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Providing Global Public Goods:
Incentives and Determinants in Global Collective Action Problems

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Abstract:

Economic growth, technology change and the global integration of markets have helped to fuel demand across the world for a stable climate, control of infectious disease and protection from terrorism. Activities such as these have been labeled "global public goods" (GPGs) by scholars and government officials who find the public good paradigm useful for raising concerns that these activities will be underprovided in the absence of centralized coordination and cooperation. This paper addresses two prior theoretical questions upon which concerns of under provision must rest. First, what qualities are needed for a good to be counted as both public and global? Second, how should these goods be produced, provided and financed in a non-cooperative environment (one that lacks a global government capable of the coercive and legitimate threat of force)?

The first question is addressed by drawing on familiar arguments in public economics and political economy. The second question is addressed using arguments from non-cooperative game theory, analyzing the criteria for efficiency in provision. Given that GPGs are still principally provided by national governments to fulfill obligations to residents within their jurisdiction, and that public goods can be provided efficiently without government under certain conditions, strategies that assess and address the incentives of candidate providers may help formulate action to enhance supply. Using cross-country data, the determinants of provision are explored using a number of examples of GPGs including security, climate change, and global health..

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I. Introduction

Governments both provide institutional support for markets and correct their failures through the provision of certain public goods. The rapid international integration of markets in recent years (Maddison, 2002; Baldwin and Martin, 1999; Mittleman, 2003) raises a question: as markets globalize, should governance as well? Currently global markets exist without corresponding levels of global governance. Labor markets, for example, continue to be regulated by decentralized, national policies (OECD, 1996). In other markets, global coordination is required to avoid inefficiencies in standards or to reduce the use of inefficient "beggar-thy-neighbor" trade policies.[1] This suggests that global governance – if necessary at all – will be most important in addressing collective action problems resulting from national policies that have cross-border externalities.

Recently much thought has been given to the international provision of "global public goods" (GPGs), a term adopted to describe a range of policy goals such as sustainable environment, prevention of terrorism, fiscal stability and social protection. While the treatment of the subject and analytical focus has differed among the various authors supporting this paradigm, the argument made, broadly stated, is that these activities (1) entail cross-border externalities, (2) individual incentives faced by national governments may not be sufficient to ensure their efficient provision, meaning (3) greater international cooperation is required to address appropriately their financing and provision. Indeed, the World Bank in their very definition of GPGs, states that

> **Global public goods** are "commodities, resources, services—and also systems of rules or policy regimes--with substantial cross-border externalities that are important for development and poverty reduction, and that can be produced in sufficient supply *only through cooperation and collective action by developed and developing countries (*World Bank, 2002A)."

The demand for global public goods (GPGs) expanded in recent decades largely as a result of per capita growth, the integration of markets and accelerated social exchange (Friedman, 2000; Held, 1999; Stiglitz, 2002). Supply of GPGs has not kept pace with these changes and the result is an increasing shortfall of such goods (Kaul, 2003). Economists and other social scientists have written extensively about this imbalance, often seeking insights into means for reducing the

[1] The WTO, and its dispute settlement procedure in particular, were created to avoid just such policies. Braman (2002) offers a discussion of the evolution of standards with respect to food policies.

unfulfilled demand. Public goods are a form of market failure in which incentives for free riding obviate free market responses to the collective demands of individuals. A presumption for many public goods is that governments are required to provide them, thus responding to market failures by directly producing them or by indirectly (though subsidies and regulations) seeing to their production. Indirect public actions allow private economic agents to produce public goods by shifting private to social profitability in the payoffs for a country's productive units. Private actors, however, can also provide GPGs, without public intervention, at least under certain circumstances.

The following sections of this paper first clarify the "public good" (PG) concept, particularly as a global phenomenon, and then propose some arguments regarding various strategies by which provision of GPGs may occur. Efficiency in the provision of PGs varies, depending on context and on the nature of the good. We review and propose a basis for evaluating the efficiency factor. Please note that *other concerns, ones not actively addressed by the paper, including effectiveness and distributional [normative] considerations, are also important in determining and appraising global public goods.* Our paper concludes with preliminary empirical analyses that suggest that provision of considerable GPGs can substantially be left to private sector agents, although some national and intergovernmental government action is required for particular types of goods. Such public sector contributions are largely by national governments, but these need not adhere to normal expectations regarding proposed incentives for hegemonic countries (Kindleberger, 1973; Gilpin 2001), nor are state contribution's inherently successful as one-shot goods or provided by any "fair" distribution of burdens. In short, solutions to the "provision problem" for GPGs will require substantial additional analysis and better informed recognition of underlying incentives and preferences by economic and political agents.

II. Principles for analyzing Global Public Goods (GPGs)

Two questions central to any discussion of GPGs are: (1) what criteria define a good as both global and public, and (2) how can it be (best) provided? While much of the popular and political science literature pointing to a need for greater production of various global public goods is creditable, answers to even these fundamental questions has been diffuse, weakening consistent persuasive arguments. The traditional strict definition of public goods put forth in the economics literature has been expanded to include discussions of equity and decision making, and the arguments made often build from an assumption that governments – or even simply centralized collective action in general – are necessary to provide public goods. Both evidence and theoretical

arguments against this assumption have been made by Coase (1960; 1973), however. A review of economic principles may help to clarify the fundamental sources of inefficiency in public goods problems, and provide some direction for more effective thinking about the institutions necessary to help bring about efficient provision of global public goods.

A. GPGs: What are they?

The "Global Public Good" paradigm is intended to draw an analogy to "Public Goods" (PG) as commonly understood at the national level (Stiglitz, 2000), and without doubt the greatest value of the paradigm is the ability to draw on the familiar results of the lengthy public goods literature. In the traditional economics' discourse, a good is defined as "public" if it is both *non-rival* – meaning its value does not decrease with use – and *non-excludable* – meaning that its use cannot be prevented. Under the first criterion efficiency requires the good be freely available to everyone (as doing so is costless), while the second implies that insufficient financing of the PG is likely to result because contributions are voluntary (hence the free-rider problem).

As such, PGs can be thought of as an example of a larger problem of market externalities – private benefits and costs are not aligned with social benefits and costs. Contributions will be made voluntarily to public goods to the point at which private benefits of additional spending equal the marginal cost. As the social benefits of an extra dollar of public good spending exceed the private benefits, however, we can expect that decentralized decision making by individuals will lead to inefficiently low levels of public good provision.

Thus stated, this traditional problem of public goods is well established and the rationale for their production is widely understood; the issue we confront now is the extent to which the jurisdiction of such goods has now become global, at least for an important set. But this "global" question is not particularly new either; an extensive literature on fiscal federalism has addressed the issue of how responsibilities for public good provision should be distributed among various hierarchical levels of governing authority (Oates, 1999). Oates argues that the balance of responsibilities between the centralized authority of the U.S. federal government and decentralized decision-making by individual state and local governments should be set so that the federal government takes responsibility for public goods over which preferences are relatively uniform, fixed costs of provision are relatively high, and for which decentralized policy making by states might generate "race to the bottom"-style competition. The global jurisdiction, by analogy, operates under similar conditions in an analysis of PGs. Recent work by Alesina and Spolare (2003) makes use of these

ideas of hierarchical structures for provision of basic goods for explaining the number and size of nation-states. Drawing on insights from this literature we propose the following definition:

Definition: A ***Global*** Public Good is a public good that

a) extends non-rivalrous and non-excludable benefits across national borders
b) has relatively high fixed costs of provision
c) exhibits characteristics over which individuals' preferences are relatively uniform.

The first of these conditions is standard for the GPG concept in the literature; it is one without which a public good cannot legitimately be considered global. Note, however, that this is a much more restrictive definition than that employed by Kaul et. al. for whom a global public good extends benefits to all generations of all people in all countries. (2003, pp. 95-103).[2] Consider the case of a cessation of hostility between Israel and Palestine as a global public good. It seems to qualify in that it would extend security benefits widely across both territories as well as the Middle East and beyond. It might not reach the standards set by Kaul et. al., however, while Sandler (1998) would appropriately term this a regional public good. While distinctions such as this may be important, they raise questions of classification that—unnecessarily--complicate the points we wish to make without offering much additional insight into them. For this reason we simply note the distinction and move on to the second and third criterion which address the issue of whether a public good that <u>can</u> be considered global <u>should</u> be.

GPGs that require high fixed costs are best provided through large, centralized mechanisms to avoid costly redundancy in provision. Examples include languages, safety standards or other activities that involve network externalities.[3] Once a language is created, for example, it can be distributed for free – making it a pure GPG. But languages and standards can be difficult to achieve through centralized coordination, because preferences vary a great deal among interested parties over what language or standard to use in global interactions, with every country preferring their

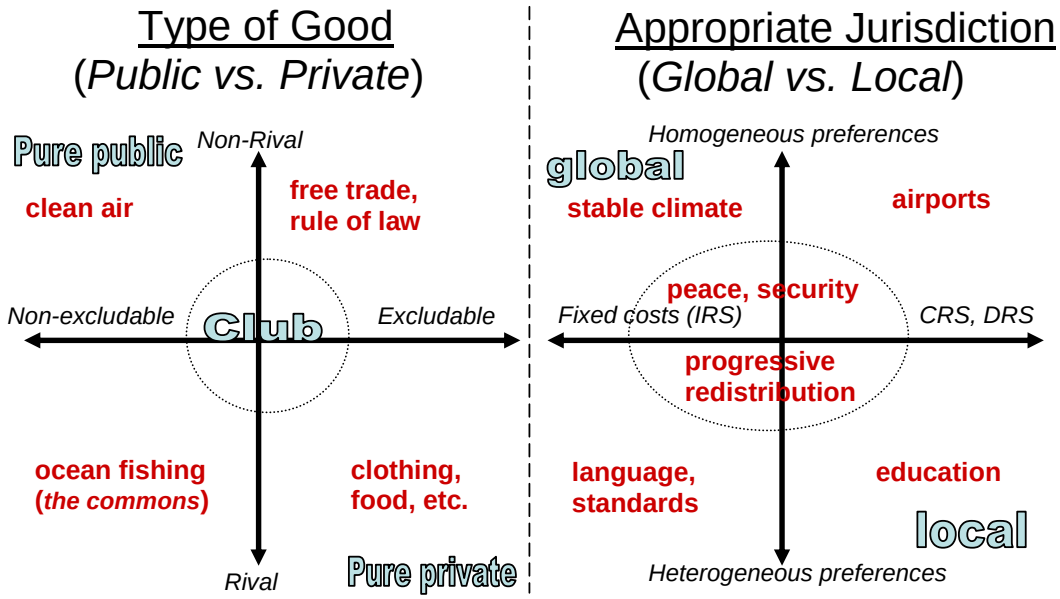
[2] Samuelson's classic essay [1954] assumed for its analysis a nation. Units within national state face similar problems in that analysis as countries do in the world. Local schools, for example, provide goods that can move, but are paid for by local taxes. Internationally this is brain drain or gain, depending on who gets what.

[3] Note high fixed costs related to low marginal cost, which is part of non-rivalry so of course a good's publicness and globalness are related!

own to others'[4]. This leads to the third criterion: goods over which there are uniform preferences should more appropriately be considered "global" in provision, while efficient provision of public goods over which substantial differences of opinion exist may require provision at a more decentralized level in the jurisdictional hierarchy.

Conclusion: airports are a public good over which there are relatively uniform preferences, but they do not fully qualify as a GPG because there is no particular cost efficiency basis for providing them through an over-arching world authority: national governments acting individually have fulfilled this provision efficiently. By comparison, language is a public good that entails a huge fixed cost (and low marginal cost), but the strong, and conflicting preferences over *which* language to adopt also argues against attempts to "manage" its provision in a centralized, cooperative framework. Thus a number of "goods" with global implications do not qualify as global public goods as suggested in Figure 1. So what does? We turn to that question after a review of the *efficiency* of provision question is addressed, to which it is related.

Figure 1: Variation among Goods: Public and Private---Global and Local



B. Efficient Provision of Public Goods

[4] On food safety standards that illustrate this, for example, see Hopkins, et. al. (2004).

Two solutions have been posed in economics to the fundamental externality problem for goods. The most familiar follows the reasoning of Pigou (1946), in which the externality problem is presented as one of establishing correct prices – that is, the equilibrium price in a market for the externality if it could be established. In the case of air pollution, for example, tax policy can be used to exact a "price" paid for clean air equal to that which would obtain if a market for clean air existed. This "Pigouvian" solution requires a government to play two roles: first, to can act as a centralized coordination agent, as a policy making body for spending and tax decisions, and second, to provide an enforcement mechanism to ensure compliance.

The public good literature largely takes as a given the state's enforcement capacity; it focuses therefore on the difficulties involved with any government's coordination role. The Clark-Groves mechanism for pricing (Dasgupta and Maskim, 2000), for instance, requires each party to announce their "valuation" of having clean air, and to pay a tax equal to the sum of the announced valuations of all <u>other</u> parties. Because the amount paid for clean air is independent of their announcement, preferences are revealed truthfully, eliminating the free-riding problem and allowing provision at an optimal level. In the absence of a centralized global institution with coercive power to levy assessments on countries, however, financing GPGs is not as easily divorced from preference aggregation and policy making.

Coase (1960) suggests an alternative to the externality problem, however, which, unlike Pigou's solution, does not require a centralized coordination mechanism but rather some (potentially arbitrary) assignment of liabilities over the externality's cost and the absence of transaction (or bargaining) costs. Coase noted that, when bargaining among parties is costless, Pareto efficient solutions (including efficient PG provision) should be expected (otherwise one party could propose an alternative they preferred to which all parties would agree; or, put another way, "no money should be left on the table" in such negotiations). In the case of the clean air, for example, the social cost of pollution exceeds the private cost to a polluter. However, once a government assigns a distribution of initial rights (either among households to enjoy clean air or among polluters to pollute), then if polluters and households are free to bargain with each other then the right to pollute can be bought or sold – achieving a Pareto optimum, just as in any market. However, in the presence of transaction costs (such as the inability to monitor polluting behavior) the bargaining process may break down. In the case of public goods, where social benefits of PG provision exceed the private benefits, a similar principal applies.

This suggests that even when formal markets do not exist, decentralized solutions to externality problems are *possible*, which has important implications for global collective action. It

should be noted, however, that yet again, an *implicit assumption is being made regarding the existence of some form of coercive institutional authority*, although in this case the responsibilities of that authority are limited to the ex ante assignment of liabilities and ex post enforcement of contracts rather than taxation and/or public good provision.

C. "Purity" and "Jurisdiction" of Public Goods

We return to the issue of GPG definition. As noted, not all public goods are pure public goods, of course.[5] In general, institutional, physical and social PGs are candidates for expansion to a global arena. Institutional public goods such a rule of law, physical goods such as communication facilities, and social goods such as health care may entail a certain amount of rivalry (congestion in use) or excludability, but are they sufficiently beneficial to people beyond those who are immediately engaged in their purchase or production, that the externality is seen to qualify them as issues of public concern. Early work on a specific global public good, collective security through military alliance, an institutional creation, reveals some free-riding behavior among NATO members (Olson and Zeckhauser, 1966). Alliances are most certainly impure GPGs, however, as inclusion of additional nations in such alliances entail some congestion costs to existing members and excludability is possible to some degree.[6] Another institutional GPG proposed by several authors in the Kaul volume, and others, is free trade. But the benefits of liberalizing markets are certainly excludable - indeed, the centrality of the Most-Favored Nation clause to the institutional structure of the GATT and WTO underline the potential for such exclusion. Thus NATO and WTO sustain activities that are partially rival and excludable and have thus been termed "club goods." In general, these suffer less from under-provision than purer public goods (Keohane, 2001; Cornes and Sandler, 1996; Buchanan, 1965). We will leave to other undertakings decisions as to how large positive externalities and free riding must obtain for a good to qualify as "public;" what is important to the discussion here is that these characteristics of "impurity" may have implications for how we think about governmental provision. Club goods may involve selective incentives, but these are complex, attracting a non-universal set of agents to band together, a process which itself heightens incentives to share in financing joint goods, including ones with global positive externalities.

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[5] A "pure" PG may have no empirical counterpart.

[6] In the case of the U.S. defense policy, for example, a country like Taiwan could be more easily excluded from the benefits of U.S. military deterrent than a country like Canada.

Another distinction among GPGs is the form of their manifestation. Type I, or "institutional" PGs such as property rights, contract enforcement, and physical safety (defense) are the most demanding of public sector provision, an observation recognized from Hobbes' time to recent emphasis on state building and the establishment of institutions of order and property rights over the entire world (Ruggie, 1993; Jackson, 1991; Fukuyama, 2004). Moreover, provision of institutional goods is mostly by states but this is no guarantee that such public goods will be effective or efficiently provided as state behavior is regularly skewed by domestic politics. Type III, or "social" public goods such as education, healthcare and social security are perhaps more closely aligned with the properties of private than pure public goods, however, even if they are frequently offered in a public framework with few exclusionary rules. This may be why global efforts at providing welfare or education goods have been least amenable to government provision, as incentives for private provision are substantial (World Bank, 2002A). Type II "physical" PGs, such roads, dams, and public buildings fall somewhere in between regarding the public/private beneficiary and government required provision. By and large, the issue of free-riding for items such as roads, and the high cost of collecting tolls over all roads if they were privately supplied—high transaction costs and uncertain property rights without a sovereign capacity to exercise "eminent domain" rules—leaves the provision of those physical goods whose excludability is low to public provision as the most efficient mechanism.

Table 1: Levels of goods

Level of Good	**Criteria:**	**Examples:**
Private Goods	Individually rivalrous and excludable	food, clothing, haircuts
Club Goods	largely individually non-rivalrous but excludable	swimming pools, credit unions, toll roads
National Public Goods	individually non-rivalrous and excludable, but nationally rivalrous and excludable or which offer limited global economies of scale and for which there are heterogeneous preferences	national defense, domestic law enforcement, highways, educational standards
Global Club Goods	internationally non-rivalrous, but excludable	free trade (WTO), IATA rules
Global Public Goods	Internationally non-rivalrous and non-excludable, human rights norms	climate change, eradication of disease

In some cases private and public benefits may coincide: basic medical care is a private good, but immunizations are better characterized as a public good because the majority of the benefit is not to the individual, but to society as a whole. Therefore, rationing vaccines through a market mechanism is likely to result in too few vaccinations occurring.

D. Roles and Goals of Global Institutional Capacity Building

Provision of GPGs, as we have noted, can be by public or private agents, and occur when even one "player" has sufficient incentive to finance the good, as with hegemonic provision (Keohane, 1984). The unreliable performance of a hegemon or even gang of a few, coupled with the uncertain tenure of any superpower (Gilpin, 1982; Rosenau, 2005) leads to a strong rationale for the establishment of basic bargaining principles – i.e. property rights/liabilities such as the case where it is determined that the polluter pays. Property rights and expectations of enforceable agreements, even if resting on self-enforcing incentives rather than a central coercive legal authority, leads toward the 1} an elimination of transaction costs (as with an information clearing house that eliminates problems of asymmetric information) and 2) coordination of policies among states (Nye and Keohane, 2001) (that reflects bargaining to efficient solutions). This well understood reduction of transaction costs for agents to seek decentralized and efficient public or semi-public goods has two problems. First, public good interactions inevitably involve trade-offs (e.g. free trade vs. environmental goals; freedom of communications vs. security, etc.). This problem has been dealt with in the economic literature by models to resolve such conflicts based on classic market exchange solutions among agents stylized as unified states (Ederington, 2001; Brander and Taylor, 1998). Even with such efficient outcomes possible via bargaining where transactions costs are low, there remains the second problem, that of enforceability. In some cases, as with the WTO, there are self-enforcing features, as seen in economics through "Nash Reversion" – this works because there is a very modest, and potentially beneficial "3rd party effect" and in

political science as obtained because of the high costs to reputation and other agreements for defecting whenever a loss is encountered (Keohane, 1984). Such enforcement in the bargain arrangement itself is not the case with all rules for securing GPGs, however. In the case of environmental agreements or security arrangements, for example, defection or non-compliance is more tempting, and perhaps even prudent for country overall. To enhance enforcement assurance is such cases, a larger package of goods needs to be bundled together, hence leveraging public goods valuable variably by parties against each other to achieve an international and domestic win-set or stable, enforceable arrangement (Putnam, 1988).

Will such decentralized outcomes satisfy basic efficiency conditions? Here we note that two elements for efficiency to occur are relevant:

- Consumption – Samuelson condition
- Production – resource allocation occurs such that the ratio of marginal efficiency of contribution to GPG to the marginal cost to a country of that contribution is equalized across countries and thus any comparative advantage in provision of the good is exploited.

These two provision constraints are usually met in the normal course of international intercourse currently, with the layers of bargaining agents and large information sources available, as depicted in the graph above. They may be undermined, however, if the level of output in an importantly contributing country is physically prohibited from its provision (Iran may be willing to have super safeguards on nuclear processing but lacks the physical technology to do so); or demand for GPGs may be skewed by inequalities, so that necessary goods are given lower value than luxury goods. In this case, and the instance of famines with their large negative externalities may illustrate the point, global public goods respecting state's rights may be a luxury in terms of efficient welfare outcomes for the globe. While in such cases private goods (food) are the most appropriate avenue in the first instance, prior to seeking global insurance against a famine shock, bargaining is incomplete to settle conditions when such private and national solutions are inferior to international action (FAO, 2002; Hopkins, 2005), and hence emergencies and failures—as in Niger in 2005--continue to reoccur which are clearly a GPG failure given the high costs imposed on non-famine victims in neighboring states and even globally.

Further, the nature of the strategic bargaining between countries over GPG provision depends in part on the *type* of GPG – formulas for provision and financing therefore do not conform to a "one size fits all solution." Public action, and IGO facilitation may be crucial in some cases, but not for all goods. Nor can we count on self-enforcing incentives to work indefinitely; the ability to sustain "cooperative" solutions through repeated play may be compromised in part by the welfare implications on 3rd parties of the punishment strategies available. Hence, China or the US may or may not comply with all their WTO commitments relying solely on iterated and 3rd party consequences to act as enforcement mechanisms. The externalities that motivate such compliance for GPG provision are subject to the question of whether units meet the increased summation criteria of the Samuelson condition (externalities in consumption) and whether externalities in production (MRT) are affected negatively by other's contributions or lack thereof (e.g. weaker link).

E. Summary of GPG arguments

The greatest problems to provision of GPGs include lack of centralized coordination mechanisms, substantial transaction costs and – this may be most formidable--the lack of well-defined property rights over the public good. Once issues of establishing the status of a GPG, and analyzing incentives associated with its characteristics, mechanisms for securing efficient provision, including private provision within the existing weak authority system can and do occur. The major approaches to PGs reviewed above began from opposite assignment of agency—public for Pigou and private for Coase. Both apply to GPGs, and within these traditions one or other will be preferred based on features of the situation.

Pigouvian vs. Coasian Traditions

Pigouvian preferred if :	**Coasian preferred if:**
Asymmetric information	Complete information
Centralized authority exists	No centralized authority exists
Property rights not well defined	Property rights defined

What then should the role of global governance? National government action is the extant reality for power, setting the frame for markets (Moe, 2005). Rational choice options by various agents in this situation clearly benefit from analysis of tasks for government that encourage private provision, since the resources of global governmental bodies and even "regimes" that include

national ministries, as with the trade regime, have weak resources. As a product of the review above, it seems reasonable that national governments assign property rights and "liabilities" to goods so as to allow collective bargaining. While adopting coordinated policies and enforcement mechanisms is desirable, and even can aid in the creation the conditions for a Coasian approach, this should not be the overarching goal. Rather because rights and liabilities are problematic in the global arena – property rights among individual and collective agents and between current and future generations—solutions to environmental and other more pure type GPGs are especially unstable or attainable. For example – to address this problem the Kyoto protocol sought not only regulations—but also a cap and trade system—that would work once initial rights were distributed. In this case, permits, but ones based on 1990 levels – implicitly providing rewards to a large polluter—Russia, and obstacles for rapidly industrializing countries, such as China. Furthermore, the degree of enforcement domestically of such international accords is not symmetrical; hence the aversion even in advance by the US Senate to any agreement. Overcoming such asymmetrical institutional features will not be easy, but again some decentralized measures, perhaps by networks of cities and local jurisdictions applying incentives and entering into international trade of locally created pollution control instruments (Ruggie, 2004) might be underway. Finally, new mechanisms for addressing contracting problem would help. Typically the contract problem arises when contracts are enforceable, but cannot be completely specified (e.g. due to the infeasibility of writing a completely state-contingent contract). However, problems arise when contracts cannot be enforced, and this is especially a concern across borders.

Thus, a sensible proposal would be testing via global authority discussions[7] to insure the GPG is absent, the good will be badly undersupplied, and that a partial remedy will arise where decentralized solutions are possible. As with climate change concerns, for example, the initiative of individual firms and local jurisdictions, such as Seattle, decentralized agents may provide a GPG by financing technology and adopting regulations that capture gains they for see in reduced CO_2 emissions. The next section explores the conditions under which optimality may be possible under such decentralized strategies in a non-cooperative international environment.

[7] Either bilateral diplomacy or multilateral meetings (e.g. the UN).

III. Optimality of Provision in a Non-Cooperative Environment

We have argued against a number of the conventional assumptions made about GPGs; in particular, that a generalized public goods paradigm may be the most effective means to understanding the problem created by transnational externalities, and that co-operation via a centralized authority is a necessary remedy. The problem facing arguments both for and against the necessity of centralized decision making, however, is that "optimal level of provision" of a GPG is almost never easily identifiable. This is why such arguments have relied heavily on *a priori* theorizing, rather than empirical analysis.

In this section we will attempt to assess the extent to which individually optimal, decentralized decision making among states, acting in the absence of any global enforcement mechanism, can generate efficient outcomes in public good situations. The model employed is a highly stylized, but highly familiar tool of game theory: a 2x2 matrix in which two agents (countries) each choose between two actions: they either contribute (*C*) to a public good or don't (*D*). The simplified nature of the model leads to rather stark results – in particular, free-riding through "too small" a contribution is not possible as it would be if the action space were continuous – but it helps to clarify a few important insights that might otherwise be obscured by complex mathematics. Moreover, while an imperfect representation of continuous policy choices like "how much to reduce carbon emissions" or "how many peacekeeping troops to provide", the binary-choice contribution framework can be thought of as representative of policies like "do we ratify the Kyoto Protocol or not."

A. The Basic Model

A public good game is played between two agents (countries), each of which chooses either to contribute (C) or defect (D). The public good is valued equally by both players, although the costs of their contributions may differ. The payoffs are as follows:

		Player B	
		C	D
Player	C	$\alpha - c_A$, $\alpha - c_B$	$(1-\delta)\alpha - c_A$, $(1-\delta)\alpha$
A	D	$(1-\delta)\alpha$, $(1-\delta)\alpha - c_B$	0,0

This parameterization has the following interpretation. Given contributions by both players, the perceived value of the public good to each player is α. If only one player contributes, however, the value of the public good falls by a discount factor $\delta \in [0,1]$. This parameterization allows for a range of public good aggregation technologies, including as special cases the traditional "summative" form (*the value of the public good equals the sum of the contributions*) when $\delta = ½$, as well as what Hirschleifer (1983)[8] terms "weakest-link" technologies (*the value equals the smallest contribution*) when $\delta = 1$, and "best-shot" technologies (*the value equals the largest contribution*) when $\delta=0$.

Assume that players have complete information regarding costs. The best response function $\sigma_j(s_{\sim j})$ of each player *j* faced with their opponent's strategy $s_{\sim j}$ can be written

$$\sigma_j(C) = C \quad iff \quad c_A < \delta\alpha$$
$$\sigma_j(D) = C \quad iff \quad c_A < (1-\delta)\alpha$$

Note that in weaker-link cases (where $\delta > ½$), a player is more likely to contribute if the other player does as well (that is, the range of costs that will induce that player to contribute is larger when the other player contributes). In better-shot cases (where $\delta < ½$), a player is less likely to contribute if the other player does. This corresponds with our intuition from the familiar extreme cases presented by Hirschleifer, where in the weakest-link case, a player will only contribute if the other does, and in the extreme best-shot case a player will never contribute if the other does.

In the traditional "summative" case where $\delta = ½$, players always have a dominant strategy – either to contribute or not, depending on whether their cost is below or above ½α. In this sense there is no "free-riding," [9] as one player's actions are entirely independent of the other's, although we will see that a socially inefficient outcome is still possible.

B. When is the Nash Equilibrium also Socially Optimal?

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[8] Hirshleifer, Jack (1983), "From Weakest-Link to Best-Shot: the Voluntary Provision of Public Goods," *Public Choice*, 41, 371-86.

[9] This is a result that differs from the continuous contribution case, where a player might contribute but not enough to obtain the social optimum.

Given a value for δ and a set of costs $\{c_A, c_B\}$ the Nash Equilibria of the game can be calculated by comparing best-response functions above. Similarly, the Social Optimal outcomes can be found as a function of costs by summing the payoffs in each square of the matrix, and calculating the maximum. These conditions are each derived and explained in an Appendix to the paper. Figure 2, below, compares these conditions graphically.

The dark shaded areas represent those combinations of country costs (c_A, c_B) which generate a Nash Equilibrium which is not Social Optimal. These are instances where non-cooperative behavior alone will lead to inefficiency: either a centralized enforcement mechanism or some ability to make side-payments is necessary to bring about a social optimum. The light, dotted-pattern areas represent those combinations of costs which generate two Nash equilibria, *one* of which is efficient. In these instances non-cooperative behavior may lead to inefficiency, but need not. These represent areas where inter-state bargaining alone – even in the absence of super-national enforcement capability, may be able to bring about an efficient outcome. The remaining, unshaded areas represent cost patterns where non-cooperative behavior is sufficient to achieve optimality.

Figure 2a: Nash Equilibria vs. Social Optima (for δ < ½)

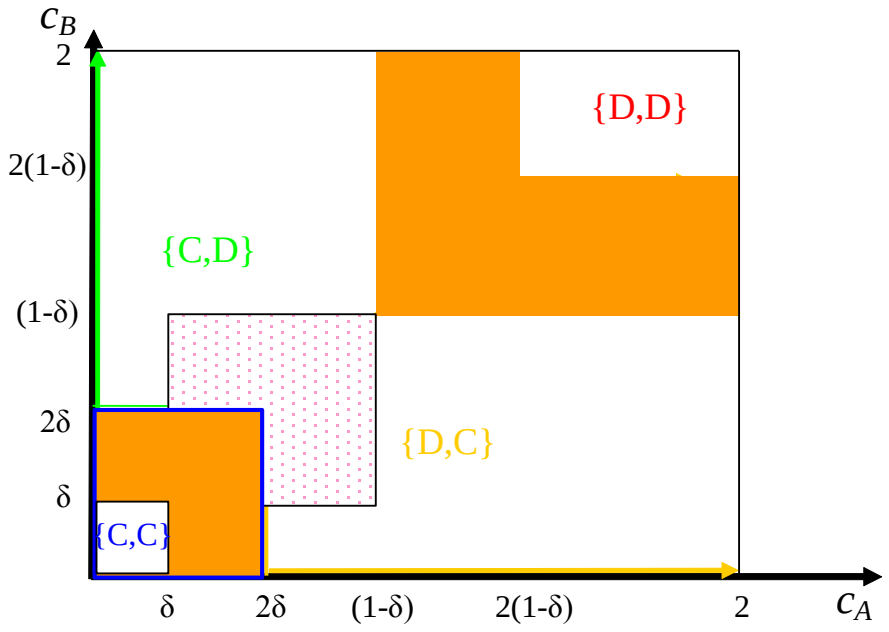
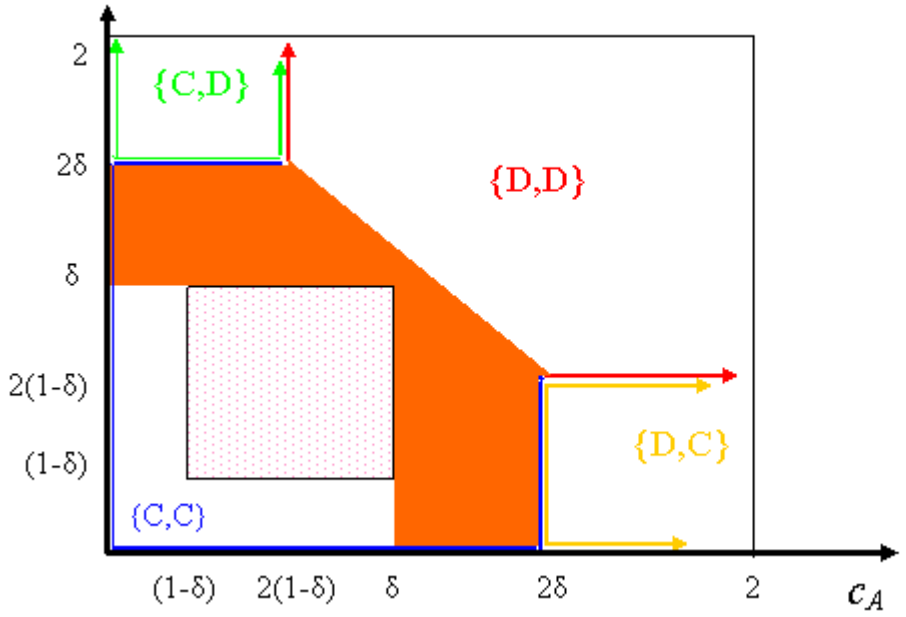


Figure 2b: Nash Equilibria vs. Social Optima (for δ > ½)



Although admittedly simplified, this analysis highlights several important points. First, the distribution of costs (or, equivalently, benefits) across parties is central to the question of whether efficiency is obtainable in an anarchic environment. Second, there is no single rule of thumb governing the pattern of these costs: disparity in costs (benefits) is *more* likely to generate efficiency for "better-shot" type public goods, but *less* likely in "weaker-link" games.

Finally, both weaker-link and better-shot public goods games can generate situations in which an efficient solution is *supportable* as an equilibrium, but *need not arise*. These are situations in inter-nation bargaining, signaling, or first mover advantages can help bring about the appropriate outcome. Again, however, the nature of this bargaining is likely to differ greatly depending on the type of GPG. Weaker-link goods – for example, battling infectious diseases like HIV – can be characterized as a coordination game in which both parties prefer the social optimum. However, better-shot goods – for example, brokering peace in the Middle East, or developing the internet – have the strategic properties of a "battle of the sexes" game, in which parties agree upon the desirability of the public good, but disagree on how to achieve it (each prefers to free-ride on the other's contribution). In these situations coordination between parties is possible, but will be compromised by the fact that the parties will <u>differ</u> on which outcome they strictly prefer. As δ grows larger (i.e., the weakest link becomes more important), the range of costs admitting multiple equilibria (and thus the possibility of a bargaining failure) falls in better-shot games and grows in

weaker-link games. In summative games, where δ = ½ exactly, inefficiency will result whenever either party has costs in the range $½ < c_A < 1$. Players will be playing dominant strategies, however, which mean communication alone cannot alter their behavior: side-payments will be necessary to achieve efficiency.

C. Imperfect Information as a Source of Transaction Costs

Our maintained assumption that each country knows the true costs of provision of the other is perhaps too strong. Political costs, for example, can be subjective to policy makers and subject to private information. The Coasian externality argument assumes no transaction costs and it has been well established in previous work that transaction costs, such as the presence of private information, can generate social inefficiency both in bargaining and in public good contexts.[10] The impact of such transaction costs may vary by type of game, however. Consider again our stylized game formulation, but now assume that parties have information only on their own costs. Assume that both parties know that costs are drawn from a uniform distribution $c \sim U\left[\underline{c}, \overline{c}\right]$. As shown in the appendix, assuming symmetry of the *distribution* of unknown costs, that each country will employ the following strategy: contribute to the public good if your cost of doing so is less than or equal to a threshold cost level *c**, where

$$c^* = \frac{\sqrt{3}\sigma + (1-2\delta)\mu}{2\sqrt{3}\sigma + (1-2\delta)}$$

Here, δ has its usual interpretation, while σ represents the standard deviation and μ the mean of the cost distribution. In any "better-shot" game, holding expected costs constant and equal to 1, an increase in the standard deviation of costs leads the maximum cost at which a player is willing to contribute to fall. Moreover, as uncertainty increases, the level of δ affects the rate at which this threshold falls, as shown in Figure 3.[11]

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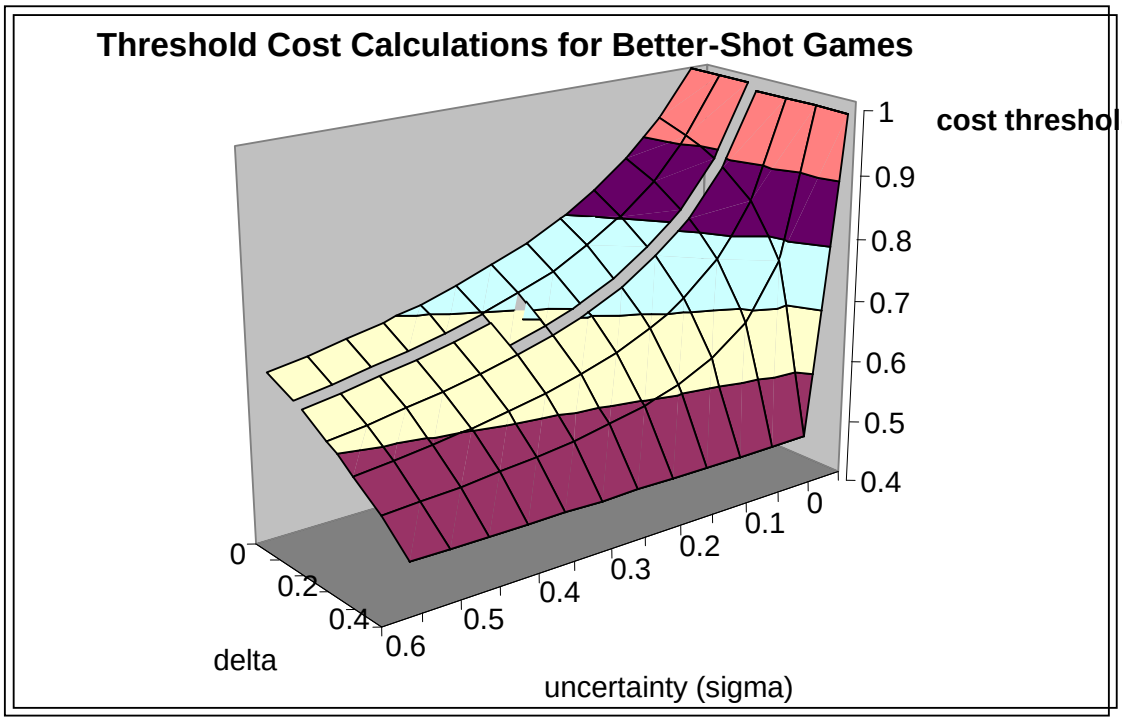
[10] See, for example, Fudenberg and Tirole (1991, pp. 211-213) who show, for the specific case of an extreme best-shot good (δ=0), with $\alpha = 1, \underline{c} = 0,$ and $\overline{c} = 2$, that imperfect information leads players to invest in the public good only if $c \leq ⅔$ - even though the benefit of investment (α=1) would exceed the cost, and there is a ⅔ probability the other player will not contribute. The question explored here is how the nature of the strategic interaction (the value of δ) also affects our conclusions about free-riding.

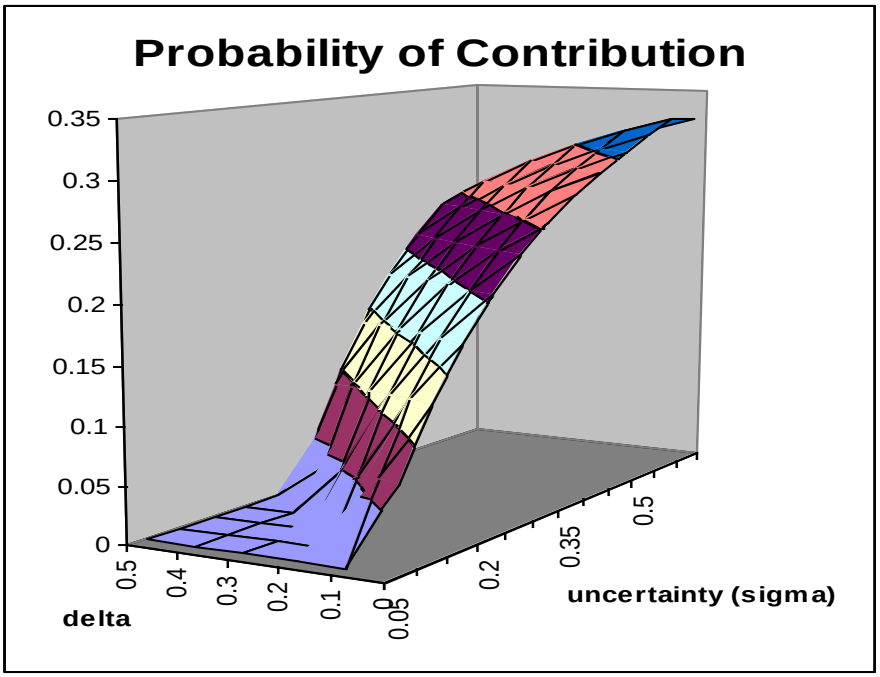
[11] As δ rises, the cost of not contributing when the opponent contributes rises, but the value of contributing when the opponent does not *falls*. In the extreme, as δ→½, each player adopts a dominant strategy: contribute as long their own (known) costs exceed the benefits.

Figure 3: Cost Thresholds for Public Good Contributions



Of course, holding average cost constant, the minimum potential cost falls along with the threshold, so that a lower threshold for contributions does not imply a lower *probability* of contributions. In fact, it can be shown that the probability of contribution rises with both the degree of uncertainty and with the redundancy of mutual contribution. Figure 4 demonstrates that the probability of contribution is highest in those instances where the importance of coordinating contributions is smallest, and uncertainty regarding the others' behavior is greatest. In other words, *transaction costs arising from uncertainty matter most as redundancy in contributions is smallest*. As δ falls to ½ and players adopt dominant strategy, the cost of imperfect information regarding the others' cost disappears entirely.

Figure 4: Probability of Contribution under Private Information



The above analysis of transaction costs in better-shot games does not immediately apply to weaker-link games, where efficiency requires *cooperation*, although a specific case has been explored by Kim Burnett (2005). Burnett shows that in some states of the world imperfect information can result in a more efficient outcome – for instance, where a low cost player incorrectly assumes the other player to be low cost as well – however, on average, private information will tend to increase inefficiency. While Burnett's specific case does not allow the extent of complementarity in the production technology for the public good, it does suggest that transaction costs can generate inefficiencies in both better shot and weaker link games.

IV. What Explains Provision of GPGs?

For practical purposes it is impossible to calculate the "efficient" level of greenhouse gas emissions, spending on infectious diseases like HIV, provision of peacekeeping troops, harmonization of standards, and so forth. Therefore, it is virtually impossible to estimate the extent of the "inefficiency" in their provision of such goods (as Sandler, Kaul and others have noted). Rather, as we have seen, we can think of provision being determined by several things:

1) Effective preference for the GPG – which could mean expected value to the "country as a whole", "value to the ruler" or "value to the median voter" – which of these may depend on

the system of governance, the identity of the median voter, and similar power considerations establishing conditions of choice (Moe, 2005).

2) Cost of providing the GPG – either in tax expenditure, including deadweight loss (e.g. does raising or forgiving $1 of tax revenue cost $1.10 or $1.30 or so on) or in other economic cost (e.g. in expenditures by firms and households of reducing CO2 emissions)
3) Transaction costs from uncertainty about those costs
4) Provision situation for the GPG (weaker link, better-shot, etc.)

In this section we will discuss factors associated with national contributions towards GPGs. Three specific expenditure streams are reviewed relevant to three GPGs—defense, health, and environment.

Defense

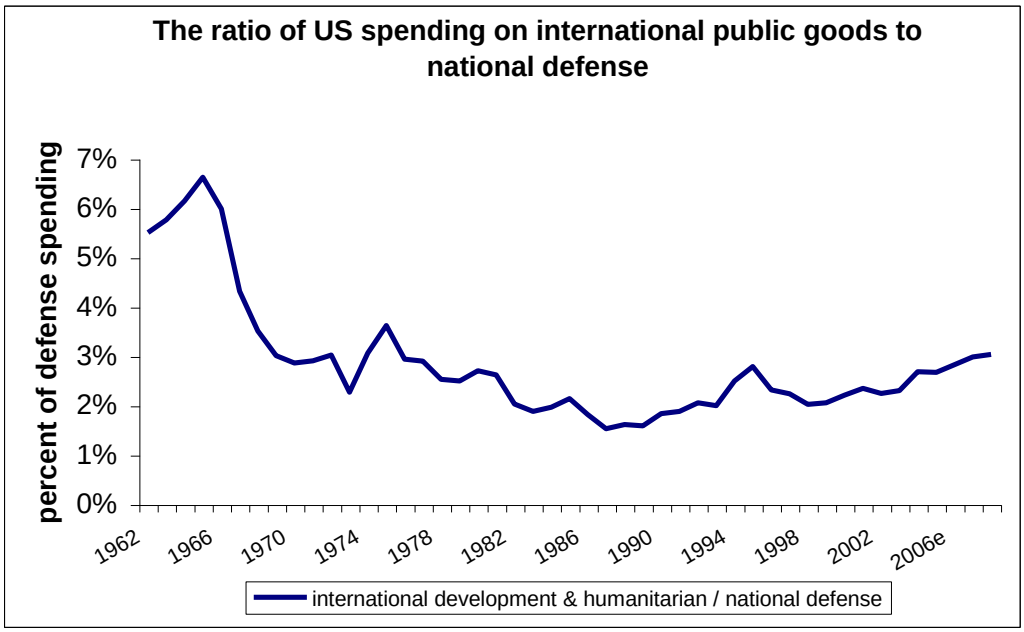
Hegemonic one-shot provision is commonly associated with this most basis of collective human demands—safety of person. Protection provided by being a member of a state, an institutional arrangement for which securing safety is a paramount, is a normal PG for which private provision is occasionally forbidden. It is provided for those within a jurisdiction, as a best shot good. In a purely rival world, defense would mean opposing all others outside a state and their collective state protectors. Of course, such Hobbesian state of nature or war of all against all, even at a global realm is an assumption far from reality. However, given the uneven resources and general non-excludability of defense as a good, its monopoly provision is conventional in all but the most failed of states.

Our concern here is cross border provision—subsidizing via club goods of NATO defense, providing extended deterrence protection by the US (at substantial cost) as a means to deter nuclear proliferation and hence overall lower risks to Americans safety. Since the end of WW II the US has been the most militarily powerful and the most assured guarantor of security for peoples and countries around the world. Witness US actions to protect Japan, defend Korea, and deter invasion of Europe. In addition, military expenditures related to Middle East peace keeping (no doubt related to stability of oil access, but not solely) have been substantial since the 1960s. Thus political scientists regularly associate the US as a provider of a global good of defense acting in response to external incentives as well as domestic preferences (Gilpin, 1981, 2001; Keohane, 1984, 2001). Such provision to others is a club good by and large, and rests on expected returns to solely national defense guarantees. What is of interest is how defense, and US expenditures demonstrate empirically the theory concerning hegemonic or best-shot provision. Since 1960 there has been

little cumulative defense goods provided and shared by others, aside from cold war rivalries that amounted to collective bads. The threat of non-state terrorists' attacks, however, has enhanced cooperative pressures, cumulative and weakest link good features for defense. Two trends are visible in US provision. First, US contributions to military spending overall have grown, albeit unevenly and with down turns, and they continue to rise above levels contributed for other global goods via the 150 or foreign affairs account. In particular, official development assistance (ODA) pays for all kinds of global goods—agencies of the UN that help coordinate policy and lower transaction costs though information and good offices; funds to encourage development and more recently create more reliable institutions of governance (Lancaster, 2006). Protecting fragile states is a new item, and one military force has not been developed to achieve, hence its location in the State Department and USAID (Krasner, 2005). The US (and other countries) now act to "stand up" governments that will supply safety and prevent terrorism within their jurisdiction (reflected in specific uses earmarked in aid to Afghanistan, Sudan, Ethiopia and the Philippines, for example). The US also supplies or guarantees funds to assist fiscal stability and international liquidity. In the latter case, monies from the treasury guarantee IMF actions, but most debt forgiveness is paid by writing off or using 150 account finances.

The graph below traces the ratio of US government expenditures on ODA compared to military outlays since 1960. These have declined; defense outlays (050 Account) grew disproportionately as the Cold War waned, and international public goods support via ODA grew more rapidly only in recent years, consistent with military needs declining after 1991 and problems of environment, health (HYV epidemic), and state collapse grew. While 2002 and past are not shown, a rise in ODA relative to military continues, although both are growing quite rapidly compared to the rest of the US budget (principally domestic PGs). Finally, the case of defense and the US expenditures for state-building and defeat of non-state threats illustrates, as noted earlier, the motivations of core global players can be central to provision, and the quality of the "good" may be affected by the quality of the provider's skills (Fukuyama, 2004; Krasner, 2005).

Figure 5: United States as a Provider of Public Goods—Global and Security Burdens



B. Climate Change

Avoiding the costs associated with climate change is perhaps one of the clearest examples of a pure global public good. It is difficult to measure contributions made to avoiding climate change, as national emissions of gasses like CO2 are related to the size and industrial composition of economy as well as national preferences for "clean technologies" and environmental regulation. Economists, following Grossman and Krueger (1995), have argued that pollution emissions can be decomposed into a *scale effect*, proportional to a country's GDP, a *composition effect*, varying with the relative importance of "dirty industries" in value added and a *technique effect*, reflecting the nation's willingness to adopt pollution controls. An estimate of this technique effect can be estimated from the residuals (ε) of the following regression, run on data taken from the World Development Indicators for a panel of countries from 1960 to 2004:

$$\log(CO_2) = \beta_0 + \beta_1 \log(GDP) + \beta_2 (IndustrialVA) + \varepsilon$$

These residuals, representing a country's "willingness to pollute" in a given year, were then used as the dependent variable on a regression of country characteristics. In particular, it was hypothesized that the probability of adopting cleaner technologies were more likely the higher a country's per-

capita income, the more literate the population, and the higher the institutional quality. Two proxies were used for institutional quality: an index of democracy – based on the Freedom House dataset on civil and political liberties and re-normalized to range from 0 to 1 – and the fraction of income accruing to the richest quintile of the population. Our prior belief was that countries with less concentration of power (in both rights and income) were likely to face more domestic pressure for cleaner technologies.

The results are shown in the table below:

"Technique Effect" of CO_2 emissions

(Dependent variable is the residual from a regression of log(C02) on log(GDP) & Industrial V.A.)

variables	**(1)**	**(2)**	**(3)**	**(4)**
log(GDP/capita)	-0.24	-0.23	-0.39	-0.30
t-stat	*-10.6*	*-8.0*	*-10.3*	*-4.1*
literacy	0.02	0.01	0.01	-0.01
t-stat	*18.0*	*14.3*	*8.3*	*-1.8*
democracy	-0.64	-0.55	0.08	-0.02
t-stat	*-10.1*	*-7.6*	*1.8*	*0.1*
richest share (avg.)		-0.03	-0.05	
t-stat		*-15.43*	*-5.12*	
lagged dep. var.				0.58
				7.5
Obs	2285	1874	1874	2132
R^2	0.137	0.229	0.1811	*n/a*
estimation procedure	pooled	pooled	random effects*	Arrelano-Bond*

** - t-stats represent z values from GLS estimator*

There is clear evidence that cleaner production techniques are adopted as per-capita income rises. There is little evidence supporting our other prior beliefs, however. Estimates based on pooling observations do suggest an association between reduced emissions and greater political freedom; however it suggests that less inequality and greater literacy are associated with dirtier techniques. These latter results appear to be driven by cross-country rather than time-series

variation, however, suggesting that omitted variable bias may be a problem. These results become less significant when random country effects or a lagged dependent variable is included.

C. Infectious Disease Prevention

As argued previously, immunization against infectious diseases is best viewed as a public rather than a private good. Due to limits on travel and immigration and the segmentation of labor markets, however, such spending could be argued to fit better under the rubric of a national public good than a global public good. The rising incidence of HIV worldwide and the severity of its threat both at the human level and for the global economy along with the "weaker-link" nature of epidemiological defenses seem to qualify it as an important GPG. The threat posed by Malaria and Tuberculosis, while more limited in geography, is equally severe for a large majority of the planet's inhabitants. Recent collective action in this area has been marked by the creation of a Global Fund to Fight HIV, Malaria and Tuberculosis, to which 50 countries (along with a number of large private and corporate donors) have contributed.

The existence of non-state donors to the Fund underscores earlier arguments that alternatives to collective action among nation-states exist for addressing GPG provision. Private contributions still represent a relatively small share of Fund contributions, however, and the motivations behind these are likely driven as much by idiosyncratic preferences of specific persons than collective desires. Thus, I will restrict our attention to understanding the contribution behavior of countries. Regressions of contribution levels on a set of country characteristics similar to that employed for $C0_2$ emissions delivered the results presented in the table below. (The right hand side of the table shows estimates based on a Heckman two-step procedure used to correct for selection effects, given the number of countries that choose not to contribute at all).

Contributions to the Global Fund to Fight HIV, Malaria and TB

dependent variable: log ($contrib/GDP)					***Heckman two-step***	
lngdppc	1.64	(*2.2*)	2.26	(*2.6*)	1.73	(*2.1*)
ssa	4.08	(*2.1*)	3.04	(*1.5*)		
hiv1549	0.11	(*1.4*)	0.16	(*1.8*)	0.20	(*3.2*)
enroll_sec	-0.10	(*-2.1*)	-0.16	(*-3.0*)	-0.20	(*-5.5*)
enroll_tert	0.01	(*0.3*)	-0.02	(*-0.4*)		
fhdemoc	4.96	(*1.2*)	4.82	(*1.1*)	4.47	(*1.3*)
tvs	0.01	(*1.5*)	0.01	(*1.8*)	0.01	(*2.1*)
richquint			-0.12	(*-1.7*)	-0.11	(*-2.1*)
obs	35		28		141 (28 uncensored)	
adj. R^2	0.47		0.57		*lngdppc, ssa, enroll_tert used in the selection equation*	

Again, per-capita income was a strong predictor of GPG contributions, with a 1 percent increase in GDP/capita corresponding to over a 1½ percent increase in contributions as a share of income. Predictably, being a Sub-Saharan African country and/or having a higher HIV rate among 15-49 year olds increased both the probability of contributing and, *ceteris paribus*, the amount contributed. In this case both the level of democracy and equality of income were associated with higher contributions, as predicted, while education (in this case, enrollment rates in secondary and tertiary education) was again associated with *lower* contributions. To control whether this was in fact a good proxy for "issue awareness" the fraction of households with televisions was also included; and, indeed, TVs do predict higher contribution levels. The reason education seems to reduce contributions to GPG is unclear, although it does lead one to speculate that the reason may be a greater understanding among the population at large of the nature of the collective action problem and the incentives to free-ride.

IV. SUMMARY AND CONCLUSIONS

The present review of GPGs, and the arguments for their existence and undersupply, affirms both their importance and their problematic condition. Unfortunately, it also raised serious questions about any single approach to identifying, providing or financing such goods. Perhaps

because of the recognition of this problem, a number of activities have been cited as public goods needing global collective action. To clarify the target of interest, therefore, this paper has proposed four questions about the character of any candidate GPG. These, in summary, are:

- *Is the good truly public*? To what extent is it fully public (non-rival, non-excludable) and to what extent is it private (and hence offers selective benefits and incentives for production).
- *Is the good truly global*? How can we establish the appropriate jurisdiction [s] for a good's provision (national, regional or global), as in the case of rain forest preservation. One approach we mentioned is to assess the extent of externality (how are benefits distributed: global vs. regional benefits and with what excludability).
- *Is centralized coordination necessary for efficient provision*? We argue for withdrawing a presumption of public sector provision. We recommended seeking efficiency—hardly a novel idea in economics.[12] Nevertheless, jurisdictional efficiency (looking at items such as fixed costs, heterogeneity of preferences) has not been a principal theme in GPG literature to date. Indeed, political science is moving to address the governance elements of such "private" actors, even as economics is moving toward greater concern for states and institutions.[13]
- *Are national incentives aligned properly*? If not bargaining may undermine GPG provision and thus create "race to the bottom" problems in which national governments lower labor and/or environmental standards?[14]

The answers to these four questions suggest a variety of strategies for GPG provision. Cooperation, either formal or informal, is basic – but such cooperation need only allow for aggregation of contributions under various types of provision, e.g. best shot, weak link, cumulative, depending on the situation. Similarly we argued because of this variety of situations emerging in

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[12] The public sector provision strategy, as derived from the Pigou tradition, presumes institutions that make coordination easy, and the problem is that liabilities are unclear; when this holds IGOs and ad hoc state coalitions are sensible, even necessary. In contrast, in the Coase tradition, if agency is decentralized but liabilities are clear, then an efficient outcome can arise from private agents striking bargains, as in the case of multinationals providing research, regulations and even funding for various goods (however skeptical we might be about pharmaceutical firms offering free AIDs drugs!).

[13] The political science move is exemplified in recent work of Peter Gourevitch (2003); economists treating institutions as public goods go beyond the framing of institutions as critical for economic outcomes North (1990) to treating institutions affecting power (Moe, 2005) such as the WTO as a public good (Bagwell and Staiger, 1999) as well as in work of sociologists such as Sassen (2002).

[14] Evidence is weak that any such "races" are resulting in lowering of standards; however, that does not exclude the prospect, since multiple incentives are shaping outcomes, some barriers to GPG provision from non-cooperative behavior exist. The fear that global markets will encourage competition that lowers standards for national (and cumulatively global) public goods, all in an effort to secure gains from trade or investment, may prove illusory because of symmetrical reciprocity by others. The incentive for this to happen, nonetheless, suggests a search for punishment / enforcement strategies are needed to obtain GPG provision. With weak institutional frameworks, however, Nash punishment may prove ineffective for efficient cooperation. If so we must return to the classical solution of public authority--altering incentives so that they are aligned with globally socially profitable outcomes—i.e. inducing non-cooperation. We may end up requiring public action, but we need not begin nor always end there.

answer to the four questions uncovered a danger for provision, namely the conflation of "global public goods" with "trans-national externalities." Economists tend to think of public goods as a subset of the larger externality problem (in particular, the social marginal benefit of contributions to GPGs exceeds the private marginal benefit, which means that SMB > PMB = MC). Many have put "too much" into GPG paradigm – stretching it to the point of excluding little. The free trade regime, for instance, is not actually a "global public good" as some suggest, but rather a "club good" – because it is excludable! Similarly, "international financial stability" and "peace/security," while in some sense "public goods," are not provided or financed in ways consistent with the central PG paradigm. Hence it does not prove a useful analytical tool for such goals. Returning to particularities for issues of exchange rate stability and aggression, as national foreign policies are determined heavily by domestic forces[15] even though disastrous policies have consequences for other nations, i.e., they have externalities.

So what should be done in the GPG paradigm? First, its core focus on "insufficient centralization" (i.e. the lack of a global government to address market failures the way national governments does) should be amended. While we do not reject the undersupply problem as related to insufficient centralized authority, it is important to recognize that this is typical of a "Pigouvian" view of externalities: a problem of incorrect prices, i.e., prices that reflect marginal benefit (or cost), not social benefit (or cost) and hence need correction (through enforced tax policy or regulation). But this is only one of two very different lines of reasoning in economics. The other tradition – following Coase (1960) – frames the problem as insufficient property rights. Coase's key conclusion is that – regardless of the assignment of liabilities – the same, optimal outcome will obtain in the absence of transaction costs.[16]

A second conclusion from the paper is that GPG literature contains excessive generality. A model/paradigm is useful as an analytical tool for generalizing problems, but there may be several "models" one can adopt of the phenomenon. Einstein once said ''everything should be as simple as possible…but no simpler.'' The question is – does this criterion say about the GPG model they adopt? We suggest that it is helpful to think about the huge range of issues in question not as being "special cases" of a broad theory of GPGs – this simply trivialize them while obscuring important

[15] Think, for instance, of Argentina in 2000 or the US in 2003

[16] The paper's argument is not that the Coasian solution is preferable, only that it may be preferable: in particular, where centralized coordination is difficult and transaction costs are low. Where centralized coordination is easier, and/or transaction costs are high, then the creation of a centralized institutional authority to regulate behavior may be the optimal solution. The point is, it depends. See Conybeare (1980) who makes a similar case.

differences. For example, consider the following common argument, as for example in Kaul (2003): (1) GPGs tend to be underprovided in the absence of a centralized government to facilitate collective action; (2) activities like security, free trade and financial stability have the qualities of a global public good; (3) there is little in the way of a centralized, global government with enforcement power. While we do not disagree with these claims individually, the authors seem to be blaming terrorism, wars, currency crises and tariffs on "free-riding behavior"…! That label is not a useful explanation for these phenomena. Or take a second example: misunderstanding of the solution. In the specific case of climate change, for instance, the Kyoto Protocol illustrates a global effort to apply traditional public goods theory to a GPG; it carries with it the potential methodological flaws of doing so. We know that efficiency in correcting market failures arising from externalities[17] requires the equalization of marginal costs. Say, for example the U.S. wants to lower pollution emissions by 10%. Telling every firm to lower their emissions by 10% is likely to be inefficient, as it is likely to much more costly for some firms than others. Thus, in the U.S., a cap & trade permit system is used to allow "dirty firms" to purchase reductions from "cleaner firms." Kyoto adopts this analogy – suggesting that uniform reductions would be inefficient, but with permit trading countries where emissions reductions would be more costly would be able to buy reductions from those countries where it is easier. Using a "Heckscher-Ohlin" model of trade and adding a negative global pollution externality, Copeland and Taylor (2005) argue that, if national governments adopt cap & trade systems individually – effectively setting a domestic "price" for the pollution externality – then free trade in goods alone will lead to an equalization of abatement costs across countries, even with no international permit trading. This result is essentially just a variant on Samuelson's familiar Factor Price Equalization Theorem in environments with more goods than factors.

A third conclusion is that GPG literature reflects an overextension of the PG paradigm. It was argued earlier that Kaul et. al. may overextend the "public good paradigm" beyond its useful range, but the authors may also have overextended the PG definition itself. While the UNDP work has taken the following from the strict formulations of economic theory:

a. Public goods are goods that are non-excludable and non-rival in consumption.
b. These qualities create incentives for agents to free-ride, leading to inefficient under-provision.
c. A centralized government, with enforcement powers, can adopt a variety of mechanisms by which citizens can vote over the preferred level of public goods and then

[17] Including weak contract or property rights as externalities not available in weak authority jurisdictions

> pay some amount in taxes, which can be used to finance the PG. Moreover, when the tax citizens pay is not proportional to their announced preference, there is no incentive to lie – thus the efficient level of provision can be obtained.

Their actual definition goes beyond these. It proposes adding criteria of "process" as in decision making standards and "fairness" as in distribution of benefits. Consider the definition: "goods whose benefits extend to all countries, people, and generations (p. 95)." And the suggestion that Millennium Development Goals such as universal education, health care and human rights are GPGs. The expansion of the paradigm amounts to a piling on of definitions to the point where the usefulness of the paradigm is jeopardized! Perhaps there are decisions made that affect the lives of a large number – and that the vast majority of those are disenfranchised. The institutions operating may or may not be public goods problems. From a Coasian perspective, absent a centralized authority, we should see institutional forums arise for parties to bargain with each other over externalities. The fact that only limited, major powers play a role is again, consistent with theory, where the optimal size of negotiating group must balance the gains from including the next member on the margin (in terms of their "importance" to the deliberations) with the marginal cost of doing so as in congestion of communications, in holding-up existing members, etc. To the extent that Coase's conditions are met, the distribution of property rights (liabilities) does not affect the final outcome or overall efficiency, but it does obviously have important distributional consequences. In this sense, the fundamental problem of global public goods is the absence of any assignment of any "property rights" to those in poor countries to clean air, clean water, security, and so forth – or even a "right to development", which has important implications to thinking about climate change policies. The issues of global justice, of yet to be realized rights being taken into account, and of other concerns related to a world order are quite different from the jurisdictional expansion of PGs to the global arena. Conflating economic "efficiency" criteria with moral "distributive justice/fairness" criteria is unhelpful. At best, we can share the justice goals, and note that empirical processes are expanding and reforming institutions (Ruggie, 2004) in ways that may make possible more provision and financing of GPGs, but done both by pubic and by private agents.

Finally, the paper examined the empirical determinants of the extent to which a country contributes towards global public goods. In the case of security, we concluded that hegemonic supply was relevant, but that incentives for one-shot provision by an agent with incentives to act alone were no guarantee of the quality or adequacy of a GPG. Costs from US general expenditures on defense, its actions in state-building and its special expenses in Iraq, mounting to over a trillion

dollars in the last three years, do not equate with benefits to either US or global society. As others have noted with regard to security and defense, once the epitome of a pure public good, expenditures do not equal benefits, and bad provision/policies can result in shoddy goods in this area as spectacularly as Soviet era Lada. With security, therefore, supply tends to involve both free-riding and flawed production. In the case of the largest burden-bearer, the US, it also is associated with a declining provision for other GPGs as seen in the relative fall in contributions to ODA and UN agencies since the 1960s.

With regard to provision of health and environmental GPGs, regression results suggest that greater democracy is associated with higher contributions, as are number televisions; surprisingly, higher education levels seems to be associated with greater free-riding. Not so surprising is that inequality--more income in the hands of the rich—is associated with lower contributions to HIV alleviation. The same inequality seems to encourage national jurisdictions to produce fewer CO2 emissions. This variation in willingness to provide or cooperate in supplying GPGs underlines our essential point: GPGs are not uniform (in quality or type), equally attractive for financing, nor supplied done so in systematic ways. Like the amorphous power configuration at the global level, GPGs--from famine relief or HYV prevention to fights against terrorism and CO2 emissions—are provided and financed unevenly, unreliably, yet in larger amounts than predictable given the absence of central coercive mechanisms.

References

Alesina, Alberto and Enrico Spolare (2003). The Size of Nations. Cambridge, MA: MIT Press.

Baldwin, Richard E. and Philippe Martin (1999), "Two Waves of Globalization: Superficial Similarities, Fundamental Differences," NBER Working Paper 6904 (January).

Bagwell, Kyle and Robert Staiger (1999). "An Economic Theory of GATT" in American Economic Review. Vol. 89, March, pp. 215-248.

Bagwell, Kyle and Robert Staiger (2002). "Economic Theory and the Interpretation of GATT/WTO" in American Economist. Vol. 46, No. 2. September, pp. 205-234.

Barrett, Scott (2003), "Creating Incentives for Cooperation: Strategic Choices," in Kaul et. al. pp. 308-328.

Bearce, David H., (2003). "Societal Preferences, Partisan Preferences, and Monetary Policy Outcomes." International Organization, Spring, Vol. 57, No. 2. Pp. 373-410.

Biermann, Frank (2002). "Institutions for Scientific Advise: Global Environmental Assessments and Their Influence in Developing Countries," Global Governance April-June, Vol. 8, No. 2, pp. 195-219.

Bhagwati, Jagdish (2002), Free Trade Today. Princeton: Princeton University Press.

Braman, Sandra (2002). "Informational Meta-Technologies, International Relations, and Genetic Power: The Case of Biotechnologies," in James N. Rosenau and J. P. Singh, eds. Information Technologies and Global Politics. Albany: State University of New York Press, pp. 91-112.

Buchanan, James. 1965. "An Economic Theory of Clubs." Economica 32 (125): 1-14.

Burnett, Kimberly M. Burnett (2005). "Provisions of Weaker Link Public Goods under Incomplete Information" (mimeo, University of Hawaii at Manoa, July 2, 2005)

Busch, Marc L. (2001). Trade Warriors. States, Firms, and Strategic-Trade Policy in High-Technology Competition. New York: Cambridge University Press.

Conybeare, John A. C. (1980) "International Organization and the Theory of Property Rights," International Organization. Vol. 34, No. 3. Summer, pp. 307-334.

Coase, Ronald H. (1960), "The Problem of Social Cost," Journal of Law and Economics, 17, 357-76.

Coase, Ronald H. (1970), "Social Cost and Public Policy," in Exploring the Frontiers of Administration, George A. Edwards ed., Toronto: York University Press pp 33-44.

Cooper, Richard (1994), Environment and Resource Policies for the World Economy. Washington: Brookings.

Copeland, Brian R. and M. Scott Taylor, "Free Trade and Global Warming: A Trade Theory View of the Kyoto Protocol" Journal of Environmental Economics and Management. Volume 49, Issue 2, March pp. 205-234.

Cornes, Richard C. and Todd Sandler (1996). The Theory of Externalities, Public Goods, and Club Goods, Second Edition New York: Cambridge University Press.

Dasgupta, Partha and Eric Maksim, (2000) "Efficient Auctions," Quarterly Journal of Economics. Vol. 115, pp. 341-388.

Edwards, Michael and Simon Zadek (2002), "Governing the Provision of Global Public Goods: The Role and Legitimacy of Non-State Actors," in Kaul et al (2002).

Edertington, Josh (2001) "International Coordination of Trade and Domestic Policies" American Economic Review, *pp.* .

Eichengreen, Barry (1999), Towards a New International Financial Architecture (Washington: Institute for International Economics).

Elliot, Kimberly Ann and Richard B. Freeman (2001), "White Hats or Don Quiotes? Human Rights Vigilantes in the Global Economy," NBER Working Paper 8102 (January).

FAO (2002). Mobilizing the Political Will and Resources to Banish World Hunger. Rome: Food and Agricultural Organization.

Fischer, Stanley (2003), "Financial Crises and Reform of the International Financial Architecture," Review of World Economics, No. 1: 1-38.

Friedman, Thomas (2000). The Lexus and the Olive Tree. New York: Farrar Straus Giroux.

Fukuyama, Francis (2004). State-Building. Ithaca: Cornell University Press.

Gilpin, Robert (1981). War and Change. Princeton: Princeton University Press.

Gilpin, Robert (2001). Global Political Economy: Understanding the International Economic Order. Princeton: Princeton University Press.

Goldstein, Judith, et al. (2000). "Introduction: Legalization and World Politics," International Organization. Vol. 54, No. 3, Summer, pp. 385-400.

Grossman, Gene M. and Alan B. Krueger, "Economic Growth and the Environment," The Quarterly Journal of Economics Vol. 110, No. 2 (May, 1995), pp. 353-377

Held, David, Anthony McGrew, David Goldblatt, and Jonathon Perraton. (1999). Global Transformations: Politics, Economics and Culture. Stanford: Stanford University Press.

Hirshleifer, Jack (1983), "From Weakest-Link to Best-Shot: the Voluntary Provision of Public Goods," Public Choice, 41, 371-86

Hopkins, Raymond F., et. al., (2004) "Regulation of GM Crops: Shaping an International Regime." in Robert E. Evenson and Vittorio Santaniello**,** eds. The Regulation of Agricultural Biotechnology. Oxfordshire: CABI.

Hopkins, Raymond F. and Marc J. Cohen (2005), "New Principles for Humanitarian Assistance," Washington: IFPRI Concept Note, August.

Jackson, Robert (1990). Quasi-States: Sovereignty, International Relations and the Third World (New York: Cambridge University Press).

Jones, Ronald R. (2000), Globalization and the Theory of Input Trade. Cambridge: MIT Press.

Kaul, Inge, Pedro Conceicao, Katell le Goulven, and Ronald U. Mendoza, eds. (2003). Providing Global Public Goods: Managing Globalization. (New York: Oxford University Press).

Kindleberger, Charles P. (1973). The World in Depression 1929-1939. Berkeley: University of California Press.

Keohane, Robert O. and Joseph S. Nye (2001). Power and Interdependence, 3rd ed. New York: Addison, Wesley, Longman.

Keohane, Robert O. (1984). After Hegemony. Princeton: Princeton University Press.

Keohane, Robert O (2001). "Governance in Partially Globalized World", American Political Science Review. Vol. 95, No. 1, March, pp. 1-14.

Kindleberger, Charles (1973), The World in Depression (Berkeley: University of California Press).

Krasner, Stephen D. (1999). Sovereignty: Organized Hypocrisy (Princeton: Princeton University Press).

Krasner, Stephen D. and Carlos Pascual (2005). "Addressing State Failure," Foreign Affairs. New York: Council on Foreign Relations, Vol. 44, No. 4, July/August.

Kremer, Michael (1993). "The O-Ring Theory of Economic Development", Quarterly Journal of Economics, August, vol. 108: (3) 551-575.

Levinson, Arik (1996), "Environmental Regulations and Industry Location: International and Domestic Evidence", in Jagdish Bhagwati and James Hudec, eds., Fair Trade and Harmonization.

Lindblom, Charles E. (1977). Politics and Markets (New York: Basic Books).

Maddison, Angus (2002), The World Economy: A Millennial Perspective (Paris: OECD).

Mittleman, James H. (2000). The Globalization Syndrome: Transformation and Resistance (Princeton: Princeton University Press).

Moe, Terry M. (2005) "Power and Political Institutions," Perspectives of Politics. Vol.3, No, 2, June, pp. 215-233.

Nordhaus, William D. (2001) "Global Warming Economics," Science (Vol. 294, 9 November pp. 1283-1284).

North, Douglass C. (1990), Institutions, Institutional Change and Economic Performance (Cambridge: Cambridge University Press).

Nye, Joseph S and John D. Donahue (2001), eds. Governance in a Globalizing World (Washington: Brookings).

Nye, Joseph S. Jr. (2002). The Paradox of American Power (New York: Oxford University Press).

Nayyar, Deepak, ed. (2002). Governing Globalization: Issues and Institutions**.** New York: Oxford University Press.

Oates, Wallace E. (1999). "An Essay on Fiscal Federalism," Journal of Economic Perspectives**.** Vol., 37, No. 3, pp. 1120-1149

Obstfeld, Maurice and Alan M. Taylor (2002), "Globalization and Capital Markets," NBER Working Paper 8846, March.

OECD (1996) Trade, Employment and Labor Standards: A Study of Core Workers' Rights and International Trade (Paris).

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

Olson, Mancur and Richard Zeckhauser (1966), "An Economic Theory of Alliances," Review of Economics and Statistics, 48, 266-79.

Olson, Mancur (1982). The Rise and Decline of Nations: Economic Growth, Stagflation, and Social Rigidities (New Haven: Yale University Press).

Pigou, Arthur C. (1946), *The Economics of Welfare* (4th edition), Macmillan (London).

Putnam. Robert D. (1988). "Diplomacy and Domestic Politics: the logic of Two-level Games," International Organization (Vol. 42, No. 3, pp. 427-460).

Rajan , Raghuram G. and Luigi Zingales (2002) Saving Capitalism from the Capitalists (New York: Crown).

Rodriguez, Francisco and Dani Rodrik (2001), "Trade Policy and Economic Growth: A Skeptic's Guide to Cross-National Evidence," in Ben S. Bernanke and Kenneth Rogoff, eds. NBER Macroeconomics Annual 2000 (Cambridge: MIT Press).

Rodrik, Dani (1999), The New Global Economy and Developing Countries: Making Openness Work, Policy Essay No. 24 (Washington: Overseas Development Council).

Ruggie, John Gerard (1993) "Territoriality and Beyond," International Organization, Vol. 47, No. 1, Winter, pp. 139-174.

Ruggie, John Gerard (2004). "Reconstituting the Global Public Domain: Issues, Actors, and Practices." European Journal of International Relations 10.4, December, pp. 499-525.

Samuelson, Paul (1954). ""The Pure Theory of Public Expenditure", Review of Economic Statistics, pp.

Sandler, Todd (1998). "Global and Regional Public Goods: A Prognosis for Collective Action," Fiscal Studies. Vol. 19, No. 3, pp. 221-247.

Sandler, Todd (2003), "Assessing the Provision Status of Global Public Goods," in Kaul et al (2002).

Sassen, Saskia (2002). "Globalization or Denationalization?" in Items and Issues (New York: Social Science Research Council, Winter, Vol. 4, No. 1, pp. 15-20).

Slaughter, Anne-Marie (2000) "Governing the Global Economy through Government Networks." In Michael Byers, ed. The Role of Law in International Politics (Oxford: Oxford University Press, pp. 7-21).

Stiglitz, Joseph E. (2000), Economics of the Public Sector, 3rd edition. New York: Norton).

Stiglitz, Joseph E. (2002), Globalization and its Discontents (New York: Norton).

World Bank, 2002A. Globalization, Growth and Poverty: Building an Inclusive World Economy (Washington: World Bank).

World Bank, 2002B. *Global Public Goods*. (Washington: World Bank).

Appendix

Nash Equilibria and Pareto Optimality in a Binary-Choice Public Good Game

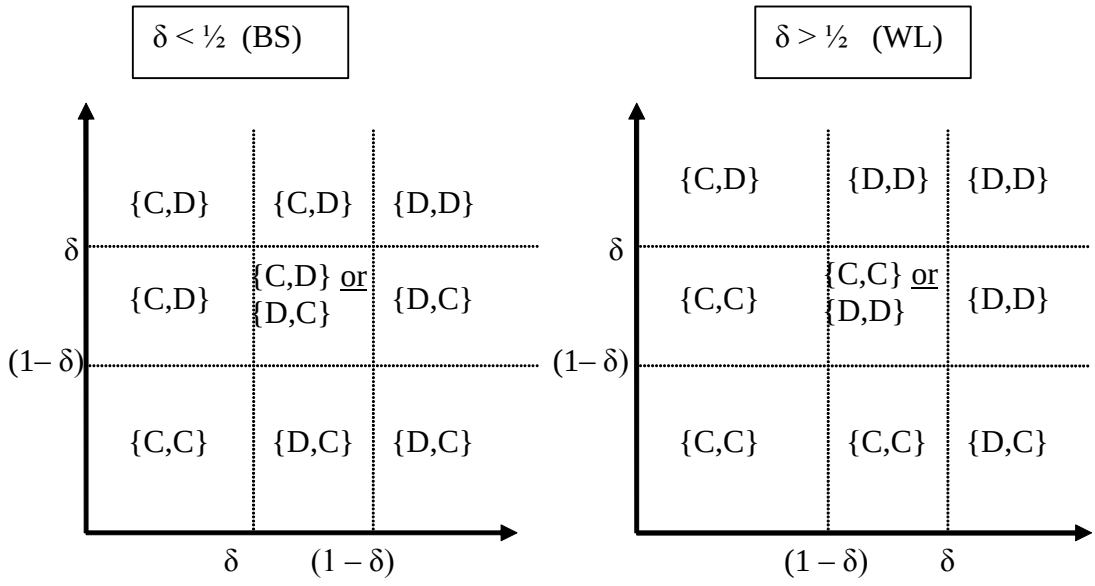
A public good game is played between two agents (countries), each of which chooses either to contribute (C) or defect (D). The public good is valued equally by both players, although the costs of their contributions may differ. The payoffs are as follows:

		Player B	
		C	D
Player	C	$\alpha - c_A$, $\alpha - c_B$	$(1-\delta)\alpha - c_A$, $(1-\delta)\alpha$
A	D	$(1-\delta)\alpha$, $(1-\delta)\alpha - c_B$	0,0

The best response function $\sigma_j(s_{\sim j})$ of each player j faced with their opponent's strategy $s_{\sim j}$ can be written

$$\sigma_j(C) = C \quad iff \quad c_A < \delta\alpha$$
$$\sigma_j(D) = C \quad iff \quad c_A < (1-\delta)\alpha$$

Since only the ratio of c_j/α matters for the decision of player j, assume the normalization $\alpha = 1$. The Nash Equilibria, as a function of the realized costs for each player are depicted on the graphs below:



When is Nash Behavior Optimal?

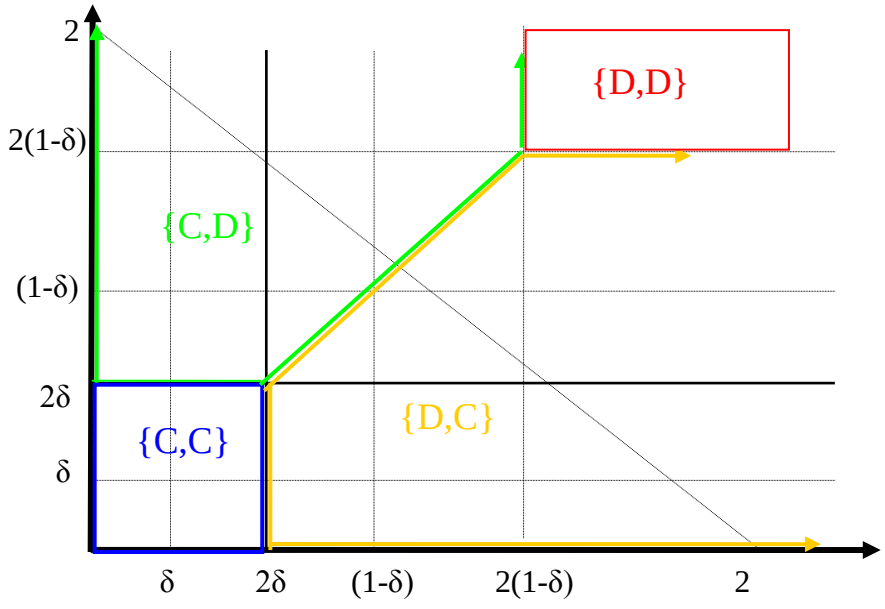
The Pareto Optimal outcomes – where joint welfare is maximized – can be found by summing the payoffs in each square of the matrix:

		Player B	
		C	D
Player	C	$2\alpha - c_A - c_B$	$2(1-\delta)\alpha - c_A$
A	D	$2(1-\delta)\alpha - c_B$	0

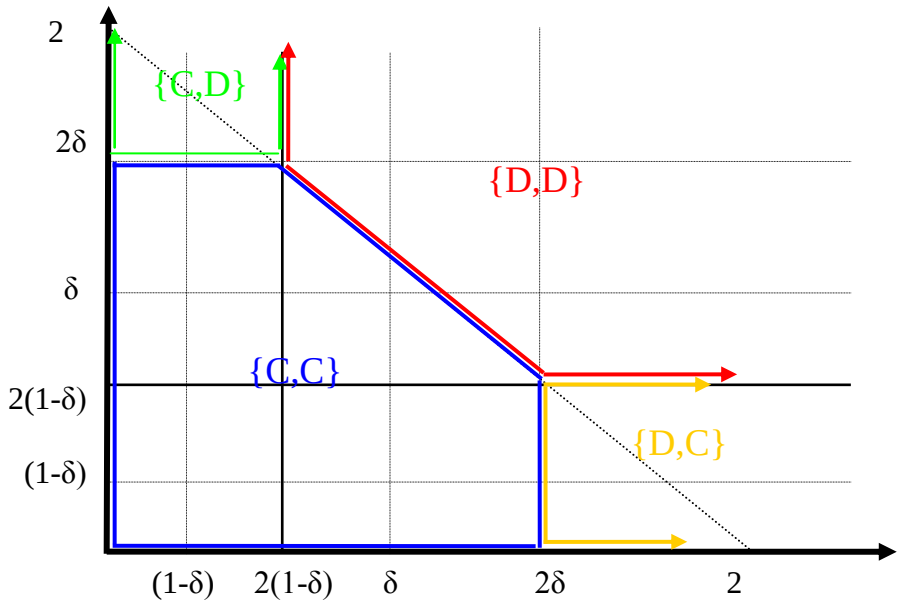
The following conditions characterize Pareto Optimality of the outcomes:

{C,C}	is PO if	$c_j \le 2\delta\alpha \quad \forall j\,;\; c_A + c_B \le 2\alpha$
{C,D}	is PO if	$c_A \le c_B;\; c_A \le 2(1-\delta)\alpha;\; c_B \ge 2\delta\alpha$
{D,C}	is PO if	$c_B \le c_A;\; c_B \le 2(1-\delta)\alpha;\; c_A \ge 2\delta\alpha$
{D,D}	is PO if	otherwise

These can also be characterized graphically. Again, using $\alpha = 1$, the case of a better-shot good ($\delta < ½$) can be depicted as follows:



Similarly, for the case of weaker-link goods ($\delta > ½$) the optimal outcomes are as follows:



Asymmetric Information and Transaction Costs

Consider again our stylized game formulation, but now assume that parties have information only on their own costs. Assume that both parties know that costs are drawn from a uniform distribution $c \sim U\left[\underline{c}, \overline{c}\right]$. This problem has been has been explored previously by Fudenberg and Tirole (1991; pp. 211-213) for the case of an extreme best-shot good (δ=0), with $\alpha = 1, \underline{c} = 0,$ and $\overline{c} = 2$. The authors find that the existence of imperfect information leads players to invest in the public good only if $c \leq ⅔$ - even though the benefit of investment (α=1) would exceed the cost. In other words, an inefficiency results from the possible opportunity to free-ride should the other player have costs below 2/3 – even though the probability of this occurring is only 1/3.

The question explored here is how the nature of the strategic interaction (the value of δ) affects the conclusions. If we let π_j characterize the probability that player *j* contributes to the public good, and normalize using $\alpha \equiv 1$, the strategy of each player *i* is as follows:

Invest if (and only if) $c_i \le c_i^* \equiv \delta\pi_j + (1-\delta)(1-\pi_j)$

Since this is true for both parties, the probability that player *j* invests (π_j) is simply the probability that *j*'s cost is below c_j*, or $F(c_j^*)$. Given a uniform distribution,

$$\pi_j = F(c_j^*) = \frac{c_j^* - \underline{c}}{\overline{c} - \underline{c}}$$

Given symmetry, $c_i^* = c_j^* = c^*$, so we can compute the probability of contribution by noting that

$$c^* = \delta\left[\frac{c^* - \underline{c}}{\overline{c} - \underline{c}}\right] + (1-\delta)\left[\frac{\overline{c} - c^*}{\overline{c} - \underline{c}}\right] = \frac{(1-\delta)\overline{c} - \delta\underline{c} + c^*(2\delta - 1)}{\overline{c} - \underline{c}}$$

which implies that

$$c^* = \frac{(1-\delta)\overline{c} - \delta\underline{c}}{(\overline{c} - \underline{c} + 1 - 2\delta)}, \text{ or equivalently, } c^* = \frac{(1-\delta)(\overline{c} - \underline{c}) + (1-2\delta)\underline{c}}{(\overline{c} - \underline{c}) + (1-2\delta)}$$

Note that in the case where $\underline{c} = 0$, $c^* = \frac{(1-\delta)\overline{c}}{\overline{c} + 1 - 2\delta}$ and $\pi^* = \frac{c^*}{\overline{c}} = \frac{(1-\delta)}{\overline{c} + 1 - 2\delta}$

Using the properties of the uniform distribution, we can denote $\overline{c} = \underline{c} + \sqrt{12}\sigma$, and $\underline{c} = \mu - \sqrt{3}\sigma$, where σ represents the standard deviation and μ represents the mean of the cost distribution. This allows us to rewrite the investment threshold condition using the standard deviation as a measure of the player's uncertainty:

$$c^* = \frac{(1-\delta)\sqrt{12}\sigma + (1-2\delta)\underline{c}}{\sqrt{12}\sigma + (1-2\delta)} = \frac{\sqrt{3}\sigma + (1-2\delta)\mu}{2\sqrt{3}\sigma + (1-2\delta)}$$