The Strategy of Global Public Goods

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Abstract

Increasingly international institutions like the United Nations and the World Bank are redefining their missions in terms of global public goods provision. Global public goods have benefits that spill across national borders, and priorities include constructing financial architecture, generating and spreading knowledge, peace-keeping, containing disease, and cleaning up the environment. The rhetoric of global public goods underscores the notion that sending foreign aid overseas can deliver benefits at home as well. As in standard analyses of public goods, under-supply can occur due to free-riding, and public action can improve efficiency. But other cases depart from the standard analysis. We consider cases in which the content of global public goods may be controversial, and where welfare may be a function of multiple public goods consumed simultaneously. In this setting, free-riding may be encouraged and strategic policymakers may choose the quality of public goods to either "crowd out" or "crowd in" the provision of other public goods. The formal analysis is illustrated with discussion of two recent initiatives to provide global public goods: the failed proposal to start an Asian Monetary Fund in 1997 and the World Bank's

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announcement in 1996 that it is becoming a \Knowledge Bank" that spreads information on international development policy.

1 Introduction

Globalization has made border-crossing routine: products, people, ideas, images, pollution, music { all cross national borders with ease. Most exchanges are enriching, while some, like acid rain, have brought new policy dilemmas. The outbreak of Severe Acute Respiratory Syndrome (SARS) in Spring 2003 is one dramatic example of how globalization is bringing local policy concerns to international attention: diseased animals in South China markets infected local workers, and the illness quickly spread to other countries. By the end of the spring, 39 people had died in Toronto and 27,000 people had been quarantined (Associated Press, 2003). SARS itself is a \global public bad", but the international e®ort to halt its progress provided a \global public good", one whose bene¯ts are non-rival, non-excludable, and spill across borders.[1]

The World Health Organization was at the helm of SARS policy coordination, and increasingly international institutions like the United Nations and the World Bank are rede¯ning their missions in terms of global public goods provision too. Under this banner, priorities include constructing ¯nancial architecture, generating and spreading knowledge, peace-keeping, containing disease, and cleaning up the environment.[2] The World Bank (2001) estimates

[1] Non-rival goods are those like clean air whose consumption by one party does not diminish the consumption of another. Non-excludable goods are those for which it is practically impossible to restrict consumption (and thus impossible to ¯nance through voluntary user fees).

[2] The World Bank has identi¯ed ¯ve areas to work on: (i) communicable diseases (HIV/AIDS, tuberculosis, malaria, and childhood communicable diseases; vaccines and drug development for major communicable diseases in developing countries), (ii) environmental commons (climate change; water; forests; biodiversity, ozone depletion, and land degradation; promoting agricultural research), (iii) information and knowledge (redressing the Digital Divide and equipping countries with the capacity to access knowledge; understanding development and poverty reduction), (iv) trade and integration (market access; intellectual property rights and standards), and (v) international ¯nancial architecture (development and international standards; ¯nancial stability; international accounting and legal framework) [from \Strategic Directions for the World Bank Group Practicing Selectivity and Aligning Global Corporate Priorities with Country Goals," Senior Management Report, February 2001, as cited in Wilks (2001)]. For more, see www.gpgNet.net, a website devoted exclusively to global public goods issues.

that $16 billion was allocated to global public goods in developing countries in 2001.[3]

The rhetoric of global public goods underscores the notion that sending foreign aid overseas can deliver bene¯ts at home as well; in the SARS case, for example, helping to strengthen China's public health infrastructure also reduced risks in donor countries. The aim of this paper is to construct an analytical framework for considering broad classes of global public goods issues, taking seriously the idea that foreign aid is often provided strategically, with self-interest at least partly in mind.

Our starting point is that the content of global public goods can be controversial.[4] Some advocate ¯nancial architecture that allows greater °exibility in capital °ows while others seek greater controls. Some advocate knowledge generation on policy that gives a strong role for public agencies while others promote private sector inititiatives. Some seek environmental accords that balance concerns with employment while others are reluctant to accept trade-o®s. As these examples suggest, disagreements center on both the quantity and the quality of global public goods. In the standard analysis of public goods, however, the starting point is consideration of a single public good with given characteristics and qualities (e.g., Samuelson 1954). Citizens may get more or less bene¯t from it and they may in turn be willing to contribute more or less to its provision, but its de¯nition is not at issue.

Our second building block is allowing welfare to be a function of multiple public goods, not just a single public good as in the traditional case: we thus focus on strategies that a®ect which of many possible public goods are produced and what their characteristics are. In the standard case, welfare losses are created by free-riding that leads to under-provision. Here in contrast, where quality matters and where bene¯ts are non-excludable, countries may strategically encourage free riding in order to a®ect subsequent decisions by other countries.[5] Given that quality is an issue, di®erent coalitions may

[3]James Gustav Speth, the former Administrator of the UN Development Program writes in the forward to Global Public Goods: International Cooperation in the 21st Century (Kaul et al, 1999), \a globalizing world requires a theory of global public goods to achieve crucial goals such as ¯nancial stability, human security or the reduction of environmental pollution ::: Indeed [the authors] point out that many of today's international crises have their roots in a serious undersupply of global public goods."

[4]Unlike in the SARS example, where there was eventually wide consensus around the need for rapid containment.

[5]The standard literature on public goods considers investment in a given public good or service, where quality or variety is not at issue. The literature on local public goods,

choose to provide their own public goods, and, in principle, more than one public good may be produced (albeit of di®ering qualities). For example, in the case of knowledge, both access to free-market libertarian perspectives and access to interventionist thinking and experience might enhance the ability to make informed choices about social policy. Information on both types of analysis and evidence can be considered public goods, and, in those cases in which views are at odds, we ask how advocates that are strongly interested in pushing their case (e.g., markets vs. states) can move to limit the e®ectiveness of the opposition. We also investigate conditions under which strategies can best foster healthy, constructive dialogues.

The analysis is illustrated through discussion of two recent initiatives to provide global public goods: the proposal to start an Asian Monetary Fund in 1997 and the World Bank's decision in 1996 to become a \Knowledge Bank" that spreads information on international development policy (Wolfensohn 1996). In the ¯rst case, the International Monetary Fund took issue with the proposed AMF. By \shifting its quality" in the direction of the proposed AMF, the IMF was able to undercut support for the AMF and ultimately kill the proposal. Through strategic action, providing one public good undermined another. In the case of the Knowledge Bank strategy of the World Bank and other development agencies, we show how the Knowledge Bank can both \crowd in" and \crowd out" local knowledge and describe important roles for complementarities. Unlike in much of the theoretical literature on strategic information dissemination, welfare losses do not emerge here because information is concealed or distorted (e.g., Milgrom and Roberts, 1986). Rather, losses can occur due to strategic interactions even when information is provided transparently and honestly. Special attention is paid to the role of the non-excludability of bene¯ts in shaping strategies and responses.

2 Free-riding and under-provision

As with the standard public goods problem, the main policy challenge discussed so far with regard to global public goods has been how to overcome free-riding (the reluctance to voluntarily contribute fully to e®orts from which bene¯ts will be received without contributing; e.g., Samuelson 1954). Free-

on the other hand, focuses on quality and variety as well, but the bene¯ts of the goods are only local. Our analysis combines the wide-spilling nature of bene¯ts associated with globalization with the quality diversity associated with local public goods.

riding tends to lead to the under-supply of public goods, and one rationale for the existence of supra-national governments is that they can, in principle, overcome the resulting ine±ciencies.

The analytical work so far identi¯es approaches and priorities based on how global public goods vary in their degree of \publicness" and how e®orts by individual countries aggregate to create the ¯nal global public goods (e.g., Mody and Ferroni 2002). Sandler (1998), for example, notes that one way that a global public good Q may be determined is by the weighted sum of the contributions q of T individual countries, $\sum_{i=1}^{T} \alpha_i q_i$: Collective action is most di±cult where the weights $\alpha_i = 1$ for every country i since countries are just as well o® if they reduce their own e®orts in equal measure when others expand. The dominant strategy in this case is one in which countries make no e®ort at all. Where weights are not all equal, as with, say, the reduction of a \global public bad" like acid rain that is a®ected di®erently by e®orts in di®erent regions, a prisoner's dilemma is potentially avoidable and a positive level of e®ort may emerge in the decentralized equilibrium. With $\alpha_j > 0$, the welfare change is non-negative for everyone when country j increases public good provision, a result that does not hold in our setting because j's action can trigger responses that hurt some countries.

In other cases, Sandler (1998) notes that the global public good may be the product of the maximum e®ort: $Q = \max\{q_1; q_2; :::; q_T\}$, e.g., when considering development of medical technologies like an anti-malaria vaccine, and richer countries may be willing to take the lead in ensuring provision. The global public good may at other times be determined by the minimum e®ort: $Q = \min\{q_1; q_2; :::; q_T\}$, as with the containment of readily communicable diseases like SARS. In this case, richer countries, even when acting out of pure self-interest, may be willing to subsidize the e®orts of the weakest links (or work to enhance the income of the poorer countries). Direct subsidy and income-enhancement emerges as the chief way of in°uencing behavior.

The simple framework captures important features in global public good provision, and the focus on aggregation technologies nicely illuminates basic issues. To clarify quality issues and consider strategic complements and substitutes, though, it is more natural to treat aggregation technologies as general functions of the underlying e®orts of individual countries. So rather than focusing on the construction of a single public good Q made up of individual contributions q_i;we characterize contributions q_i as global public

goods in themselves.[6] We then focus on how shifting quality can influence the behavior of others and on implications for global welfare.

3 The basic model with two countries

In the basic model, there are two countries, N and S (roughly "North" and "South"[7]). Each country is capable of producing one unit of global public good. The quality of the public good can be strategically chosen by the respective countries from the real line R.

Country N acts as a leader, while Country S acts as a follower: Country N produces the public good without fail, choosing its quality q_N from R and using it regardless of the choice of the other country. After observing the choice of q_N, Country S has the choice set $\{;\} \cup R$; i.e., it chooses whether or not to produce the public good and its quality $q_S \in R$ if it produces it. We often write $q_S = ;$ to imply no production.[8]

The cost of producing the public good incurred by Country S is $c > 0$. In the basic model, it is assumed that the cost of production is incurred by the country that produces it. In the following, subscripts i and j stand for either one of the two countries, i.e., $\{i;j\} = \{N;S\}$.

3.1 Application to the Knowledge Bank

In thinking about this setup, we draw parallels to the World Bank's strategy to transform itself into a "Knowledge Bank". The idea is to help spread new solutions to common problems faced by low-income countries. Much of the motivation for the World Bank's involvement is their belief that the ideas would not otherwise be transmitted since "knowledge is a global public

[6] In the standard approach with a uniform quality of good, multiple provision would be redundant, but here it is natural to consider multiple goods, either competing or complementary. In focusing on strategic complements and substitutes, we formalize some of the analysis of Barrett (2002).

[7] Although, as with the case of the Asian Monetary Fund, "West" and "East" may be more appropriate.

[8] Two important simplifications are achieved by assuming that Country N produces always and always uses its public good. This means, taking one of our examples, that N never abandons the IMF to join the Asian Monetary Fund. Also note that, without loss of generality, we ignore N's costs of production. We have also simplified matters by assuming that cost is independent of quality.

good" and thus will be under-provided without coordination (Stiglitz, 1999). The World Bank has made great strides in this direction, and in 2000 the Bank was named one of the ¯ve top knowledge management organizations in the United States in one survey, and one of the top ten in another (according to experts in \Fortune 500" companies; see Fukuda-Parr and Hill, 2002, Box 3.1.4).

A distinction between \information" and \knowledge" is not always made, but we use the term \information" to refer speci¯cally to the advice, case studies, surveys, reports, and other bits of data that decision-makers use as inputs when making choices. Many have qualities of global public goods. \Being knowledgeable" or \having knoweldge" is in turn a function of having useful, relevant information and being able to process it. In this terminology, \knowledge" is not a public good in itself, but it is a product of having various kinds of information, which are public goods.[9]

As a \Knowledge Bank", the World Bank provides many kinds of information to those who seek it, some via the internet, some through documents and survey data, and some through conferences and face-to-face meetings. In the six years since announcing the Knowledge Bank strategy, the World Bank founded 37 distance learning centers, hosted 875 distance learning conferences, created 80 new practitioner networks, and run over 4,700 video conferences. Much of the information is at a fairly high-level of analysis, and the hope is that users will gain a sense of broad options from the Knowledge Bank and then ¯gure out local implementation independently. This follows the dictum to \scan globally and reinvent locally" (Stiglitz, 2001). One way of formalizing the notion is that being knowledgeable puts together (at least) two kinds of information, both of which are public goods. The ¯rst type of information is q_N, which is high-level and global (e.g., \best practices" for designing health systems). The second is q_S; which re°ects the particular context, objectives, and constraints of the decision-maker; while these \lower-level" elements may be locally-de¯ned, useful information on them may come from learning about experiences in other countries. The quality continuum R might thus be seen as proceeding from high-level information to locally-relevant information.

A di®erent way of thinking about knowledge in this framework is that

[9] The terminology contrasts with a usage common in game theory, where \information" is used with regard to learning about parameters and \knowledge" is used with regard to learning about the structure of the game or the economy.

being knowledgeable entails access to data and analysis re°ecting alternative viewpoints{for example, \orthodox" positions (q_N) together with counter-arguments and critical alternatives (q_S): The question is whether and how the varying positions are represented.

The World Bank has a special role here since for decades it has been the world's leading producer of development research and ideas. At the same time, the World Bank is not a neutral actor (Fukuda-Parr and Hill, 2002), and critics have questioned \whether the Bank has the legitimacy and trust from all parties to be involved" (Wilks, 2001). A Swedish study argues, \The World Bank continues to be dominant as the main purveyor of development ideas. Although its policy prescriptions change signi¯cantly over time, a `the Bank can never be wrong' mentality still prevails in much of the institutions thoughts and actions."[10] The Bank itself admits fairly frequent failure: in 1996, 31% of projects were classi¯ed as \unsatisfactory" by the Bank's in-house evaluation department, improving to 22% by April 2003.[11]

A di®erent kind of study is needed to weigh these claims. Our argument is instead that even if the information provided by the World Bank is accurate and transparent, its role is complicated. The World Bank is both an information provider and an advocate for particular policies, most often coming down on the side of \market friendly" solutions. As an advocate of particular views, the choice of \quality" of knowledge can set in motion responses that further the Bank's position, whether fully intentionally or not. Our analysis focuses on cases in which the Bank's views and data are critical inputs to informed decision-making, but where having other views and data is required for a full picture. One essential concern is with the fate of those other views.

3.2 Payo® functions in reduced form

For the most part, we assume that countries ultimately care only about their own income and consumption.[12] Each country uses global public goods to

[10] From A Foresight and Policy Study of Multilateral Development Banks (MDBs), prepared by the Institute of Development Studies for the Swedish Ministry of Foreign A®airs (cited in Wilks, 2001).

[11] Data are from April 2003, from \A Changing World Bank", posted on DevNews Media Briefs on the World Bank website, www.worldbank.org

[12] When discussing policy, objectives might instead be poverty reduction or meeting speci¯c goals like improving health and easy access to clean water{but the analysis will

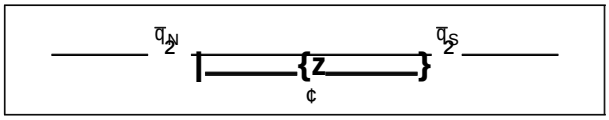

Figure 1: Ideal qualities of Countries N and S

produce a private good or to create a new institution or policy, and each country can take advantage of a global public good regardless of its producer. Thus $y_i = f_i(q_N; q_S)$ is the amount of private good/institution/policy produced by Country i: (To simplify exposition, we will refer to the private good interpretation of y_i only.)

The payo® function of Country i is $v_i(y_i)$, which is a function only of the production of the private good. The utility function of Country i in reduced form is thus $u_i(q_N; q_S) = v_i(f_i(q_N; q_S))$. In order to calculate the net payo® of Country S, one has to subtract c from the gross utility obtained above if it decides to produce.

Country i's utility in reduced-form, $u_i(q_N; q_S)$; is assumed to be concave on $R \pounds R$ as well as on $R \pounds f; g$. We also assume that Country i has an ideal quality $\bar{q}_i$ in R, i.e., $u_i(\bar{q}_i; q) > u_i(q'; q)$ and $u_i(q; \bar{q}_i) > u_i(q; q')$ for all $q \; 2 \; R \; [\; ;$ and $q' \; 2 \; R \; ¡ \; f\bar{q}_i g$. We assume $\bar{q}_N < \bar{q}_S$ for convenience. Let $¢ = \bar{q}_S \; ¡ \; \bar{q}_N$.

Country S can free ride on the provision of the public good by N, though it tends to be the case that the free rider has to accept a quality that is not particularly preferred by itself. For example, if Country N produces a public good of quality q_N, and Country S chooses not to produce, then Country N obtains the total payo® of

$$u_N(q_N; \; ;);$$

and Country S obtains

$$u_S(q_N; \; ;):$$

On the other hand, if Country S produces its own public good at q_S, Country N obtains the total payo® of

$$u_N(q_N; q_S);$$

be similar.

and Country S obtains

$$u_S(q_N; q_S) \; ¡ \; c:$$

4 Subgame perfect equilibria

Country S's only decision is whether to produce a global public good or not. If it does produce, it will do so at quality $\bar{q}_S$. To see this, consider the case in which Country N is not a®ected by whether Country S free-rides or not. In this case, Country N chooses $q_N = \bar{q}_N$ since no other factor a®ects its utility. Thus, the analysis is reduced to seeing if Country S produces the good at $q_S = \bar{q}_S$, which is determined by the relative size of $u_S(\bar{q}_N; ;)$ and $u_S(\bar{q}_N; \bar{q}_S) \; ¡ \; c$. It produces if the latter outweighs the former.

The South's decision to not produce independently may be bene¯cial to the North. In the case in which the public good involves setting standards, for example, we have

Condition A. $u_N(q_N; ;) > u_N(q_N; \bar{q}_S)$ for all $q_N \; 2 \; R$.

Here, every country is best o® using the same standards rather than creating their own. Assuming that Country S is comfortable with the standards set by q_N, it decides not to produce its own version of the public good ($q_S = ;$) even at zero cost ($c = 0$): In other cases the nature of standards and quality may be at issue so that choices will hinge on the balance of bene¯ts and costs of producing at various qualities. The condition captures the °avor of the aggregation technology $Q = \max\{q_1; q_2; :::; q_T\}$ described in Section 2.

The opposite condition:

Condition A^c. $u_N(q_N; \bar{q}_S) > u_N(q_N; ;)$ for all $q_N \; 2 \; R$,

occurs if the North obtains bene¯ts from the public good provided by the South (it has the °avor of the function $Q = \min\{q_1; q_2; :::; q_T\}$ of Section 2). This case is standard in the public good provision literature, and below we use these two conditions to characterize results.

4.1 Strategic \convergence"

In general settings the North's payo® will be a®ected by the South's actions, and the North will choose the quality of its public good in part to in°uence

the South's subsequent choices. If the public goods are \substitutes", then the North would like to deter the South from providing its own public good (condition A), while if they are \complements", then the North would like to encourage its e®ort (condition A^c).

4.1.1 Substitutes (crowding out)

We ¯rst describe cases in which the North acts to deter the South from producing their own competing public good. One example where this could happen is the case of standards mentioned above; another arises with trade policy, when the North wants to dissuade the South from creating its own cartel or customs union and instead to join the North in a global agreement that the North helps to design. A third example arises with information provision when advocates of policy positions supported in the North hope to dissuade others from gathering their own critical responses and formulating counter-arguments. Unlike the standard public good analysis, the North's aim here is to encourage the South to free-ride.

In terms of payo® functions, we have Condition A and

Condition B. $u_S(q_N; ;)$ ¡ $u_S(q_N; \bar{q}_S)$ is increasing in q_N.

Here, Condition A expresses the fact that the North wants the South to refrain from producing its own public good. Condition B implies that the South's incentive to produce its own public good diminishes as q_N comes closer to its ideal point $\bar{q}_S$. In these cases, Country N may choose to strategically shade its quality choice away from $\bar{q}_N$ (i.e., $q_N = \bar{q}_N$ may no longer hold) and move it toward $\bar{q}_S$.

To see this, suppose ¯rst that Country N chooses $q_N = \bar{q}_N$. There are two cases depending upon the relative size of $u_S(\bar{q}_N; ;)$ and $u_S(\bar{q}_N; \bar{q}_S)$ ¡ c. If the former is greater than the latter, then the best response of Country S is not to produce the public good, which in turn makes Country N choose $\bar{q}_N$.

But if the latter is greater than the former, i.e.,

$$u_S(\bar{q}_N; ;) < u_S(\bar{q}_N; \bar{q}_S) - c \tag{1}$$

holds, then we need more analysis. In this case, without some concession by Country N, Country S produces its own public good. Let $q^¤$ be the quality that satis¯es

$$u_S(q^¤; ;) = u_S(q^¤; \bar{q}_S) - c: \tag{2}$$

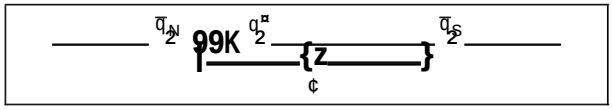

Figure 2: Country N shifts quality toward the ideal point of Country S

From (1), $c > 0$ and the continuity of u_S, such a q^{α} exists and lies in $(\bar{q}_N; \bar{q}_S)$ as depicted in Figure 2.

If Country N chooses q^{α} thus de¯ned, then Country S is indi®erent between producing and not-producing. Thus, a candidate of subgame perfect equilibria is the one in which Country N chooses q^{α}, and Country S produces $\bar{q}_S$ if and only if $q_N < q^{\alpha}$. For this strategy pro¯le to be an equilibrium, it must be the case that Country N prefers q^{α} chosen by both countries to $\bar{q}_N$ chosen only by itself, i.e.,

$$u_N(q^{\alpha}; ;) \geq u_N(\bar{q}_N; \bar{q}_S): \tag{3}$$

Proposition 1 Suppose that Conditions A and B hold. Then the followings are the (only) subgame perfect equilibrium outcomes of this game:

1. $u_S(\bar{q}_N; ;) > u_S(\bar{q}_N; \bar{q}_S) \Leftrightarrow$ c: N chooses $\bar{q}_N$, and S free rides upon it.
2. $u_S(\bar{q}_N; ;) < u_S(\bar{q}_N; \bar{q}_S) \Leftrightarrow$ c:
   (i) $u_N(q^{\alpha}; ;) > u_N(\bar{q}_N; \bar{q}_S)$: N chooses q^{α}, and S free rides upon it.
   (ii) $u_N(q^{\alpha}; ;) < u_N(\bar{q}_N; \bar{q}_S)$: N chooses $\bar{q}_N$, and S chooses $\bar{q}_S$.

In the ¯rst case, the South would free-ride if the North produced at its preferred quality level, $\bar{q}_N$: Since the North does not want the South to produce its own public good, the North has no incentive to do anything but produce at its ideal quality $\bar{q}_N$: In the second case, the South would not free-ride if the North produced at quality $\bar{q}_N$;and in order to induce free-riding, the North must shift the quality of its public good closer to the South's ideal point (case i). Case (ii), however, shows that moving closer to $\bar{q}_S$ is not always to the North's advantage and it may end up that both produce independent public goods.

Since the South acts voluntarily, all outcomes are Pareto e±cient. If there were pre-existing ine±ciencies, the North's strategy could exacerbate ine±ciencies, and in Section 6 we show a case with two southern countries in which collective action problems become worse when the North acts strategically.

Even if outcomes are e±cient in the present case, the North's move to spread information of quality q^{α} rather than $\bar{q}_N$ (perhaps touting the action in the name of global public goods provision) may reduce the total information used by decision makers since it deters simultaneous production of information by the South. As the example in section 4.4 shows, it may also reduce welfare. If the North had no choice but to produce at $\bar{q}_N$, the South would produce too and a greater quantity of total information would emerge. The example shows that, paradoxically, providing information that is closer to the ideal chosen by recipients, can in the end make people less informed.

4.1.2 Complements (crowding in)

Alternatively, actions by the North may \crowd in" e®orts by the South. Consider the case in which the North is eager for the South to also produce on its own. Moreover, the South sees the North's output as an important complementary factor to its own production. As the North shifts its quality closer to the South's ideal the complementarities grow, and it becomes more worthwhile for the South to also produce. If the North instead produced at its ideal point $\bar{q}_N$, though, it may not be worthwhile for the South to produce, providing an incentive for the North to shift from its ideal position toward the South's. One example is recent research on AIDS, where the North (in part under pressure from the South) developed protocols and medicines most relevant to low-income countries (rather than at a \quality" level most relevant for the North itself), and experts and practitioners in low-income regions in turn stepped up e®orts to complement the new technologies with appropriate delivery mechanicms and complementary treatments. Another example comes from e®orts to reduce chloro°uorcarbons to help protect the earth's ozone layer (Barret, 2002). In the 1970s the United States, Canada, Norway, and Sweden, among others, unilaterally reduced chloro°uorcarbon consumption. The Montreal Protocols then were negotiated to bring others into accord, and many European countries signed on, which was easier given the initial actions of the leading actors. Barrett argues that if the positive feedback had been strong enough, reductions could have been reached without a treaty. In our setting, the question is how much the early leaders were willing to voluntarily abate emissions{and how their actions helped push others to follow suit.

In terms of payo® functions, we have the mirror image of the previous case of \crowding out", i.e., Condition A^c and

Condition B^c. $u_S(q_N;\,;) - u_S(q_N;\bar{q}_S)$ is decreasing in q_N.

Here, Condition A^c expresses the fact that the North wants the South to produce its own public good. Condition B^c implies that the South's incentive to produce its own public good increases as q_N comes closer to its ideal point $\bar{q}_S$. In these cases, Country N may choose to strategically shade its quality choice away from $\bar{q}_N$ and move it toward $\bar{q}_S$.

Now de¯ne $q^{\alpha\alpha}$ as the q satisfying:

$$u_S(q^{\alpha\alpha};\,;) = u_S(q^{\alpha\alpha};\bar{q}_S) - c$$

if $u_S(\bar{q}_N;\,;) > u_S(\bar{q}_N;\bar{q}_S) - c$. The condition states that the South would free-ride if the North produces at $\bar{q}_N$. But if the North produces instead at quality level between $\bar{q}_N$ and $\bar{q}_S$; it can ¯nd a point $q^{\alpha\alpha}$ at which the South is indi®erent between producing and not.

Proposition 2 Suppose that Conditions A^c and B^c hold. Then the followings are the (only) subgame perfect equilibrium outcomes of this game:

1. $u_S(\bar{q}_N;\,;) < u_S(\bar{q}_N;\bar{q}_S) - c$: N chooses $\bar{q}_N$, and S chooses $\bar{q}_S$.
2. $u_S(\bar{q}_N;\,;) > u_S(\bar{q}_N;\bar{q}_S) - c$:

   (i) $u_N(q^{\alpha\alpha};\bar{q}_S) < u_N(\bar{q}_N;\,;)$: N chooses $\bar{q}_N$, and S free rides upon it.

   (ii) $u_N(q^{\alpha\alpha};\bar{q}_S) > u_N(\bar{q}_N;\,;)$: N chooses $q^{\alpha\alpha}$, and S chooses $\bar{q}_S$.

In the ¯rst case, the South would produce if the North produced at its preferred quality level, $\bar{q}_N$: Since the North wants the South to produce its own public good, the North has no incentive to do anything but produce at its ideal quality $\bar{q}_N$: In the second case, the South would free-ride if the North produced at quality $\bar{q}_N$;and in order to deter free-riding, the North must shift the quality of its public good closer to the South's ideal point (case ii). Case (i), however, shows that moving closer to $\bar{q}_S$ is not always to the North's advantage and it may end up that the North accepts the South's free-riding.

In the context of information, the result says that if the North does a better job of customizing its information production to accord with the South's constraints and objectives, the South will be in a better position to use it{ and to generate its own complementary information. But if the information

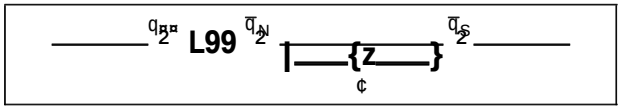

Figure 3: Country N shifts quality away from the ideal point of Country S

provided by the North is less useful, the South will have less incentive to produce on its own. Without, for example, data collection supported by the North, the South sees limited value to generating the analytical frame or comparative cases to contextualize results. Another example is given by Sandler and Arce (2002), who point to important complementarities between the World Health Organization's biomedical expertise and the World Bank's information-spreading capabilities. By strengthening its ability to disseminate health-related ¯ndings, the Bank's Knowledge Bank strategy in turn raises the return to WHO research and can spur it forward.

4.2 Strategic \divergence"

Strategic \divergence" might occur, too. In this case, we may observe the opposite strategic move of the North, i.e., it may locate its public good away from $\bar{q}_N$; moving it further away from $\bar{q}_S$ as depicted in Figure 3. We call this \divergence" in the sense that strategic concerns make the North choose a quality further away from the South's optimum than the North would othersie choose. Non-excludability has particular bite here.

4.2.1 Substitutes

Suppose that Condition A^c and Condition B hold. De¯ne $q_{\alpha\alpha}$ as q satisfying:

$$u_S(q_{\alpha\alpha}; ;) = u_S(q_{\alpha\alpha}; \bar{q}_S) \text{ ¡ } c$$

if $u_S(\bar{q}_N; ;) > u_S(\bar{q}_N; \bar{q}_S)$ ¡ c. The condition states that the South prefers free-riding to both producing{as long as the North produces at its ideal point $\bar{q}_N$. The quality level $q_{\alpha\alpha}$, if it exists, is the q chosen by the North below q_N at which the South is indi®erent between producing on its own and not.

Proposition 3 Suppose that Conditions A^c and B hold. Then the followings are the (only) subgame perfect equilibrium outcomes of this game:

1. $u_S(\bar{q}_N;;) < u_S(\bar{q}_N;\bar{q}_S) - c$: N chooses $\bar{q}_N$, and S chooses $\bar{q}_S$.

2. $u_S(\bar{q}_N;;) > u_S(\bar{q}_N;\bar{q}_S) - c > u_S(0;;)$:

   (i) q^{**} does not exist, or $u_N(q^{**};\bar{q}_S) < u_N(\bar{q}_N;;)$: N chooses $\bar{q}_N$, and S free rides upon it.

   (ii) q^{**} exists and satisfies $u_N(q^{**};\bar{q}_S) > u_N(\bar{q}_N;;)$: N chooses q^{**}, and S chooses $\bar{q}_S$.

In the first case, the South would produce if the North produced at its preferred quality level, $\bar{q}_N$; so the North simply chooses its ideal quality $\bar{q}_N$: In the second case, the South would free-ride even if the North chose the quality 0 furthest away from the South's ideal point. Given that, the North opts to accept free-riding and produces at its own ideal point $\bar{q}_N$: In the third case, if the North chooses a quality level between 0 and $\bar{q}_N$, the South will be induced to produce too. In case (i), there is no such quality level that the North prefers to $\bar{q}_N$. But in case (ii) such a point exisits and the North shifts its quality further from the South's ideal point in order to get the South to produce on its own.

4.2.2 Complements

Finally, consider the case in which the North wants to deter the South from producing (Condition A) and the South is more likely to produce as q approaches $\bar{q}_S$. Here, if the North produces with quality $\bar{q}_N$, it may still not be enough to deter the South. Define q^* as q satisfying:

$$u_S(q^*;;) = u_S(q^*;\bar{q}_S) - c$$

if $u_S(\bar{q}_N;;) < u_S(\bar{q}_N;\bar{q}_S) - c$. The condition states that the South prefers producing to free-riding if the North produces at its ideal point $\bar{q}_N$. The quality level q^*, if it exists, is the q chosen by the North below q_N at which the South is indifferent between producing on its own and not.

Proposition 4 Suppose that Conditions A and B^c hold. Then the followings are the (only) subgame perfect equilibrium outcomes of this game:

1. $u_S(\bar{q}_N;;) > u_S(\bar{q}_N;\bar{q}_S) - c$: N chooses $\bar{q}_N$, and S free rides upon it.

2. $u_S(\bar{q}_N;;) < u_S(\bar{q}_N;\bar{q}_S) - c$:

(i) $q_¤$ does not exist or $u_N(q_¤; \bar{q}_S) < u_N(\bar{q}_N; ;)$: N chooses $\bar{q}_N$, and S chooses $\bar{q}_S$.

(ii) $q_¤$ exists and satis¯es $u_N(q_¤; ;) > u_N(\bar{q}_N; \bar{q}_S)$: N chooses $q_¤$, and S free rides upon it.

In the ¯rst case, the South would free ride, which is preferable for the North, if the North produced at its preferred quality level, $\bar{q}_N$; and therefore, the North simply chooses its ideal quality $\bar{q}_N$: In the third case, if the North chooses a quality level below $\bar{q}_N$, the South will be induced to free ride upon it. In case (i), there is no such quality level that the North prefers to $\bar{q}_N$. But in case (ii), such a point exists and the North shifts its quality further from the South's ideal point in order to get the South to free ride upon it.

4.3 Summary

The summary of strategic moves of the North is shown in Table 1.

	B	B^c
A	convergence North only	divergence North only
A^c	divergence both produce	convergence both produce

Table 1: Summary of strategic moves

The top left-hand corner captures crowding out, while the bottom right-hand corner re°ects crowding in. In the bottom left corner, where A^C and B hold, the North must produce at a level su±ciently less appealing to the South such that the South is induced to produce on its own. In the top right corner, where the North seeks to deter the South's production, moving away from the South's optimum reduces the South's return from producing as well.

4.4 Welfare implications: an example

We have described strategic behavior from a purely positive perspective. From a normative standpoint, there is no reason to believe that the level and

positions of public goods thus provided are optimal. The public good may be over- or under-produced.

Suppose that the welfare of the world economy is the sum of the two countries' payo®s. This criterion would be especially plausible if, for example, there was a global government capable of transferring payo®s. More generally, the utilitarian welfare function provides a good benchmark for considering welfare

Since the purpose of the welfare analysis is not to provide comprehensive results, we specify the payo® functions as follows (we also let $\bar{q}_N = 0$ and $\bar{q}_S = 1$):

$$u_N(q_N; q_S) = \begin{cases} -(q_N)^2 + E & \text{if } q_S = \bar{q}_S = 1; \\ -(q_N)^2 & \text{if } q_S = 0; \end{cases} \tag{4}$$

and

$$u_S(q_N; q_S) = \begin{cases} -\theta(1 - q_N)^2 + B & \text{if } q_S = \bar{q}_S = 1; \\ -(1 - q_N)^2 & \text{if } q_S = 0; \end{cases} \tag{5}$$

where E is the externality that the North incurs from the provision by the South, and B is the direct bene¯t the South obtains by producing its own public good. We suppose $q_S = \bar{q}_S$ whenever the South produces its own public good.

Functions (4) and (5) capture the distinctions made in the taxonomy above. When $E < 0$, the function corresponds to Condition A in which the North seeks to deter the South from producing, and $E > 0$ corresponds to Condition A^c in which the North wishes to encourage the South's production. When $\theta < 1$;the public goods have characteristics of substitutes (Condition B) and when $\theta > 1$ they are complements (Condition B^c).

Consider a global government that chooses q_N and q_S to maximize the sum of the payo®s of the two countries. If $q_S = \bar{q}_S$ is chosen, the ¯rst order condition implies that the optimal value $\hat{q}_N$ is given by

$$\hat{q}_N = \frac{\theta}{1 + \theta}.$$

On the other hand, if $q_S = 0$, then we have

$$\hat{q}_N = 1/2.$$

Thus, the total payoff $W(\hat{q}_N; q_S)$ of the world is given by

$$W(\hat{q}_N; q_S) = \begin{cases} -\frac{\bar{q}_S}{1+\bar{q}_S} + (E + B - c) & \text{if } q_S = \bar{q}_S; \\ -1/2 & \text{if } q_S = 0. \end{cases}$$

Suppose next that the two countries move independently as we analyzed in the previous sections. First of all, the position q^a, which is taken when the North deters the provision by the South, has nothing to do with the optimal positions above.

To see the possibilities of over- and under-provision, suppose $\bar{q}_S = 1$. This implies that the position of q_N does not affect the decision of S so that there will be no strategic move by the North, i.e., $q_N = \bar{q}_N = 0$. Also, in this case, we have a simple characterization of the solution: $q_S = \bar{q}_S = 1$ if $B > c$, and $q_S = 0$ if $B < c$. From (4) and (5), the total payoff is higher under $q_S = 0$ than under $q_S = \bar{q}_S$ if and only if $E + B < c$ holds. Over-provision may arise when both $B > c$ and $E + B < c$. Correspondingly, under-provision occurs when $B < c$ and $E + B > c$ hold.

Next, in order to illustrate a possibility of strategic moves, suppose that $E < 0$, $\bar{q}_S < 1$, and $B < c$ hold. This is the case in which strategic crowding out by convergence may occur. If, furthermore, $c - B < 1 - \bar{q}_S$ holds, then we have

$$q^a = 1 - \sqrt{\frac{c - B}{1 - \bar{q}_S}}.$$

Thus, from Condition 2.(i) of Proposition 1, strategic convergence occurs if

$$E < -\left(1 - \sqrt{\frac{c - B}{1 - \bar{q}_S}}\right)^2.$$

5 Transfer from North to South

The analysis above highlights the roles of complementarities. One implication is that outcomes rest not just on the public goods that are provided but also on the capacity to take advantage of their presence. With regard to information, the World Bank (2001) report recognizes that just 2 per cent of people in developing countries have internet access, versus one third in

richer countries; one start is to push harder on reducing the global digital divide. Another is to continue building networks of development experts in low-income countries and making resources available to them (one example is the Global Development Network, www.gdnet.org). Another is to keep pushing to make more data publicly available. The analysis also carries a cautionary note: e®orts by richer countries to engage more intimately with policy discourse in low-income countries may spur increased activity by all (the hopeful case of \crowding in") but they might also crowd out e®orts when it is seen that the external e®orts are \good enough". The analysis in Section 4.4 showed that outcomes may not be socially optimal in these cases.

The results above show ways that leading countries can in°uence global investments in global public goods, even without recourse to subsidies or sanctions. Incorporating subsidies into the analysis could be done easily, though the analysis becomes less straightforward. Depending upon the decision making process of the amount of transfers, di®erent models emerge. One possible scenario is that Country N makes a unilateral decision on the transfer scheme and commits to it. A transfer scheme $(T_0; T_1)$ is a pair of nonnegative numbers where T_0 (resp. T_1) is the amount of transfer in case of $q_S = \ ;$ (resp. $q_S = \bar{q}_S$).

The game has two stages as in the basic model. In the ¯rst stage, Country N chooses $(T_0; T_1)$ as well as q_N. Observing it, Country S chooses $q_S \ 2 \ f \ ; ; \bar{q}_S g$ in the second stage.

In this case, Country N can make a take-it-or-leave-it o®er. The schemes that emerge will allow the North to a®ect the South's decisions without having to shift the quality of its public good as far away from the ideal point $\bar{q}_N$. The transfer mechanism thus plays o® against quality choices. By the same token, the North can reduce transfer levels by opting to shift the quality of the public good it produces. Introducing transfers attenuates the tendencies described above, but the spirit of the results remains intact.

Using the same speci¯cation as in Subsection 4.4, we can see the above argument analytically. Suppose $E < 0$, i.e., the North wants the South to refrain from producing the public good. Then, it must be the case that $T_1 = 0$. Therefore, the North chooses a pair $(q_N; T_0)$ to deter the provision by the South if it pays.

In order to deter the South's provision, the following incentive constraint must hold:

$$\ _i (1 \ _i \ q_N)^2 + T_0 \ \ , \ \ _i \ ^{-}(1 \ _i \ q_N)^2 + B \ _i \ c: \qquad (6)$$

If (6) holds, then the North's payo® is given by

$$-(q_N)^2 - T_0.$$

Therefore, the cheapest way to satisfy (6) is $(\tilde{q}_N; \tilde{T}_0)$ where

$$\tilde{q}_N = \frac{1-\bar{\gamma}}{2-\bar{\gamma}}; \tag{7}$$

$$\tilde{T}_0 = \frac{1-\bar{\gamma}}{(2-\bar{\gamma})^2} + B - c. \tag{8}$$

if $\tilde{T}_0 \geq 0$; otherwise, $(q^n; 0)$. The strategic convergence is more likely to occur under subsidy than otherwise if $\frac{1-\bar{\gamma}}{(2-\bar{\gamma})^2} + B - c \geq 0$. If this is the case, however, the degree of convergence is smaller under subsidy.

6 Multiple southern countries: Application to the proposed Asian Monetary Fund

The analysis above can also be extended to cases in which there are two or more southern countries. We take up one strand in detail in the next sections. The analysis so far is su±cient to address a di®erent set of issues that arises in the case in which the North wants to help one country but not others. In seeking a balance between objectives, our conjecture is that the case will lead to under-provision of the North's public good or a choice of quality shifted substantially away from the North's ideal point.

In a related case, the North may want to di®erentiate the public goods o®ered to di®erent countries (e.g., provide di®erent information and advice), but non-excludability of bene¯ts makes that di±cult. We conjecture that there are cases in which it may not be possible for the North to provide information at all, or the North may provide information only of one sort, to the loss of the other country. Lack of customization of information may thus emerge as a strategic outcome, not as a product of lack of resources, incentives, or will as is the common story (e.g., Khanna, 2000, p. 9).

One of the most important categories of global public goods concerns maintenance of world ¯nancial stability by creating appropriate ¯nancial architecture. No organization has been more important in this regard than the International Monetary Fund, which was created in 1944 to improve

the stability of the world ¯nancial system. The IMF's Articles of Agreement describe its goals as promoting international monetary cooperation and exchange stability; fostering economic growth and employment; and aiding countries facing short-term balance of payments di±culties. While IMF loans are private goods, the stability that is generated has the hallmark of a global public good.

The IMF is constituted as an international agency with inputs and representation from 184 member countries. Unlike in the United Nations, though, each country does not get an equal vote. Votes are determined in large part by ¯nancial contributions, so that the United States and, to a lesser degree, a handful of European countries have dominated the IMF's agenda and policymaking. Barro and Lee (2002) use cross-section panel data to show that IMF lending has been sensitive to a country's economic and political proximity to the United States. The higher are bilateral trade volumes and the higher the correlation of UN General Assembly votes with the US, the greater is the likelihood of receiving IMF support and, conditional on that, of getting larger loans. A slightly weaker pattern is found with regard to economic and political proximity to France, Germany, and the United Kingdom.

The Asian ¯nancial crisis of 1997 and 1998 was one of the most dramatic tests of the IMF, and criticisms became voluble in August 1997 as the IMF was putting together a ¯rst response to Thailand's crisis.[13] Policymakers in Asian countries, particularly in Japan, were upset by the harshness of conditions that the IMF was planning to impose on Thailand (together with the unwillingness of the US to contribute to a supplemental $10 billion emergency fund for Thailand). Malaysia's Prime Minister Mahathir was also eager to see greater regulation of international capital markets to limit currency speculators, a policy that initially found little favor at the IMF. That August, Eisuke Sakakibara, Japan's Vice Minister of Finance for International Affairs, began sketching a plan for an Asian Monetary Fund that could serve as an alternative funding mechanism to the IMF. It too would provide a global public good, but with di®erent qualities than the IMF. The Asian Monetary Fund's goal was to be able to coordinate larger sums to handle crises, and to do it faster than the rule-laden IMF. It would also give Asian policymakers a greater say in the terms and conditions of loans.

In principle, the IMF and the AMF could work alongside each other, but the IMF was worried about having an alternative mechanism to which

[13] This account draws on Blustein (2001), pp. 162-8.

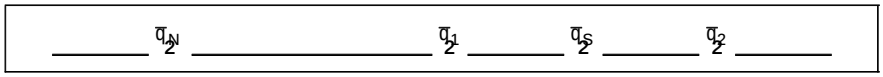

Figure 4: Two Southern Countries S_1 and S_2

countries could turn if they found the IMF's terms unpalatable. In particular, the IMF hoped to reduce the cronyism and close links between business and government that have long been part of the development model of many Asian countries. One fear was that the AMF proposal could be a way to dodge IMF attempts to clean up business-government links. The proposers of the AMF, in contrast, saw the main problems behind the crisis as lying with the unregulated international ¯nancial system, not the Asian model. The international ¯nancial architecture that would be pushed by the AMF would thus have a di®erent cast than that coming out of the IMF.

To illustrate the strategic issues behind the Asian Monetary Fund, we keep the basic setup intact, but introduce a third country to the model. This third country is essentially a replication of Country S of the two-country model, but the two countries, Countries S_1 and S_2, are di®erent in their ideal positions, and we can think of them, roughly, as China (S_1)and Japan (S_2), the two cornerstones of the Asian Monetary Fund strategy. Let q_i ($i = 1; 2$) be the ideal position of Country S_i. Ignoring the case of tie, we assume without loss of generality that $q_1 < q_2$ holds.

In order to focus on the issues associated with the diversity of the South, we assume, for the sake of simplicity, that neither S_1 nor S_2 has an incentive to produce the public good by itself, and therefore, when they produce one, they do so jointly. To express this point, we modify the model in the following manner. As before, Country N chooses $q_N \in R$ in the ¯rst stage. In the second stage, Countries S_1 and S_2 simultaneously make decisions: Country S_i ($i = 1; 2$) chooses a quality $q_i \in R \cup \{f; g\}$ and contribution $d_i \in [0; c]$. The second public good is provided by the South if and only if $q_1 = q_2 \neq$; and $d_1 + d_2 \geq c$, in which case $q_S = q_1 = q_2$ is chosen as the quality, and the cost shared by S_i will be $c_i = \frac{d_i}{d_1 + d_2} c$.

The payo® function of Country N is the same as before, and that of Country S_i ($i = 1; 2$) is also similarly determined, i.e.,

$$u_i(q_N; ;)$$

if the South does not produce the public good, and

$$u_i(q_N; q_S) - c_i$$

if q_S is provided by the South, and its share of burden is c_i. We assume that there exists the unique $\bar{q}_S \in (\bar{q}_1; \bar{q}_2)$ such that for all $q_N \in R$, for all $q_S \in R$, and for $i = 1; 2$,

$$u_i(q_N; \bar{q}_S) \geq u_i(q_N; q_S):$$

This assumption, albeit not innocuous, simplifies the analysis to a great extent in the sense that there is no dispute over the quality of q_S if it is produced jointly, and all the bargaining is made in terms of cost sharing. In the following, therefore, we assume that both S_1 and S_2 choose either $\bar{q}_S$ or $;$ in addition to d_1 and d_2, respectively.

We can now formally state one of the above assumptions mentioned informally: no southern country has an incentive to provide the public good all by itself even if it produces at its own ideal point: for all $q_N \in R$, and for $i = 1; 2$,

$$u_i(q_N; ;) > u_i(q_N; \bar{q}_i) - c:$$

6.1 Solution Concepts and Two Scenarios

If we adopt subgame perfect equilibrium as the solution concept, then we may face a classical problem of miscoordination in the second stage: both S_1 and S_2 choose $;$ simply because the other country chooses $;$. This happens even if they obtain a large surplus if they produce the public good jointly. This problem is overcome by refining the equilibrium concept. One way to do it is to consider undominated equilibrium in that each country does not use a weakly dominated strategy in equilibrium.

The subgame perfection coupled with undomination refines the set of equilibria, but still leaves a multitude of equilibria since the problem of the second stage is essentially reduced to that of the division of surplus between the two countries. In order to analyze the two-stage game, it would be better if we fix some rule as to how the cost is divided between the two southern countries. In the sequel, we consider two representative scenarios.

The first scenario is to divide the cost equally between the two as long as both obtain surplus through the provision of their own public good. If one of

the countries, say, S_1, obtain a negative surplus, while the bene¯t S_2 obtains exceeds the loss incurred by S_1, then and only then S_2 compensates S_1 so as to make the provision possible.

Second, if we introduce a little perturbation, say, in the cost c, then we can identify a single equilibrium outcome. To be precise, suppose that c˜ is a stochastic variable that follows a normal distribution with the mean of c and the variance of $¾^2$. Then the second stage subgame becomes the Nash demand game, and in the limit of ¾ converging to zero, we identify the Nash bargaining solution as the unique equilibrium outcome of the second stage (Nash 1953).

In the light of this argument, we assume, without formally incorporating the stochastic term, that the Nash bargaining solution is selected in the second stage. Since there is a transfer term, c_1 and c_2, S_1 and S_2 divide the second stage surplus equally. Thus, what determines the second stage outcome is the threat point that is a®ected by the choice of Country N in the ¯rst stage. We now turn to the analysis.

6.2 Analysis

Let q_N be given. If we use equal division as a basic cost sharing rule, then $c_i = c=2$ for $i = 1; 2$ if we have

$$u_i(q_N; \bar{q}_S) - c=2 > u_i(q_N; ;): \tag{9}$$

If (9) does not hold for Country S_i, then we have

$$c_i = u_i(q_N; \bar{q}_S) - u_i(q_N; ;):$$

and

$$c_j = c - c_i:$$

This result holds as long as we have

$$u_1(q_N; \bar{q}_S) + u_2(q_N; \bar{q}_S) - c > u_1(q_N; ;) + u_2(q_N; ;): \tag{10}$$

If this inequality is violated, they simply decide not to produce, relying solely on the public good provided by the North.

On the other hand, if the Nash bargaining solution is used to determine the share of the cost, we need to calculate the threat point ¯rst. For Countries

S_1 and S_2, the threat point is determined by choosing $;$. Given q_N, the threat point of the second stage bargaining is calculated as

$$(u_1(q_N;;);u_2(q_N;;)):$$

Assume a tie breaking rule according to which the South chooses non-provision in case of indi®erence. In the second stage, therefore, the public good is provided by the South if and only if

$$u_1(q_N;\bar{q}_S) + u_2(q_N;\bar{q}_S) \text{ ¡ } c > u_1(q_N;;) + u_2(q_N;;): \tag{11}$$

If (11) holds, then $\bar{q}_S$ will be provided, and the cost sharing is given by

$$c_i = \frac{1}{2}[c + fu_i(q_N;\bar{q}_S) \text{ ¡ } u_i(q_N;;)g \text{ ¡ } fu_j(q_N;\bar{q}_S) \text{ ¡ } u_j(q_N;;)g] \tag{12}$$

for $i = 1;2$ where $j \neq i$.

Once we determine the second stage outcome as above, the analysis of the ¯rst stage is essentially reduced to that of the two-country model, except for some welfare evaluation. Note that (10) and (11) are identical, i.e., that the condition under which the South jointly provides the public good is the same for both cost-sharing rules.

First, if there is no externality (i.e., the North is una®ected by the South's actions), Country N chooses $\bar{q}_N$ since no other factor a®ects the utility. Thus, the analysis is reduced to checking if the South produces the good at $\bar{q}_S$, which is determined by whether or not (11) holds for $q_N = \bar{q}_N$: if this inequality holds, then the second public good is produced, and not otherwise.

If the North is a®ected by the South's actions, then N may move strategically. In the ¯rst stage, what N can a®ect in its interest by choosing q_N strategically is whether or not the second public good is provided. Therefore, the key positions are $\bar{q}_N$ and q^{α}, which is given by

$$u_1(q^{\alpha};\bar{q}_S) + u_2(q^{\alpha};\bar{q}_S) \text{ ¡ } c = u_1(q^{\alpha};;) + u_2(q^{\alpha};;): \tag{13}$$

Consider the case of strategic complementarity in using public good. If either q^{α} satisfying (13) does not exist or $q^{\alpha} < \bar{q}_N$ holds, then the analysis becomes trivial as it is Country N's interest to play non-strategically by choosing $\bar{q}_N$.

If, on the other hand, q^{α} exists and satis¯es $q^{\alpha} > \bar{q}_N$, then Country N chooses q^{α} if and only if

$$u_N(q^{\alpha};;) > u_N(\bar{q}_N;\bar{q}_S): \tag{14}$$

If (14) holds, then the strategic move of the North leads to the collapse of the Southern league's attempt to produce the public good by itself; at least one of the Southern countries is better off by such a move of the North. If the North was instead forced to stay at its initial position $\bar{q}_N$, the Southern league's effort would have succeeded.

The situation parallels that of the Asian Monetary Fund strategy. The IMF (and the US Treasury acting along with them) wished to stop the AMF proposal before it could take root. The first step was to pressure Asian leaders, particularly in China, to back off from the plan, and China turned from being an AMF supporter to being agnostic. But to snuff the AMF, the IMF has to adjust its policies to adopt some of the AMF's agenda; in essence, the IMF shifted its own quality in the direction reflected by the AMF. Most importantly, the IMF agreed in November 1997 to allow greater regional involvement in dealing with the Asian crisis, and it established a new mechanism to provide larger loans more quickly than standard practice had allowed. In taking these steps, the IMF made sure that it remained in the leading role, even as it expanded fallback options for major crises. The proposed AMF idea thus died.

Turning back to theory, we can see that the welfare effect of such a strategic move is ambiguous. If we assume, however, that each country (of the South) uses and is affected by only one public good, then we may have a clearcut welfare evaluation. This assumption implies $u_i(\bar{q}_N; \bar{q}_S) = u_i(q^a; \bar{q}_S)$ for $i = 1; 2$. This equation together with Equation (13) implies

$$u_1(\bar{q}_N; \bar{q}_S) + u_2(\bar{q}_N; \bar{q}_S) - c = u_1(q^a; ;) + u_2(q^a; ;): \tag{15}$$

Therefore, in this case, the sum of the welfare levels of the two southern countries does not change by this strategic move of the North.

This does not mean that each country of the South is indifferent. Moreover, which country is better off and which worse off typically depends upon the cost sharing rule. Suppose that the two countries are more or less the same in terms of the need for the public good in the sense that

$$u_i(q_N; q_S) = \begin{cases} v(|q_N - \bar{q}_i|; |q_S - \bar{q}_i|) & \text{if } q_S \neq ; \\ v(|q_N - \bar{q}_i|; ;) & \text{if } q_S = ; \end{cases}$$

holds for both $i = 1; 2$ for some v. Note that v is concave and decreasing in its arguments.

Then in the first scenario of dividing the cost equally, it is the first country which gets the benefit. This is due to the inequality $q^{\ddagger} < \bar{q}_1 < \bar{q}_2$ together with the shape of the utility function assumed above.

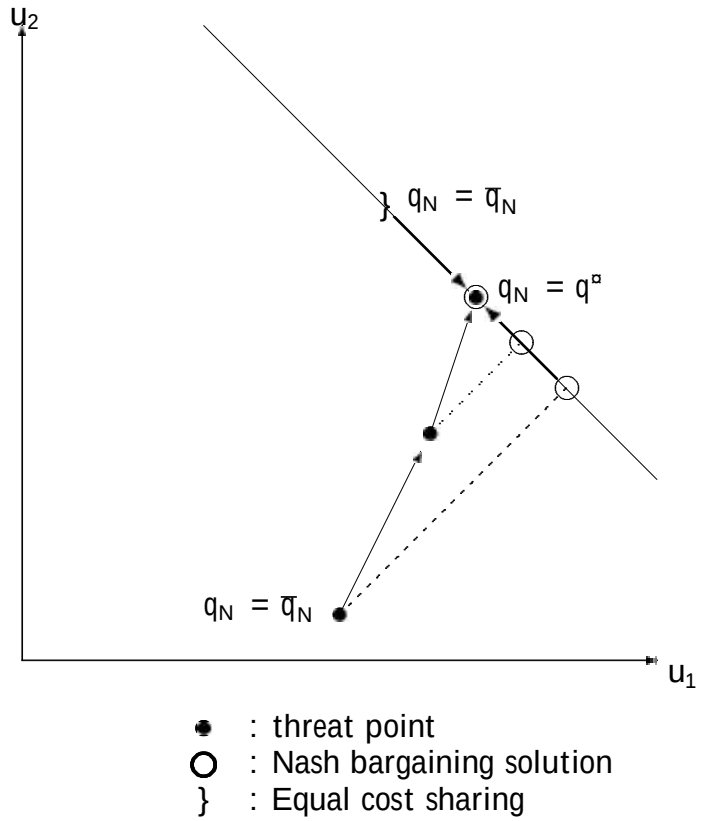

Figure 5: Nash bargaining and equal cost sharing: North's convergence changes the threat point

On the other hand, if the Nash bargaining solution is used for the cost sharing, then the result is reversed, i.e., Country S_1 is worse off, while Country S_2 is better off through the North's strategic move to choose $q^{\ddagger}$. This is due to the change in threat point in favor of S_2. Indeed, by way of concavity together with the above assumption on the shape of the utility function, we

have the following relationship between the two threat points:

$$u_1(\bar{q}_N; ;) - u_2(\bar{q}_N; ;) > u_1(q^{\alpha}; ;) - u_2(q^{\alpha}; ;):$$

From this inequality, (12) and (15), we obtain

$$u_1(q^{\alpha}; ;) < u_1(\bar{q}_N; \bar{q}_S) - c_1;$$

and

$$u_2(q^{\alpha}; ;) > u_2(\bar{q}_N; \bar{q}_S) - c_2:$$

The reason that we have different conclusions under two different scenarios can be seen in Figure 5. In order to see the logic behind the result, suppose that the position of the North does not affect the South once the public good is provided by them. Other things being equal, since $\bar{q}_2$ is located further away from $\bar{q}_N$ than $\bar{q}_1$, it is Country S_1 that obtains a greater benefit from the North's public good. Under the equal cost sharing rule, however, this benefit is wiped out because no consideration is made of this advantage. But when the North gets closer to the South so that the South decides not to produce the public good, Country S_1 obtains a higher payoff than S_2 since this advantage reappears.

In the case of Nash bargaining, the strategic advantage of S_1 mentioned above is directly reflected in the cost sharing, and it is Country S_2 that incurs the greater cost. As the North approaches toward the South, both countries gain provided that it is the only public good, but Country S_2's marginal gain exceeds that of Country S_1 because of the concavity of the payoff functions. Thus, the threat point moves toward north-north-east, which benefits Country S_2.

In the case of the Asian Monetary Fund, discussions did not get far enough for precise cost-sharing rules to be worked out. The post mortem discussion of the AMF suggests that Japan felt the blow the hardest, but partly that may reflect a broader discomfort with the strong show of power from Washington. Former Vice Minister of Finance Eisuke Sakakibara, looking back, noted that "we were taught a valuable lesson on the influence the United States wields in Asia" (Blustein 2001). Although the IMF had made concessions, in the end it was able to maintain its monopoly position.

7 Conclusions

For the most part, providing global public goods is an important way to improve the world's well-being. The countries of the world will be better o® with cleaner air and oceans, a healthier ozone layer, less acid rain, more stable ¯nancial systems, fewer virulent diseases, and better information. Traditional analyses of public goods have been helpful in explaining why it has been so di±cult to achieve those ends. Their focus is on under-provision and free-riding.

The Asian Monetary Fund controversy described above shows a case in which the issue was not at root whether or how much of a global public good could be provided. The ultimate debate was over the quality of the public good: what kind of ¯nancial stability? Generated on what terms? Issues around global public goods are often controversial, and we have put forward a framework to analyze competing strategies and their welfare implications.

The present paper shows that when countries behave strategically and when the quality of public goods is at issue, traditional analyses may come up short. In the context of knowledge and information, for example, the results show that in some cases information provision by one party can paradoxically lead to less information in total, even when there is no deception or distortion. In other cases, though, generating the right kind of information can spur others to generate complementary information{\crowding in" e®orts and leading to greater knowledge. The framework reinforces the role of building up complementarities through capacity-building.

References

[1] Associated Press (2003), \Toronto removed from SARS list" Houston Chronicle, July 2.

[2] Barrett, Scott (2002). \Supplying International Public Goods: How Countries can Cooperate," chapter 3 in Ashoka Mody and Marco Ferroni (eds.). International Public Goods: Incentives, Measurement, and Financing. Dordrecht, NL: Kluwer.

[3] Barro, Robert and Jong-Wha Lee (2002). \IMF Programs: Who is Chosen and What are the E®ects?" Harvard University and Korea University, unpublished manuscript.

[4] Blustein, Paul (2001), The Chastening: Inside the Crisis that Rocked the Global Financial System and Humbled the IMF. New York: PublicA®airs.

[5] Fukuda-Parr, Sakiko and Ruth Hill (2002). \The Network Age: Creating New Models of Technical Cooperation", chapter 3.1 in Sakiko Fukuda-Parr et al., eds., Capacity for Development: New Solutions to Old Problems. London: UNDP/Earthscan Publications Ltd.

[6] Kanbur, Ravi and Todd Sandler with Kevin M. Morrison (1999), The Future of Development Assistance: Common Pools and International Public Goods, ODC Policy Essay No. 25. Washington, D.C.: Overseas Development Council/Johns Hopkins University Press.

[7] Khanna, Anupam (2000), \Knowledge Creation and Management in Global Enterprises: Some Issues for Discussion", The World Bank, O±ce of the Vice President for Development Economics.

[8] Kaul, Inge, Isabelle Grunberg, and Marc Stern, eds. (1999), Global Public Goods: International Cooperation in the 21st Century. New York: Oxford University Press.

[9] Milgrom, Paul and John Roberts (1986). \Relying on the Information of Interested Parties," Rand Journal of Economics 17 (1), Spring: 18-32

[10] Mody, Ashoka and Marco Ferroni, eds. (2002). International Public Goods: Incentives, Measurement, and Financing. Dordrecht, NL: Kluwer.

[11] Nash, John (1953). \Two-person cooperative games," Econometrica 21: 128-40.

[12] Samuelson, Paul (1954). \The Pure Theory of Public Expenditure," Review of Economics and Statistics 36 (4): 387-9.

[13] Sandler, Todd (1998), \Global and Regional Public Goods: A Prognosis for Collective Action", Fiscal Studies 19(3): 221-47.

[14] Sandler, Todd (2002), \On Financing Global and International Public Goods," ch. 4 in Ashoka Mody and Marco Ferroni (eds.). International Public Goods: Incentives, Measurement, and Financing. Dordrecht, NL: Kluwer.

[15] Stiglitz, Joseph (1999), \Knowledge as a Global Public Good," in Inge Kaul et al, eds. Global Public Goods: International Cooperation in the 21st Century. New York: Oxford University Press.

[16] Stiglitz, Joseph (2001), \Scan Globally, Reinvent Locally: Knowledge Infrastructure and the Localization of Knowledge," ch. 6 in Ha-Joon Chang, ed., Joseph Stiglitz and the World Bank: The Rebel Within. London: Anthem Press.

[17] United States Agency for International Development (2002). Foreign Aid in the National Interest: Promoting Freedom, Security, and Opportunity. Washington, DC: USAID.

[18] Wilks, Alex (2001), \The World Bank's Global Public Goods Agenda: Good for Whom?" Essay posted on Bretton Woods Project website, (www.brettonwoodsproject.org/topic/environment/e22wbgpgs.html).

[19] Wolfensohn, James, D. (1996), \People and Development," speech at 1996 Annual Meetings of the World Bank and International Monetary Fund. (Available at: www.worldbank.org/html/extdr/extme/jdwams96.htm).

[20] World Bank (2001), \Poverty Reduction and Global Public Goods: A Progress Report," Report prepared for the IMF-World Bank Development Committee Meeting, April 13, 2001.