputations may be manifested in higher incomes. Thus, by tradition basic scientific results have found their way readily into the public domain for all of competence to use.

Conventional conceptions of IPRs firmly embody this distinction between basic knowledge and commercial applications. Most prominently, in most countries outside the United States it is impermissible to patent basic discoveries (as opposed to

inventions), mathematical algorithms, and genetic research tools. Further, for a patent to be awarded the invention must meet a utility standard under which the technology must be reduced to some industrially or commercially useful form. A rigorous utility standard is a central means by which public authorities deny proprietary rights to basic scientific knowledge. For its part the United States has greatly weakened its utility standard and thus permitted property rights on basic enabling technologies.

Also relevant is the inventiveness standard under which a new technology must display real creativity in order to achieve exclusive rights. However, the EU's Database Directive vitiates this requirement by awarding patent-like protection to simple compilations of data and information on the theory that "sweat of the brow" effort is sufficiently creative to deserve reward. This diminution of an essential standard also threatens to remove important research results from the public domain.

Taken together, the U.S. and EU expansive treatments of public research findings as commodities on which property rights may be asserted has significantly eroded the practical distinction between basic knowledge and applied R&D. The political rhetoric justifying the mixing of public funding with private rights is couched in competitiveness terms. Specifically it is argued that the mixture will procure greater economic rents from the public investment in research and provide more incentives for product development, to the ultimate benefit of society.

It remains to be seen whether this salutary outcome emerges in the context of technologically advanced countries. It is by no means a settled issue among scientists, economists, and legal scholars, and there are several who have expressed significant concerns (Mowery & Sampat 2004 and Nelson 2004). A careful look at licensing regimes emerging from patents on basic tools in biomedical research suggests that transactions costs in organizing scientific inquiry have been increased markedly (Heller and Eisenberg, 1998).[7] Ideas are inherently heterogeneous and the costs of merging them into useful technologies likely are raised by IPRs on scientific knowledge. The essential point is that providing patents to basic technologies can be harmful to dynamic competition by raising licensing costs and extending reach-through proprietary rights to all potential new innovations using those technologies (Aoki and Sadaoka 2003).

This concern is buttressed by the fact that open-access basic science and commercial R&D traditionally have enjoyed a complementary relationship, with the former having little direct utility in terms of marketable goods but supporting a range of innovative products and follow-on technologies. Put differently, open science tends to raise the expected returns to private investment in proprietary R&D (David, 2003). One reason is that access to existing knowledge provides developers with a roadmap of promising areas in which to invest and likely dead ends, increasing the efficiency of capital allocation. Another is that public funding for university research and training generates high-quality technical personnel that often move into industrial employment, a key element of technology transfer in the United States. These spillovers serve essentially as a general subsidy to applied R&D but as proprietary

[7] However, see Walsh, Arora and Cohen (2003) for a survey-based skeptical view of the proposition that these costs deter scientific research. Their data, however, indicate that there were sometimes costs and delays, associated with, for example, obtaining licenses, conducting research offshore, running the risk of infringement, or modifying research strategies.

rights are extended on public research results the scope for such spillovers is likely to be diminished.

Ultimately the mix of intellectual property rights and public provision of research needs to strike a balance between resolving problems of appropriability in order to induce investment and commercialization and ensuring that basic knowledge is accessible and widely distributed. The diffusion and use of knowledge itself serves as a platform for both further basic research and development of applied technologies.

We have argued that the increasing application of proprietary rights to publicly funded and basic research results may be problematic even within the United States and the European Union. Research universities and large firms in those countries may be able to engage in sufficient patent pooling and cross-licensing that their research programs are not greatly inhibited (Walsh, Arora and Cohen 2003). However, it has been observed that startup firms and small enterprises in developed countries have been placed at a distinct disadvantage in this context (Reichman and Uhlir, 2003).

This problem is compounded when one considers research processes in most developing countries. Public research institutes, university science and education, and the development and diffusion of applied technologies all are dependent on access to basic knowledge, which is overwhelmingly generated in the rich nations (Evenson, 2004). Increasing privatization of basic data by entities in the developed countries threatens to retard the diffusion of such knowledge into science and competition in developing countries. Few of the latter are in a position to mount significant public funding for basic research in their own universities and institutes. Thus, we remain concerned that one significant outcome of IPRs policy in the United States and the European Union will be higher costs for, and diminished access to, the fundamental scientific results that have been a foundation for technical change.

Put another way, public research traditionally has generated large spillover benefits across borders in the forms of improved education, research, and competition. Technological change is the main engine of growth, but learning from such change, and contributing to it, requires basic educational, scientific and technological capabilities. Thus, access to knowledge is central to prospects for growth and transformation, especially for developing countries. The more such knowledge is protected by exclusive rights, the lower these spillovers are likely to be.

Why Is a Multilateral Agreement Needed?

We have argued that knowledge is, in fact, a global public good because its non-rivalry clearly transfers across borders. Thus, widespread international access to basic knowledge generates multilateral gains in terms of science, education, technological change and dynamic competition, even as it reduces the economic rents that might be available to those entities that would control its diffusion. Seen in this light, it is unsurprising that those technologically advanced countries generating the major share of global knowledge increasingly view it as a source of competitive advantage if it can be protected on a preferential basis.

However, if we conceive of basic science and technology as an essential component of the public and global commons then we must recognize that national governments cannot be expected to provide such investments at the optimal international level. At one level, governments may fail to provide sufficient resources to support nationally optimal levels of basic science and technology research, even for their own

economies. There are several reasons for this situation, ranging from greater priorities for limited budgets to political-economic structures disfavoring the provision of national public goods. It also reflects, in some part, the non-rivalry problems discussed above, which manifest themselves in too-little domestic science and a heavy reliance on access to international science. Certainly, most developing countries may be characterized as having inadequate education and research infrastructures, along with little effort to promote scientific research. Without adequate access to general technologies, their attempts to develop effective "national innovation systems" are unlikely to bear much fruit.

A more fundamental problem for our purposes, however, is that national governments, acting on their own to establish support policies for basic science and technology, will jointly under-invest in that area from a global standpoint. Again, the essential difficulty is the non-rivalrous nature of basic science and technology. In setting their own subsidies to the development of basic knowledge, individual countries would not take into account the spillover benefits to other countries (Drahos, 2004). That is, each country would rationally fund research up to the point at which the marginal cost of developing knowledge equals the sum of the marginal valuations of all domestic users. From a global view, however, the domestic marginal cost would be less than the sum of international valuations in any nationally determined equilibrium. As a result, too little investment in basic knowledge would be undertaken, even in the absence of free riding. That is, even if international valuations were known, individual countries would be loath to fund additional knowledge to meet international needs. If we add free riding (an unwillingness of importing countries to reveal their social valuations for knowledge) to this equation, the situation is made yet worse.

In asserting private ownership rights to basic knowledge, the United States and the European Union essentially are trying to solve the international free riding problem, but in an inefficient manner. While extracting some international surplus for the fruits of its investment, the U.S. policy does so on behalf of private interests rather than the public purse. More importantly for welfare, the provision of private exclusive rights can be expected to reduce net international access to information and, if transactions costs are raised sufficiently, to inhibit future investments in technology. Put in the language of economics, strong IPRs endowed upon basic research results are the wrong instrument for meeting the dual targets of expanding investments in knowledge as a global public good and making it widely available.

In principle there are two appropriate solutions to this set of problems. The first would be for a centralized global authority to fund the development of basic technologies that cost less than the sum of global valuations. However, no such central authority exists and this solution cannot be considered feasible.

The second would be a multilateral agreement on access to basic science and technology, which is the proposal we advance in this paper. A bargaining approach could permit countries to exchange concessions about access to their own basic technologies, recognizing that their own educational and technological enterprises would benefit from reciprocal access. The reciprocity associated with bargaining can mitigate some of the spillover problems deterring investments, There may be some decrease in political incentives to invest in research, because the competitiveness motivations would be less intense, but this decrease would be minimized by the reciprocity requirement, and any impact that it may have should be counterbalanced

by the increased productivity of the global research enterprise. Moreover, to the extent that bargaining permits rationalization of basic research, in the sense of avoiding wasteful duplication of similar programs, bargaining can mitigate the underlying provision problem as well. Research costs in some forms of basic science may be so large that private rights could not generate sufficient revenue to cover them. In some cases shared financing across governments may be required.

In the following section we set out the framework of an ABST and discuss why the WTO is the appropriate forum for achieving it. We also consider its feasibility in terms of the political economy of market access exchanges.

4. An Agreement on Access to Basic Science and Technology

We have argued that, as things stand today, too little basic science is developed, too little of that flows to developing countries, and the intellectual property system needs to be complemented with a mechanism for resolving these failures. We therefore offer a proposal for an international agreement aimed at meeting these needs.

In our view an ABST would be best fashioned within the WTO, for several reasons. First, without a multilateral agreement to discipline free riding, any bilateral or plurilateral agreement is liable not to be sustainable. Second, the WTO already has responsibility for major agreements governing intellectual property, subsidies, standards, and trade in services, all of which would be interrelated strongly with transfer of scientific results. Third, the WTO offers a recognized format for arbitrating and settling disputes arising between governments, which would be primary players in this treaty. Fourth, the organization has a dynamic negotiating process that permits tradeoffs in concessions across sectors and functional agreements. Fifth, the organization has become a focal point for the strengthening of national constituencies seeking the benefits of multilateral agreements. Finally, many of the essential WTO principles may be applied to ABST, as we discuss next.

Format of an Agreement

Several provisions would need to be addressed in the treaty. The first, and most basic, would be its scope in terms of subject matter and processes. We have used the term "basic" science and technology but it is not easy to determine the dividing line between basic and applied research. In principle, one would describe basic knowledge as that which is truly non-rival and, by itself, has limited commercial utility. Examples are numerical formulas, algorithms, discoveries, surgical methods, research tools, and genetic sequences. Note that such forms of knowledge are not patentable under most legal jurisdictions. Another class of basic technologies would be those supporting the provision of global public goods, such as environmentally sound processes and health care.

However, there is no clear practical sense in which these characteristics might be defined. One way to manage the distinction would be to include research processes and results and data that are largely publicly funded, whether through direct research in government laboratories or grants to universities, NGOs, or other institutions. Observe that this distinction between technological characteristics and funding may not be critical, for presumably most basic and public-goods technologies require public financing in any event. Thus, focusing on publicly funded research and data may be sufficient.

A second aspect of scope relates to the forms in which access is to be granted, or the nature of liberalization. In principle, three levels of commitment could be entertained. First, "input liberalization" 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. Thus, particular provisions could prohibit preferences for national firms and institutions as regards publicly funded research consortia and access to research-based tax advantages. Commitments could be reached narrowing visa restrictions that inhibit the ability of students to study at universities in another nation or restrict the scope for scientists and engineers to participate in conferences or training programs. However, under this alternative, 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.

Second, "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. It is evident that we favor full liberalization to the extent it is politically feasible. In getting there, however, it may be necessary to adopt something like a GATS approach, permitting governments to reserve sensitive areas of technology and to designate different levels of commitment to open access.

Consistent with other WTO agreements, national treatment would be a key legal provision of the treaty, requiring that, in as many ways as possible, foreign scientists and firms be treated the same way as national ones with respect to access to a country's scientific and technical support programs and outcomes. Like TRIPS, ABST could also build on an MFN commitment, unless there were compelling reasons for regional preferences.

It is evident that a treaty of this kind would need to be balanced by safeguard clauses. One issue involved in international scientific and technological collaboration relates to the equitable and efficient distribution and management of intellectual property that could emerge from subsequent applied innovation. Another is that concerns regarding national security and technology proliferation would need to be addressed. For example, the United States has moved to establish new security classifications for biological data and restrict some foreign students form studying particular areas of biotechnology. Such restraints need to be balanced with the advantages of promoting the scientific and technological commons, a balance that could be set out in an international agreement.

In recognition of the need for encouraging a "sound and viable technological base", it would be possible to build in certain preferential advantages 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 proposal solicitations. 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. Assistance in development and use of electronic resources, especially the internet, could be particularly valuable.

While perhaps not fitting within the parameters of a treaty, additional commitments would be beneficial. Donor nations might consider establishing special trust funds to encourage research and science in developing countries and to help them benefit from ABST and other international commitments (Roffe 2002). Of particular importance would be expanded commitments to support programs for providing public scientific and technological goods to developing countries. Examples include the Consultative Group on International Agricultural Research and the new public-private partnerships for research on HIV, TB, and malaria. Such programs are greatly under-funded (Commission on Macroeconomics and Health 2001). Financial commitments could be supplemented by agreements to help manage potential problems with intellectual property rights, including gaining access to patented technologies.

Two other issues arise for construction of an ABST agreement. First, careful consideration is needed of how its provisions relate to other WTO agreements and even such non-WTO accords as the Convention on Biodiversity. Within the WTO, efforts to harmonize ABST and TRIPS would be required. In effect, ABST would be an attempt to re-balance the strong privatization of rights in information implicit in TRIPS. Similarly, specification of ABST could usefully sort out the meaning of pre-competitive research subsidies and how they might be provided internationally. However, some forms of research support could be problematic in terms of the WTO Agreement on Subsidies and Countervailing Measures.[8] The GATS Agreement ("Mode 4") might need to accommodate more liberal treatment of temporary research and educational visas.

Second, there would need to be provisions for regular meetings, for a small secretariat or council to evaluate the extent of scientific and technological cooperation and its benefits, and for ongoing negotiations. These negotiations could provide a forum for scientific and technical communities to pursue further expansion of the global information commons.

Arguments for Concluding an ABST Treaty

We see several arguments in favor of developing a global treaty on science and technology. First, we reiterate our concern that the United States, the EU, and other developed economies are rapidly moving toward establishing private property rights in basic knowledge and data, even when developed from public resources. This tendency threatens to reduce excessively the amount and scope of information in the public domain, with deleterious impacts on the provision of public goods and on prospects for dynamic competition. This "new enclosure movement" may be detrimental even for the countries that practice it (Boyle 2003). However, it raises

[8] Hoekman and Kostecki (2001) provide a comprehensive discussion.

significant difficulties for the diffusion of information to developing countries and the prospects for building a capability in science and technology. In short, we offer the proposal as a means of recapturing publicly funded and basic research for the public domain and for encouraging knowledge transfers to developing economies.

Second, as noted above, many countries remain disappointed with the apparent inability of TRIPS and the other WTO Agreements to induce additional and large transfers of technology. Those provisions are largely aimed at transfer of commercial technologies and an ABST agreement would focus on transfer of basic (and somewhat less commercial) technologies. In that context, it would provide a re-balancing of benefits under TRIPS in favor of technology users. We emphasize that ABST would serve as a complementary and supporting mechanism for market-mediated technology transfers, rather than substitute for them.

Third, TRIPS itself recognizes the need for building "…a sound and viable technological base" in poor countries without providing any means for achieving it. Surely one important reason that there evidently has not been much expansion of technology flows to developing countries since the implementation of TRIPS is that this technological base often is not sufficiently viable to reduce the transactions costs of transfers. No doubt much capacity needs to be built, in terms of governance, transparency, infrastructure, and other environmental characteristics, before much scope for private technology transfers to some countries could emerge. However, a central component must be the construction of a national science and technology capability for purposes of adapting technologies to local needs and for performing local research. If the ultimate outcome of TRIPS and stronger protection in the rich nations is to restrict access to basic research and data from abroad, the prospects for building such a capability could be damaged irrevocably. Our proposal aims at sustaining and enhancing such access.

Fourth, TRIPS Article 66.2 makes reference solely to the least developed countries as potential beneficiaries of government efforts to encourage private technology transfers. There are 30 WTO Members that are designated "least developed", a roster that hardly exhausts the list of countries that could benefit from greater access to scientific opportunities and results. Thus, Article 66.2 can do virtually nothing to provide access to basic technology on behalf of the broad scope of developing countries. In contrast, ABST would be a global agreement.

Finally, we believe that such a treaty could be structured in a way that, while restraining the movement toward privatizing rights in basic information, would respect exclusive rights in commercial information and applied technologies. Inevitably there would be difficult negotiations over international benefit-sharing and licensing terms at the interface between basic science and technology and its commercial applications. However, such negotiations should be more efficient when undertaken against a backdrop of an international legal agreement regarding access and rights allocation.

Political Economy Issues

Our proposal aims at resolving the problems described earlier but is keyed on the free riding problems that have pushed science providers into an increasingly protectionist treatment of information. That treatment is "protectionist" in that it limits foreign access to basic knowledge, in a manner analogous to trade restrictions that limit

market access. As such, a WTO approach that offers reciprocal and non-discriminatory access to knowledge is appropriate for restoring the public domain and promoting international competition.

The nature of the treaty we have in mind would increase global access to the fruits of public research funding. An obvious difficulty is that research decisions are endogenous and funding might decline in authorities in the major countries perceive that an ABST would dilute the ultimate economic benefits from such investments without reciprocal benefits from abroad.

Thus, analysis of national economic interests in an ABST treaty is relevant for considering its construction and feasibility. Mutual trade liberalization in the WTO has been achieved through a mercantilist agenda in which countries were willing to offer greater market access to foreign firms in return for reciprocal access abroad. A similar reciprocity in which access of foreign researchers to grants and research results is provided in return for related opportunities abroad could appeal to competitiveness concerns. A broader scope of opportunities and research competition presumably would expand the efficiency with which public science and technology are generated, resulting in mutual gains from trade. And the opportunity to negotiate liberalization will focus the attention of those in the scientific and technological communities to press politically for the benefits of liberalization. Moreover, with a wider base of basic technologies from which to work, and with these technologies largely in the public domain, the scale of product innovation built on such information should increase.

At the same time, countries are highly asymmetric in terms of their abilities to finance and develop basic science and technology. The United States, the EU and Japan may see some complementarities in mutually integrating access to these resources. Some large developing countries such as Brazil, India and China could be attractive as well. However, small and developing countries with limited research resources offer little in the way of "export" interest to researchers in the main technology-developing nations. In this environment, governments of the developed countries might effectively restrict access by encouraging exclusive rights in research outcomes and data, as they are doing. Yet, even the United States, by far the preeminent technological power, is now seeing the need to depend on scientists from other nations (National Science Foundation 2004). Thus, it is not yet clear whether there is a balance of mercantilist interests to support a multilateral ABST treaty.

In consequence, a WTO treaty to ensure access to basic science might require technology importers to offer other, perhaps complementary, concessions in such areas as services, investment and product-market access. In addition, the case could be made that firms in the poorest countries pose no competitive threat in the medium term and that permitting them to join on a preferential basis could help develop their research and innovation capabilities, in line with other development assistance.

There is another reason to think that an agreement may be supported by powerful economic interests. Unlike the situation 30 years ago, multinational enterprises now often transfer technology in order to build export products in developing countries. The costs of doing so would diminish when local researchers have access to basic technologies and can effectively deploy them. Thus, multinational enterprises might be expected to lobby for such an agreement, particularly to the extent that it can be accompanied by appropriate policy responses in recipient countries regarding governance and infrastructure. Further, the treaty would provide legal certainty about

the scope of the public and private domain across countries, which would benefit global enterprises.

A Smaller Substitute

While we are optimistic about the prospects for such an agreement to work, we recognize that the problems noted above are serious and raise obstacles to the negotiation of a maximal treaty. In that context, we provide brief comments on a less ambitious approach that could achieve some of the objectives we have identified for greater international access to basic science and technology. This approach essentially would work through the intellectual property system itself.

First, from the standpoint of distinguishing between basic and applied research, it would be beneficial for countries to reassert the importance of a rigorous utility standard in patenting. For those jurisdictions, such as the United States, that offer patents to basic research tools and software careful consideration to limiting the breadth of reach-through claims is in order. For their part, developing countries should avoid adopting weak eligibility standards for patents and broad claims of this kind, while sustaining research and education exemptions in the use of patented knowledge. Negotiations at WIPO regarding the Substantive Patent Law Treaty offer scope for rebalancing patent rules on behalf of restoring the public domain in this way.

Next, if governments insist on permitting the registration of private rights on the results of publicly funded basic research they could limit the risk that such rights would support monopoly restrictions on access by establishing careful guidelines on licensing as suggested in Nelson (2004) or a wide domain for automatic licensing on receipt of a modest fee. This form of "liability rule" would permit those who wish to use fundamental scientific results to do so upon payment of a well understood licensing fee or royalty (Lewis and Reichman 2004). In establishing such a system it should be feasible to organize a fee schedule that discriminates in favor of users in developing countries and educational institutions. This kind of price differentiation is an especially attractive form of gaining some returns on investment in research while encouraging wider dissemination.

5. Concluding Remarks

We have outlined a proposal for negotiating a multilateral agreement on open access to publicly funded research results and data. In our view this agreement could have at least five globally beneficial impacts. First, it would help resolve the free rider problems that reduce investments in science and technology relative to a global optimum. Second, it could restrain the tendency of governments to restrict access and to encourage privatization of basic knowledge. This rebalancing of technology development norms in favor of expanding the public domain could help vitalize scientific research in many countries, while promoting applied innovation.

Third, the treaty could provide an important plank for the construction of modern technological capabilities in poor countries, while sustaining access to information for educational purposes. Fourth, it should not unduly restrict the rights of firms to exploit intellectual property in applied technologies and products. Finally, it could help restore confidence on the part of developing countries that TRIPS and the WTO are institutions that facilitate, rather than hinder, technology transfer.

This essay sets out the positive case for such an agreement. Undoubtedly numerous practical difficulties would arise in working out specific provisions and defining terms. Even the notion of what is "publicly provided" or "basic science and technology" is not easily determined in each case. Nevertheless, we think the principles set out here can offer a platform for moving forward.

REFERENCES

Aoki, Reiko and Sadao Nagaoka (2003). "The Utility Standard and the Patentability of Intermediate Technology," manuscript, Hitotsubashi University.

Arrow, Kenneth J. (1962), "Economic Welfare and the allocation of Resources for Invetions," in Richard R. Nelson (ed), *The Rate and Direction of Inventive Activity: Economic and Social Factors* (Princeton: Princeton University Press).

Barton, John H. (2003a). "Patents and the Transfer of Technology to Developing Countries." Prepared for OECD Conference on IPR, Innovation and Economic Performance, Paris, 28-29 August 2003.

Barton, John H. (2003b). "Preserving the Global Scientific and Technological Commons," manuscript, Stanford University. Available at stdev.unctad.org/services/Barton.doc.

Barton, John H. (2004), "Issues Posed by a World Patent System," *Journal of International Economic Law* 7: 341-358.

Becker, Gunnela (2002). "Transfer of Technology and the TRIPS Agreement: A Study of Article 66.2 in the WTO/TRIPS Agreement," report for Swedish International Development Agency, manuscript.

Boyle, James (2003). "The Second Enclosure Movement and the Construction of the Public Domain," *Law and Contemporary Problems* 66: 33-74.

Commission on Macroeconomics and Health (2001). *Macroeconomics and Health: Investing in Health for Economic Development* (Geneva: World Health Organization).

David, Paul A. (1993). "Intellectual Property Institutions and the Panda's Thumb: Patents, Copyrights and Trade Secrets in Economic Theory and History," in M. Wallerstein, M. Mogee, and R. Schoen (eds), *Global Dimensions of Intellectual Property Rights in Science and Technology* (Washington DC: National Academy Press).

David, Paul A. (2003). "The Economic Logic of 'Open Science' and the Balance between Private Property Rights and the Public Domain in Scientific Data and Information: A Primer" Stanford Institute for Economic Policy Research, Discussion Paper No. 02-30.

David, Paul A. (2004). "*Koyaanisqatsi* in Cyberspace," in Keith E. Maskus and J. H. Reichman (eds), *International Public Goods and Transfer of Technology under a Globalized Intellectual Property Regime* (Cambridge: Cambridge University Press) forthcoming.

Drahos, Peter (2004), "The Regulation of Public Goods," *Journal of International Economic Law* 7: 321-339.

Evenson, R. E. (2004), "Agricultural Development and Intellectual Property Rights," in Keith E. Maskus and J. H. Reichman (eds), *International Public Goods and*

Transfer of Technology under a Globalized Intellectual Property Regime (Cambridge: Cambridge University Press) forthcoming.

Heller, Michael A. and Rebecca S. Eisenberg (1998). "Can Patents Deter Innovation? The Anticommons in Biomedical Research," *Science* 280: 698-701.

Hoekman, Bernard M. and Michel M. Kostecki (2001). *The Political Economy of the World Trading System: 2d Edition* (Oxford: Oxford University Press).

Hoekman, Bernard M., Keith E. Maskus, and Kamal Saggi (2004). "Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options," World Bank, manuscript.

Lewis, Tracy and J. H. Reichman (2004), "Using Liability Rules to Stimulate Local Innovation in Developing Countries: A Law and Economics Primer," in Keith E. Maskus and J. H. Reichman (eds), *International Public Goods and Transfer of Technology under a Globalized Intellectual Property Regime* (Cambridge: Cambridge University Press) forthcoming.

Maskus, Keith E. (2000). *Intellectual Property Rights in the Global Economy* (Washington DC: Institute for International Economics).

Maskus, Keith E. and J. H. Reichman (2004). "The Globalization of Private Knowledge Goods and the Privatization of Global Public Goods," *Journal of International Economic Law* 7: 279-320.

Mowery, David C. and Bhaven Sampat (2004). “The Bayh-Dole Act of 1980 and University-Industry Technology Transfer: A Model for Other OECD Governments?”. Forthcoming in *‘Ivory Tower” and Industrial Innovation: University-Industry Technology Tfransfer Before and After the Bayh-Dole Act* (Stanford: Stanford University Press).

National Science Foundation (National Science Board) (2004). *Science and Engineering Indicators 2004*. (Arlington, VA: National Science Foundation).

Nelson, Richard R. (2004). “The Market Economy, and the Scientific Commons,” *Research Policy* 33: 455-471.

Reichman, J. H. and Paul Uhlir (2003). "A Contractually Reconstructed Research Commons for Scientific Data in a Highly Protectionist Intellectual Property Environment," *Law and Contemporary Problems* 66: 315-462.

Roffe, Pedro (2002). "Preliminary Note on the WTO Working Group on Trade and Transfer of Technology," UNCTAD, manuscript.

Smith, Pamela J. (2001). "How Do Foreign Patent Rights Affect U.S. Exports, Affiliate Sales, and Licenses?" *Journal of International Economics* 55, 411-439.

Walsh, J. P., Ashish Arora, and Wesley M. Cohen (2003), "Research Tool Patenting and Licensing and Biomedical Innovation," in *The Operation and Effects of the Patent System*, Report of the STEP Board of the National Academy of Sciences, National Research Council (Washington DC: National Academy Press).