GLOBAL GOVERNANCE AND TECHNOLOGY

Calestous Juma
calestous_juma@harvard.edu
Center for International Development at Harvard University and
Belfer Center for Science and International Affairs at Harvard University
Cambridge, MA, USA

And

Jayashree Watal
jayashree_watal@hotmail.com
Center for International Development at Harvard University
Cambridge, MA, USA

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CONTENTS

Introduction

Rapid globalization of firms and markets is leading inexorably to the globalization of rules governing business. Many of these global rules on international trade, environment or security relate to technology. Technology plays a major role in economic and human development and can help the poor in the developing world. The most important decisions taken by the international community are taken within intergovernmental organizations (IGOs). Promoting international development is one of the tasks of many IGOs. The growing recognition of the role of science and technology in international development raises a number of questions on the ability of these institutions to promote growth in developing countries.

An examination of sectors such as health, agriculture and environment reveal a bewildering array of international organizations but little success in technology development programs. Many of them have turned their attention to advocacy over narrower issues such as the presumed impact of intellectual property protection on development, in general, and human welfare, in particular. This attention represents the interest of these organizations to engage with issues related to technology. However, the approaches have not always been very informative due to the limited understanding of the complex issues related to technology development. From this broad frame we derive a subsidiary argument that the failure to outfit technology to the needs of the poor countries is largely a result of the current inadequacies in the global governance system to guide the process of technological change.

By definition, IGOs are comprised of the representatives of nation states. It is the nation state or groups of nation states that are the most important actors in the global governance of technology. The most active of these actors is, not surprisingly, the governments of the important net exporters of technology, notably the United States (Braithwaite and Drahos). Increasingly, however, global attitudes toward technology are being shaped by important non-governmental organizations (NGOs), especially as non-state actors start to play a greater role in global governance. It is also important to place the role of NGOs in perspective, in terms of their importance in channeling flows of technology to developing countries to meet their human development requirements.

Human development has been defined in the Human Development Report, 2001 outline (draft 1.xi.00) as including the choices of people to live long healthy lives, to be knowledgeable, to enjoy a decent standard of living, to participate in the life of a community, to enjoy political freedoms and personal security. The Human Development Index compiled every year as a part of this report takes into account life expectancy, educational attainment and adjusted real income. Technologies are continuously being generated that affect, albeit to a varying degree, almost all facets of human development such as improved health, nutrition, education or environment.

Certainly, the richer countries have greater access to these new technologies and products. This is evidenced by the strong correlation between per capita income and the human development index, although the causality could run in both directions.

Sometimes, a vast improvement in human outcomes can be made through low-level technologies available in the public domain. There is every reason to adopt such technologies widely to achieve the ends of improved human development, however, we are not discussing this set of technologies in this paper. We focus our attention on rapidly evolving technologies that help human development and that are vastly improving the quality of life in the developed world. The question we address in this paper is whether the decisions taken by the international community are helping make these new technologies available or helping develop other appropriate technologies for meeting the human development needs in developing countries, in particular the poorest of such countries.

It is a fair generalization that thus far the generation of technology has been confined to a few countries and is becoming increasingly capital-intensive, making it more difficult for developing countries to catch up. Also, more and more R&D is increasingly originating in the private sector (Sagasti, 2000). The private companies that produce new goods and services that improve human outcomes are motivated, like others in the private sector, by higher sales revenues and profits for their shareholders. These companies expend huge amounts on R&D and capture the returns to such expenditures by staying ahead of the competition, using a number of different means. These include intellectual property protection, continuing innovation, secrecy, and lead time lags.

In this context, the most important intellectual property rights are patents and trade secrets, although copyrights, design rights and trademarks can also be used to deter competition. Patents, considered to be the most important means of appropriating returns to R&D only, were prized in only a few sectors such as pharmaceuticals and specialized chemicals (Levin et al, 1987), however, today, biotechnology and information and communication technologies (ICT) are sectors where patents are also considered important. It must be understood that secrecy would be the preferred mode of protection, and patents are used where secrecy cannot be maintained, either because of regulatory approvals or ease of duplication. Even in the sectors where patents are important, secrecy is used where possible[1].

Countries also have competitive strategies in technological development and use different public policy instruments at the national and international level. An example of national level instruments is the provision of public funding to achieve higher levels of competence in certain key areas such as biotechnology. An example of international level instruments is the position of the net technology exporters in the negotiations on the WTO agreement to respect intellectual property rights i.e. Trade-related aspects of Intellectual Property Rights (TRIPS) or more recently in the negotiations on the Biosafety Protocol. These strategies deliberately aim to consolidate or improve the competitive advantage over rival countries in the use of commercially viable technologies.

[1] For example, the know-how to manufacture drugs such as penicillin or cefaclor is kept secret, and these drugs are difficult to duplicate even in developing countries with no patent protection and efficient generic drug industries. Indian pharmaceutical companies had to purchase the new technologies for penicillin and took more than ten years to reverse engineer cefaclor (Lanjouw, 1998).

1. PRODUCT LIFE CYCLE ANALYSIS OF TECHNOLOGY FLOWS

Technology is generated or developed to solve particular problems. It is then adopted, adapted for adoption or otherwise diffused or made accessible through the production of intermediate or final products. Such products are then made available for consumption through market or non-market mechanisms. It is this stylized framework of generation, diffusion and consumption that is useful in evaluating what the objectives of the international community should be in relation to technology for human development.

1.1 Technology generation

It is evident that the international community should help generate new technologies that help solve the human development problems that face the majority of the poor in the developing world. So, what kind of decisions made thus far at the international level have affected the generation and diffusion of technology? It is not possible to provide a general answer to this question, however, evidence from a number of sectors and regimes illustrate the dynamics associated with the product cycle approach to global technological development. For instance, in the area of health, it has been recorded that very little R&D being done by the private research-based pharmaceutical industry is done on tropical diseases (Kremer, 2000a). Indeed, motivated by profit, there are no incentives for the pharmaceutical industry to develop such medicines.

The following two tables show the diseases that are largely endemic in developing countries and the relative importance of some selected diseases in terms of a proxy for the size of the market. These tables reveal the stark differences in the pharmaceutical R&D priorities of developing and developed countries. Research-based pharmaceutical companies in the developed world focus their efforts, for instance, on disease conditions such as cardiovascular, cancer or diabetes. These are clearly not the priorities for the poor countries, whose global share of these diseases is less than 10%. Not surprisingly, private pharmaceutical companies in India that are investing larger amounts in R&D are similarly motivated by profit and are also focusing on diseases such as diabetes or cancer with large global markets and perhaps also higher effective demand locally. Only 16% of the current research or development expenditures in India is targeted at tropical diseases or LDC markets, about half of which was focused on developing more suitable products for LDC markets in global disease conditions (Lanjouw and Cockburn, 2000).

Table: 1.1

Diseases for Which 99% or More of the Global Burden Fell on Low- and Middle-Income Countries in 1990		
Disease	**DALYs (Thousands, 1998)**	**Deaths per Year (Thousands, 1998)**
Chagas Disease **	588	17
Dengue**	558	15
Ancylostomiasis and Necatoriasis	Na	na
Japanese Encephalitis*	502	3
Lymphatic Filariasis**	4,698	0
Malaria**	39,267	1,110
Onchocerciasis-river blindness**	1,069	0
Schistosomiasis**	1,696	7
Tetanus*	12,950	409
Trachoma*	1,255	0
Trichuriasis	1,287	5
Trypanosomiasis**	1,219	40
Leishmaniasis**	1,707	42
Measles*	30,067	882
Polio*	213	2
Syphilis*	4,957	159
Diphtheria*	181	5
Leprosy**	393	2
Pertussis*	13,047	342
Diarrhoeal Diseases*	72,742	2,212

Source: Lanjouw (2000) who cites: "Global burden from World Health Organization (1996); Figures from WHO (1999). DALYs are estimates of years of life lost or lived with a disability, adjusted for its severity."

- = treatment available for these diseases.

** = WHO offers research grants of $50,000 for the invention of vaccines/medicines for these diseases.

Table 1.2

Selected Disease Categories Share of Market in Rich Countries & Importance in Poor Countries		
	Of Global DALYs Lost, Rich Countries' Expenditure-Weighted Share	**Of Poor's DALYs Lost, Share of Disease**
Cardiovascular	91%	10%
Cancers	94%	5%
Diabetes Mellitus	96%	1%
Infectious & Parastic	38%	21%
HIV/AIDs	49%	6%
Malaria	0%	4%

Source: Lanjouw (2000) who notes:
"Weighted percents use 1990 Per-capita Drug Expenditure times DALYs in 1998.
Source: The World Health Report 1999, WHO, for disease statistics. IDMA (1994) for expenditures."

(These two charts were presented by Prof. Jean O. Lanjouw and at the NIH, September 19, 2000).

More has been done by the international community in generating appropriate R&D for agriculture in developing countries, although most of the past efforts were guided by the imperative of the Cold War (Perkins, 1997). This research is in large measure due to the success of the Consultative Group for International Agricultural Research (CGIAR) and its network of International Agricultural Research Centers (IARCs) and the National Agricultural Research Systems (NARS) located throughout the developing world. In recent years, there has been a shift of agricultural R&D spending from the public to the private sectors, beginning with the developed countries. There are, however, some major concerns on the generation and diffusion of new technologies even in the area of agriculture. Just as in other sectors, here too, new technologies are increasingly being developed only in a few developed countries and in a few large, research-based multinational companies. The recent mergers and acquisitions in the life sciences sector has given rise to fears of market power for seeds being concentrated in a few companies (Human Development Report, 1999). Yet, each jurisdiction only considers the effect on domestic competition of such mergers and acquisitions and generally no developing country has a voice in such matters.

However, knowledge of the existing agricultural technologies is more widespread in the developing world, where there is also a predominance of state-funded research. This gives rise to optimism in the generation of appropriate research for tropical agriculture relative to that for combating tropical diseases. Some of this optimism was dampened by the widespread fears raised by the “terminator” technology (Box 1.1). However, it is not clear that the international community, guided in this case mostly by NGO activists, necessarily considered the scientific and economic arguments fully before deciding to disfavor this technology.

Box 1.1 Plant variety protection vs. technological protection – the case of 'terminator' seeds

In 1998, leading NGOs focused world attention on a patent over an invention in genetic engineering (US patent no. 5,723,765) owned jointly by a US seed company, Delta and Pine Land, and the US Department of Agriculture, that was creatively dubbed the "terminator." This invention, and other patented inventions in this group, more generally called Genetic Use Restriction Technologies (GURTs), can potentially transform plants to ensure that the resulting plant varieties either do not produce their own seeds, thus forcing the farmer to repurchase the protected seed in the next crop season (variety-GURTS or V-GURTs), or do not express some particular traits unless "switched on" through the application of a proprietary chemical (trait-GURTs or T-GURTs). V-GURTs are somewhat similar in effect to hybrids, which do not reproduce seeds of the original quality. Farmers world over, including in developing countries, have already been using hybrid seeds in certain important crops, such as maize and rice, for decades now by re-purchasing such seed for every crop season. However, importantly breeders can use hybrid seed for breeding other varieties by independently discovering the parent lines. The debate on GURTs has focused attention on "biological" protection that exceeds the time-limited, narrower intellectual property protection, including patents, available so far for plant inventions. Unlike hybrids, GURTs may be difficult and expensive to copy and can potentially extend to most, if not all, plants, preventing seed germination altogether. It is expected that GURTs would especially target crops where hybrids are not feasible, not readily accessible to private sector or relatively ineffective e.g. rice, wheat, soybean, cotton. However, GURTs are still at laboratory stage and are unlikely to be commercialized for at least five years. On the other hand, such technology, if successfully developed, could promote private investment in crop research. This is because IPRs on plants are extremely difficult to enforce even in developed countries, thus raising problems on the appropriability of the returns to R&D. This issue becomes very important with the relatively larger investments on genetic engineering than made in the past for traditional plant breeding. Thus, private research-based seed companies would opt to use such technologies, as they did hybrids.

However, reports on the "terminator" have raised alarm in developing countries that the farmer's practice of saving and re-planting seed or using it for breeding new varieties could be effectively nullified even in countries that choose to allow this as an exception in their patent or PBR laws. Subsistence level farmers, it is argued, cannot afford to purchase expensive seed for every crop season. The possible effects on agricultural biodiversity through non-generation of farmers' varieties or through gene drift of the V-GURTs-incorporated seeds to other traditional crops being grown in neighboring fields, thus rendering them sterile, has created further panic in developing countries. The IARCs, supported by the CGIAR system and the Rockefeller Foundation, were the first to decide not to incorporate into their breeding material any genetic system designed to prevent seed germination. Reacting to public opinion, Monsanto announced in late 1999 a voluntary commitment not to use V-GURT type of technologies. But suspicions of large multinationals involved in this research continue as no one has forsaken T-GURTs so far, and, in this case, important genetic traits in plants would be activated only with the use of an external chemical catalyst, usually the company's proprietary chemical. This would not only make farmers re-purchase seeds every year but also purchase the company's chemicals. Moreover, with the continuing mergers of multinational companies engaged in the 'life-sciences' sector, it is feared that there may not be competing substitutes to effectively limit the market power conferred by "technological" protection.

Rational economic behavior should make plant innovators price the seed that can be effective for several generations higher than the seed that is valid for a one-time use only. Therefore, even small farmers who do purchase seed commercially, could decide to purchase GURT seeds on say, a one-time trial basis, if they see economic benefits as being higher than the costs. No farmer would be forced to purchase these seeds and traditional varieties will continue to be used. Some of the environmental concerns expressed over the "terminator technology" appear legitimate. However, induced sterility will need to reduced through biological containment strategies and the challenge for the international community should be how to ensure that adequate remedial measures are taken against such potential environmental threats, while not condemning the technology altogether. The international community should give better guidance to developing country policy makers so that they are able to properly evaluate the scientific and economic analysis and not be rushed into taking the wrong decisions.

Source: Watal (2001); Kremer (2000b)

1.2 Technology diffusion

When new technologies are generated, albeit primarily for developed country markets, which are useful for or have the potential to be successfully adapted to address important human development needs of the impoverished, it is clear that the international community should do its best to see that such technologies and products are widely disseminated in the developing world. For instance, if biotechnology has the potential to improve health and nutrition levels in developing countries via genetic engineering of staple foods eaten by the poor, the global community should do everything to ensure that this potential is realized.

Box 1.2 Vitamin-A enriched rice

In the late 1990's two European scientists, Dr. I. Potrykus of the Swiss Federal Institute of Technology, Zurich and Dr. Peter Beyer of the University of Freiburg, Germany, succeeded, with funding from the Rockefeller Foundation, the European Union and the Swiss Federal Institute of Technology, in genetically engineering rice with daffodil genes to produce vitamin-A enriched rice. This rice has become known as 'golden rice' because of its rich, golden yellow color. Facing a maze of patents and proprietary materials needed to develop and test this rice variety, the two scientists entered into an agreement with the Anglo-Swiss company, Zeneca (now Syngenta). This agreement facilitates the development and testing of a commercially viable variety, with the expertise and proprietary technologies of Syngenta. Under this agreement, the two scientists have the right to share 'golden rice' with public-sector rice breeding programs to develop new varieties for dissemination to poor farmers in developing countries, generously defined as those earning less than US$10,000 per year from the sale of 'golden rice'. Syngenta has the commercial rights in all countries but has agreed to support the humanitarian objectives of the program. It must be noted that this definition would practically cover all farmers in the developing world. Syngenta will profit from sales of 'golden rice' in developed countries and from sales to farmers in developing countries whose incomes are higher than U$10,000 per year.

With the hue and cry on patents, in August 2000 Monsanto, the agricultural products arm of the Pharmacia group, announced that it would make all its agricultural genetics technologies available on a royalty-free basis to scientists working on the development of 'golden rice' and other vitamin A rice varieties (Financial Times, August 4, 2000). It is not clear how many Monsanto patents are required to be used in the course of development and testing of all vitamin-A rice. Some claim it is as low as five and that two other private companies, Aventis and Dupont have important patents that have not been similarly surrendered (www.rafi.org).

The rhetoric from the pro-GM crop and anti-GM crop interest groups has clouded some real lessons. It is by sheer happenstance that 'golden rice' has become the flagship project for the biotechnology industry, which the other side opposes as unwarranted. It is because of the effectiveness of the anti-GM lobby that Syngenta and Monsanto have more readily agreed to surrender of its commercial rights in the developing world. 'Golden rice' can be the success story of public-private partnerships as it is being developed for use in developing countries with public and private funding and efforts. No country, no farmer, no consumer will be forced to adopt, grow or consume this rice. NGOs can play a constructive role in following through with the promise of this technology and ensure its effective availability and affordability. Yet there is no international forum to bring together these various actors and arbitrate their differing points of view. The rhetoric and half-truths from both sides, freely available on the Internet, would leave developing country policy makers more confused than enlightened. The atmosphere could be clouded by the entry of new approaches to producing Vitamin A using other methods. Policy guidance on this issue could benefit from technology assessment efforts which would provide comparisons of the competing technology.

Source: www.ft.com, www.rockfound.org and www.rafi.org.

An example of the international community's lack of interest in technology diffusion in developing countries is taken from environmental negotiations, where technology transfer plays a key role in the decision of countries to join multilateral agreements. For example, if the international community makes climate change or ozone depletion a global environmental priority, developing countries argue that the new substitute products or technologies must be widely disseminated at fair and reasonable prices in the interest of achieving maximum global environmental benefits with the minimum cost. A specific proposal made by India in the WTO in 1996 to reconcile the goals of the international community on the environment and on intellectual property rights is discussed in Box 1.3 below.

Box 1.3 Reconciling TRIPS and environment law

The Montreal Protocol on Substances that Deplete the Ozone layer mandates, *inter alia*, the phasing out of chlorofluorocarbons (CFCs), one of the principal ozone depleting substances (ODS), in developed countries by 1996 and in developing countries by 2006. The transition from the use of ODS in the manufacture of final or intermediate goods to the use of substitute substances essentially involves changes in technologies and in technological capabilities, especially if such a transition includes the domestic production of ODS substitutes themselves. Acquisition of such technologies forms an essential part of such a transition and generally involves heavy financial outflows when such technologies are new and are proprietary in nature i.e. where these are covered by intellectual property rights. There is a specific provision on the transfer of technology in Article 10 A of the Montreal Protocol included in 1990 which enjoins each Party to take every practicable step, consistent with the programs supported by the financial mechanism, to ensure that the *best available, environmentally safe* substitutes and related technologies are expeditiously transferred *under fair and most favorable conditions* (*emphasis added*).

Despite this strong wording, the three developing countries—India India, China and Korea—that had the capability of producing ozone-depleting CFCs and needed the substitute technologies, had difficulties getting these from the multinational proprietary owners. In 1996, in the Committee of Trade and Environment (CTE) of the World Trade Organization (WTO), India and Korea had argued that there is a problem in reconciling the provisions on transfer of technology in the Multilateral Environmental Agreements (MEAs) such as the Montreal Protocol and the provisions for enhanced protection of IPRs in TRIPS. India had, *inter alia*, proposed that in the interest of protecting the environment, an obligation be imposed in TRIPS on the owners of intellectual property (IP) covering environmentally-sound technologies and products (EST&Ps) that are mandated to be used under national or international law as a part of environmental standards, (including under MEAs such as the Montreal Protocol), to transfer such technologies and sell such products on fair and most favorable terms and conditions to all those who demand them. India opined that, in the context of MEAs, where substitute technologies are covered by IPRs, legal monopolies ensure that supply is restricted whereas the MEAs ensure that almost every country in the world needs to use them, thus not only enhancing demand globally but also making such demand relatively price inelastic. This could lead to the situation of extremely high prices and also to the situation where access to these technologies, even on commercial terms, is controlled by a few IP owners. Although, Indian companies have recently agreed to close CFC production in return for compensation, India continues to insist that this is a generic problem, which has been specifically encountered in the implementation of the Montreal Protocol in the case of CFC substitutes, but could arise in other cases in the implementation of the Montreal Protocol or in any other such MEA in future. To the argument presented by some developed countries that such an obligation under TRIPS could act as a disincentive for the future generation of EST&Ps, and that the question of transfer arises only after ensuring first the generation of such technologies and products, India has proposed that the financial mechanism under the MEA be used to compensate such owners of proprietary EST&Ps for any losses they may incur in undertaking such an obligation to make their technologies and products available at fair and most favorable conditions. The onus would thus shift from the technology-importing to the technology-exporting countries, the latter also being the ones to contribute to the financial mechanisms of the MEA. It may be noted that this pull mechanism can be used ex-ante as proposed by Kremer (2000) for generating products suited to developing countries to combat tropical diseases or for tropical agriculture.

Source: Watal (2000b) in Jha and Hoffman, eds. (2000).

In yet another international environmental negotiation, that of the Biosafety Protocol, the role of technology transfer has been ignored (Box 2.4).

Box 1.4: Biosafety and biotechnology

Nearly a year ago governments meeting in Montreal adopted a treaty to regulate international trade in certain products of biotechnology. At its adoption, the protocol was hailed as a victory for the environment and human health. Today only two countries have ratified or acceded to the treaty, with hundreds remaining uncertain about the relevance or effectiveness of the instrument. This slow pace of ratification is not a product of administrative malaise but a reflection of the growing concern among countries, especially in the developing world, that the protocol does not address many of their fundamental related to technology development and cooperation. The concerns of developing countries that are reflected in the parent convention, the Convention on Biological Diversity, have been cast aside and financial resources previously destined for conservation efforts is now being earmarked by agencies such as the Global Environment Facility (the financial mechanism of the parent convention) to support the implementation of the protocol. The biosafety protocol focuses on risks associated with international trade and pays little attention to domestic biotechnology activities. Shifting the global attention to the safe use of biotechnology would strengthen its ability to address risks of biotechnology arising from domestic activities. The protocol has become a source of inspiration for public debate over the safety of biotechnology. But the debates are likely to drive a portion of the biotechnology research underground or limit it to products for domestic markets. This, in turn, could increase the risks posed by biotechnology activities unless countries take the necessary measures to develop biosafety regulations. Unfortunately, the tone of the debate is poisoning the atmosphere and making it less conducive to dialogue and compromise.

Governments have a responsibility to restore balance in the debate. First, the biosafety protocol should serve as a forum for a balanced consideration of the benefits and risks of biotechnology. Global demographic projections indicate clearly that humanity will need all the tools at its disposal to mitigate massive starvation and human misery in the years to come. Discussions on the benefits and risks of biotechnology should be based on scientific assessments. If the protocol cannot serve as forum for developing scientific consensus, the parent convention should promote national scientific assessments that can contribute to global discussions. And if the parent convention cannot do this then other institutions should take charge. Only a science-based process can reassure the international community that the biosafety protocol is not to address trade-related issues. To carry out scientific assessments, the convention will have to reach out to the wider community and involve other constituencies. For example, agricultural products are at the center of the current debate on the risks of biotechnology. But the protocol is dominated by environmental agencies and hardly involves those responsible for ensuring food security in developing countries. Global transparency is needed to give credibility to biosafety negotiations. Failing to involve agricultural constituencies, especially in developing countries, will only delay the effective implementation of biosafety measures at the national level.

Second, implementing biosafety measures cannot continue to be based on ambiguous concepts such as the Precautionary Principle. This principle as currently advocated can be used to justify or ban the use of biotechnology depending on how a particular society perceives risk. This ambiguity is a useful tool for exercising national sovereignty but offers little as a guide for international cooperation. Safety is too important to be left to arbitrary decisions. It is important that the best available scientific knowledge be used in discussions.

This case illustrates the need for the international community to provide policy guidance on the need for technology cooperation on matters related to biotechnology.

Source: Juma, C. (Forthcoming).

1.3 Consumption of final products

The developing world's consumption of final products produced through new technologies would depend upon their availability and affordability in these [WHICH ONES?] countries. The international community must consider policy measures that target the increased consumption of such products that have a positive effect on fulfilling human developmental needs. For instance, if medicines are available in the developed world that can contain or limit the deaths related to HIV/AIDS, a pandemic that has reached epic proportions in Sub-Saharan Africa, obtaining affordable access to these medicines should be the top priority of the international community. This objective can be achieved by diffusion of technologies to produce these medicines, as discussed above, as well as by other direct actions to procure and distribute the products either free of cost or at reasonable prices.

Some argue that with perfect market segmentation, monopolists would have the incentive to have differential or tiered pricing according to willingness to pay. This point of view argues for removal of price controls, prohibition of parallel imports and other distortions in the free play of market forces. However, evidence on pricing strategies of pharmaceutical companies on HIV/AIDS antiretrovirals reveal no such consistency.

Chart 1.1 shows the ratio of annual price per pill of leading multinational enterprise (MNE) brand to per capita income in purchasing power parity (PPP) terms of HIV/AIDS triple therapy drugs in 1999 selected developing countries or groups of countries. There is a stark difference between the proportionate cost to US HIV/AIDS patients and to those in French West Africa and Central America. Chart 1.2 shows the average wholesale price per pill of leading MNE brand of the triple therapy drugs in nominal terms in these developing countries. Wile in most cases these prices are below the US price, it is not clear as to why there are such great difference among country prices. What is clear is that HIV/AIDS patients in some developing countries have to pay almost as much as those in the US for some drugs even where their ability to pay is far lower. Further analysis shows that nominal prices are fairly high in Argentina and other South and Central American countries even though they did not make available product patents for these drugs, whereas prices were relatively lower in South Africa and Malaysia which offered patent protection for these products in this period. However, generic drug manufacturing capability and competition does make even MNE prices lower where there is no patent protection, e.g. in India . In these countries the price levels of future pharmaceutical inventions with the full implementation of TRIPS may be far higher (e.g. Indian estimates in Watal, 2000a). A more detailed analysis is being undertaken by Watal and Borrel (forthcoming) on reasons for the differences in HIV/AIDS drug prices among these countries[2].

[2] The data used in this analysis was provided to the Center for International Development at Harvard University by IMS Health.

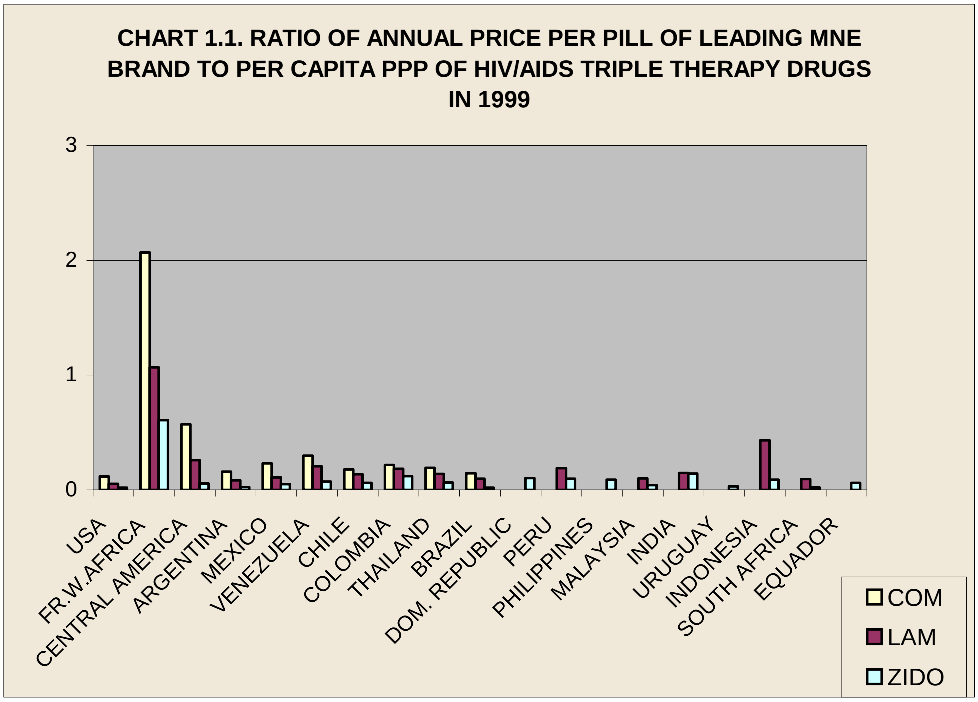
CHART 1.1. RATIO OF ANNUAL PRICE PER PILL OF LEADING MNE BRAND TO PER CAPITA PPP OF HIV/AIDS TRIPLE THERAPY DRUGS IN 1999
3
2
1
0
USA
FR.W.AFRICA
CENTRAL AMERICA
ARGENTINA
MEXICO
VENEZUELA
CHILE
COLOMBIA
THAILAND
BRAZIL
DOM. REPUBLIC
PERU
PHILIPPINES
MALAYSIA
INDIA
URUGUAY
INDONESIA
SOUTH AFRICA
EQUADOR
COM
LAM
ZIDO

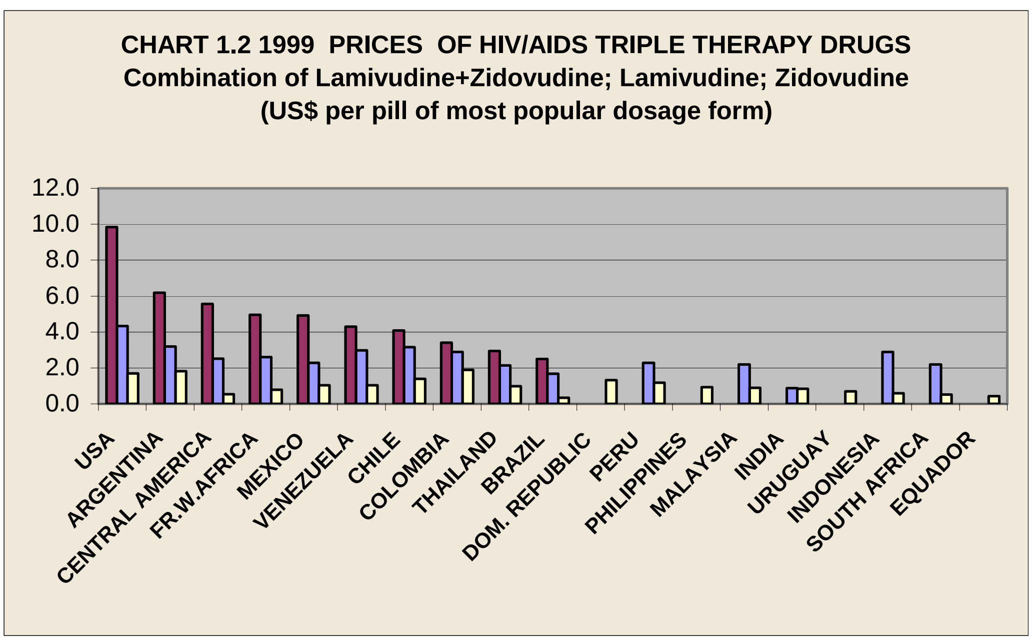
CHART 1.2 1999 PRICES OF HIV/AIDS TRIPLE THERAPY DRUGS
Combination of Lamivudine+Zidovudine; Lamivudine; Zidovudine
(US$ per pill of most popular dosage form)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
USA
ARGENTINA
CENTRAL AMERICA
FR.W.AFRICA
MEXICO
VENEZUELA
CHILE
COLOMBIA
THAILAND
BRAZIL
DOM. REPUBLIC
PERU
PHILIPPINES
MALAYSIA
INDIA
URUGUAY
INDONESIA
SOUTH AFRICA
EQUADOR

What is evident from these examples is there is a growing recognition of the need to create "functional alliances" around specific activities and to design instituitional interactions to suit the needs of the identified organizational tasks. This approach seeks to balance between a purely jurisdictional approach that relies on centralized mandates of single organizations to a more open and dynamic system that is more inclusive and adaptive (Juma, 2000d).

There are many lessons to be learnt from the field of agriculture. There is a different set of actors involved in decisionmaking relating to the diffusion of agricultural and other technologies. For instance, implementing agencies like the World Bank, the CGIAR, the UNDP, FAO and other UN agencies have projects that help spread new technologies and products in the developing world. This may involve making available materials, technicians or other consultants from the developed countries or even installing turnkey projects that manufacture the needed products. Such work can also be carried out through private foundations or NGOs.

For the most part, however, transfer of technology takes place through private partnerships and contracts that involve arms-length licensing agreements or foreign direct investment i.e., the establishment of fully-owned subsidiaries or joint ventures. There have been attempts to have international rules on licensing agreements in UNCTAD and the erstwhile UNCTC with little success. TRIPS broke new ground in providing a measure of acceptance to policies that limit the use of restrictive conditions in licensing agreements involving intellectual property protection. There are efforts underway to begin negotiations on a multilateral investment agreement and on global competition policy in the WTO.

It is on the question of consumption of the intermediate or final products of technology that there has been the least international intervention, until very recently. The issue under discussion here is what the international community is doing to ensure that products of existing technologies relevant to human development are available and affordable to those who need them in the developing world. The recent initiative by the UNAIDS and private pharmaceutical companies on the distribution of HIV/AIDS medicines at reasonable prices has not yet achieved its goals, although there have been recent press reports on the successful conclusion of negotiations with two African nations, viz. Uganda and Senegal.

The international community, however, has not even begun to resolve the difficult question of what is the "reasonable price" at which HIV/AIDS medicines should be available to developing countries. The institutional mechanisms to achieve this objective are fairly weak at present with a number of actors, viz. the pharmaceutical companies, their home governments, IGOs, activists, private foundations and others speaking in different voices in different fora. In some other critical technologies, such as biotechnology, there is no forum to discuss the question of affordable access to genetically modified crops or future gene-based therapies in the developing world.

1.4 Limits of the linear model: the new genetic divide

But nowhere is the limit of the linear model as apparent as in the case of agricultural biotechnology. In fact, much of the debate over agrobiotechnology is a result of the objection over a linear model under which one region of the world proposes to generate the food required by the rest of the world, the so-called "feed-the-world model." This model is associated with the uneven distribution of biotechnological capacity and threatens to create a new genetic divide between the rich and poor nations (Juma and Aerni, Forthcoming). Ironically, the development of agrobiotechnology has been consistent with this model as reflected in the distribution of transgenic crops around the world. But the future of biotechnology will depend on the extent to which specific technologies, not just products, are shared among nations. This will be a true challenge to the ability of globalization to generate win-win solutions for the generators of the technology and its users subsequent around the world.

Over the 1996-2000 period 85% of global transgenic crops were growing in the industrial countries. However, the share of transgenic crops grown in developing countries has risen consistently from 14% in 1997, to 16% in 1998, to 18% in 1999 and 24% in 2000. In fact, the area of transgenic crops is growing faster in the developing world than in industrialized nations, but the coverage of transgenic crops is limited to a small number of countries with relatively similar ecological conditions (Juma and Aerni, Forthcoming). Some 99% of the world's transgenic crops are grown in the USA and Canada, Argentina and China (James, 2000).

The coverage of agrobiotechnology products is also limited to a small number of crops with soybean occupying 58% of the area followed by corn, cotton and canola. Equally limited are the number of traits used in transgenic crops. Herbicide tolerance covers 74% of the coverage of transgenic crops, followed by Bt crops. Herbicide tolerant soybeans remain the most dominant transgenic crop in six countries–USA, Argentina, Canada, Mexico, Romania, and Uruguay—occupying 59% of the global transgenic crop area. This is followed by Bt maize, which occupies 15% of global transgenic crops and grown in six countries—USA, Canada, Argentina, South Africa, Spain, and France (James, 2000).

These patterns show both the limitation of the linear model—because not all countries of the world consume these crops—and the potential to use the technology to diversify agricultural production in other parts of the world, especially by focusing on crops that hitherto only play a marginal role in the world food budget. Doing this, however, will require a shift from the product cycle model to an approach that includes developing countries as users of biotechnology and not mere consumers of final products.

Shifting from this linear model to one that takes into account the diversity of competencies around the world as well as the need to bring developing countries into the global economy through enhanced technological capacity will require significant changes in the existing system of global governance. The structure and dynamics of global governance are under scrutiny and are the subject of growing scholarly analysis (Keohane and Nye, 2000). Ironically, much of the material available on the subject does not deal with scientific and technological capabilities despite the growing importance of this subject in international diplomacy (Juma, 2000a).

2. GLOBAL INSTITUTIONAL ARRANGEMENTS: A FUCTIONAL ANALYSIS

So far in this paper the role of IGOs has been considered mainly in the context of their juridical mandates. It is preferable to classify IGOs according to their functional competencies such as: (1) guidance and advocacy; (2) rule-setting; (3) scientific and technical advice; (4) research and development; (5) monitoring and reporting; and (6) operations. This classification of functional competencies is only meant to be indicative and to be used heuristically to understand the role of multilateral organizations in the global governance of technology. The focus on functional competencies is based on the view that the use of new technologies depends very much upon the institutional arrangements made to serve specific time-bound tasks. This approach suggests that an organization with diverse functional competencies is better equipped to meet the challenges of technological innovation.

However, functional competencies will not be fully utilized unless there is a management system that allows for flexible interactions between the various institutions. The full utilization of functional competencies in the multilateral system is somewhat undermined by the compartmentalization of IGOs. Recognizing these juridical realities would make it possible to design a governance system that accommodates the special political circumstances under which these institutions operate. This section presents a functional analysis of the multilateral systems that is relevant to global technology governance.

2.1 Guidance and advocacy

Policy guidance and advocacy are central functions of many international organizations. The guidance and advocacy are either provided through universal bodies such as the UN General Assembly or the decisions of the conferences of the parties to the various international agreements. The Millennium Declaration issued by the UN General Assembly in 2000 is an example of a guidance and advocacy statement. The effectiveness of the declaration will depend largely on the extent to which its elements are translated into the governmental and non-governmental programs. The relevance that governments place on technology for development can be discerned from such guidance and advocacy documents.

Currently, the general attitude toward technology in a number of international agencies towards technology and bodies, is skeptical or even hostile. This is partly because technology challenges traditional views about human progress. Another source of disenchantment with technology is the view that technological risk has had a negative impact on culture and the environment. Those who hold this view argue that slowing down technological advancement contributes to environmental and cultural protection.

Some of the anti-technology sentiments are starting to acquire legitimacy through treaties such as the Protocol on Biosafety under the Convention on Biological Diversity as we have seen in Box 1.4.

The emergence of regimes that have far-reaching implications for technology development and yet do not adequately address the concerns of the developing countries is a major impact of the lack of global guidance. For example, in the trade regime, the GATT membership decided that intellectual property rights are an important tool for the generation of technology and thus need to be protected worldwide. It did so through the TRIPS Agreement, negotiated under the auspices of the Uruguay Round and implemented through the present successor organization, the WTO. There have been further refinements made to TRIPS through the WIPO, particularly on copyrights, related rights and trademarks. More work is on the anvil in the area of patent harmonization in WIPO. The actors, apart from the secretariat of GATT/WTO or WIPO, are the member governments, particularly those that were net exporters of technology, the private research-based companies in business of developing exportable products in pharmaceuticals, entertainment, software, semiconductors, design, and non-governmental organizations, such as consumer groups or other public interest groups. Some developing countries also actively participated and formed issue-based alliances with other countries to significantly influence the final agreement with respect to concerns on the consumption of final products and obtained crucial flexibility, particularly on compulsory licenses and parallel trade (Watal, forthcoming). Yet, when the TRIPS Agreement was negotiated and finalized in the WTO in 1993, there was no discussion about what obligations the developed world would have to ensure the generation and dissemination of appropriate products to combat tropical diseases or for tropical agriculture. Nor, indeed was there any discussion on environmentally sound products and technologies as raised in Box 1.3 above. At that time, there were not as many NGOs involved with developing country issues on TRIPS as there are today.

Similarly, when the international community decides that free and easy access to plant genetic resources is essential for continuing crop research, agreements are negotiated in different fora such as the CBD or the FAO or the CGIAR. The actors, apart from the IGOs themselves, are national governments, research-based agro or life-sciences multinational corporations, their industry associations, environmental activists, consumer groups and private foundations. Decision-making in these organizations is more transparent, as all interest groups can be represented in or can have ready access to the negotiating forum. It is in this area that the NGO community has been most active and the websites of GRAIN, RAFI, and others provide a wealth of guidance to developing country negotiators.

2.2 Rule-making

The International Monetary Fund (IMF) and the WTO epitomize rule-making IGOs. Good governance is a *mantra* that the Bretton Woods institutions, in particular, have been repeating. Governance refers to the processes of decision making as much as to the substance of such decisions. There are four core principles of good governance: political accountability; participation and ownership of policies; predictability and impartiality in the application of rules; and transparency (Woods, 1999). The more important the nature of the decisions taken and their implications the more important these principles become.

Yet, it is the inter-governmental organizations that have the most control and influence on human development policies in developing countries, viz. the Bretton Woods institutions and the WTO that the decision-making processes are the least accountable, participatory, impartial or transparent[THIS IS CONFUSING]. In practice, these institutions follow decision-making by consensus either formally or informally. It is important to understand that by definition, such procedures are non-transparent and favor the more powerful in the group. This is because consensus does not mean unanimity: it only means absence of dissent. Such absence can be achieved by exclusion and by non-transparent procedures such as unrecorded meetings. Some view these procedures as essential to make at decisions speedily and efficiently on difficult and controversial issues. However, as the breakdown of the trade talks at Seattle showed, participation and ownership of the eventual decisions are important for implementation of decisions taken.

Box 2.1 Breakdown of decision-making in the WTO at Seattle

The WTO operates by consensus, but the process of "consensus-building" broke down at the WTO ministerial meeting held in Seattle at the end of 1999. Indeed, this problem emerged long before Seattle; it was evident at the birth of the WTO itself. It has two main causes:

First, WTO membership has greatly expanded, encompassing many developing countries that previously were outsiders or inactive players in trade negotiations. The GATT had 23 signatories when it came into effect in January 1948, and 84 signatories by the end of the Tokyo Round in 1979. More than 110 countries signed the Uruguay Round accords in Marrakesh in April 1994 (including several countries with observer status in the GATT). As of December 2000, the WTO has 140 members with an additional 33 observers, many in the process of accession. As a result of domestic economic reforms, including trade liberalization undertaken unilaterally and pursuant to GATT negotiations, developing countries now have a greater stake in the world trading system and a greater claim on participation in the WTO's decision-making process.

Second, starting with the Uruguay Round accords, countries have had to participate in all of the negotiated agreements as part of a "single undertaking." This requirement means that developing countries have to commit to substantially greater reforms of their trade barriers and trade practices than they did in the past. Consequently, they need to be better informed about issues under negotiation. In the Uruguay Round, many countries had to accept obligations developed without their participation, and which required the implementation and enforcement of regulatory policies that they have had great difficulty in fulfilling. They want to be represented around the decision-making table, known in WTO jargon as the Green Room.

At present, participation in the Green Room varies by issue and has increased over time. For instance, in the Tokyo Round, these talks normally involved less than 8 delegations while today it is not uncommon to have up to 25-30 participants in a "full" Green Room. There is no objective basis for participation in these meetings but generally only the most active countries in the negotiations participate. As it has evolved over time, Green Room consultations typically include the Quad (i.e. United States, European Union, Canada, and Japan), Australia, New Zealand, Switzerland, Norway, possibly one or two transition economy countries, and a number of developing countries. Developing countries that often participate in the Green Room include Argentina, Brazil, Chile, Colombia, Egypt, Hong Kong, China, India, Korea, Mexico, Pakistan, South Africa and at least one ASEAN country; most smaller developing countries stay out for lack of adequate resources or capabilities. For instance, 18 of the WTO members from Africa have no representation in Geneva. Decisions taken in the Green Room are conveyed to the larger membership for final decision. Prior to Seattle, the larger membership rarely differed with proposals developed by the small group. But the system broke down in preparations for and deliberations in Seattle. The smaller developing countries from Africa and the Caribbean demanded a place in the Green Room and were not happy with being passive participants. Suggestions have been made for reforming the structure of the Green Room to include representatives from the entire membership . Yet the currently active WTO members, both developed and developing, are not prepared to even concede the need for change in the decision-making processes.

Source: Schott and Watal, (2000)

2.3 Scientific and technical advice

In his report to the Millennium General Assembly entitled, We the Peoples, the United Nations Secretary-General Kofi Annan says that the UN "is the only body of its kind with universal membership and comprehensive scope, and encompassing so many areas of human endeavor. These features make it a uniquely useful forum—for sharing information, conducting negotiations, elaborating norms and voicing expectations, coordinating the behavior of states and other actors, and pursuing common plans of action." Its ability to convene States and other actors makes it an indispensable forum for international diplomacy (Juma, 2000a).

The United Nations, especially those organs that address international peace and security issues such as the Office of the Secretary-General and the Security Council, will increasingly be confronted by emerging issues such as infectious diseases, ecological degradation, electronic crimes, biotechnology and biological weapons. The ability of these organs to resolve many of the challenges associated with these issues will require greater access to scientific and technical advice. Scientific and technical communities, of the other hand, will require the involvement of the United Nations in dealing with the diplomatic aspects of these issues.

While career diplomats in United Nations agencies and missions will still play important roles in international diplomacy, their influence and effectiveness will depend of the extent to which they can mobilize scientific and technical expertise in their work. The challenge is not to build in-house scientific competence, but to use advisory services to identify, mobilize and utilize the best available expertise. While a large number of United Nations agencies, programs and treaties rely on scientific and expertise for their work, they are not designed to give systematic science advice as a key basis for diplomatic activities. Moreover, the more technical agencies of the United Nations do not readily interact with the Office of the Secretary-General of the United Nations except on special collaborative efforts.

The institutional terrain is broad and populated by a wide variety of approaches, intellectual traditions, disciplinary inclinations, political persuasions and internal cultures. There are specialized agencies that deal with issues such as the World Health Organization (WHO), Food and Agriculture Organization (FAO), World Intellectual Property Organization (WIPO), International Telecommunications Union (ITU), the World Meteorological Organization (WMO), UN Educational, Scientific and Cultural Organization (UNESCO), International Labour Organization (ILO) and the International Civil Aviation Organization (ICAO). Other matters are handled through programs of the UN covering issues such as development and environment while other issues are addressed through treaty bodies on peace and security and economic and social welfare. The Commission on Science and Technology for Development focuses on advice to countries but its agenda is limited to developing country issues. It is now linked to the UN Conference on Trade and Development (UNCTAD).

The level of scientific and technological advice needed by these agencies varies depending on their functions. Organizations such as ICAO and ITU that are involved in setting international standards rely on technical input in their regular functions. So are other bodies such as WMO and WIPO that processes large quantities of data. Other UN organs such as the UN Environment Programme (UNEP) deal with issues that are largely scientific. There is also the UN University with its satellite research centers and programs (covering issues such as new technologies, natural resources, sustainability, software, advanced studies, biotechnology, water, food and nutrition, goethermal energy, biotechnology and fisheries). Although the UNU is empowered to undertake research and training and operates under a charter that guarantees intellectual autonomy, it does not have the capacity to convene states and therefore its advice is not readily available to governments and other entities. It lacks the convening authority that is entrusted to other UN organs although it could engage governments through its intellectual autonomy.

Specialized agencies and treaty bodies have their own internal mechanisms for mobilizing scientific expertise and are accountable to their governing bodies. The structure of scientific input is internal to each body and its global value is reflected either in the availability of its reports to the general public or through the implementation of the advice by national governments. There is considerable variation in the content and modality of scientific advice provided to the specialized agencies and treaty bodies. These include technical committees, scientific advisory bodies, conferences, workshops and consultants in various combinations.

Environmental treaties, for example, rely on a variety of mechanisms including special organs established to address scientific and technical issues. In fact, many of the environmental treaties are a result of the work of scientific groups and conferences. The UN Framework Convention on Climate Change (UNFCCC), for example, draws its scientific input from the Intergovernmental Panel on Climate Change (IPCC). This is an independent body of government-nominated experts. UNFCCC maintains its own Subsidiary Body for Scientific and Technical Advice (SBSTA), which considers information from IPCCC and from other sources. While IPCC focuses on carrying out scientific assessments, SBSTA is an internal organ that draft recommendations for the consideration of the Conference of the Parties. The Convention on Biological Diversity (CBD) and the UN Convention to Combat Desertification have their SBSTA analogs but do not have an IPCC-like body. Attempts by the United Nations Environment Programme (UNEP) to serve as a source of scientific input was abandoned when Parties to the CBD declined to endorse the 1995 *Global Biodiversity Assessment*. This comprehensive assessment of the knowledge on global biological diversity has served as an important reference point but was never recognized by the Parties as a formal input into the functioning of the CBD.

Governments have generally been reluctant to establish under treaty bodies scientific advisory organs who agenda they do not tightly control. In the case of the CBD, for example, the scientific community envisaged the creation of a body that would alert governments on emerging threats to biological diversity. But governments insisted that they needed a body that would respond to their explicit request for advice. They agreed to set up a subsidiary that prepares: (a) scientific and technical assessments of the status of biological diversity; (b) assessments of the effectiveness of measures undertaken under the convention; (c) reports on innovative, efficient and state-of-the-art technologies and know-how; (d) responses to methodological questions; and (e) reports on relevant activities of other international organization. They have, however, been open to ad hoc scientific input from other organizations, especially where the contributions are a response to the request of the governments.

The first phase of the implementation of the CBD has shown that little progress will be made without effective scientific and technical advice is key issues. For example, the CBD has adopted an ecosystem approach as a guiding principle for its operations. This was a result of prolonged debates over the use of species as the unit of conservation. But little work has been done to provide guidelines on how to manage ecosystems. In fact, there is more scientific research available to the CBD on species conservation than on ecosystems. Furthermore, several other conventions and international agencies already work on species conservation. The CBD will need to bring more scientific and technical analysis to inform the formulation of policies on ecosystem approaches.

It is envisaged that the scientific advisory body under the CBD will function through expert groups selected from a roster of names submitted by governments. The composition of the rosters vary considerably depending on the subject matter. In many cases, however, governments have submitted names of their negotiators on the subject matter and not specialists in that area. The reports of such expert groups are subject to political "corrections" by the advisory body before they reach governing bodies of the treaties. In many cases the same individuals participate on the advisory and governing bodies. For many countries this happens by default because one negotiator attends all the meetings under the treaty. And even if they did not governments make every effort to ensure that there is consistency between the reports of the advisory bodies and the final decisions of the governing bodies.

Reforms in the advisory functions on governing bodies have often ignored the differences in access to scientific capacity in countries as well as the time needed to undertake domestic consultations, especially where the issues involve a wide range of institutional actors. The frequency of meetings makes it difficult to for many countries to undertake meaningful consultations and issues tend to be deferred from one meeting to another. This is compounded by the fact the scientific uncertainties surrounding many of the issues discussed under the treaties require internal negotiations in countries to establish a common position.

The absence of a body that focuses on identifying emerging issues is a major weakness of treaty bodies that address issues such as environmental management that are characterized by high levels of uncertainty, irreversibility and long timeframes for remedial actions to show effect. But it is also because these factors that governments want to have greater control over the identification of emerging issues. What is notable about the UN is that its organizations cater to a wide range of interest groups, with the notable exception of the growing community of science advisors. UNESCO has tried to perform this role but the organization remains largely a focal point for government authorities responsible for education. The International Science Council (ICSU) has previously served as a forum for national academies of science but their presence has often been overshadowed by the more visible scientific committees. In effect, organs that provide scientific and technological advice to national governments do not have clear focal point in the UN systems.

2.4 Research, development and technical assistance

There are a number of international organizations that conduct biotechnology research relevant to developing countries. These institutions fall in two broad categories. The first group includes institutions that focus on biotechnology but are relatively small. The second category includes institutions that work on wider issues such as agricultural development but have been slow to adopt biotechnology techniques. Institutions such as the International Center for Genetic Engineering and Biotechnology (ICGEB) bi-located in Trieste, Italy and New Delhi are an example of the first category. The second group includes the Consultative Group on International Agricultural Research (CGIAR).

The ICGEB conducts research, provides services to member states and undertakes training. ICGEB's research covers both basic and applied research problems, focusing on developing country problems such as novel malaria and hepatitis vaccines and studying human pathogenic viruses, human genetic diseases as well as the genetic manipulation of plants. More than 300 people from 30 different countries are working in its laboratories. In addition to training which is provided through affiliate centers, ICGEB also distributes polynucleotides and polypeptides when requested, and facilitates access to a bioinformatics network and the related biological fields as well as software for retrieval and analysis.

Similar training and informatics services are also provided by other UN entities such as the Programme for Biotechnology in Latin America and the Caribbean of the United Nations University (UNU/BIOLAC) established in July 1988 in Caracas, Venezuela. The aim of the program is to promote the development of biotechnology in the Latin American and Caribbean region covering issues such as agricultural biotechnology, industrial microbiology, medical biotechnology, industrial relations, molecular pathology, genomics, manufacturing, and molecular biology.

The program operates a Tuberculosis Research Network aimed at using biotechnology to develop better diagnostic methods and effective vaccines against the disease. The network consists of members from Argentina, Bolivia, Brazil, Canada, Chile, Colombia, Cuba, Dominican Republic, Honduras, Mexico, the Netherlands, Nicaragua, Peru, Spain and Venezuela. The work focuses on exchanging strains of microorganisms and epidemiological data, use of genetic engineering methods such as restriction fragment length polymorphism (RFLP) for typing the strains, standardization of techniques and reference strains and dissemination of rapid detection methods.

These efforts are too limited to meet health and agricultural challenges facing the tropics. While modern advances in genetic engineering offer possibilities to address some of these challenges, there are limited incentives for the private sector in the industrialized countries to develop crops for tropical conditions. In agriculture, for example, public sector funding to the Consultative Group on International Agricultural Research (CGIAR) has been declining at a time when major biotechnology corporations are focusing on temperate crops. This trend suggests that tropical countries are unlikely to benefit from the biotechnology revolution taking place in industrialized countries unless there is a substantial increase in the flow of financial resources, access to new technologies and radical change functioning of the CGIAR. Without such reform the CGIAR will soon be reduced to a network of gene banks and natural resources conservation agencies with little capacity to contribute to food security in developing countries.

The CGIAR reports that it has been spending 40 percent of its funds in Africa (CGIAR, 1998). Success, however, has been limited, except in areas such as the biological control of cassava mealy bug and the diffusion of improved varieties of maize, wheat, barley, cassava, and a few other crops. This should not come as a surprise, since the success of the Green Revolution was dependant on the availability of a large pool of scientific and technical knowledge available in the public domain. The Cold War provided an ideal geopolitical imperative for mobilizing and using the publicly available agricultural knowledge to meet the food needs of parts of Latin America and Asia (Juma, 2000b).

Both of these models seek to promote the use of biotechnology but suffer from a wide range of limitations. International agencies lack the resources needed to mount major programs. The CGIAR has on the other hand been too slow to adopt biotechnology techniques. Political uncertainty over the future of biotechnology, especially among European countries that are the main donors to international organizations is a major source of influence on policy of international institutions regarding biotechnology. A global biotechnology governance approach that does not take into account the impact of national policies towards biotechnology in industrialized countries will most likely not function effectively.

The overall effectiveness of biotechnology activities in international organizations will depend largely on the extent to which they are integrated into national research and development systems. Furthermore, evidence from a wide range of studies shows that the adoption of biotechnology products is often related to the degree to which private enterprises (domestic or foreign) are linked to the research and development processes. International organizations often face major challenges in designing activities that effectively involve the private sector.

Close cooperation between international institutions and the private sector will occur in very specific areas. In some cases, institutions such as the United Nations may not be the most suited to partnerships with the private sector, especially where cooperation involves product development. This does not mean that the UN would have no role. To the contrary, what is needed is to find a role that the UN can perform well and leave product development activities to institutions that are better suited to this purpose.

2.5 Monitoring and reporting

Monitoring trends and reporting on progress are key functions of United Nations agencies. Many of these institutions have elaborate mechanisms for these tasks, which include national offices. The World Meteorological Organization (WMO) collects data related to changes in the weather and has played an important role in providing information for international decision-making on issues related to global change. Other institutions also monitor technological development, especially for purposes of setting performance and safety standards. Examples of these institutions include the International Standardization Organization (ISO), the International Civil Aviation Organization (ICAO) and the International Telecommunications Union (ITU). Other organizations that monitor and record technological trends include the World Intellectual Property Organization (WIPO)—although these functions are limited to intellectual property information. Many of these organizations operate through networks of national and regional institutions and the information is brought together for setting standards or making rules.

In the field of environmental management the function of monitoring technological development is currently restricted to a few institutions that work on specific technical problems such as developing substitutes for ozone-depleting substances. The ozone regime has a strong scientific and technological basis and is structured to focus on identifying alternatives to ozone-depleting substances. In addition to the technology monitoring function, it also has a mechanism for providing financial assistances to countries to phase out ozone-depleting substances. Efforts to replicate this regime have not been successful and many similar efforts such as the UN Framework Convention on Climate Change continue to face implementation difficulties because they focus on emissions targets and pay less attention to technological change.

On the whole, the international system does not have robust a institution or mechanism for monitoring technological development of relevance for developing countries. The only major effort to do this was the now defunct United Nations Centre for Science and Technology for Development (UNCSTD). This Centre has been succeeded by the UN Commission on Science and Technology for Development which has the potential to perform some functions related to technology monitoring. Much of this work has so far been carried out by advocacy organizations, such as the Rural Advancement Fund International (RAFI), which focus on identifying the negative aspects of technological change and corporate control in agriculture and other related fields. There are similar activist organizations that carry out similar tasks but focus on issues such as intellectual property rights. But there are no major institutions that monitor technological development with the aim of identifying those that might benefit developing countries.

There have been efforts to fill this gap through the creation of various clearinghouse mechanisms under international conventions, but they have all failed to perform this tasks do to the complexity of the task, undue politicization of the task, and limited competence in international organizations. Evidence from agricultural biotechnology suggests that active efforts will need to be made to find an efficient way to identify emerging technologies of relevance to developing countries. The pressure of biotechnology firms to commercialize their products in the best available markets have usually opted to exclude technologies that might be relevant for developing countries long before they are tested. Developing countries, on the other hand, have been too slow to devote resources to this task as part of their technology cooperation initiatives.

2.6 Operations

Operations functions among international organizations range from the implementation of specific projects, technical assistance to the provision of finances in various forms. This is probably one of the most contested functions of the United Nations and its sister organizations. Many of these functions could be performed by the private sector. Concepts such as "global public goods" are in danger of being used to justify the continued involvement of international organizations in operations program that could be better undertaken through private or non-governmental initiatives. The full impact of the role of international organizations in project implementation needs to be reviewed, especially in relation to technological development in the developing world.

3. FOSTERING INSTITUTIONAL INNOVATIONS

The kinds of institutional innovations needed to promote the utilization of technology in developing countries should be considered as part of an overall strategy to redirect technology to meet human needs. In other words, discussions on biotechnology, for example, need to be considered in the wider context of agriculture, health and environmental management. This approach, however, does not mean that individual strategies are irrelevant. To the contrary, operational issues will need to be handled on a case-by-case basis but the governance structure for handling individual cases must be supportive of the overall goal of bringing technology to solve human needs. In the discussion that adheres to the elements of such a governance program is drawn largely from examples taken from the biotechnology and pharmaceutical sectors but these elements are generic and could apply equally well to other fields of technology.

3.1 Policy guidance

Link science, technology and human development

Global governance of technology is largely an expression of the collective will governments and other actors to recognize the importance of science and technology in development. The global system will only be as effective as individual governments want it to be. This suggests that the first major step in global technology governance is reforming national policies and positions in international fora to reflect the essential considerations and underlying ethical values.

For most developing countries, especially those in Africa, issues such as public health, food and nutrition, energy and environmental conservation have become serious public policy issues, and yet national governance structures have not been adjusted to reflect this reality. It is here that the challenge really starts. For example, countries that give national priority to science and technology will also seek to articulate the same vision at the global level. This requires a wider disclosure of the policy implications of the various choices available to a country in the generation, adoption and consumption of technology and its products.

Recognizing these links, however, will require greater investment in policy analysis capacity, especially given the fact that the development theories used by the dominant institutions have yet to recognize the central role played by science and technology in development. These institutions have a long way to go before they recognize that a failure to address development challenges is a result of poverty of ideas rather than the lack of adequate financial resources.

Undertake policy research

The limited understanding of the role of science and technology in economic transformation is one of the main barriers of the global system not successfully governing technological change. United Nations institutions that have internal competence in science and technology capacity are far removed from the locus of diplomatic and political power. For example, the United Nations Institute for New Technologies (UNU/INTECH) was established to undertake policy research on these issues but there are no effective mechanisms for ensuring that its outputs are used by other United Nations agencies. UNU/INTECH has at times served as a source of input into the work of UNCSTD, but this has been done on an ad hoc basis. As the Vitamin-A and terminator examples have shown, there is a great deal of confusion in the debate on the benefits of these technologies. The UN system could serve as a major source of policy research for other UN agencies using existing resources. Doing this will require a greater degree of policy cooperation, especially through the office of UN secretary-general.

A practical measure that could be taken under UN leadership would be to bring the world's leading institutions in science and technology studies together to map out the frontiers of knowledge in this field and to identify new research areas that could contribute to efforts bringing science and technology to the core of development thinking. In addition to these institutions, there is also an important role to be played by schools of diplomacy. These schools could play a key role in clarifying the linkages between science and diplomacy in general and science and development in particular. The first part of this equation is being covered by institutions such as Columbia University (USA) which offers training in science, technology and international affairs.

Build policy analysis capacity

As part of strengthening policy research capabilities, the UN could provide leadership in supporting the creation of training programs that equip policy makers with the capacity to undertake technology policy analysis. Training in "science, technology and human development," for example, would start the creation of the professional cadre needed to bring clarity to the role of science and technology in development. Currently, only a handful of universities around the world offer training in this field and efforts to create networks of researchers in this area have not been successful.

Agencies such as UNDP and institutes such as UNU/INTECH could promote this through partnerships with universities around the world in the same way the World Bank works with universities to train analysts in economic policy. Such training efforts will also help to bring the intellectual and analytical rigor needed to support policy and other initiatives in this area. Other institutions such as national academies of science could also provide leadership in this area by identifying training needs and encouraging universities to develop appropriate curricula to meet the growing need for science and technology policy analysis. Private foundations could also be encouraged to provide exploratory support to such activities.

One of the areas that require special attention is the ability to undertake negotiations on scientific and technological issues. Recent experiences in areas such as biosafety show clearly that only a handful of developing countries have the capacity to understand the complex issues surrounding the development of biotechnology and to formulate negotiating positions that genuinely reflect their national interests. Strengthening and widening such capabilities will enable national civil servants and diplomats to understand the possibilities of negotiating fairer and more equitable agreements than they have been able to do thus far (for example, see Box 1.4 on the Biosafety Protocol or the discussion on TRIPS above). In additional to international diplomacy, negotiating capacity is also needed when dealing with technology acquisition or transfer arrangements. While the former entails building up capacity in science advice in the foreign affairs departments, the latter involves negotiating capacity levels in enterprises and other non-diplomatic institutions.

Promote global policy advocacy

One of the most difficulty challenges in international development is providing effective policy advocacy on emerging issues. Previous advocacy efforts through mechanisms such as commissions have played an important role in placing new issues on the global agenda. One of the most successful efforts was the World Commission on Environment and Development under the former Norwegian Prime Minister Gro Harlem Brundtland that provided the political impetus for the concept of sustainable development. Other commissions have sought, albeit with little success, to emulate this effort.

It would be unwise to seek to mimic the experiences of previous commissions but some lessons can be learnt from past commission. Issues such as conceptual clarity, intellectual autonomy, personal leadership, sovereign activism, public consultation, trans-jurisdictional outreach and urgency are elements that should form part of any serious global policy advocacy program on issues of science and technology.

One of the main reasons for the success of the Brundtland Commission was the commitment to the integration of environmental considerations into activities of existing institutions. This commitment not only helped reduce possible conflicts between existing institutions, but it make it possible for these institutions to reallocate their resources to support environmental activities without requiring additional resources.

The Commission on Macroeconomics and Health recently set up by the WHO aims to do for health what the Brundtland Commission did for the environment. There is need to set up a Consultative Group on Global Health Research to bring under one umbrella the diverse public-private partnerships in this area. This would make for far better coordination in this crucial aspect of human development. Such a group could help to identify the key issues needed to strengthen global public health institutions. The decision of the United States to define HIV/AIDS as a national security issue raises the profile of global public health. It notable that the US decision has not been followed by other developing countries despite the clear recognition that HIV/AIDS and even hunger constitute clear national security challenges. The UN, especially the office of the secretary-general, could play an important role in promoting a better understanding of the linkages between science, technology and the wider issues of international peace and security (Juma, 2000c).

Most of the major UN or international agencies, agreements and institutions have science and technology mandates that could be strengthened through such an advocacy process. The WTO, for example, has provisions on technology transfer and access to patented products whose implementation could receive political support from such wide-ranging consultations and advocacy. Clarity on the policy implications of the options that TRIPS allows on access to patented medicines in particular may be helpful in resolving some of the uncertainty in this regard in domestic legislative and other measures. Leaving such matters only to NGO forums may be an inadequate solution. Already the European Union has begun a dialogue with interested parties on this issue and the WTO and WIPO should follow suit. Similarly, technology cooperation provisions in environmental conventions such as the CBD could receive renewed attention.

Refocus institutional mandates

The role of science and technology in development is reflected in the mandates of a wide range of treaties and organizations. However, these treaties and organizations have so far not explored ways of realizing these objectives. The WTO, for example, has committed itself to promoting technology transfer and cooperation, in addition to protecting intellectual property rights. However, it has done little about this so far. As we have seen, the Montreal Protocol on the ozone layer did little to transfer the necessary substitute technologies despite a commitment to do so.

The Convention on Biological Diversity has clear technological goals that have received little attention over the years. To the contrary, much of the work under the CBD has focussed on safety issues without examining the technological basis for such discussions. A focus on technological development would provide greater opportunities for the two bodies to go beyond current tensions and focus on constructive activities of relevance to developing countries.

Improve decision-making processes

There are four core principles of good governance: political accountability; participation and ownership of policies; predictability and impartiality in the application of rules; and transparency. Rule-making organizations, in particular, need to ensure that all these principles are followed, ensuring that the rules made are willingly adopted and faithfully adhered to by all members. The WTO has to ensure that its smaller-sized members do not feel excluded from the secretive, deal-making meetings that characterize the way sensitive and controversial issues are resolved in that organization. Similarly, the Bretton Woods institutions should ensure that its members fully understand and "own" the decisions and conditions imposed on them when faced with financial crises.

3.2 Strategic considerations

Provide strategic guidance

Current discussions on the role of biotechnology in developing countries are not guided by any strategic considerations. Providing such guidance entails reaching an agreement on a program of work involving a specific technology for a specific place or community of people. It is generally accepted that local priorities should determine the nature of such programs, but most international institutions have tended to promote their own ideas at the expense of local initiatives. Many development strategies and action plans in developing countries are a product of donor interests and not local priorities.

Today many of the decisions regarding biotechnology are greatly influenced by the industrialized countries with little consideration of local priorities and needs of developing countries. Shifting the focus from these historical practices will require strengthening the capacity of developing countries to define their needs. In some cases, it will require the applications of the principles of ethical diplomacy to show some respect for local priorities.

Institutions such as the UNDP that are charged with coordinating developing activities at the national level carry a major burden of responsibility to ensure that local needs and priorities are fully taken into account in the various international initiatives. It is also their responsibility to ensure that other international agencies do not become the conduit through external influence and spent on local governance systems. Timely strategic advice is what developing countries need when faced with the more skillfully articulated demands of the technology suppliers of the industrialized world.

Forge functional technology alliances

The creation of a program of work should be accompanied by the identification of all the actors with functional relevance. These actors will include government agencies, industry, civil society and private individuals that can make specific contributions to the implementation of the program. A technology alliance can evolve depending on the nature of tasks to be performed and the kinds of actors needed at specific times. For example, early stages following problem identification may require global searches for relevant technological solutions, knowledge or property holders as well as prior examples of the use of such technologies.

Later stages of the development of the technology may involve alliances of enterprises involved in the commercialization of the technology. The choice of actors therefore should be determined by the functions that need to be performed, not merely by their stated mandates. This process requires expertise in technology management that is often lacking in developing countries. However, cases of previous experiences show that such expertise can be acquired through learning-by-doing.

One of the most critical elements in the creation of technology alliances is the identification of product champions. These are individuals who are committed to the development of particular technological systems, are familiar with their intricacies and are recognized by their peers, colleagues, and legitimate leaders. But, in many cases, authority over technology projects tends to rest with program officers in public institutions rather than product champions who have invested in promoting the successful adoption of a particular technology.

There are a number of examples of functional technology alliances in the health sector. Realizing that taking effective action on disseminating existing vaccines and developing new vaccines for tropical diseases requires massive finances and efforts involving organizations in both the public and the private sector, several new initiatives were taken.

The Global Alliance for Vaccines and Immunization (GAVI) represents an alliance of public and private sector partners such as the Bill and Melinda Gates Children's Vaccine Program, the International Federation of Pharmaceutical Manufacturers Associations (IFPMA), public health and research institutions, national governments, the Rockefeller Foundation, UNICEF, the World Bank Group and the World Health Organization (WHO). The international AIDS Vaccine Initiative (IAVI) and the Medicines for Malaria Venture (MMV) are set up to develop vaccines and medicines for specific diseases.

IAVI is a global non-profit organization that has been funded by public international organizations like the World bank and UNAIDS as well as by government agencies such as the UK DFID and the USAID. Its major donor is, however, a private foundation, the Bill and Melinda Gates Foundation, although there are many others. MMV, also funded by the Bill and Melinda Gates Foundation, is a similar public-private initiative taken by the WHO and the World Bank with funding from many private organizations, including the International Federation of Pharmaceutical Manufacturers' Association.

Forging functional alliances will need to take into account the decline of scientific and technological infrastructures, especially in Africa. This decline has been associated with the flight of trained expertise to other parts of the world. It is estimated that some 30,000 African Ph.D. degree holders live outside the continent (UNESCO, 1999). Most students—especially males—who study aboard do not return because of the poor state of the research environment. Previous efforts to address this problem have tended to focus of activities that encourage students to return to their home countries (Juma, 2000b).

An additional way of using the available expertise is to seek to link students of African origin to research alliances focusing on African problems. Under this premise, the expertise can be mobilized to contribute to research activities irrespective of the physical location of the people and can take advantage of the growing globalization of research activities. New forms of research alliances could emerge that would be open to those interested in contributing irrespective of their origin or association. Taking this approach could turn what appears to be a serious problem of "brain drain" to an investment that can be used to respond to specific scientific and technological challenges through functional alliances (Alberts, 1999).

Create incentives for innovation

These efforts will not be sustainable in countries that do not provide concurrent policy reforms to support technological and institutional innovations. So far, the issue of policy reform has been colored by a history of macroeconomic initiatives that did not take into account the importance of technological and institutional innovation. These policies assumed that the mere act of reforming macroeconomic policies would provide an enabling environment for innovation. This has not happened, and there is a need to focus national attention on policies that stimulate technological and institutional innovations. One of the areas that require special attention is the role of private enterprises and how they relate to public institutions. The recent establishment of several private-public partnerships in the generation of new vaccines and medicines has shown promise but needs to be watched carefully before it is emulated in other areas.

Evidence from other countries shows that the emergence of the private sector is in itself a product of sensible policies that creates incentives for the transformation of knowledge into products and processes. This is a key element of technological change, and it is not a surprise that rapid technological innovation is often associated with the development of private industry. This is not to argue against the role of the public sector, but rather what is needed are strategies that provide for mutual benefits between the public and private sector with support for the increased involvement of the latter in productive activities.

Public institutions like the IARCs of the CGIAR system need to have clear IPR policies for their own innovations. Clearly instead of the profit motive these institutions may be more interested in defensive patenting to create “bargaining chips” (Barton et al, 1999).

The field of biotechnology offers a number of examples where developing countries have already identified priorities based on choice of crops and regions. In many parts of Africa, for example, governments have identified drought-resistance as one of the main targets for research. Other countries have identified salt-tolerance and disease-resistance as key priorities. In other fields such as aquaculture, disease-resistance and productivity enhancement are emerging as priorities. It is around such locally-identified priorities that research and development programs should be established. Regional research organizations or consortia can be established to enable pooling of limited resources. (Byerlee and Fisher, 2000).

3.3 Institutional commitment

One of the sources of development failure is the lack of appropriate institutional commitments to research programs. There is a wide range of reasons that account for this failure. Many of them are related to weak managerial capacity, external interference and lack of adequate financial resources. Another key element is the mismatch between planning horizons that are often short-term and dictated by bureaucratic imperatives. Studies of successful technology-based programs show long periods of experimentation. Bringing program planning in line with these timeframes requires a certain degree of institutional commitment that goes beyond the political support that leads to the initiation of new programs.

Developing countries could secure this institutional commitment through a specialized treaty arrangement focusing on particular problems. This can be done more easily if small and medium sized countries are grouped at the regional level. Most of the regional cooperation agreements in the developing world are too broad to address the specific concerns associated with developing a particular technological program. A scientific and technical agreement on addressing specific diseases or food production challenges would provide the institutional commitment needed to sustain a long-term program. Such agreements could take advantage of the existence of broader regional cooperation agreements.

Last, but far from least, there is an urgent need to dramatically increase the global financing of appropriate R&D for raising human development standards in developing countries. For some time to come this effort would largely have to be met through the budgets of industrialized countries. For instance, the total of $200 million spent by donors, CGIAR and developing country NARS on agricultural biotechnology far outstrips private investment in the developing world. The international community could, through such increased aid, support the establishment of regional National Science Foundations, modeled on the lines of the US NSF, which would provide the financial grants necessary to conduct relevant applied research. Another institutional innovation could be the adoption of a revised version of legislation similar to the US Bayh-Dole Act that allows universities/research institutions to obtain patent rights over government-funded research. Provided that such legislative reforms ensure that the private use of research results does not adversely affect the enterprise of science itself by promoting excessive secrecy, conflict of interest or other maladies that are associated with Bayh-Dole Act, developing country researchers can hold bargaining chips in the form of patents to evoke sufficient interest in the private sector of the industrialized world.

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