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Global and Regional Public Goods: A Prognosis for Collective Action

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Abstract

This paper applies modern concepts from the theory of public goods to indicate why progress has been made with respect to some global and regional public goods (for example, cutting sulphur emissions) but not with respect to others (for example, cutting greenhouse gases). Factors promoting collective action at the transnational level include the removal of uncertainty, a high share of nation-specific benefits, a limited number of essential participants and the presence of an influential leader nation. The impact of public good aggregation technologies on the future provision of transnational public goods is related to the trend in world-wide income inequality. Principles are presented for designing supranational structures for addressing transnational public good problems.

JEL classification: H41, D70, Q20.

I. INTRODUCTION

Technology continues to draw the nations of the world closer together and, in doing so, has created novel forms of public goods and bads that have diminished somewhat the relevancy of economic decisions at the nation-state level. Political borders, once secured by armies and artilleries, are now transversed daily by unseen assailants, capable of causing widespread havoc. Acid rain falls from the sky; greenhouse gases warm the atmosphere; a thinned ozone shield lets in harmful ultraviolet radiation; computer viruses travel cyberspace; and antibiotic-resistant diseases are dispersed world-wide aboard commercial airliners. In each of these instances, activities in one country spill over political borders, thus

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jeopardising the well-being of people in other countries. Even political grievances thousands of miles away can erupt in death and destruction from a terrorist incident, staged in another country's capital city to capture maximum headlines. Efforts to increase world commerce through trade and to integrate financial markets have made economies more vulnerable to financial crises from abroad; thus the collapse of a brokerage house in Japan can erode confidence on financial markets half a globe away. Fiscal and monetary policies in one country can influence economic activities and stability in other countries, thus limiting a nation's autonomy over its own stabilisation policies. Population and industrial pressures have stressed ecosystems beyond their carrying capacity, so that additional demands placed on these systems lead to their permanent degradation.

Technology has provided humankind with the means to monitor the earth and its atmosphere in novel ways: remote sensing satellites have identified holes in the stratospheric ozone layer; atmospheric observatories atop Mauna Loa on the island of Hawaii record the accumulation of carbon dioxide, sulphur dioxide and other air pollutants; and monitoring stations throughout Europe track transboundary pollutants (for example, sulphur, nitrogen oxides and methane).[1] With these means, countries have become more cognisant of public goods and bads of a global and regional nature. Global pure public goods — for example, decreased greenhouse gas emissions, reduced ozone shield depletion and disease eradication — provide non-rival and non-excludable benefits to the world at large. Similarly, regional pure public goods — for example, less acid rain, reduced ground-level ozone and decreased terrorism threats — yield non-rival and non-excludable benefits to a more limited geographical area. If a global or regional public good possesses benefits that are either partially non-rival or partially excludable, then the good is impurely public. When, for example, an impurely public good's benefits can be excluded at an affordable cost, then pseudo-market arrangements in the form of clubs can collect tolls or membership fees to finance the good (Buchanan, 1965; Cornes and Sandler, 1996). In the absence of an exclusion mechanism, a real concern exists as to how nations will confront insidious global pollutants, the threat of rogue nations (Klare, 1995), the proliferation of weapons of mass destruction and the instability of world financial markets. All of these problems possess public good aspects that may motivate many nations to rely or free-ride on the actions of other nations. In the extreme, no nation may act, but a more likely scenario will be suboptimal provision carried on by a few well-to-do nations (Olson, 1965).

There is much concern about these global public goods in both political science and economics, leading to a variety of recommendations ranging from

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[1]These monitoring stations are maintained by the Co-operative Programme for Monitoring and Evaluation (EMEP). The 1979 Convention on Long-Range Transboundary Air Pollution (LRTAP), ratified on 16 March 1983, established the EMEP grid of monitoring stations. See United Nations Environmental Programme (1991) for treaty text.

doing nothing to creating world governance bodies.[2] The intention here is to take neither of these extreme positions, but, instead, to argue that not all global and regional public goods problems necessarily lead to inactivity. This is clear when viewing the tremendous progress achieved in curbing sulphur emissions in Europe or in limiting the emissions of chlorofluorocarbons (CFCs) during the last decade (Murdoch and Sandler, 1997). By identifying factors that promote collective action at the transnational level, I can distinguish problems that need little attention from those that require substantial intervention. These distinctions mean that scarce policy-making resources can be directed to where they are needed most. A primary purpose here is to differentiate sufficiently among global and regional public good problems, thus eschewing the tendency to lump all such problems together. This differentiation depends on the aggregation of individual contributions to the public good, the number of essential participants, the range of spillovers, the pattern of benefits and costs among agents, the intertemporal character of the public good, the extent of uncertainty and the presence of a leader nation. Based on these considerations, policy recommendations can be tailored to specific transnational collective action problems. Another purpose is to recommend principles for designing more effective institutions for addressing transnational public good problems when intervention is necessary. In particular, features that provide a comparative advantage to one supranational institution over another are identified. These may involve economies of scope, the size of the associated political jurisdiction or the linkage form among participating members.

A final purpose is to speculate on the effect that changes in the world's income distribution are apt to have on the ability of nations to provide global and regional public goods. In the future, traditional forms of foreign aid may be replaced by the rich countries providing these public goods to the less well-off countries. Tomorrow's foreign aid may be 'free-rider aid' that forestalls the spread of diseases, sequesters deadly pollutants (for example, plutonium), eliminates threats to world peace, provides much-needed information and accomplishes scientific breakthroughs. If the trend toward income inequality continues (Pritchett, 1997; United Nations Development Programme, 1992, 1994 and 1996), then the rich countries may have little choice but to underwrite these free rides in order to ensure their own well-being. This anticipated change in foreign aid will circumvent foreign-aid fatigue and the reluctance of countries to give aid that ends up in the hands of corrupt officials.

Section II focuses on a crucial feature distinguishing public goods — the aggregation technology of public goods. In Section III, this technology concept is used to predict the future of foreign aid. Section IV addresses factors other than this technology that promote collective action at the international level, while

[2]A few representative pieces from these two disciplines are Barrett (1993 and 1994), Helm (1991), Mathews (1997), Runge (1990), Sandler (1996 and 1997) and Zacher and Sutton (1996).

Section V presents some guiding principles for designing supranational structures. Aspects that provide a comparative advantage to one type of supranational institution over another are investigated in Section VI, followed by concluding remarks in Section VII.

II. AGGREGATION OF PUBLIC GOOD CONTRIBUTIONS

The association between individual contributions and the total quantity of the public good available for consumption is known as the *technology of public supply aggregation*.[3] The overwhelming analyses of public goods represent these goods as abiding by a *summation* technology of supply aggregation, so that each nation's contribution to the public good adds to the overall level of the good. Thus the contribution of one agent serves as a perfect substitute for that of another — that is, contributions are anonymous in the sense that each unit contributed adds the same at the margin regardless of who gives. This technology is represented by

$$(1) \qquad Q = \sum_{i=1}^{n} q^i$$

where the total level of the public good, Q, equals the sum of the n contributors' individual efforts of q^i.

This summation technology for individual contributions often results in public good provision being associated with Prisoner's Dilemma games when the benefit derived per unit, b_i, from an agent's contribution to the public good is less than the provision cost per unit, c_i. In this situation, when an agent is faced with the choice of whether or not to contribute toward the public good, the agent loses $c_i - b_i$ from each unit contributed, regardless of the actions of others. As a consequence, each potential contributor has a dominant strategy (i.e. best regardless of the strategies of others) to provide none of the public good. If everyone were to view the contribution problem in this manner, then the public good would not be provided unless some higher authority (for example, a supranational structure) intervened. The summation technology is also responsible, in large measure, when voluntary contributions are positive[4] for the *neutrality theorem* in which an engineered redistribution of income, through, say, taxes, among a set of contributors results in the same aggregate level of the public good, as income gainers' increased contributions precisely offset income

[3]Hirshleifer (1983) refers to the technology of public supply aggregation as the social composition function. Also see Cornes (1993), Sandler (1992) and Vicary (1990) on the technology of public supply aggregation.

[4]For the summation technology, voluntary contributions can be positive when some individuals view the net benefits from providing one or more units of the public good as positive. This may occur for some individuals whose tastes for the public good are strong and/or whose income is larger than that of non-contributors.

losers' decreased contributions (Cornes and Sandler, 1981 and 1984; Warr, 1983). The neutrality theorem can be circumvented when one of the following applies: non-contributors are taxed; the set of contributors is affected by the redistribution; a technology other than summation applies; or the public good is impure. If a supranational government supplies the pure public good from funds collected from public good providers, then the neutrality theorem again applies and government-provided contributions are crowded out on a dollar-for-dollar basis. When a summation aggregation applies for a global or regional public good, the prognosis for effective collective action is pessimistic, especially if a large number of countries need to act.

Consider global warming, which derives from a greenhouse effect as trapped gases in the earth's atmosphere let sunlight through but absorb and capture infra-red radiation, thereby raising mean air temperature. The greenhouse gases (GHGs) that contribute most to global warming are carbon dioxide, followed by CFCs, nitrous oxides and methane (Nordhaus, 1991). The precise relationship between the accumulation of GHGs in the atmosphere and the extent of global warming is not yet known owing to offsetting influences from other pollutants (for example, sulphur dioxide which reflects solar radiation), intervening variables and an imprecise knowledge of long-range weather. Unlike most transboundary pollution problems, global warming can create winners as some growing seasons are lengthened and rainfall distribution is altered. This presence of winners compounds the collective action problem, because some nations would be motivated to undo the efforts of others to augment their own gains from warming (Caplan, Ellis and Silva, 1997). Another cause for concern hinges on the large number of participating countries required to achieve any kind of significant reduction in the emission of GHGs. This number of participants will surely increase as China and other developing countries raise their living standards. In many ways, global warming is the quintessential global pure public good, because each country's release of GHGs augments the world's atmospheric stock in an additive fashion and each country's cut-back results in a greater cost than benefit for that country unless assurances can be given that a sufficient number of nations will act. If doing nothing to curb emissions eventually leads to dire consequences, then a chicken-type game can apply, thus leading some subset of countries to act to avert disaster. In the absence of these dire consequences from inaction, repeated interactions among countries may lead to some kind of co-operative response as nations employ strategies such as tit-for-tat that punish non-co-operators (Sandler, 1992, pp. 79–83). Even then, problems arise because of the short decision-making horizons of government officials, who may greatly discount future consequences and, as a result, place more weight on short-run gains from non-co-operation than on long-run losses from punishment. This problem may be particularly acute for authoritarian governments, which tend to be shorter-lived and less risk-averse than their democratic counterparts (Congleton, 1992; Olson, 1993).

More hopeful scenarios can arise when a summation technology of aggregate supply does not apply. Since many transnational public goods contingencies confronting the world abide by these alternative technologies, the prognosis for collective action is more optimistic than usually presupposed for these contingencies, as shown below.

1. Weighted Sum

This technology has the following form for nation *i*:

$$(2) \qquad Q^i = \sum_{j=1}^{n} \alpha_{ij} q^j, \qquad i = 1, \ldots, n$$

where Q^i is the amount of the public good received by nation *i*, q^j is country *j*'s provision of the public good and α_{ij} is the share of country *j*'s provision received by country *i*. Since equation (2) applies to each of the countries, the overall technology is represented by

$$(3) \qquad \mathbf{Q} = \mathbf{Aq}.$$

In equation (3), **Q** is the $n\times1$ vector $(Q^1,...,Q^n)'$, **A** is the $n\times n$ matrix of α_{ij}s and **q** is the $n\times1$ vector $(q^1,...,q^n)'$. This technology of aggregation is a generalisation of the pure public good summation technology. If, that is, all of the α_{ij}s are 1, then the pure public good model results; if, however, the α_{ii}s are 1 and the off-diagonal α_{ij}s are 0, then the pure private good model follows. When distance, but not direction, from the source of the provider is important (for example, national parks), then the **A** matrix is symmetric. In other cases, it is asymmetric.

The technology in equation (3) applies to the acid rain problem where **A** is an asymmetric 'transport' matrix owing to the dispersion of sulphur by the wind (Murdoch, Sandler and Sargent, 1997; Sandnes, 1993). If the α_{ii}s dominate this transport matrix, so that the largest non-zero entries lie along the diagonal, then the underlying public good is quite impure with large nation-specific private components being derived from reducing sulphur emissions. These large α_{ii}s motivate nations to act as they have for the sulphur emission case where large cut-backs in emissions have been achieved starting in 1985 (Sandnes, 1993). Understandably, much less dramatic success has been true with respect to nitrogen oxide emission reductions, where the α_{ii}s are significantly smaller, so that less of the benefit associated with a cut-back in emissions is conferred on the country doing the reduction (Sandler, 1997, pp. 115–29).

Another interesting feature of this technology concerns neutrality. When the weights differ among countries, redistributing income or employing tax policies can engineer desired changes in the level of the public good. A redistribution from countries with small α_{ij}s to those with larger α_{ij}s can improve the overall level of the public good. Redistribution to countries with a larger private gain from action can also improve the provision level of the public good. Furthermore, weighted summation does not necessarily imply a Prisoner's Dilemma with a dominant strategy not to contribute. A likely scenario is the case where a country's share of its public good provision is sufficiently large that it can reap a net benefit from provision even if it goes it alone, thus implying that some nation(s) will act. In fact, a host of game forms can apply including Prisoner's Dilemma, assurance and co-ordination games (Runge, 1984; Sandler and Sargent, 1995).

2. Weakest-Link and Weaker-Link

The next two technologies of public supply aggregation imply that the contributions of everyone will be more or less similar in an equilibrium. In its strictest form, the relevant technology is that of weakest-link where the least effort level fixes the effective public good level for the community, so that

$$(4) \qquad Q = \min\{q^1, \ldots, q^n\}$$

where q^i is contributor i's provision of the public good. In curbing the spread of an epidemic or a revolution, the least effort of the nations sets the safety level of all nations. Similarly, the nation with the smallest efforts at immunisation determines the chances of eradicating a disease. If communities are equally threatened by a raging fire, the community that does the least to contain the fire would have the biggest impact on whether the fire is contained. A related, but less strict, form of this technology is that of weaker-link in which the least effort has the greatest marginal impact on the level of the public good, followed by the next least effort and so on (Cornes, 1993). Thus provision levels above the minimum add progressively less to the overall level of the public good. The elimination of pests or weeds abides by weaker-link, as do efforts to educate the public about a disease such as AIDS.

To examine the strategic implications of these two technologies, I shall present a couple of normal-form games associated with weakest-link and weaker-link. The strategic differences between these games and the standard Prisoner's Dilemma are quite telling. In Figure 1a, focus first on the thick-bordered 2×2 game box (embedded in the 3×3 game), in which players A and B have two strategies: to contribute no units or to contribute one unit of the public good. Unless *both* players contribute a unit of the public good, the effective level of the public good remains at zero, so that no benefits are derived from the public good. The pay-offs in the thick-bordered 2×2 matrix in Figure 1a are based on each unit costing 2. Moreover, a benefit of 4 per player is only achieved if both players provide the public good. If no units are provided, then the pay-offs are 0 for each player since no benefits or costs arise. If, say, player A contributes one unit and player B contributes nothing, then A has to pay the cost of 2 but receives no benefits. Since the effective provision level remains at zero, player B does not then get a free ride. The pay-offs are then (–2, 0); they are (0, –2) if players' roles are reversed. When, however, both players contribute, each receives 2 (= 4 – 2) as per-unit costs of 2 are deducted from a player's benefits of 4. Unlike the Prisoner's Dilemma, this game has no dominant strategy — for the row (column) player, 0 exceeds –2, but 0 does not exceed 2, so that the pay-offs in any row (column) do not exceed the corresponding pay-offs in the other row (column).

A Nash equilibrium results when neither player would *unilaterally* want to change his or her strategic choice. As such, a Nash equilibrium represents the best (optimising) response for a player, given his or her opponent's (opponents') best response(s). In the thick-bordered matrix in Figure 1a, the diagonal cells marked with an asterisk are the two pure-strategy Nash equilibria.[5] When both players contribute, neither could gain from not contributing, because 2 > 0. Similarly, if no one contributes, then neither can gain from contributing alone, since 0 > –2. The essential distinguishing characteristics of the weakest-link game is the matching behaviour of the Nash equilibria along the diagonal of the matrix. The focal equilibrium is where each person contributes, since these pay-offs Pareto-dominate the no-contribution cell's pay-offs. Furthermore, a contract to contribute is self-enforcing once one player fulfils his or her end of the bargain. Thus collective action is more promising in a weakest-link scenario than in a summation-based Prisoner's Dilemma.

If both players possess three strategies — to provide zero, one or two units of the public good — then the 3×3 matrix in Figure 1a applies. Suppose that each unit of the good still costs the provider 2. If the smallest contribution is one unit, then each player receives 4 in benefits; if, however, the smallest contribution of the players is two units, then each player receives 8 (or 4 per unit) in benefits. If, say, one individual provides two units and the other provides one unit, the larger provider gets 0 (= 4 – 4), which equals the benefits from one unit minus the costs

[5]A third Nash equilibrium involves mixed strategies in which each pure strategy is played in a probabilistic fashion. To find this mixed strategy, one would determine player B's probability of contributing that makes player A indifferent between contributing and not contributing. A similar calculation would be done for player A's probability of contributing. For the game depicted, the mixed-strategy equilibrium would have both players contributing 50 per cent of the time.

from two units, while the smaller provider gets 2 (= 4 – 2), which equals the net benefits from one unit. Other pay-offs are computed in a similar fashion for the new cells. There is now the additional Nash equilibrium of matching two units of contributions. This situation is generalisable to more units, in which all equilibria will lie along the diagonal. In practice, the resulting equilibria depend on the relative endowments or well-being of the players. When public goods are normal with respect to income, as is typically presupposed, the poorest individual picks the smallest contribution and, in doing so, fixes the public good level for everyone. This follows because everyone else will match this level, since further units would add nothing to benefits but would be costly.

A weaker-link technology opens up more possible equilibria including those not involving matching behaviour. Consider the thick-bordered 2×2 matrix embedded in the 3×3 matrix of Figure 1b. Once again, costs per unit are 2. If

FIGURE 1

Weakest-Link and Weaker-Link Games

a. Weakest-link

		Player B: *0 units*	Player B: *1 unit*	Player B: *2 units*
Player A:	*0 units*	* 0, 0	0, –2	0, –4
	1 unit	–2, 0	* 2, 2	2, 0
	2 units	–4, 0	0, 2	* 4, 4

b. Weaker-link

		Player B: *0 units*	Player B: *1 unit*	Player B: *2 units*
Player A:	*0 units*	* 0, 0	* 2, 0	3, –1
	1 unit	* 0, 2	* 2, 2	* 4, 2
	2 units	–1, 3	* 2, 4	* 4, 4

only one player contributes a unit, then each player receives benefits of 2 from this unit prior to costs being deducted. If, however, both players contribute a unit, then each player receives 4 in benefits before costs are paid. Thus a unit contributed has a greater marginal benefit when matched by the other player. The weaker-link pay-offs in the diagonal cells are the same as those of the weakest-link; but the pay-offs in the off-diagonal cells are different. If, say, player B contributes one unit while player A contributes nothing, then B obtains a net pay-off of 0 when costs of 2 are deducted from benefits of 2, while A receives a free-rider pay-off of 2. In the 2×2 game depicted, every cell is a Nash equilibrium, from which neither player is able to improve his or her well-being. If the single-contributed unit had a higher marginal gain of 3, then the off-diagonal cells with just one contributor would be the pure-strategy Nash equilibria; if, however, the single-contributed unit had a lower marginal gain of 1, then the ‘matching’ diagonal cells would be the pure-strategy equilibria.

Finally, the game is extended to include three possible discrete contribution levels for each player so that the 3×3 matrix in Figure 1b applies. In this scenario, the contribution of just one unit by a single player again gives 2 in benefits before costs are deducted. If both players contribute a single unit, each receives 4 in benefits prior to costs. When only one player provides two units, the other player can either give no units or one unit. In the former case, the two units provided by a single person yield 3 in benefits prior to costs — i.e. 2 from the first unit and 1 in additional benefits from the second unit. In the latter case, the three units provide 6 in total benefits prior to costs — i.e. 4 from the matching two units and 2 in additional benefits from the unmatched unit. When a match of two units for the players takes place, benefits for each player equal 8 before costs are deducted. To arrive at the pay-offs listed in the matrix in Figure 1b, I must deduct costs of 2 per unit from the providers’ respective benefits described above. Thus, for example, player A receives 4 when giving one unit to B’s two units as player A’s costs of 2 are subtracted from benefits of 6, while player B receives just 2 as costs of 4 are subtracted from benefits of 6. Other pay-offs are calculated similarly. Seven pure-strategy Nash equilibria are identified with asterisks. For this example, the ‘unmatched’ equilibria occur when only one provision unit separates the highest and lowest contributors. Such equilibria allow for greater collective action possibilities, because perfect co-ordination is not required with a weaker-link technology. If an ‘unmatched’ equilibrium results, the richest player will normally provide the greatest number of units of the public good. The focus equilibrium with the greatest total pay-offs for both players is where the greatest number of units apiece are contributed, but this equilibrium might not be feasible when incomes are unequal.

3. Best-Shot and Better-Shot

A best-shot technology equates the level of the public good to the largest individual provision level, so that

(5) $$Q = \max\{q^1, \ldots, q^n\}.$$

In confronting a rogue nation whose actions threaten the world community, the nation exerting the largest effort can neutralise the threat. To find a cure for Ebola, AIDS or antibiotic-resistant tuberculosis, the research with the greatest effort is typically the one that meets with success. For best-shot, whoever is first over the line wins for everyone.[6] Thus, once a breakthrough is found for safely storing highly radioactive materials, the nation achieving this discovery determines the public good level of containment for everyone. A less strict form of this technology is better-shot, for which the largest individual provision level has the greatest marginal impact. Smaller provision efforts can also add to the overall public good supply but by much less than the greatest effort.

Best-shot technologies are associated with co-ordination games where one or the other player only needs to act in equilibrium (Farrell, 1987; Sandler, 1992, pp. 41–2). For an *n*-player scenario, only a single player needs to act. Action is typically undertaken by the player with the greatest stake in the outcome, which is often the richest when the public good is income-normal. Figure 2 depicts an illustrative two-player game in normal form for best-shot, for which each player can provide no units, one unit or two units of the public good. The provision of the first unit gives 4 in benefits for each player, while the provision of a two-unit block yields 7 in benefits for each player. Each unit costs the provider 2, which must be deducted from benefits to ascertain net pay-offs. Once the first unit is provided, another unit contributed by the other player gives no benefits. Similarly, when one player provides two units, the other player's contribution, if less than or equal to two units, adds no additional benefits. That is, different individuals' provisions are not cumulative; only the same individual's provision is cumulative, as is often true for research discoveries. The pay-offs in the 3×3 matrix follow from deducting the relevant costs of provision from the benefit scenario described. If, for example, player A provides two units and player B provides one unit, then A receives 3, which equals benefits of 7 minus costs of 4 from giving two units, and B receives 5, which equals benefits of 7 minus costs of 2 from giving one unit. Other entries are computed analogously. There is no

[6]For some research pursuits, there may be some benefit from having extra research teams involved, especially when there is some uncertainty as to which will make the discovery. There may be an element of luck present so that the size of the effort, while the crucial determinant of which will make the breakthrough, is not the only determinant. By adding to the likelihood of success, all research teams promote the sought-after discovery even though the best-equipped team adds the most to this likelihood. In this scenario, a better-shot technology applies — see the later discussion in the text. This point is due to Simon Vicary.

FIGURE 2

Best-Shot Game

		Player B: *0 units*	*1 unit*	*2 units*
	0 units	0, 0	4, 2	* 7, 3
Player A:	*1 unit*	2, 4	2, 2	5, 3
	2 units	* 3, 7	3, 5	3, 3

dominant strategy in this game. The two Nash pure-strategy equilibria are indicated with asterisks, where either player A or player B provides two units unassisted. If additional contribution levels were allowed, the equilibria would always involve just one player contributing. When more participants are allowed, a single player would still be the provider unless two or more players pooled their efforts and acted like a single contributor (for example, the coalition during the Gulf War of 1991, the European research consortium to develop fusion power and the European Space Agency to participate in a space station).

If a better-shot scenario applies, then the appearance of gains from contributions below the best-shot level would induce others to participate even if they cannot be the best. For some scientific breakthroughs, even the research group that does not win the race may discover something of value. Better-shot games give an impetus to spread effort over the players depending upon the assumed marginal gain to the smaller contribution levels — numerous scenarios are possible.

4. Implications for Global and Regional Collective Action

The presence of these and other alternative technologies of public good aggregation has a number of important implications for the possibility of providing public goods and eliminating public bads at the transnational level. First, non-summation technologies do not necessarily imply Prisoner's Dilemmas where the dominant strategy is to do nothing. Second, many technologies of public supply aggregation can result in some form of provision of the public good. In so far as some of the most worrisome public good challenges confronting humankind adhere to a best-shot technology — for example, curing epidemics — the prognosis that some nation or collective of nations will act is encouraging. Third, these aggregation technologies can be consistent with income redistribution and taxation having an influence on public good levels even when redistribution is just among the set of contributors. For example, redistribution to those providers who receive relatively large shares of the benefit of their own contributions in a weighted-sum scenario can increase provision levels. Fourth, since some technologies of public supply aggregation are more conducive to collective action, the design of supranational structures should account for this influence. In many instances, supranational structures are not needed and, in other instances, they can be designed to make provision levels abide by an aggregation technology of public supply that is more supportive of action.

III. INCOME DISTRIBUTION AND THE FUTURE OF FOREIGN AID

For some technologies of public supply aggregation, the underlying income distribution can have a profound impact on the resulting collective provision of the public good and/or the extent of suboptimality. If, for weakest-link, the income distribution among countries were to become more equal, then the smallest contribution level is anticipated to increase as the poorest country acquires more income (Cornes, 1993; Sandler, 1992; Vicary, 1990). An increase in this smallest provision level will lead everyone to match this new greater minimum provision amount. If, on the other hand, the income distribution among countries were to change so as to increase the income disparity between the poorest and the richest nations, then the contribution of the weakest-link nation, which is usually the poorest nation, is expected to fall relative to the desired contribution of the richest countries. A similar, but less pronounced, prediction corresponds to the weaker-link case. Greater income inequality (equality) will lead to a fall (rise) in the provision of the public good, but this fall (rise) is cushioned by the non-weakest-link contributions yielding some marginal benefits, so that more than just the poorest nation determines the provision level.

An opposite prediction relates changes in the income distribution to changes in the provision level of the public good for best-shot and better-shot scenarios. If the income distribution among nations becomes more biased to the top end, the best-shot nation, which is typically the richest, is anticipated to increase its quantity supplied of these global and regional public goods. As such, the other nations can just sit back and enjoy a greater free ride, so that something positive can come from increased inequality. If, say, greater income permits the best-shot nation to mount a better effort to cure a plague, to achieve a research breakthrough or to unarm rogue nations, then income inequality has a positive side-effect. When, instead, income distribution becomes more equal, this increased equality will hamper the supply of best-shot public goods by reducing the income of the richest nation. These same general predictions hold for better-shot scenarios, but are less pronounced in so far as a group of higher-income nations are contributors and not all might become relatively richer as income inequality increases.

Even the summation technology of public supply implies that rich nations assume a greater burden for the public good (Cornes and Sandler, 1996). As income becomes more favourable for the richest with time, the upper echelons of rich nations are expected to assume a greater burden for providing global and regional public goods for the rest of the world. The clean-up or the curbing of many environmental pollutants (for example, GHGs) follows a summation technology.

1. How is Income Distribution among Nations Changing?

Between 1960 and 1991, the richest fifth of all nations had their share of world income rise from 70 per cent to 85 per cent, while the poorest fifth of all nations had their share fall from 2.3 per cent to 1.4 per cent (United Nations Development Programme, 1992 and 1994, p. 35). This widening gap between the two *ends* of the income distribution continues to grow even though some increased equality has occurred within the spectrum (United Nations Development Programme, 1996). There are a number of factors that support this trend toward a widening gap between the richest and poorest nations and that show every indication of persisting into the future. First, the richest countries have the resources to invest in R. & D. and to develop innovations. Most patents are held by people and institutions of the wealthiest nations. Second, the poorest nations must rely on technology transfers, which are often ill-suited for their labour-rich economies. Third, the have-not nations have difficulty saving, which finances investment and growth. As a consequence, these nations' income levels fall ever further behind those of the richest nations. Fourth, the poorest nations tend to export income-inelastic goods, whose demands increase less proportionately than the rise in world income. In contrast, the richest nations export a large amount of technologically advanced goods that are income-elastic. Fifth, many of the poorest nations are plagued by political instability which dissuades foreign direct investment and diverts scarce resources to maintaining order. Sixth, some of these poor countries are ruled by autocratic regimes that siphon resources to support a ruler's extravagant lifestyle. Seventh, population growth in the poorest countries limits savings and leads to vast sums being needed to furnish infrastructure for the ever-growing urban centres. Eighth, debts burden these countries with interest payments which could have supported investment and growth.

Will this trend of the last four decades to greater income inequality in the community of nations increase? There is disagreement about the answer among researchers, with some (for example, Pritchett (1997)) making the case for greater divergence and others (for example, Jones (1997)) making the case for greater convergence of the world income. These differences in prediction derive, in part, from the underlying model — for example, a standard growth model *or* a divergence-from-steady-state model (Mankiw, Romer and Weil, 1992) — upon which the predictions are drawn. Despite these differences, there is a consensus that the income gap between the very richest nations and very poorest nations will increase. It is this growing gap that underlies this paper's prediction about the future of foreign aid.

2. 'Free-Rider' Foreign Aid

Despite the divergence in income distribution during the last decades, US foreign aid has decreased greatly from its high of $51 billion (in 1997 dollars) to its 1997 figure of $14 billion (in 1997 dollars).[7] Since 1970, world-wide foreign aid to developing countries has increased at a fairly modest rate, while foreign direct investment has grown greatly, despite fluctuations. There is every indication that countries, especially the rich, are becoming 'fatigued' with foreign aid, preferring instead private capital flows to finance development. This fatigue may be bolstered by the realisation that some aid merely enriches corrupt regimes and does not necessarily benefit the poor for whom it is intended.

An additional source of future fatigue is predicted to stem from an ever-increasing provision of global public goods by the richest echelon of nations. As the world confronts pending environmental, health and security exigencies of a best-shot, better-shot or summation nature, the richest countries will provide the free rides for the world community. Thus the US and its nearest income cohort of nations will be the nations to avoid future environmental disasters, to cure diseases, to monitor the planet and to disarm rogue nations. The December 1997 Kyoto agreement on curbing GHG emissions, which only placed limits on the richest countries, is consistent with this prediction.[8] The anticipated divergence between the richest and poorest countries will place ever-increasing burdens for these goods on the shoulders of just a few rich countries. For weakest-link and weaker-link public goods, the growing divergence of income between the richest and poorest nations will imply that the weakest-link and weaker-link nations' provision level will fall *relative to the desired level of the richer countries*. Consequently, the suboptimality of the provision levels of these weakest-link or weaker-link transnational public goods is anticipated to increase *unless* the richest countries either subsidise the poorest countries' provision or else step in and provide the public good for these poor countries. This is precisely what the US Center for Disease Control does to track and contain deadly viruses world-wide. An analogous situation involves the containment of radioactive material in crisis — for example, the Chernobyl meltdown. Similarly, the effort expended

[7]The figures and facts from this paragraph come from Congressional Budget Office (1997).

[8]Ratification of this agreement, which places no limits on China or India, by the signers is not certain. Even less likely is signers' adherence to this agreement unless a technological breakthrough increases the efficiency of engines.

by the richest nations to keep instabilities in places such as Bosnia and Kuwait from spreading represents an example where the weaker-link public good of stability maintenance is being provided by the richest nations.

As the gap between the richest and poorest nations widens, the richest countries will assume a greater burden for transnational public goods of varying aggregation technologies. The resulting free-rider foreign aid will be acceptable to the voters of rich donor countries, because these voters benefit from the public goods provided. Moreover, the 'aid' is spent by the providing nation(s) so that it cannot pad the pockets of corrupt leaders or officials. As this form of assistance grows, in keeping with events since 1990, free-rider aid is apt to crowd out traditional forms of giving. If, additionally, these public goods maintain political and environmental stability, then private direct investment flows will be attracted to finance development.

IV. OTHER FACTORS PROMOTING COLLECTIVE ACTION

Thus far, we have seen that transnational public goods can abide by differing aggregation assumptions in terms of provision, which, in turn, can affect which nations will support the goods' provision and how income distributions can influence provision. These goods can differ along a number of other dimensions — for example, spatial range of spillovers, temporal range of spillovers, extent of uncertainty regarding benefits and costs, the mix of local versus transnational benefits — that can influence the possibility of collective action. Explicit efforts to promote international co-operation should only be applied to those public goods where the incentives for collective action are weak, non-existent or perverse. By removing barriers to collective action (for example, uncertainty as in the case of ozone shield depletion), policy can promote the provision of the public good without necessarily having to co-ordinate the nations' contributions to the public good.

A key factor promoting provision of a transnational public good is the *mixture between nation-specific and transnational* public benefits. As the proportion of nation-specific benefits to total benefits increases, the likelihood of national action increases (Sandler and Forbes, 1980; Sandler, 1992). Consider sulphur-induced acid rain coming from power plants and other fossil-fuel users. In so far as these emissions do not typically travel vast distances once airborne, over 50 per cent of European sulphur depositions typically fall on the emitter nation's own soil, meaning that there are tremendous nation-specific gains from curbing these emissions (Sandnes, 1993). This is why cut-backs of these emissions from 1980 levels averaged almost 25 per cent for European nations by 1990 (Murdoch, Sandler and Sargent, 1997, p. 289). The Helsinki Protocol of 1985, mandating reduction of 30 per cent from 1980 levels, merely codified reductions that an overwhelming majority of nations had already achieved. In the case of nitrogen oxides emissions — another cause of acid rain — the ratio of nation-specific to total benefits is much smaller, thus explaining the very modest reductions in emissions achieved thus far.

Another conducive influence for transnational collective action is the presence of a ‘leader’ nation whose own efforts are a key influence on providing the public good. Thus the lead taken by the US — the greatest consumer and producer of CFCs — to limit its production and use of CFCs was a major inducement to getting other nations to frame and ratify the Montreal Protocol and its subsequent amendments (Benedick, 1991). When, however, New Zealand and other Pacific island states take a leadership role in curbing GHGs, little is anticipated to come of it because these states are inconsequential contributors to the accumulation of GHGs. In contrast, a strong role by the US, China, the European Union and Russia would do much to address the problem. A nation will assume a leadership role whenever its perceived benefits from acting alone exceed the associated costs, as was the case for CFCs reduction but not for GHGs in the US. If these public goods are income-elastic and require initial large-scale investments, then rich democracies are more apt than their poorer autocratic counterparts to assume such a leadership role (Congleton, 1992; Olson, 1993).

As a precondition for collective action, uncertainty must be resolved. The nature of the public good problem must be well understood before nations are prepared to act.[9] For example, once the link between CFCs and stratospheric ozone destruction became known, collective action followed rapidly in the form of the Montreal Protocol. Moreover, the distribution of benefits and costs from collective action must be identified. If the consequences of inactivity (for example, irreversibilities) are known and dire, then action would be swift. The removal of uncertainty is itself a transnational public good whose provision may require collective action. This is why United Nations conventions on environmental concerns (for example, the Vienna Convention on ozone shield depletion and the Long-Range Transboundary Air Pollution Convention on acid rain) typically provided for gathering this information. Global and regional action would be a lot faster if the global community permanently maintained a body of scientists, social scientists and medical experts to evaluate pending public good crises. Such a body would be comparatively inexpensive but could save the world community billions or more through quicker and more decisive action when warranted.

V. DESIGN PRINCIPLES FOR SUPRANATIONAL STRUCTURES

Supranational structures join two or more nations together to address one or more collective concerns that often involve the provision of a public good. These

[9]On the effects of uncertainty on public good provision, see Sandler, Sterbenz and Posnett (1987). The text deals with a general tendency.

structures can assume a wide variety of forms, ranging from very loosely integrated linkages (for example, NATO alliance) to tightly linked structures where, in the limit, participating countries act like a single decision-making unit regarding the contingency. As a supranational structure is tightened by increasing the participants' responsibility to the structure, both linkage costs and benefits increase. Greater tightness can take the form of a smaller decision-making majority, a larger share of common funding of the collective action, more frequent meetings, greater bindedness of the decisions (i.e. less discretion in abiding by decisions) and stricter sanctions for non-compliance (Sandler and Forbes, 1980). Linkage costs derive from decision-making, enforcement and interdependency costs. The latter is particularly important and arises when a nation sacrifices its autonomy and subjects itself to the decision of the collective, of which it might be in a minority (Sandler, 1997). Linkage benefits stem from increased efficiency of allocation, scale economies, and information and communication gains.

These structures should be a last resort, used only after less-drastic measures for providing the public good have failed. At least five principles of designing these structures should be kept in mind. First, only structures for which aggregate net linkage benefits (linkage benefits minus linkage costs) are positive for the group of potential participants should be instituted so as to ensure collective rationality. Second, these latter structures must also provide a net positive linkage for each and every participating nation, so that it is also individually rational to participate. Third, the parameters of integration should be chosen so as to equate marginal linkage benefits to marginal linkage costs for each such parameter. If, however, a choice must be made from a discrete number of alternative forms, the structure that fulfils the first two restrictions and provides the greatest net linkage benefits is best. Fourth, as circumstances change over time, linkage benefits and linkage costs will change and, with them, there is a need periodically to re-evaluate and redesign the structure. Fifth, these structures should be designed so that co-operation becomes a dominant strategy, thus limiting enforcement and making co-operation incentive-compatible (also see Barrett (1994)).

On Making Co-operation a Dominant Strategy

To illustrate how institutional design can promote co-operation as a dominant strategy, I shall consider some variants of a standard n-player Prisoner's Dilemma. Each of the homogeneous players is a country that can contribute either one unit or no units of the public good at a per-unit cost of 6. Further suppose that every unit provided gives 4 in benefits to each and every player — contributor and non-contributor alike. The matrix in Figure 3a indicates the associated pay-off for a representative nation i for alternative numbers of other contributing nations, up to n–1, along the columns. If neither nation i nor any other nation contributes, then nation *i* receives a pay-off of 0. If, however, *i* contributes alone, it gets –2 (= 4 – 6). In the top row of the matrix in Figure 3a, nation *i* does not contribute and receives the free-rider pay-off of four times the number of other contributors. In the bottom row, nation *i* contributes a unit of the public good and receives pay-offs equal to the number of contributors (including itself) times the benefit per unit (i.e. 4) minus the one-unit cost of 6. The pay-offs in the top row exceed the corresponding pay-offs in the bottom row by 2, so that nation *i*'s and, hence, every nation's dominant strategy is to not contribute, leaving the cell marked with an asterisk as the Nash equilibrium. This Prisoner's Dilemma scenario applies whenever the per-unit cost, c_i, exceeds the per-unit benefit, b_i.

Next suppose that costs are evenly shared, so that each participant is obligated by a supranational agreement to pay $6/n$ for each and every unit contributed regardless of the contributor. The resulting matrix is *not* displayed in Figure 3. Not contributing now yields $[4 - (6/n)]j$ when j others contribute, while contributing yields $[4 - (6/n)](j+1)$ when j others contribute. This latter pay-off exceeds the former for $j = 0,1,...,n$, provided that $n > 3/2$, or in general that $n > c_i/b_i$. If, therefore, n is sufficiently large, the dominant strategy is to contribute. Sharing costs makes every nation part of each contribution decision and, in doing so, can circumvent free-rider motives. The Nash equilibrium is the Pareto-optimal one in which everyone gives a unit of the good for a per-nation net pay-off of $4n - 6$.

Figures 3b, 3c and 3d correspond to 'minimal-threshold' games, in which a minimum of $j+1$ units of the public good must be provided before a benefit of 4 per unit is received by every nation.[10] In Figure 3b, per-unit costs of 6 are neither shared nor refunded. Until $j+1$ nations contribute, the public good yields no benefits, so that the pay-offs are 0 in the top row and –6 (reflecting the costs of providing a unit) in the bottom row. A threshold aggregation technology characterises some transnational public goods. For example, the 1997 forest fires in South-East Asia and Australia could not be contained until a threshold level of fire-fighting had been expended. Similarly, a flood cannot be contained unless a dike is built high enough. There are a number of equilibria in Figure 3b, including doing nothing (marked with an asterisk) and just meeting the minimal threshold of $j+1$ contributors (also marked with an asterisk). This latter situation represents myriad equilibria in which precisely $j+1$ nations contribute. The number of ways of drawing $j+1$ things from n represents the number of such equilibria. These are the only positive-contribution equilibria, because if more than $j+1$ nations contribute, the pay-offs in the top row again dominate those in

[10]Threshold games are analysed by Palfrey and Rosenthal (1984) and Sandler (1992).

FIGURE 3

Four *n*-Player Games

a. Prisoner's dilemma

Number of contributors in the group besides *i*:

	0	*1*	...	j–*1*	j	j+*1*	...	n–*1*
i does not contribute	* 0	4		4(*j*–1)	4*j*	4(*j*+1)		4(*n*–1)
i contributes	4 – 6	2×4 – 6		4*j* – 6	4(*j*+1) – 6	4(*j*+2) – 6		4*n* – 6

b. Minimal threshold: no refunds, no cost-sharing

Number of contributors in the group besides *i*:

	0	*1*	...	j–*1*	j	j+*1*	...	n–*1*
i does not contribute	* 0	0		0	0	4(*j*+1)		4(*n*–1)
i contributes	–6	–6		–6	* 4(*j*+1) – 6	4(*j*+2) – 6		4*n* – 6

c. Minimal threshold: refunds, no cost-sharing

Number of contributors in the group besides *i*:

	0	*1*	...	j–*1*	j	j+*1*	...	n–*1*
i does not contribute	0	0		0	0	4(j+1)		4(n–1)
i contributes	0	0		0	* 4(j+1) – 6	4(j+2) – 6		4n – 6

d. Minimal threshold: refunds, cost-sharing

Number of contributors in the group besides *i*:

	0	*1*	...	j–*1*	j	j+*1*	...	n–*1*
i does not contribute	0	0		0	0	$\left(4-\frac{6}{n}\right)(j+1)$		$\left(4-\frac{6}{n}\right)(n-1)$
i contributes	0	0		0	$\left(4-\frac{6}{n}\right)(j+1)$	$\left(4-\frac{6}{n}\right)(j+2)$		* 4n – 6

the bottom row, inasmuch as beyond the threshold a summation technology of public supply applies. For more than j+1 contributors, another unit adds less in benefits than in costs. This situation is of interest, since the appearance of a threshold means that positive provision levels can characterise the equilibrium, unlike the analogous Prisoner's Dilemma in Figure 3a.

The role of institutional design is evident in Figures 3c and 3d. In Figure 3c, a refund of contributions is permitted if the threshold is not attained. For example, nations pledging to dispatch troops to quell civil unrest in a distant venue may not be required to meet their pledges unless a threshold level of troops has been pledged in total to ensure the success of the mission. The only pay-off difference between Figures 3b and 3c concerns the bottom row in the latter where 0 replaces –6 in each column up to the threshold level. As a result, the bottom row now weakly dominates the top row until j+1 contributors are on board. The most interesting Nash equilibria (marked with an asterisk) are for there to be exactly j+1 contributors. An equilibrium where less than the threshold number contributes is less interesting, since a player has nothing to lose by contributing if the threshold is not met and will gain the pay-off marked with an asterisk if it is met (Bagnoli and McKee, 1991).

In Figure 3d, both refunds and cost-sharing are permitted so that, beyond the threshold, each nation nets 4 – (6/n) per unit contributed.[11] Consequently, the pay-offs in the entire bottom row weakly dominate the corresponding pay-offs in the top row, thus implying a single interesting Nash equilibrium in which everyone contributes (marked with an asterisk). This equilibrium is Pareto-optimal and clearly illustrates the power of institutional design for promoting collective action among nations. Often, the best designs manipulate the underlying aggregation technology to make contributing a dominant strategy. Cost-sharing works because it makes for a more favourable comparison of individual benefit and cost per unit.

VI. TOWARD A COMPARATIVE ADVANTAGE THEORY OF SUPRANATIONAL STRUCTURES

Supranational linkages should be viewed as a last-resort measure, because the transaction costs involved with this mode of allocation can be quite formidable. Nevertheless, there are instances when action at the national level is not anticipated — for example, curbing global warming — but the benefits (particularly, efficiency gains) from linkage may be sufficient to offset the associated costs for some level of integration. When designing these structures, the framers should begin with a loosely integrated structure where linkage costs,

[11]Throughout this section, provision levels are still determined by the players' actions. The group of participants creates a central authority (for example, an international organisation) to collect the money, purchase the public good or reimburse contributors if the threshold is not reached.

especially interdependency costs, are low in order to ensure that the two rationality requirements for viability are satisfied. Since nations are loathe to sacrifice their authority to a supranational body, interdependency costs are apt to rise quickly with linkage integration.

By using cost-sharing or refund arrangements, designers of these structures may avoid the need to enforce decisions, thereby limiting structural integration and linkage costs. Supranational linkages that rely on market transactions (for example, emission trading) to achieve goals also limit integration and associated costs. A homogeneous set of participating nations can economise on linkage costs, because decisions with large majorities can be reached easily. As a supranational structure becomes established, it can take in more heterogeneous members, as NATO did with Greece and Turkey in February 1952 and is about to do with the Czech Republic, Hungary and Poland.

The number of nations is another design concern for identifying the most effective structure. As a basic principle, the fewer the participants, the better. By limiting the number of participating nations, a supranational structure economises on linkage costs of decision-making, interdependency and enforcement. This essential principle fails if additional nations add more to linkage benefits than to the associated linkage costs. If two alternative structures are able to provide the same provision level of the public good, then the structure with the smaller linkage costs is preferred. For the Montreal Protocol, a limited set of initial participants was required owing to the concentration of production and consumption of CFCs. This small number of essential participants economised on linkage costs, thus facilitating an agreement. An agreement between developed countries and tropical countries to preserve the rain forest is probably best initiated with a limited number of tropical countries possessing the largest remaining forest tracts — i.e. Brazil, Indonesia, Zaire, Peru, Bolivia and Mexico — so as to derive the greatest pay-off per participant.

In the standard theory of jurisdictional design, a principle of fiscal equivalence is espoused whereby the economic domain or spillover range of the public good matches the political jurisdiction (Olson, 1969). A perfect match is more conducive to an efficient allocation of the public good, since those with a stake in the decision can influence the decision-makers. If the size of the political jurisdiction exceeds that of the economic domain, then an oversupply is anticipated. An opposite prediction characterises political jurisdictions that are a subset of the economic domain. If fiscal equivalence were applied to the determination of the appropriate linkage structure for transnational public goods, one would conclude that there should be a plethora of supranational structures, each of which corresponds to the relevant economic domain of the underlying public good or externality.

This fiscal-equivalence prescription is, however, based on the absence of linkage costs from expanding the size of a political jurisdiction. These latter costs can serve to modify the requisite boundaries for a supranational linkage. If, for example, an existing supranational linkage for some public good has an infrastructure with an unused capacity, then *economies of scope* may limit linkage costs because of common costs that can be shared to provide another public good, even if a complete matching of boundaries does not result. Thus NATO and the United Nations provide a host of regional and global public goods to their members, and these public good spillover ranges do not coincide. These economies of scope will eventually be exhausted or else outweighed by either the inefficiencies of non-matching jurisdictions or adverse cross-linkage effects from using the same structure to address two or more distinct problems. On fiscal-equivalence grounds, supranational structures that include the countries affected by the public good have the advantage, while, on linkage-costs grounds, supranational structures that economise on these costs have the advantage over other structures. When the nature of the linkage between the actual decision-makers and those affected is also taken into account, fiscal equivalence can lose its appeal because more localised decisions followed by bargaining among jurisdictions may perform as well despite the non-coincidence (Inman and Rubinfeld, 1997). That is, centralised structures for global public good must decide a voting rule for allowing the lower-government participants to express their opinions. When non-unanimous decisions are followed, optimality is not assured despite the coincidence of domains for the centralised structure, thus leaving the door open for more localised governments to do better.

Both the fiscal-equivalence and the linkage-costs paradigms appear to have merit in practice. In Bosnia, the United Nations was unable to act and NATO, whose political interests better matched the threat posed by Bosnian instability, managed to reach a consensus to intervene. The Interim Force (IFOR) and the subsequent Stabilization Force (SFOR) included non-NATO participants from Central and Eastern Europe, whose security was also at risk from Bosnian civil strife. In this example, the resulting institutional arrangement was closer to the prediction of fiscal equivalence. The same could be said of the Long-Range Transboundary Air Pollution Convention and its subsequent protocols for acid-rain inducers and volatile organic compounds (VOCs). In responding to instabilities and civil strife in Africa, the United Nations has, however, proved effective even though its jurisdiction does not match with those most at risk from the conflict.

Currently, a supranational linkage that either closely matches the economic domain of the public goods or else can economise on common linkage costs in a multi-purpose structure has a comparative advantage over other such structures in allocating transnational public goods. Thus both specialised structures and multi-purpose structures coexist today. As these multi-purpose structures embrace more public good problems, their comparative advantage is anticipated to dissipate. The United Nations's recent strain with peacekeeping, when 32 missions were initiated from 1988 to 1997 despite numerous ongoing missions, is, perhaps, an indication that this supranational structure is becoming overextended (Sandler and Hartley, 1999). If this is the case, then more limited-purpose supranational structures may become more prevalent in the future.

VII. CONCLUDING REMARKS

This paper has focused on the inhibitors and facilitators of collective action at the transnational level. Contrary to standard practices, I have stressed that the manner in which individual provision levels determine the total public good available for consumption has a profound role to play for the possibility of collective action. Some aggregation technologies are associated with underlying game forms that are more supportive of collective action than the Prisoner's Dilemma associated with the standard summation technology. The nature of these aggregation technologies was also related to the effects of income distribution on the provision of global and regional public goods. Current trends toward a greater gap separating the income of the richest and poorest nations were shown to imply that foreign aid will increasingly take the form of public good provision. If this prediction is correct, then more traditional forms of foreign aid will dry up.

Supranational structures were characterised as a last resort when alternative means for promoting collective action at the transnational level have failed. Such structures are best initiated at a loose level in order to fulfil individual and collective rationality constraints and then tightened with time as warranted. If these structures are designed keeping incentives in mind, then co-operation can be made to be a weakly dominant strategy — for example, a minimal-threshold situation with cost-sharing and refunds — so that the structure can remain loose, thus saving on linkage costs and increasing the likelihood of formation. Transnational public goods that possess a large share of localised benefits for the participants may require little intervention. This paper has identified a number of factors that allow some transnational public good problems to be self-correcting. Alternative problems from the real world were evaluated in terms of the inhibitors and facilitators identified.

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