A CONCEPTUAL FRAMEWORK FOR UNDERSTANDING GLOBAL AND TRANSNATIONAL PUBLIC GOODS FOR HEALTH

by

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Final Revision: March 2002

Abstract

The paper presents two taxonomies for classifying global and transnational health-promoting activities according to three parameters of publicness – nonrivalry of benefits, nonexcludability of nonpayers, and the aggregation technologies. Based on these taxonomies and their implications for efficiency and equity, this paper identifies the need for international cooperation in some, but certainly not all, areas concerning the provision of such health-promoting activities. Additionally, institutional responses are evaluated in light of the various health-promoting activities. The role of multilaterals, nongovernmental organizations, foundations, and nations are addressed. A host of current global health issues – e.g., public-private partnerships, international orphan drug legislature, patent protection – are addressed.

JEL classification: H41, I18

I. INTRODUCTION

Globalization has caused increased awareness of human health interdependency through the international pathways and transmission of disease. The health of far-distant countries and people can have an impact on the well-being of the global community. For example, during the Indian plague outbreak of 1994, the New York City public health department had to develop a response that included an alert to educate local doctors on how to spot the disease, and that relied on non-health specialists (e.g., airline employees and US Customs agents) to check incoming passengers. In reaction to the possible spread of mad cow disease from Europe, the American Red Cross has banned – for life – donors who have lived for more than six months in the United Kingdom or Ireland between January 1980 and December 1996. This last incident highlights that transnational interdependencies are not simply a by-product of increased interaction between the North and South. We are now in what Berlinger (1999) labels as a microbial-unified world.

This essay focuses on health-promoting activities that have wide-ranging benefit or cost spillovers to the global community. As such, we are not interested in traditional development assistance in health targeted to specific countries or projects – e.g., improving a country's sanitation or public health infrastructure. Although such assistance can have some global consequences in limiting the vulnerability of a population as a breeding ground for infectious diseases, these spillovers are often small compared with the associated country-specific benefits. We are, instead, concerned with health-promoting public goods with spillovers for a large number of countries. In some cases (e.g., finding a cure to a disease), the spillovers are global; however, in other cases (e.g., developing a treatment regime for malaria), the spillovers are transnational, but not global. To limit confusion, we shall distinguish global from transnational health-promoting public goods.[1]

Transnational and global health-promoting activities involve properties that vary along

three essential dimensions. The first is *nonrivalry*, for which the confirmation of the benefits of an activity on one nation does not, in any way, preclude other nations from partaking in the good's benefits. Since the eradication of smallpox in 1977, people no longer need to be vaccinated, thus conferring a nonrival health benefit worldwide. The threat of bioterrorism may change this. A second dimension of publicness is *nonexcludability*, for which the provider of the good cannot prohibit its use by others. Knowledge of best treatment practices fits this description. A third dimension, the *technology of public supply aggregation*, refers to the manner in which overall contributions are combined to create a public good.[2] Typically, the supply of a public good is taken to be determined by the sum of individual contributions. Yet alternative supply aggregators, such as weakest-link and best-shot, have been shown to significantly modify the degree of underprovision and thus the need for actions by multilaterals or other global players.

At the conclusion of the nineteenth century, three conditions led to effective collective action against transmissible diseases: (i) the knowledge of their causes, (ii) the identification of appropriate prevention and therapy, and (iii) the will for international action (Berlinger, 1999, p. 18). These actions resulted in a constant increase in life expectancy. Despite this progress, the world population continues to be vulnerable to new microbes and viruses, and to the resurgence of old ones. Thus, nations cannot insulate themselves from the consequences of a breakdown in *global* public health or from activities in far-distant places. An understanding of the public good properties of global health activities identifies not only what public policies are needed, but also who should take them. These publicness properties of health-promoting activities can facilitate the design of institutional arrangements. The entire question of public good financing can be shown to depend on the dimensions of public goods (Sandler, 1997, 2002).

One of the most worrisome aspects of globalization for worldwide health is the growing

income inequality. The relative disparity in life expectancy between countries has not improved over the last half century, and health inequalities within many countries are increasing. Infectious disease epidemics, most of which are preventable with existing knowledge, are of special relevance to the poorest 20% of the world's population that lives in Sub-Saharan Africa and Asia (Beaglehole and McMichael, 1999, p. 13). As a consequence, this inequality makes poor countries the breeding ground for diseases. As long as the potential for the international spread of diseases exists, both industrialized and developing countries have an interest in proactive surveillance of emerging and reemerging diseases.

The purpose of this paper is to link the characterizations of global and transnational public goods for health with public policy issues concerning the provision and financing of such goods. In so doing, we will provide two alternative taxonomies of transnational health-promoting public goods based on these goods' properties. The way in which we delineate the different types of public health benefits and concerns then allows us to gauge the potential for institution building for transnational collective action and the roles that various agents can play in leading, coordinating, and delivering upon the promise of global public health. Policy prescriptions differ with the typology of publicness; therefore, the emergence of new institutions such as foundations and public-private partnership is a sign *that tailored solutions to the problems of global health-promoting public goods are often warranted.*

II. GLOBAL AND TRANSNATIONAL HEALTH ACTIVITIES: TWO FACETS OF PUBLICNESS

At the transnational level, healthcare involves myriad activities that vary in their public benefits. By formulating a taxonomy of transnational health-promoting activities from a public goods perspective, we are able to assess the prospects for collective action and financing in ways that have not been previously examined by the institutions that provide these goods. This, in turn,

leads to new intuition regarding how efforts toward promoting international health should be tailored according to the categories identified.

Our first taxonomy of transnational health-promoting activities is dependent on the two *classic* properties of public goods – nonrivalry of benefits and nonexcludability of nonpayers. At the transnational level, the benefits of a public good are nonrival if one nation's consumption of the good does not detract, in the slightest, from the consumption opportunities still available to other nations from the same unit of the good. Some economists equate nonrivalry of benefits with a zero marginal cost of extending consumption privileges to additional users (Bruce, 2001), so that there is no degradation in benefits. Nonexcludability of benefits implies that, once provided, payers and nonpayers alike receive a good's benefits. Global and transnational health-promoting public goods can possess these two classic properties to varying degrees.

There is no unique or best taxonomy for such public goods. A taxonomy can differ depending upon which of the three dimensions of publicness is being distinguished, and the purposes for which the taxonomy is intended. The first taxonomy of transnational health-care public goods indicates five alternative types of goods that capture many essential functions of transnational health activities. This scheme also permits institutional implications to be drawn concerning alternative allocative mechanisms.

1. Pure Public Goods

For each class in Table 1, the properties and four relevant transnational health-promoting examples are given, along with each class's efficiency and equity implications. Discovering a cure to a disease displays nonrival global benefits, because one country's application of the cure's procedure to its patients does not detract whatsoever from the benefits still available to other countries from applying the procedure.[3] Extending the knowledge of the cure to others

worldwide has negligible cost in today's digital age. Once the principles behind the cure are brought to light, their application by others is nonexcludable, provided these other countries have the requisite capacity to apply the cure. Similarly, uncovering basic research findings, from which other health-related breakthroughs of a clinical nature can follow, is nonrival and nonexcludable globally once announced to the research community.

Another transnational health-augmenting pure public good concerns curbing harmful pollutants. Efforts to reduce sulfur emissions represent nonrival and nonexcludable benefits to all downwind countries. Because sulfur emissions, once airborne, can travel upwards of seven days, their cleanup can have far-reaching external benefits – e.g., emissions from Europe can travel as far as Asia. Cleaner air provides respiratory relief to anyone in the pollutant's pathway. Such benefits are nonrival, in the sense that gains experienced from the healthier environment by people in one country does not detract from the benefits still available to people in other downwind countries. Moreover, no nation in the sulfur pollutants' pathway can be denied the benefits from the emission reduction. In the case of chlorofluorocarbons, reduced emissions have nonrival and nonexcludable health benefits globally by not worsening ultraviolet radiation exposure.

New treatment regimes or best practices also represent global purely public goods. Following development, their dissemination and use need not imply rivalry. Once these findings are made public, it becomes difficult to exclude others from applying the methods revealed. Even as they are developed and later applied by the originators, others quickly learn about the new procedures, and this knowledge can be rapidly spread with the Internet.

A primary implication of pure publicness has to do with the preference-revelation problem where a user is inclined to take advantage of the good's benefits without paying for them. In the absence of an exclusion mechanism, *free-riding* behavior is anticipated to be the

norm. Why should a nation spend scarce resources on something that it can get for free? Because there is no cost in extending the pure public good's benefits to additional consumers, access should be unrestricted. Provision can be anticipated to come from either the nation(s) with the largest potential gain or the richest nations that can best afford it (Olson, 1965; Sandler, 1992). In either case, there will be disproportionate burden sharing with one or a few nations shouldering the bulk of the burden. In the absence of such a "leader" nation, the supranational community would have to direct its resources to provide these purely public health-promoting activities. Even in the presence of a leader nation, the global community, as guided by the World Health Organization (WHO) or some other appropriate supranational body, may have to act to overcome the expected shortfall of supply. A leader nation is anticipated to include the benefits received by its citizens, and ignore those conferred on others when determining provision. The failure to account for these "spillover" benefits is likely to lead to a suboptimal supply.

When a supranational organization augments the supply of the purely public good through collective provision, its source of funding is a crucial consideration. The so-called *neutrality theorem* indicates that, when pure public good draws its finances from voluntary contributors and these contributors are made to support the collective provision, the latter then crowds out voluntary contributions on a dollar-for-dollar basis (Warr, 1983; Cornes and Sandler, 1985, 1996). This neutrality or crowding-out problem arises because one contributor's provision of a pure public good is a *perfect substitute* for that of the collective. Quite simply, increased provision, no matter how it is financed, *replaces* the need to contribute on one's own. To maintain their well-being, contributor nations, which are made to support a transnational pure public good through payments to a supranational organization, will merely reduce their voluntary support in relationship to their lost income, relying instead on public good supply from the organization. As a consequence, neutrality limits the policy options for increasing the supply of

purely public health activities. *Provision of such goods can be raised if funding is sought from or assigned to noncontributors*. Thus, funds coming from *some* nongovernmental organizations (NGOs) or charitable foundations may draw from sources, not previously involved with providing such health-promoting public goods, so that net increments in overall supply can follow. In the case of the Gates Foundation, a charitable organization is allocating philanthropic contributions from a $21.8 billion endowment to address diseases in developing countries. Because this money is supporting efforts to find cures for diseases ignored by tax-raised contributions from developed countries, neutrality-induced crowding out is not a concern.

Many less-developed countries (LDCs) and even developed countries do not possess the capacity to benefit from many purely public health goods, and this raises some distributional concerns that go beyond the efficiency questions addressed thus far. Just because the benefits are freely available, this does not mean that a country has the ability to take advantage of them. Many nations may not possess the appropriately trained doctors, the diagnostic equipment, or the properly fitted operating theaters to practice new procedures. To acquire these requirements, a nation may have to receive income or in-kind transfers from donor countries or the global community. Fairness and distributional concerns can be associated with any pure public good, but in the health area, they are particularly prevalent and poignant, since the well-being of entire nations and even regions may depend on their ability to use these pure public goods to foster a healthy population.

2. Impurely Public Goods

This is a large class of transnational health-promoting public goods that fails the pure public criteria either because there is some consumption rivalry or partial excludability of nonpayers, or both. At this juncture, exclusion is not complete or costless, so that club goods are specifically

left out of this category. The monitoring of borders or entry points (e.g., airports and train stations) for diseases involves partial rivalry, because surveillance thins as longer borders or more entry points must be protected with given resources.[4] Transnational concerns are involved with such surveillance, because failure to stem the advance of a disease at one border puts other countries at risk. Once AIDS left its African origin, it spread to the far reaches of the earth. Some degree of exclusion can be practiced in terms of where surveillance resources are deployed. In the case of disseminating research findings, nonpayers are only partially excluded, because one purchaser can make them available to a nonpurchaser without the provider's permission. Although exclusion is not complete, the benefits of these research findings are nonrival.

Finally, consider the actions to curb an epidemic through sterilization, quarantine, and treatment. Action concentrated in one place limits efforts that can be applied elsewhere, so that a clear rivalry is present. For a transnational epidemic, WHO must make a choice to concentrate its resources where marginal (additional) benefits are perceived to be the greatest if its resources cannot cover all infected areas. WHO achieves an optimal allocation of resources to curb an epidemic when the marginal benefits for all infected areas are equated, provided that marginal deployment cost is the same everywhere.

Even a small amount of rivalry may distinguish a global or transnational impure public good from a pure public good in terms of implications. Partial rivalry can make provision less than perfectly substitutable among units supplied. We have just seen that the returns to efforts to ameliorate a global epidemic through sterilization and treatment may depend on where these efforts are directed. For example, actions may have a greater payoff in urban centers, where people are more concentrated, than in rural areas. Without perfect substitutability, neutrality is less of a concern, implying that transnational taxes may be employed to provide the impure

public good without trading public for private provision on a one-for-one basis (Cornes and Sandler, 1996). The presence of rivalry also means that the size of the transnational group receiving the benefits may have to be restricted. Unlike a pure public good, the optimal sized consumer group is not all-inclusive in the presence of congestion cost. Some efficiency is sacrificed when exclusion is not perfect, so that a degree of free riding results.

Next consider an impure public health-promoting activity, which is transnationally *perfectly nonrival* but excludable, which may characterize efforts to *disseminate* research findings or improved clinical procedures. Only those nations will subscribe to such findings whose marginal willingness to pay (MWTP), which accounts for the financial means to express a preference, is at least as large as the price charged. Those potential subscribers, whose MWTP is greater than zero, but less than the subscription rate, are excluded. *If their consumption implies no cost to society owing to the absence of rivalry*, then including these agents can raise social welfare, as their positive benefits add to social welfare. This inclusion and enhanced well-being can be accomplished through support by charitable foundations, supranational organizations, bilateral aid, and NGOs.

3. Club Goods

If a health-promoting public good that serves people internationally is partially rival in terms of crowding, but nonpayers can be completely excluded at a negligible cost, then the activity is a transnational club good. Users can form a collective called a *club* to provide such goods (Buchanan, 1965; Sandler and Tschirhart, 1997).[5] Utilization rates of a club good can be carefully monitored, so that a *toll* or user fee is levied to reflect the crowding cost associated with using the shared good. Transnational health-promoting activities that are club goods include renowned clinics and hospitals, global medical communication networks, and technical

consultation networks. The Mayo Clinic has global reach in some of its medical procedures, which are sought after by foreigners and even world leaders. In Bogotá, eye clinics once served the residents of much of Latin America. Similarly, renowned cancer hospitals in Houston attract patients worldwide for treatment. For such transnational clubs, greater utilization by one member or user reduces the quality or quantity of the service available to others. In some cases, longer queues may form (e.g., longer waits to see specialists), while, in other cases, interference (e.g., for communication networks) or reduced service (e.g., less time with technical consultants over the Internet) may result. Nevertheless, some nonrivalry is present as the same facilities can serve a *variable* number of patients; hence, such facilities are club goods. These club goods are transnational, because the sharing of the goods' benefits involves users from many countries, who are excluded from the benefits unless a fee or toll is paid. There is no inefficiency in excluding a user who creates sufficient crowding costs that exceed the benefits that the marginal user associates with a visit.

Clubs account for their crowding through tolls and, in so doing, maintain the tie between benefits received and the charges levied on a member or user. The toll equals the crowding cost imposed on the membership that results from the marginal or last visit to the shared good. Although users pay the same toll per use, a member with a greater taste for the health good will use it more often, thereby paying more in total tolls. For example, a country sending more patients to the Mayo Clinic will have more hospital fees to cover, which can be paid by the patient or the sending country. A member nation will partake in the club good until its demand for the club matches the per-unit toll. The money collected from membership visits goes toward financing the provision of the shared good. If the toll mechanism is properly designed, then the club is often able to finance itself from the revenues collected.[6] When financing falls short, the difference can be made up with either a membership fee or else outside subsidies. At the

transnational level subsidies could be supplied by supranational organizations, NGOs, charitable foundations, or a rich nation. Within a region, nations can form a club to share medical teams that are dispatched to address epidemics when they arise. A member nation's share of the cost of the team depends, in large part, on how often it requires the team on its territory.

Unlike public goods, club goods require that membership be restricted based on the capacity of the shared good and the membership's tolerance for crowding or queuing. As a club for a health-promoting good closes off its membership, excluded nations can *form additional clubs* until the entire population of nations is accommodated in some optimal-sized club. If a shared health-promoting good has a limited capacity and waiting costs are very high, then there will be many small clubs, each with its own shared good. These clubs may be based on geographical considerations.

Insofar as clubs exclude nonmembers, there is a significant equity concern for those who do not possess the means to pay. This is especially worrisome for health-promoting club goods, where exclusion may result in dire consequences. At the transnational level, one solution would be foreign aid that allows a country to join such clubs to augment its citizens' health (Kanbur, Sandler, with Morrison, 1999). From an allocative viewpoint, it makes sense to rely on a club arrangement with its benefit-based charges that are easy to administer, while addressing the equity issue separately through income transfers.

4. Joint Products

From a health-care perspective, joint products represent one of the most prevalent and important classes of public goods. Joint products occur when a single activity yields two or more outputs that may vary in their degree of publicness. In particular, an activity may result in a pure public output, agent-specific private outputs, or a club good. When sharing surveillance intelligence on

epidemics, the nation doing the providing achieves country-specific benefits from being the first to assess a threat and by controlling what gets released, while the release also generates a transnational pure public good through facilitating the preparation of others that reduces health risks far beyond the provider's political borders. By immunizing its population, a country achieves a less contagious citizenry and a smaller incidence of the disease, while lessening the risk abroad. Teaching hospitals train a country's doctors and, at the same time, may develop novel clinical procedures or discover research breakthroughs that benefit the global community. Moreover, these hospitals train doctors drawn from countries worldwide and, in so doing, provide global spillovers. Even the deployment of health-care workers abroad has both a nation-specific output from in-the-field training and transnational pure public benefits from curbing the sources of contagion worldwide.

An important instance of joint products is the so-called *merit good, where equal access and consumption* benefits all of society. Merit goods are an instance where government involvement at the national or transnational level is justified to improve equity, because society values that a particular good should be consumed universally. Economists often characterize healthcare as a merit good (Bruce, 2001, pp. 280-281). For a merit good, a nation's consumption is a private good, while the benefits derived by the global society from the enhanced equity that follows from extending the good's benefits to other nations is a global pure public good.

Nation-specific benefits serve an essential preference-revelation role; these benefits perform a "privatizing" role that motivates nation-based contributions. Thus, a joint-product activity encourages contributions, owing to the nation-specific benefits that can only be acquired through a nation's own provision efforts. If the nation-specific benefits from a joint product are best consumed along with the jointly produced purely public benefit, so that one component of the activity augments the satisfaction derived from the other, then the joint outputs are

complementary. In this case, the spillovers of the purely public benefits may induce further rather than less provision on behalf of the benefit recipient. Optimality with respect to health-promoting joint products hinges *on the ratio of excludable benefits* (i.e., private plus club good benefits) *to total benefits*, derived from the activity. As this ratio approaches 1, all benefits are excludable and so can be efficiently allocated by markets and clubs. This is the scenario where equity is a particular concern, because nations with limited income will be excluded by markets and clubs and will require some assistance from the global community for those health activities deemed essential for them to consume. If, in contrast, this ratio approaches 0, so that the share of benefits are increasingly purely public, then the activity is anticipated to be undersupplied, leading to the need for outside intervention by multilaterals, NGOs, and charitable foundations.

These institutions may, of course, have their own political agenda that can limit the organization's effectiveness in redressing the undersupply of transnational public goods. For example, a multilateral may be heavily influenced by its largest contributors. NGOs may also be driven by specific interests, while a charitable foundation is largely directed by a board of trustees. While recognizing these obstacles to efficiency, we focus on the role that these diverse institutions can potentially play in providing undersupplied health-promoting public goods when incentivies for voluntary provision is perverse.

5. Private Goods

In stark contrast to a pure public good, a transnational private good possesses completely rival benefits that are excludable among nations at virtually no cost. Many health-care activities are transnationally private, including medicines and vaccines for noncommunicable or endemic diseases, where a unit of the good given to one patient is a unit less for someone else. Other examples are diagnostic tests and the spraying for disease-carrying pests (e.g., mosquitoes). In

the case of spraying, the resulting benefits of a pest-free environment may be public to the nation, but private among nations – i.e., generating little or no transnational benefits. Markets function to direct resources to their most valued use, so that efficiency is not a problem unless the market is imperfectly competitive or made so by patent protection. Equity is, however, a major issue, which is only too evident when one sees the plight of millions infected with the HIV virus in Africa and their inability to afford the anti-retroviral treatments that inhibit AIDS symptoms.

III. A THIRD PROPERTY OF PUBLICNESS: AGGREGATION TECHNOLOGIES

When transnational health-care activities are investigated, the manner by which the provision efforts of the nations determine the global level of the public good – the technology of public supply aggregation (henceforth, the *aggregation technology*) – is an essential consideration. The aggregation technology is a means for further subdividing pure and impure health-promoting public goods as well as joint products into subcategories, whose prognosis for efficiency and the need for public policy at the transnational level hinges on the underlying aggregation. Until this dimension came along, pure publicness was synonymous with suboptimality and the need for intervention, but this is no longer the case.

1. Summation

Table 2 indicates six alternative aggregation technologies, along with examples of each, provision prospects, and public policy implications for transnational health-promoting public goods. Prior to 1983, public goods were always assumed to abide by a summation technology, for which individual provisions are merely added up together to find the aggregate level of the public good available to recipients. With summation, each contributor's effort is perfectly

substitutable for that of another, so that the marginal impact of a unit of provision is independent of which nation provides it. The top row of cells in Table 2 lists four examples. A population's awareness and knowledge of a disease cumulate with overall educational actions; the global community's stock of knowledge is the sum of national and international collective action to educate. A reduction in the incidence of a disease responds to the total efforts expended to curtail the disease's spread. A global assessment of health risks corresponds to the sum of national and international actions to monitor the foothold of an illness. In addition, the global level of medical aid administered to victims during adversities (e.g., armed conflicts, epidemics, and natural disasters) equals the sum of aid contributed on the part of nations, charitable foundations, and other institutions.

When a pure public good is matched with a summation technology, the underlying incentives to act are usually those of the Prisoner's Dilemma, for which the best individual strategy is to free ride (Olson, 1965; Sandler, 1992). For identical nations, things are not promising as nations sit back until one of them takes the lead. When potential contributors differ according to income, the rich nations are anticipated to underwrite the transnational provision. For this case of transnational health-promoting public goods, there is a clear role for multilateral organizations and NGOs to support provision, thus making up for suboptimal national contributions.

2. Weighted Sum

A generalization of the summation technology is that of a weighted sum, for which differential weights are attached to each provider's efforts *prior* to summing. If, for example, country *A* is twice as effective as other countries in providing technical assistance, due to a higher level of human capital embodied in its advisors, then a weight of two is required to apply to country *A*'s

efforts. Reducing transnational air pollution is a weighted-sum technology, because depositions downwind depend on an emitter's size and position along with the prevailing winds (Sandler, 1998). The percentage of an emitter's pollutants that falls on others depends on these considerations. Similarly, efforts to augment the global pool of health-care workers or to remove toxins from the environment are anticipated to relate to who is doing the contributing or where it is being done. A fourth example of weighted sum involves the global spread of AIDS, for which West and Sub-Saharan Africa contribute proportionally more to the total of new infections than do the United States and Eastern Europe. The same number of cases in different regions has different impacts on new cases owing to education, culture, and sexual practices, so that different regional weights on existing diseased individuals must be used to project the epidemic.

Incentives to provide these transnational health-promoting public good may now be different, because one nation's efforts are *not* substitutable for another's actions when the weights are not all one. If a large percentage of a supplier's actions are self-enriching (e.g., most of the pollutant reduction benefits the provider's own environment), then a nation may be properly motivated to act. Conversely, if those countries with the highest weights are poorest (e.g., AIDS in Africa), the underprovision problem worsens. Thus, the need for international intervention must be addressed on a case-by-case basis. To achieve the greatest impact, income redistribution should favor those with the largest weights or marginal impact on the public good's aggregate level. By eliminating the perfect substitution among providers' actions, the weighted-sum technology is not necessarily plagued with neutrality, where transfer-induced contributions are undone by offsetting cutbacks by those financing the transfers through taxes.

3. Weakest-link Public Goods

In the study of health, the weakest-link aggregation technology is especially pervasive. For this

technology, the smallest contribution determines the overall level of the global or transnational public good. Suppose that nations confronted with the spread of a pathogen or pest take steps to close off their borders. The ability to stop the global diffusion depends on the country that expends the smallest effort, since it is there where any passage will occur. Similarly, the overall success of global measures to eradicate a disease hinges on the country that does the least. Despite the drive and means to eradicate polio with mass vaccination programs in much of the industrial world, the disease persisted because of the much smaller actions taken elsewhere. Surveillance of outbreaks, which allows for rapid reaction to isolate the disease before it spreads, also abides by a weakest-link technology. This means that within nations and regions, rapid responses to outbreaks are largely dependent on the least adequate monitoring efforts. When India abandoned its bubonic plague (yersina pestis) surveillance program in 1987 (Garrett, 2000, p.19), it made India vulnerable to a wider spread of the 1994 outbreak. Another weakest-link example involves the sharing of medical information in a transnational network where the least adequate parts influence the overall effectiveness of the arrangement.

When a weakest-link public good is present, *matching* behavior is anticipated, in which nations supply only as much as the smallest contribution. This follows because larger contributions use up scarce resources without augmenting the level of the public good. If the relevant group of countries is homogeneous in tastes and income, then suboptimality should not be as much of a concern as each country desires similar levels of protection and are strongly motivated to copy one another's efforts. Free riding is not a worry when nations have the financial resources to support the health-promoting weakest-link public good.[7] A problem, however, arises when some LDCs do not have the assets to achieve an acceptable standard of provision and the failure puts other countries at too high of a risk. If this is the case, then there are two options for the global community. Rich nations can provide the weakest-link public

good on these inadequate suppliers' territory through vaccination programs, surveillance teams, technical assistance, or medical aid. In the absence of a rich nation, donor institutions can provide the shortfall. Partnerships among diverse agents can also provide these weakest-link public goods (see Section IV). A second option is for donor countries or institutions to bolster the income of these LDCs so that they can afford such goods.

Which of these two strategies – in-kind or income transfers – is best hinges on the *relative price* of the weakest-link activity in the donor and recipient countries (Jayaraman and Kanbur, 1999; Vicary and Sandler, 2002). When a donor possesses a comparative advantage in the activity, an in-kind transfer is a more efficient use of resources. Foreign aid from donor institutions in the form of disease-preventing assistance is an easy political sell in the donor country whenever there exists a possibility for contagion from abroad. In cases of noncommunicable or nonthreatening diseases, the potential (rich) donor countries are likely to have no interest in providing the assistance. When an in-kind transfer appears best, there is a dynamic issue that must be addressed. If the weakest-link public good is provided for LDCs by developed countries without building up the recipient countries' capacity to provide such goods on their own, then LDCs' reliance will never end.

4. Weaker-link Public Goods

As its name implies, transnational weaker-link public goods of a health-promoting variety are a less extreme case of weakest-link, since for the former there are some marginal gains from exceeding the smallest national provision level. For weaker-link public goods, the smallest contribution has the greatest influence on global or transnational provision, followed by the second-smallest contribution, and so on (Arce and Sandler, 2001; Cornes 1993). When some pests are eradicated, a country can achieve a greater pest-free environment when it exceeds the

efforts of its least diligent neighbors. Nevertheless, such a country still has a pest problem to contend with, owing to these smaller actions of its neighbors. Another instance is the collection of vital health statistics for a transnational data base, where one country's greater diligence may prepare it better than another less vigilant country to contend with transnational health contigencies. Nevertheless, these smaller provisions still have a disproportionately large impact on benefits received from such collections. Maintaining sterilization in hospitals and clinics also abides by weaker-link, because a greater effort by a country beyond the minimal level achieved by the collective of countries *adds* to the overall sterilization achieved globally, but not by as much as augmenting this minimal level. A fourth instance is port-of-entry quarantine, where nations that achieve a greater cordon bolster the effectiveness of the global quarantine beyond that determined by the smallest effort. Nevertheless, this shoddiest national effort is the greatest single determinant of the level of global containment. Another weaker-link public good is antimicrobial resistance. National efforts to curb the abuse of antibiotics use domestically will prolong the lag phase of resistance beyond that determined by the least global effort to curtail this abuse.

Under weaker-link public goods, the trend toward matching behavior is attenuated with some countries motivated to provide more than others if they perceive sufficient additional benefits from doing so. Which country is to do more presents a coordination problem (Arce and Sandler, 2001). There are many incentives not to free ride, so that policy intervention must again be directed at those nations that fall well below provision norms for the transnational community. Given that supplying more on one's own soil can make up some of the shortfall, there may be somewhat smaller inducements to achieve acceptable standards globally or regionally. When assistance is required, one must turn to well-endowed nations, multilateral institutions, and other funding entities to provide the means for bringing up the provision

laggards.

5. Best-shot Public Goods

Health-promoting global and transnational public goods of the best-shot variety have their aggregate provision levels fixed by the largest single supply effort. Levels below the maximal add nothing to the amount of the public good available for world consumption. When finding a cure for AIDS, malaria, or Ebola, the research team expending the greatest effort is most apt to meet with success that benefits all countries at risk, now and into the future. Once a cure is uncovered, other efforts may be redundant and achieve very little. Isolating a new bacteria or virus also abides by a best-shot technology. Similarly, the development of a diagnostic procedure is a best-shot public good where the largest effort is likely to met with success and other procedures are redundant once a reliable one is uncovered. The same is true for recent efforts to map the human genome; once mapped, other efforts do not add further benefits.

For some best-shot public goods, suboptimality may be particularly acute, when the overall provision level, and not just surpassing a threshold, matters. This may be the case for basic research and justifies public support by the National Science Foundation and the National Institutes of Health (NIH). A single supplier is not anticipated to account for the benefits conferred on others in the form of benefit spillovers. *If*, however, *exclusion can be practiced after the discovery* through a patent and the subsequent marketing of pills, vaccines, or treatment regimes, then suboptimality is less of a concern, *but equity becomes an issue*. When, however, incentives for such breakthroughs are removed, such discoveries will be less frequent, implying that governments will have to support or engage in the research.

When a single provider is needed, it may be either a research team in a nation that has sufficient resources, or a group of researchers drawn from a set of nations that pools its

resources. In either scenario, efforts must be coordinated. If efforts are combined into a research collective, then, once again, coordination is needed to achieve the requisite sharing of tasks among the researchers. When potential contributors have equal likelihoods of success, independent efforts in a contest environment may be more fruitful unless combining their efforts sufficiently augments this success probability. When research teams differ in their capabilities, best-shot public goods call for resources to flow to the team or nation best able to supply the good. Competitive grants or a research university's past successes are used by funding institutions (e.g., NIH) to identify the best research team to support. In the medical research area, there is a rationale for well-endowed resource centers.

6. Better-shot Public Goods

Better-shot is the less extreme form of the best-shot public good, in which provision below the largest level can still add to the aggregate level of the health-promoting public good. For this technology, the largest provision has the greatest impact on overall supply, followed by the second-largest provision, and so on. Specialized facilities – e.g., Biohazard Level-4 (BL-4) laboratory for studying extremely infectious diseases – is a better-shot global public good. It is essential to have backup BL-4 laboratories in case the prime laboratory becomes contaminated or exigencies require capacity beyond that of the best facility. Another instance concerns the development of the polio vaccine, where the less-preferred Sabin oral vaccine added to the overall protection provided by the more-preferred Salk vaccine. This occurred because these vaccines worked differently to produce the immunity. The discovery of multiple antibiotics targeted to the same kinds of bacteria has provided second-lines of defense as bacteria acquired immunity over time to the preferred antibiotic.

With better-shot goods, there is apt to be multiple suppliers and this may curtail

suboptimality as compared with a best-shot public good as more interests are represented. If exclusion can be practiced for a particular better-shot good, then incentives exist even for additional finds (efforts) of a lesser kind. Of course, these lesser discoveries will capture less of the market (e.g., cheaper but less effective antibiotics), so that the number of such multiple suppliers is anticipated to be small. The need to concentrate resources is less than for best-shot goods, owing to these secondary, but useful, additional benefits provided by the smaller supply levels. In allocating resources to support a better-shot public good, there is a strong rationale for resources to flow to those *potential suppliers* with the greatest likelihood of success, but some secondary prospects should also be supported. Coordination of effort, while not as important as for best shot, is still desirable.

IV. INSTITUTIONAL PLAYERS AND GLOBAL HEALTH-PROMOTING PUBLIC GOODS

In the previous sections, collective support for health-promoting transnational public goods is required in a number of scenarios – e.g., when these goods are purely public, or impurely public and nonexcludable. If joint products characterize the health-promoting activities and there is a relatively low ratio of excludable to total benefits, then collective action may also be required. A summation technology bolsters substitutability and free-riding behavior, so that the associated health-promoting public good may be undersupplied. In the case of a weakest-link technology, transnational collective action might be required when some nations have inadequate capacity to meet an acceptable provision standard – e.g., insufficient surveillance of disease outbreaks. Transnational collective action might also be needed when resources must be focused to surpass provision thresholds for some best-shot, health-promoting public goods.

A variety of nation-based institutions, private foundations, NGOs, multilaterals, and partnerships have developed to bolster transnational public goods for health. A selection of these

institutions under these five categories is given in Table 3 along with their function and provision activity. At the national level, the US Centers for Disease Control (CDC), the French Pasteur Institute, and the US NIH have global reach. CDC maintains a global health-promotion program that advises countries on issues ranging from vaccination schemes and infrastructure development to providing communicable disease surveillance (McQueen, 2000). The Pasteur Institute focuses on infectious diseases and plays a leading role in AIDS research. NIH, which is supported by taxes and patent royalties, is also a leader in AIDS and other infectious diseases research. In funding extramural research at major universities and medical schools, NIH is consciously trying to finance best-shot public goods. All three institutions produce global joint products by providing aid in the form of field teams dispatched to the sites of epidemics to identify the cause, chart out the disease progress, and halt its spread. Joint products result from the local public good at the point of the outbreak (e.g., stopping the disease) and the knowledge-gained global public good. Finally, these institutions can provide a weakest-link public good in the form of a health-care infrastructure for countries with insufficient resources to keep diseases from gaining a foothold.

A second institutional category consists of private foundations that fill the gap between funding and global health priorities. Examples include the Wellcome Trust, the Gates Foundation, the Rockefeller Foundation, and the Open Society Institute. The lack of political restrictions on such foundations enables them to be an important player for coordinating global efforts, especially with respect to orphan diseases and purely public health activities. Britain's Wellcome Trust – the world's biggest medical charity – is not even accountable to donors. The Trust's single biggest project is its funding into the sequencing of the human genome, a best-shot global public good.

The independent Gates Foundation focuses its attention on diseases in the developing

world in an effort to revitalize initiatives and provide credible signals of the importance of a problem through its start-up funding for best-shot and weakest-link public goods. For example, its Children's Vaccine Program has targeted the worldwide development and delivery of vaccines to achieve universal immunization against preventable childhood (respiratory, diarrhea, and liver) diseases. This effort brings all countries up to an acceptable standard of immunization.

The Open Society Institute (part of the Soros Foundation Network) has a program that concentrates on drug-resistant tuberculosis. This project, joint with WHO and Harvard Medical School, further indicates the potential of foundations as global coordinators. Another example is the Rockefeller Foundation, which has underwritten advancements that include the development of a Yellow Fever vaccine and the eradication of hookworm (*Fund Raising Management*, 2000). The Foundation has recently redefined its mission around the concept of global *merit goods*. In the end, foundations represent an important means of circumventing the neutrality theorem, because they attract funding, not previously involved with global public health donors.

NGOs, like private foundations, support underprovided health-related public goods through new sources of funds. Médecins Sans Frontières (MSF) is the largest NGO providing aid for victims of armed conflicts, epidemics, and natural disasters. MSF derives its funding from public donations, and also accepts support from foundations, thereby sidestepping the neutrality theorem through the creation of a new set of donors. Through its disaster relief, the Red Cross/Red Crescent provides joint products by curbing the spread of diseases following disasters or conflicts. The Cooperative for American Relief Everywhere (CARE) is more directly involved with issues of global public health. In addition to supplying services for disaster relief, CARE attends to the immunization of children worldwide and to the building of public health infrastructure (e.g., wells, latrines). CARE also provides training for health-care

workers, who are later deployed to assist in remote areas. Such workers provide transnational joint products by treating patients while limiting the spread of diseases.

The best-known providers of global health-promoting public goods are multilateral institutions, which allocate pooled funds to provide capacity building for health-promoting weakest-link and best-shot public goods. The World Bank, for example, currently sees itself as a 'knowledge bank,' for providing best practices as a global public good. WHO has a comparative advantage in biomedical expertise, and faces tighter budget constraints that limit the delivery of its knowledge. A pairing between the World Bank and WHO is potentially complementary; however, any duplication of services is wasteful. In partial contrast to the Bank, the UN Development Program (UNDP) provides weakest-link health activities through field projects.

Our final category is *public-private partnerships*, a new avenue for the delivery of global health-promoting public goods that may involve any or all of the institutions in Table 3. A visible example of a public-private partnership targets river blindness (onchocerciasis), which is endemic in 34 countries in Africa, and elsewhere in Latin America and the Arabian Penninsula. In 1988, Merck gave a push to the efforts of WHO to control this disease by pioneering a new strategy; Merck agreed to give away the drug Invermectin (Mectizan) in order to provide mass community treatment to at-risk populations.

Stemming from the Roll Back Malaria initiative of the WHO, the Medicines for Malaria Venture (MMV) is another example of the potential of public-private partnerships. The MMV is now an independent non-profit foundation that provides funding incentives for public-private partnerships between pharmaceutical companies, academic groups, and public agencies for the development of new medicines, treatments, and prevention regimes. Products generated from these partnerships are contracted out for manufacture and commercialization. MMV recognizes the excludability aspects of drug development and patents, as well as the nonrivalry properties

that knowledge of a cure embodies. Funding is focused on a limited number of projects, consistent with the best-shot nature of finding a cure.

The INBio partnership between Merck and the Costa Rican government underscores that diverse agents can combine to provide a push to the best-shot activity of finding new cures through bioprospecting.

V. FURTHER POLICY RECOMMENDATIONS

There are several issues related to global public goods for health that do to fit easily into our taxonomy, and we address them here. For example, many health issues involve intergenerational aspects, given that policies that limit or even eradicate a disease today can benefit far-distant generations who are not around today to influence provision decisions (e.g., research on new antibiotics). If long-term efficiency is to be fostered, then spillovers to the yet unborn must be included in the estimation of the benefits when allocating resources to global health-promoting public goods. The presence of foundations and multilateral organizations that take a long-run viewpoint may steer nations and other agents, with more myopic horizons, to not lose sight of future generations. The responsibility to the future is especially germane when a decision today either closes out options in the future (e.g., the extinction of a species may lose an important genetic code, abuse of antibiotics may limit their effectiveness), or else is irreversible (e.g., the release of a pathogen). Intertemporal public good spillovers are not necessarily taken into account through enhanced spatial awareness; i.e., the inclusion of the benefits received by residents in a neighbor country is not the same as those to be received two generations hence. This type of farsightedness is unlikely to be expected in practice (Sandler, 1978, 1999). Altruism toward the future generations must somehow be introduced into a political system with short-lived constituencies who demand rapid payoffs from health-promoting activities.

Patent arrangements must not only provide incentives for drug companies to invest fully in the development of new cures and treatments, but must also permit wider dissemination of the drugs even to some who cannot typically afford them. Such actions protect everyone's safety, both rich and poor. Recent actions by Merck and other companies to slash prices for their AIDS-fighting drugs in Africa is an attempt to introduce a two-tier pricing for the haves and the have nots (*The Economist*, 10 March 2001, pp. 43-44). This generosity on the part of the pharmaceutical companies may, however, be largely driven by South Africa's willingness to ignore patents by allowing generics at substantially lower prices. For deadly diseases, especially those that affect the developed world, these life-saving drugs can be made available through price cuts to LDCs and subsequent purchase, funded by multilateral organizations and other donors. Residents in developed countries also underwrite the price cut either through higher prices or even possibly an extended patent period.

Another policy concern is the need for an *international "orphan drug act"* for developing drugs that impact a sufficiently impoverished population whose demand is insufficient to underwrite the large fixed cost of R & D. This orphan drug issue is a particular problem of diseases that are neither endemic to developed countries nor a communicable threat to the rest of the world. For LDCs, the low level of effective, but inelastic, demand arises from a lack of income, not from the low numbers infected. The development of a transnational orphan drug program is justified based on a merit good rationale.

At the transnational level, a system is needed to establish priorities for drug availability, research focus, and burden sharing. Issues concern not only drug development, but also aggressive stances against diseases. Such questions involve both allocative efficiency and distributional aspects of global health-promoting public goods. The requisite coordination is particularly difficult given the large number of interested parties drawn from diverse levels

within and among nations. When incentives work well to motivate exchanges, the resulting markets and clubs will exclude individuals leading to distributional problems. If, in contrast, markets do not operate, then efficient allocation is a concern with free-riding problems surfacing. Any coordination today must come from either a couple of dominant nations, whose interests are focused on their own agenda, or a multilateral organization, which must act on some kind of consensual basis.

VI. CONCLUDING REMARKS

This paper has served some modest, but important, goals. First, it has displayed two alternative taxonomies for classifying global health-promoting public goods. One is based on the two classic publicness properties of nonrivalry of benefits and nonexclusion of nonpayers, while the other is based on the aggregation technologies. These two schemes can by synthesized into a single taxonomy, where the aggregation technologies can be applied to further subdivide each class of public goods in the first classification scheme. Thus, a pure public good can be further broken down according to the six aggregate technologies. The rich array of global health-promoting public goods means that *institutional designs and policies must be sufficiently tailored to reflect the underlying public good's properties*. Second, both allocative and distributional aspects of these diverse public goods have been addressed. Equity can be fostered by multilateral organizations, donor countries, NGOs, and charitable foundations. Efficiency should be promoted even if inequality results, because equity can be improved with a second set of policies. Third, the rich array of private-public institutions and their role in pursuing health-promoting public goods has been examined. Novel forms of these organizations include the public-private partnerships that tie together diverse players to develop, fund, and provide new drugs and treatments for diseases of the developing world. There are many essential players that

go beyond the nation-state and that can offer much to address the exigencies posed by AIDS, malaria, river blindness, and other diseases.

Using a public good framework, this paper has indicated the need for international cooperation in some, *but certainly not all*, areas concerning the provision of global health-promoting public goods. By distinguishing among diverse such public goods, we are able to identify when international cooperation is essential and which institutions should play a role. Equally important, there are many instances where no cooperation is required, because nations face the right incentives for voluntarily providing the public good (e.g., some weakest-link public goods). To conserve scarce resources, it is essential that resources and funds be only directed to where the problem is not self-correcting.

Footnotes

* Sandler is the Robert R. and Katheryn A. Dockson Professor of International Relations and Economics, University of Southern California; Arce is the Robert D. McCallum Professor of Economics and Business, Rhodes College. The project was funded in part by a grant from the Institute for Global Health, University of California, San Francisco and Berkeley. We have profited from comments by Inge Kaul and an anonymous referee on an earlier draft. All views expressed are solely those of the authors.

1. The term "public" is reserved for goods with some degree of nonrival and nonexcludable benefits. Public does not refer to how the good is provided.

2. In his introduction to this dimension of publicness, Hirshleifer (1983) labels it as the *social composition function*. Arce (2001) refers to it as the *contribution aggregator*.

3. This is not true for the use of antibiotics to cure a bacterial-based infection, since antibiotic use can reduce its effectiveness over time as bacteria acquire immunity. Even the use (misuse) of anti-retroviral treatments to curtail AIDS symptoms can allow the bacteria to acquire immunity. The failure to use these drugs properly in Africa may have long-term global consequences; thus, there is a rivalry of an intergenerational nature (Sandler, 1978).

4. Surveillance cost savings can result if nations form coalitions to sequester interior borders so that efforts can be focused on exterior perimeters (Arce and Sandler, 2002).

5. Clubs can be privately owned and operated (e.g., the Mayo Clinic) or can be formed by the members.

6. Financing depends on the form of the crowding relationship and the nature of the production function for the shared good (Cornes and Sandler, 1996).

7. On the strategic aspects of weakest-link and other technologies, see Sandler (2002) and Sandler and Sargent (1995).

References

Arce M., D. G. (2001), 'Leadership and the aggregation of international collective action', *Oxford Economic Papers*, vol. 53, pp. 114-131.

— and Sandler, T. (2001), 'Transnational Public Goods: Strategies and Institutions', *European Journal of Political Economy*, vol. 17, pp. 493-516.

— and — (2002), 'Health-promoting alliances: a cooperative-game approach', unpublished manuscript, Rhodes College, Memphis, TN.

Beaglehole, R. and McMichael, A. J. (1999), 'The future of public health in a changing global context', *Development*, vol. 42, pp. 12-16.

Berlinger, G. (1999), 'Health and equity as a primary global goal', *Development*, vol. 42, pp. 17-21.

Bruce, N. (2001), *Public Finance and the American Economy*, Reading, MA: Addison-Wesley.

Buchanan, J. M. (1965), 'An economic theory of clubs', *Economica*, vol. 32, pp. 1-14.

Cornes, R. (1993), 'Dyke maintenance and other stories: some neglected types of public goods', *Quarterly Journal of Economics*, vol. 108, pp. 259-71.

— and Sandler, T. (1985), 'The simple analytics of pure public good provision', *Economica*, vol. 52, pp. 103-16.

— and — (1996), *The Theory of Externalities, Public Goods, and Club Goods*, 2nd Ed., Cambridge: Cambridge University Press.

Economist (2001), 'A war over drugs and patents', *Economist*, March 10, vol. 358, pp. 43-4.

Fund Raising Management (2000), 'Rockefeller foundation announces new global mission', *Fund Raising Management*, vol. 30, p. 12.

Garrett, L. (2000), *Betrayal of Trust: The Collapse of Global Public Health*, New York: Hyperion.

Hirshleifer, J. (1983), 'From weakest-link to best-shot: the voluntary provision of public goods', *Public Choice*, vol. 41, pp. 371-86.

Jayaraman, R. and Kanbur, R. (1999), 'International public goods and the case for foreign aid', in I. Kaul, I. Grunberg, and M. A. Stern (eds.), *Global Public Goods: International Cooperation in the 21st Century*, New York: Oxford University Press.

Kanbur, R, Sandler, T., with Morrison, K. (1999), *The Future of Development Assistance: Common Pools and International Public Goods*, Washington, DC: Overseas Development Council.

McQueen, D. (2000), 'Guru promotes global health', (interview), *British Medical Journal*, vol. 320, p. 1164.

Olson, M. (1965), *The Logic of Collective Action*, Cambridge, MA: Harvard University Press.

Sandler, T. (1978), 'Interregional and intergenerational spillover awareness', *Scottish Journal of Political Economy*, vol. 25, pp. 273-84.

— (1992), *Collective Action: Theory and Applications*, Ann Arbor, MI: University of Michigan Press.

— (1997), *Global Challenges: An Approach to Environmental, Political, and Economic Problems*, Cambridge: Cambridge University Press.

— (1998), 'Global and regional public goods: a prognosis for collective action', *Fiscal Studies*, vol. 19, pp. 221-47.

— (1999), 'Intergenerational public goods: strategies, efficiency, and institutions', in I. Kaul, I. Grunberg, and M. A. Stern (eds.), *Global Public Goods: International Cooperation in the 21st Century*, New York: Oxford University Press.

— (2002), 'On financing global and international public goods', in M. Ferroni and A. Mody (eds.), *International Public Goods: Incentivies Measurement, and Financing*, Dordecht,

NL: Kluwer.

— and Sargent, K. (1995), 'Management of transnational commons: coordination, publicness, and treaty formation', *Land Economics*, vol. 71, pp. 145-62.

— and Tschirhart, J. (1997), 'Club theory: thirty years later', *Public Choice*, vol. 93, pp. 335-55.

Vicary, S. and Sandler, T. (2002), 'Weakest-link public goods: giving in-kind or transferring money', *European Economic Review*, vol. 46, forthcoming.

Warr, P. G. (1983), 'The private provision of a public good is independent of the distribution of income', *Economics Letters*, vol. 13, pp. 207-11.

Table 1. Taxonomy of Global and Transnational Health-Promoting Activities Based on Benefit Rivalry/Excludability

Class of Good	*Properties*	*Examples*	*Implications/Remarks*
• **pure public**	nonrival benefits nonexcludable benefits	• discovering a cure • uncovering basic research findings • curbing harmful pollutants with significant transnational reach • developing treatment regimes	Preference-revelation problem in terms of free riding. Because there is no cost to extending benefits, access to the good should be unrestricted. Suboptimal provision with disproportionate burdens placed on the rich nations or those with greatest preference. Neutrality property limits policy options. Equity issue over access.
• **impurely public**, but not a club good	partially nonrival and/or partially nonexcludable	• monitoring disease entry points • disseminating research findings • curbing epidemics	Because exclusion is not complete, some suboptimality is anticipated with any allocation mechanism. There may be more incentives to support provision owning to partial exclusion and lack of substitutability. Neutrality is less of a policy concern. Must judge whether inefficiency warrants some form of intervention.
• **club good**	excludable, but partially rival in terms of crowding (congestion)	• sharing of clinics/hospitals with global reach (e.g., Mayo) • communication network • technical consultation network via the Internet	Voluntary clubs can charge each use according to associated incremental crowding costs. Tolls not only internalizes the crowding externality, but also can self-finance the good under some circumstances. For a large number of nations, multiple clubs can accommodate all. Equity concerns.
• **joint products** (includes merit goods)	multiple outputs which can vary in their degree of publicness	• sharing surveillance data • immunizing populations • teaching hospitals • deploying health-care workers abroad	The extent of suboptimality depends on the ratio of excludable to total benefits. As this ratio goes to one, markets and clubs can efficiently allocate resources. However, as this ratio approaches zero, the activity becomes more purely public and intervention is needed. Equity is a worry in either case.
• **private** (marketable) **goods**	rival and excludable benefits	• medicines and vaccines • diagnostic tests • spraying for disease-carrying pests	Markets operate so that resources are directed to their most valued use. Developing countries will lack the means to purchase some of these goods. Remedies and medicines most suited to those countries will not be developed and sold. Equity concerns and the need for new institutions – e.g., partnerships – to address discovery, production, and distribution of such goods.

Table 2. Alternative Aggregation Technologies of Public Supply for Global and Transnational Health-Promoting Public Goods (TPGs)

Supply Technology	*Examples*	*Provision Prospects*	*Public Policy Implications*
• **Summation**: overall level of public good equals sum of individual contributions.	• educating a people about a disease • curbing incidence of disease • assessing health risks • medical aid during adversities	Likely contribution by richest nations. Underprovision with a need for public intervention at a supranational level. Prisoner's Dilemma outcomes anticipated with much free riding.	Supranational coordination or provision needed. Taxes or mandated contributions aimed at noncontributors, if feasible. A role exists for multilateral organizations and NGOs to support provision.
• **Weighted sum**: each agent's contribution can have a different additive impact on the overall level of the public good.	• providing technical assistance abroad • reducing harmful transboundary air pollutants • removing toxins from shared environments • spread of AIDS	A wide variety of outcomes are possible with varying degrees of suboptimality. If provider receives a lion's share of its generated benefits, then it may be sufficiently motivated to act. Spillover patterns determine provision.	Need for intervention must be on a case-by-case basis. Some health-promoting TPGs may need no boost, while others will need assistance depending on the weights. Limited substitutability. Redistribution to favor contributors.
• **Weakest-link**: only the smallest effort determines the overall public good level.	• prophylactic measures to limit a disease's domain • eradicating a disease • surveillance of an outbreak • sharing information in a network	Matching behavior, where the smallest effort is mimicked. Suboptimality is expected to be less of a problem, especially when participants are more homogeneous.	If the standards met by the poorer nations are inadequate, rich countries may have to augment the poor's effort. NGOs and multilaterals may assist. Easy political sale for constituency in providing country.
• **Weaker-link**: smallest contribution has the greatest marginal influence, followed by the next smallest, and so on.	• eradicating a pest • collecting vital statistics for transnational data base • maintaining sterilization • port-of-entry quarantine	Some equilibrium behavior involves matching behavior, while others do not. Unequal contributors with some agents doing somewhat more than others. Some coordination may be required.	Less need for public policy. The need for matching behavior is less pronounced. When assistance is needed, a small subset of nations may require help from those who are better endowed.
• **Best-shot**: only the largest effort determines the overall public good level.	• finding a cure for a disease • isolating a bacteria or virus • developing a diagnostic procedure • human genome mapping	A sole provider is anticipated. Earnings from the discovery can support efforts. Suboptimality may or may not be a problem, depending on whether the good can be continuously varied.	Concentrating resources where there is expertise. Severely restrict the number of research groups. Coordination needed. Resources flow to agent best able to address problem.
• **Better-shot**: largest contribution has the greatest marginal influence, followed by the next largest, and so on.	• Providing specialized facilities (e.g., BL-4 laboratory) • polio vaccine discovery • discovering new antibiotics	Suboptimality is likely to be curtailed compared with best-shot. Multiple providers are anticipated. Incentives exist if can charge for breakthroughs.	Concentration of resources is less than in best-shot. Some coordination may still be required. Resources flow to agents with greatest likelihood of success.

Table 3. Institutional Structures

Institutions	*Examples*	*Functions*	*Provision Assessment*
• **Nation-based with global reach**	• CDC • Pasteur Institute • NIH	• outbreak surveillance, promote global health • research on infectious diseases • funding research, epidemic surveillance	These organizations provide joint products with global consequences, particularly for communicable diseases. Can foster best-shot and weakest-link public goods for health.
• **Private Foundations**	• Wellcome Trust • Gates Foundation. • Open Society Institute, Rockefeller Foundation.	• funding, research • funding, prioritizing, and leadership • leadership, disease, and needs forecasting	Budgets can rival largest health-specific multilaterals. New form of global coordinator because of lack of political restrictions. Provide best-shot and weakest-link health-promoting transnational public goods. Avoids neutrality theorem.
• **NGOs**	• Médecins Sans Frontières (MSF) • Red Cross/Red Crescent • CARE	• treating the ill in poor countries • disaster relief/medicine provision worldwide • public awareness programs, disaster relief, and donor intermediation	Becoming an increasing important player in globalized economy. Serves an important charity function and provision of global public goods. Neutrality theorem circumvented.
• **Multilaterals**	• World Bank • WHO • UNDP	• education, research funding for various health-promoting programs, disease eradication, and poverty reduction • monitoring, immunization, and information provision • field projects, health information, and publications	Address a wide variety of global public goods and can pool funds for weakest-link and best-shot cases. Can serve a redistribution role to address equity concerns. Can help fund public-private partnerships, while coordinating partners. Overlapping functions leading to duplication and wastes.
• **Partnerships**	• River blindness: Onchocerciasis Control Partnership • Medicines for Malaria Venture • INBio (Merck/Costa Rica)	• parasitic worm eradication/human transmission inhibited • development of new antimalarial drugs and assist in their commercialization; research on a cure • bioprospecting for medicines	Involves a variety of different private-public participants with nonstandard institutional arrangements. Gives a push for weakest-link and best-shot public goods. Synergy promoted through organizations' alternative expertise.