# Foreign Aid and International Public Goods: Incentives and Strategic Behavior*

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**Abstract**

This paper considers a stylized model where a donor and a recipient government derive utility from a public good (for example consumption among the poor or defense capacity in the recipient country), in addition to a private good each (for example their own tax-payers' consumption). The main point is to discuss how the aggregate provision of funds earmarked for the public good and the distribution of the costs depend on the pattern of interaction between the two governments. Both non-cooperative interaction patterns (leading to undersupply of the public good) and cooperative patterns (leading to Pareto-efficient outcomes) are discussed. Cooperation is unlikely unless it is backed by institutions or credible sanctions. Among the non-cooperative interaction patterns the Nash-Cournot type is the best, in the sense that the supply of the public good is highest. If one of the governments behave as a (passive) Stackelberg leader (and the other as a follower) the supply is considerably lower. The distribution of the cost depends on who the leader is but it may be very uneven. If the Stackelberg leader government is active and behaves as a principal, making the other an agent, undersupply is eliminated but the distribution of the costs become even more uneven.

A donor may have many motives or goals for his presence or activities in a poor country. An *altruistic* donor primarily wants to contribute to

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reduced poverty and/or increased economic growth. As a result, he engages in activities like education, road construction, etc. and encourages domestic decision-makers in the recipient country to do the same. Other donors base their activities on more narrow *self-interest*, for example reduced pollution or deforestation, arming, etc. Accordingly, they engage in activities meant to reduce pollution or increase the country's defence capacity, etc., and ask domestic decision-makers to do the same.

As a rule, the goals of the donor are shared to some extent by important domestic decision-makers in the aid-receiving country, for example the government and other politicians. *Ceteris paribus*, they also want reduced poverty, increased economic growth, reduced pollution, stronger defence, etc.

In the discussions below we assume that there are only two actors or decision-makers: the government in the donor country and the government in the aid-receiving country.

In many ways, then, the donor and the recipient governments are partners with common objectives, but it is important to bear in mind that they both have other objectives as well - and budget constraints (and possibly other constraints as well). They both know that to the extent they contribute to the satisfaction of the common goals, there will be a cost in the sense that the contribution to the satisfaction of other goals will be reduced. As a result, even though there are common objectives there are conflicting interests when it comes to the burden-sharing. Each actor definitely wants the other to carry as much as possible of the cost. It follows that the goods or services contributing to the satisfaction of the common goals represent what is usually called *international public goods.* The actual supply of such goods, and also the burden-sharing, depend on the nature of the interaction pattern between the two actors.

The paper is organized as follows. The first section contains the presentation of a simple model and a characterization of the economic situation in both the donor and the recipient countries if only one of them contributes to the production of the public good. Then, in section two both countries contribute but the interaction pattern is non-cooperative. Both the traditional Nash-Cournot game, resulting in under-supply in the Paretian sense, and various Stackelberg games, where the under-supply may be even worse, are discussed. In section three cooperative solutions are discussed. Cooperative solutions are not likely to be implemented unless they are backed by institutions or credible sanctions.

The paper is meant as an exposition of some basic incentive problems of relevance for both recipients and donors of foreign aid, see Pedersen (1997) for a non-technical survey. Such problems have not been taken seriously in the traditional literature on development aid, see for example Cassen (1994) or World Bank (1998b). In addition, the paper may also be read as an introduction to strategic behavior in the supply of international public goods. Apart from discussions of free-rider problems related to the private production of public goods, there is not much about strategic behavior in the literature on public goods, neither national nor international, see for example Cornes and Sandler (1996) and Kaul, Grunberg, and Stern (1999) for surveys and discussions.

# 1 A SIMPLE MODEL

Let $V^P$ symbolize whatever argument in the two actors' (i.e., the governments') welfare functions that is common (for example consumption for the poor, investment, environmental standards or defence expenditures). Let $Y^P$ $(\geq 0)$ be the level of $V^P$ in a situation where the two actors are passive, in the sense that they do not engage in activities meant to contribute to $V^P$. When the donor government does engage in such activities we shall simply say that it spends an amount $A$, financed through a tax on domestic value added, $Y^D\,(\gg 0)$, in the donor country. When the recipient government intervenes actively in order to increase $V^P$ it is assumed to spend an amount $T$, also financed through a tax on domestic value added, $Y^R\,(\gg 0)$. We let $\theta^D$ be the cost of public funds in the donor country, $\theta^R$ be the cost of funds in the recipient country, and $\theta^P$ be the return of donor and recipient funds in the production of $V^P$. In order to obtain simple and explicit solutions in the model exercises to follow, these parameters are assumed to be constant[1].

Income in the donor country at the disposal for taxpayers' consumption may now be expressed as

$$V^D = Y^D - \theta^D A,$$

Income at the disposal for taxpayers' consumption in the recipient country

[1] This means, of course, that the actors' flexibility is overestimated and, accordingly, that the results are exaggerated. The principles we want to illustrate, however, remain valid also for more realistic formulations.

may be expressed as

$$V^R = Y^R - \theta^R T.$$

In addition, the level of public good, $V^P$, is found as

$$V^P = Y^P + \theta^P (T + A).$$

We now introduce a welfare function, $W^D$, guiding the donor government's decisions, with $V^D$ (the taxpayers' consumption) and $V^P$ (the public good) as arguments and a corresponding function, $W^R$, with $V^R$ (taxpayers' consumption) and $V^P$, guiding the recipient government's decisions[2]. In order to obtain simple and explicit solutions we simplify by adopting the following functional forms:

$$\begin{aligned} W^D\left(V^D, V^P\right) &= \overline{W}^D + \rho^D \ln V^D + \rho^P \ln V^P \text{ (with } \rho^D + \rho^P = 1\text{) and} \\ W^R\left(V^R, V^P\right) &= \overline{W}^R + \gamma^R \ln V^R + \gamma^P \ln V^P \text{ (with } \gamma^R + \gamma^P = 1\text{).} \end{aligned}$$

$\overline{W}^D$ is a constant that equals zero if the donor government does not engage in aid activities. It may be positive if there is such engagement; it represents the benefit derived from being involved. Similarily, $\overline{W}^R$ is zero if the recipient government is not engaged in activities contributing to the public good but may be positive if it does[3].

Such formulations of the welfare functions clearly show that from the donor government's and the recipient government's point of view $V^P$ is a public good. The main point of this paper is to show how the actual supply of this public good and the distribution of the costs between the taxpayers in the donor and recipient countries depend on the nature of the interactions between the two actors[4].

[2]It follows from our formulations that private agents do not voluntarily give contributions to the public good. They have solved the free-rider problem (at the national level) by letting the government take care of the supply of public goods. However, the consequences of private contributions within this framework will be discussed below.

[3]The actual interpretation of these constants are not important. We may need them in our simple example in order to obtain interior solutions, i.e., solutions where $T \neq 0$ and $A \neq 0$. If they are set equal to zero corner solutions, i.e., $T = 0$ or $A = 0$, may be optimal. In the real world such corner solutions may be important, but from a theoretical point of view they are rather uninteresting.

[4]The two actors' private goods, $V^D$ and $V^R$, may be given very wide interpretations

However, before we start on that discussion we illustrate the results if only one of the actors contributes to $V^P$. Those situations are useful reference points.

## 1.1 Only domestic contributions

When there is no aid the domestic government maximizes $W^R$ with respect to $T$ for $A = 0$. The first-order condition, from which the level of $T$ can be derived, is

$$\frac{\partial W^R}{\partial T} = -\frac{\gamma^R}{V^R}\theta^R + \frac{\gamma^P}{V^P}\theta^P = 0$$

The welfare gain derived from the last unit of government income spent on the public good will equal the welfare cost resulting from the last unit of public income taxed away from domestic tax-payers.

The results in the recipient-to-be country are the following

$$\begin{aligned}
T_{A=0} &= \gamma^P \frac{Y^R}{\theta^R} - \gamma^R \frac{Y^P}{\theta^P} \\
V^P_{A=0} &= \theta^P \gamma^P \left[\frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right] \\
V^R_{A=0} &= \theta^R \gamma^R \left[\frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right] \\
W^R_{A=0} &= \overline{W}^R + \gamma^R \ln V^R_{A=0} + \gamma^P \ln V^P_{A=0}
\end{aligned}$$

The interpretation is clear; the amount collected from the taxpayers and spent on $V^P$ depends on the government's preferences, the cost of public funds and the productivity of public funds in the "production" of $V^P$, in addition to the taxpayers' income level and the initial level of $V^P$, $Y^P$. If we interpret the public good as consumption for the poor, it may be convenient to interpret $\frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}$ as the aggregate income at the government's disposal,

in addition to taxpayers' consumption. $V^D$ may represent any use of funds that does not enter the recipient government's welfare function, for example aid given to another poor country. $V^R$ may be any use of funds not entering the donor government's welfare function, for example a new aeroplane or palace for the president.

given that private income has been transformed into public income. From the government's point of view it is optimal to let the weights in the welfare function ($\gamma^R$ and $\gamma^P = 1 - \gamma^R$) determine the distribution of this income between the two groups, $\frac{V^R}{\theta^R} = \gamma^R$ units to the (rich) taxpayers and $\frac{V^P}{\theta^P} = \gamma^P$ to the poor.

The resulting welfare level has been illustrated using the indifference curve $W^R_{A=0}$ in figure 1.

The donor-to-be government simply lets all domestic value added be consumed. It benefits, however, from the recipient-to-be government's contribution to $V_{P.}$

$$\begin{aligned} V^D_{A=0} &= Y^D \\ W^D_{A=0} &= \rho^D \ln V^D_{A=0} + \rho^P \ln V^P_{A=0} \end{aligned}$$

Since we want to avoid corner solutions we shall assume that $\overline{W}^D$ is so high that setting $A = 0$ is not an optimal strategy.

## 1.2 Only foreign contributions

Without domestic contributions the donor government maximizes $W^D$ with respect to $A$ for $T = 0$. The first-order condition, which has the same interpretation as the corresponding condition above, is

$$\frac{\partial W^D}{\partial A} = -\frac{\rho^D}{V^D}\theta^D + \frac{\rho^P}{V^P}\theta^P = 0$$

and the results, as perceived by the donor country is

$$\begin{aligned} A_{T=0} &= \rho^P \frac{Y^D}{\theta^D} - \rho^D \frac{Y^P}{\theta^P} \\ V^P_{T=0} &= \theta^P \rho^P \left[ \frac{Y^D}{\theta^D} + \frac{Y^P}{\theta^P} \right] \\ V^D_{T=0} &= \theta^D \rho^D \left[ \frac{Y^D}{\theta^D} + \frac{Y^P}{\theta^P} \right] \\ W^D_{T=0} &= \overline{W}^D + \rho^D \ln V^D_{T=0} + \rho^P \ln V^P_{T=0} \end{aligned}$$

The amount given in aid depends on the donor government's preferences, its cost of public funds, and the return of aid in the production of $V^P$, in addition to the income level in the donor country and the initial level of $V^P$. The indifference curve labelled $W^D_{T=0}$ reflects the resulting welfare level.

In the receiving country the entire value added is consumed by the potential taxpayers but the government derives benefits from the donor's contribution to $V_P$.

$$\begin{aligned} V^R_{T=0} &= Y^R \\ W^R_{T=0} &= \gamma^R \ln V^R_{T=0} + \gamma^P \ln V^P_{T=0} \end{aligned}$$

Again we shall assume that the constant in the welfare function, $\overline{W}^R$ this time, is so high that setting $T = 0$ is not optimal.

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Given our assumptions, for the corner solutions above to be realistic they must be imposed by some exogenous factors, specifying that one of the actors is not allowed to contribute to the public good. Without such a restriction both will end up as contributors. When they both contribute they may, to some extent, crowd out each others contributions. There may even be crowding in. It all depends on the nature of the interaction between them. The interaction pattern will also determine how much each actor will contribute and the level of the total contribution.

Actually, we shall discuss equilibria where both $T$ and $A$ are positive as well as equilibria where one of them may be negative. A negative $T$, means that some of the aid ends up as consumption for the (rich) taxpayers in the recipient country - not at all an unrealistic scenario. A negative $A$ means that some of the taxes paid by the taxpayers in the recipient country, $T$, ends up as consumption in the donor country. This situation is not necessarily too unrealistic in a situation where the recipient government owes some debt to the donor government. A negative $A$ will then simply mean that some debt is repaid. We shall assume that in such situations $\overline{W}^R$ and $\overline{W}^D$ are high enough to make sure that none of the actors want to withdraw from their engagement and that none of them wants to exclude the other.

We first discuss interaction patterns predicted by non-cooperative game theory, where the solutions reflect serious Pareto inefficiencies, in the sense that the aggregate contribution to the public good is too low. In addition, some of the solutions lead to very uneven distribution between the donor and the recipient governments of the aggregate cost of providing the public good.

Then we show how genuine cooperation may reduce (and actually eliminate) these problems. However, since the two actors have incentives to cheat, cooperation is not likely to happen.

# 2 NON-COOPERATION

## 2.1 Nash-Cournot

The traditional way of modelling non-cooperative supply of public goods is as a Nash-Cournot game (see Cornes and Sandler (1996) for an introduction and a survey). In a situation where the interaction pattern may be characterized as a non-cooperative game of the Nash-Cournot type each actor does the best he can, taking the other actor's contribution as given. The donor government maximizes $W^D$ with respect to $A$ taking $T$ as given and the recipient government maximizes $W^R$ with respect to $T$ taking $A$ as given. The first-order conditions and the corresponding reaction functions $A(T)_N$ and $T(A)_N$ which can be derived directly from those conditions, are the following.

The donor:

$$\begin{aligned}\frac{\partial W^D}{\partial A} &= \frac{\rho^P\theta^P}{V^P} - \frac{\rho^D\theta^D}{V^D} = 0 \\ A(T)_N &= \rho^P\frac{Y^D}{\theta^D} - \rho^D\left(\frac{Y^P}{\theta^P} + T\right)\end{aligned}$$

The recipient:

$$\begin{aligned}\frac{\partial W^R}{\partial T} &= \frac{\gamma^P\theta^P}{V^P} - \frac{\gamma^R\theta^R}{V^R} = 0 \\ T(A)_N &= \gamma^P\frac{Y^R}{\theta^R} - \gamma^R\left(\frac{Y^P}{\theta^P} + A\right)\end{aligned}$$

Each actor will tend to set his own marginal welfare gain from the supply of the public good equal to the marginal welfare cost from taxation (and reduced taxpayers' consumption). It is clear in our simple example that aid is perfectly fungible and that the two actors tend to crowd out each other's activities meant to contribute to the public good: $A'(T) \equiv \frac{\partial A}{\partial T} = -\rho^D$ and $T'(A) \equiv \frac{\partial T}{\partial A} = -\gamma^R$. A share $\rho^D$ of domestic expenditures on $V^P$, i.e., of $T$ , ends up as private consumption in the donor country. Similarily, a share $\gamma^R$ of $A$ ends up as private consumption among the taxpayers in the recipient country.

The reaction functions have been illustrated in figure 1. The slope of the recipient government's reaction function is $T'(A) = -\gamma^R$ and we know that $-1 \ll T'(A) \ll 0$. The slope of the donor's reaction function is $\frac{1}{A'(T)} = -\frac{1}{\rho^D}$ $\ll -1$ and we know that it is clearly steeper than the recipient government's reaction function.

The slopes of the recipient government's indifference curves are (see the appendix)

$$\left.\frac{dT}{dA}\right|_{W^R} = -\frac{\frac{\gamma^P\theta^P}{V^P}}{\frac{\gamma^P\theta^P}{V^P} - \frac{\gamma^R\theta^R}{V^R}}$$

From the first-order condition above we see that along the reaction function the denominator is zero, i.e., $\frac{\partial W^R}{\partial T} = \frac{\gamma^P\theta^P}{V^P} - \frac{\gamma^R\theta^R}{V^R} = 0$, so that the slope tends to infinity (the indifference curve is vertical). The slope is positive above the reaction function where $\frac{\partial W^R}{\partial T} \ll 0$ and negative below the reaction function because $\frac{\partial W^R}{\partial T} \gg 0$.

The slope of the donor government's indifference curves are

$$\left.\frac{dT}{dA}\right|_{W^D} = -\frac{\frac{\rho^P\theta^P}{V^P} - \frac{\rho^D\theta^D}{V^D}}{\frac{\rho^P\theta^P}{V^P}}$$

Along the reaction function the first-order condition, $\frac{\partial W^D}{\partial A} = \frac{\rho^P\theta^P}{V^P} - \frac{\rho^D\theta^D}{V^D} = 0$, tells us that the numerator equals zero and so does the slope (the indifference curves are horisontal). It is positive to the right of the reaction function, where $\frac{\partial W^D}{\partial A} \ll 0$ and negative to the left of the reaction function where $\frac{\partial W^D}{\partial A} \gg 0$.

The reaction functions give us two equations that can be used to calculate the levels of $A$ and $T$.

$$A = \frac{1}{1-\rho^D\gamma^R}\left[\rho^P\frac{Y^D}{\theta^D} - \rho^D\gamma^P\left(\frac{Y^R}{\theta^R}+\frac{Y^P}{\theta^P}\right)\right]$$
$$T = \frac{1}{1-\rho^D\gamma^R}\left[\gamma^P\frac{Y^R}{\theta^R} - \gamma^R\rho^P\left(\frac{Y^D}{\theta^D}+\frac{Y^P}{\theta^P}\right)\right]$$

The resulting levels of $V^P$, $V^R$, and $V^D$ are easily calculated once $A$ and $T$ are known:

$$V^P = \frac{\theta^P\gamma^P\rho^P}{1-\rho^D\gamma^R}\left[\frac{Y^D}{\theta^D}+\frac{Y^R}{\theta^R}+\frac{Y^P}{\theta^P}\right]$$
$$V^R = \frac{\theta^R\gamma^R\rho^P}{1-\rho^D\gamma^R}\left[\frac{Y^D}{\theta^D}+\frac{Y^R}{\theta^R}+\frac{Y^P}{\theta^P}\right]$$
$$V^D = \frac{\theta^D\rho^D\gamma^P}{1-\rho^D\gamma^R}\left[\frac{Y^D}{\theta^D}+\frac{Y^R}{\theta^R}+\frac{Y^P}{\theta^P}\right]$$

The result has been illustrated as point a in figure 1 where also the indifference curves have been drawn, $W_a^D$ for the donor government and $W_a^R$ for the recipient government.

**Figure 1 about here**

It is still convenient to consider $\frac{Y^D}{\theta^D}+\frac{Y^R}{\theta^R}+\frac{Y^P}{\theta^P}$ as the aggregate amount, measured in a common *numeraire* to be spent on private consumption among the taxpayers in the two countries and the public good, for example consumption for the poor. $\frac{V^P}{\theta^P}$ units (or the share $\frac{\gamma^P\rho^P}{1-\rho^D\gamma^R}$) are spent on the public good. $\frac{V^R}{\theta^R}$ (the share $\frac{\gamma^R\rho^P}{1-\rho^D\gamma^R}$) units end up as consumption by the taxpayers in the recipient country. $\frac{V^D}{\theta^D}$ units ($\frac{\rho^D\gamma^P}{1-\rho^D\gamma^R}$) are being consumed by taxpayers in the donor country.

It follows, *ceteris paribus*, that the amount spent on $V^P$ depends positively on $\frac{\gamma^P}{\gamma^R}$ and $\frac{\rho^P}{\rho^D}$, i.e. the relative weighs of the public good in the welfare functions. However, because of the non-cooperative structure of the game it is also the case that the amount spent on $V^R$ depends positively on $\frac{\rho^P}{\rho^D}$ and the amount spent on $V^D$ depends positively on $\frac{\gamma^P}{\gamma^R}$. The more important the public good is perceived by the donor government, the lower the the amount spent on that good by the recipient government and the higher the taxpayers' consumption in the recipient country will tend to be. Similarily, if the recipient government cares much for the public good, the donor government will spend less on that good than if the recipient government had cared less.

We see from figure 1 that there are many combinations of $A$ and $T$ where both actors are better off (the shaded area) than in point a. Those combinations also reflect higher aggregate contribution to the public good. Both actors, however, are bound to loose from unilateral increases (as well as reductions) of their contributions, i.e., they end up on indifference curves reflecting lower utility.

The Nash-Cournot solution, where the two actors take each other's decision as given, is definitely not the best. As will be shown below, among non-cooperative interaction patterns, however, worse solutions easily come to mind, especially if one of the actors can be characterized as a passive Stackelberg leader and the other a Stackelberg follower.

*A digression on (non-)neutrality*: Since the productivities of aid and domestic transfers are equal, $\theta_P$, the traditional neutrality results (Bergstrom, Blume, and Varian (1986)) follow - in the sense that whether the donor government gives aid earmarked for the production of public goods or general transfers to the recipient government, is of no importance in the present context. Of course, if those productivities had differed between them, this type of neutrality would not hold (Cornes and Sandler (1996)). A general transfer to the recipient government would be more valuable for all than the same amount earmarked for the production of the public good if the recipient government's productivity was higher than that of the donor, and *vice versa*.

However, it is interesting to observe that the neutrality result has to do with transfers of income in the hands of the donor government to the "production" of the public good or to the recipient government, i.e., *after* the correction for a cost of public funds different from unity. When the cost of public funds is higher (or lower) than unity, it is important to distinguish between public and private aid.

If we assume that private aid is given from taxpayers in the donor country[5] to taxpayers in the recipient country (a lump-sum transfer between taxpay-

[5] Because of the free-rider problem private contributions may be negligible in the real world.

ers), the net effect depends on the relative levels of the cost of public funds: We see that if $Y^D$ is reduced by one unit and $Y^R$ is increased by one unit, taxpayers' consumption in both countries, $V^D$ and $V^R$, as well as aggregate production of the public good, $V^P$, will increase only as long as the cost of public funds in the donor country, $\theta^D$, is higher than the cost in the recipient country, $\theta^R$. Since such a transfer will cause the aid from the government, $A$, to go down the aggregate tax level in the donor country goes down as well. Accordingly, there is an efficiency gain. In the recipient country, on the other hand, the aggregate tax level must increase, leading to an efficiency loss. As long as $\theta^D \gg \theta^R$ the gain in the donor country will outweigh the loss in the recipient country. In the real world it seems more likely that $\theta^D \ll \theta^R$ so that private aid of the type in question will be directly counterproductive.

Maybe a more natural way of thinking about private aid is to let it contribute directly to the public good. If we let the public good be consumption for the poor, there are at least two ways of doing that: The aid can either be given directly to the poor as an income increase, i.e., as increased $Y^P$, or it can be given in the same way as government aid, as a contribution to the "production" of $V^P$[6]. In the first case the result can be found formally in exactly the same way as the results of a private transfer to the taxpayers in the recipient country. Both $V^D, V^R$, and $V^P$ will increase as a result of a combined increase of $Y^P$ and a reduction of $Y^D$ as long as $\theta^D \gg \theta^P$, i.e., as long as the cost of funds in the donor country exceeds the productivity of the two governments' contributions to the "production" of consumption for the poor. In the second case all the three interesting variables will increase if $\theta^D$ exceeds unity, i.e., as long as taxes collected in the donor country are distortionary[7].

## 2.2 The passive Stackelberg leaders

As mentioned above, usually the non-cooperative supply of public goods is modelled as a Nash-Cournot game. When the actors are relatively few, however, there is no reason why one (or more) of them should not think

[6] Private transfers from the tax-payers in the recipient country may, of course, be treated in a similar way.

[7] This conclusion will be reinforced if private aid is more effective than public aid, in the sense that $\theta^P$ is higher for private aid.

more strategically, for example as in a Stackelberg game (see for example Gibbons (1992)). When in a game between two actors one is characterized as a Stackelberg follower and the other a Stackelberg leader, one of them (the follower) still takes the other's (the leader's) decision as given, but the other (the leader) incorporates the other's (the follower's) reaction to his own decision. When we say that the leader is *passive*, it simply means that he lets the follower do whatever he finds best, given his own preferences. The *active* leader, however, discussed below, intervenes directly in the sense that he dictates what the follower is expected to do.

Who is actually the leader and who is the follower in the donor-recipient relationship? The answer is not at all clear and it may even be time and context specific.

In the aid literature, very often it is assumed that the donor is the leader and the recipient is the follower, especially when conditionality is involved. However, conditionality is not always adhered to by the recipient and in reality, the donor may end up as the follower, see the discussion of the Samaritan's dilemma below.

Also, the "new" ideas in multilateral organizations about partnerships for development[8], based on recipent country "ownership" may seem to recommend handing over the leadership to the recipient country's government and accept the position as followers for the donors.

### 2.2.1 The donor as the leader and the recipient government as the follower

The follower recipient government still takes the inflow of aid as given and is, accordingly, on its reaction curve. The leader donor government, on the other hand, incorporates the recipient's reaction to its own action. Using the recipient government's reaction function above it calculates the "production" of the public good as a function of its own contribution as $V^P = Y^P + \theta^P (T + A) = \theta^P \gamma^P \left[ \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P} + A \right]$. When it determines how much aid to give, it knows that a share of it, $\gamma^R$, in reality ends up as consumption for the taxpayers in the recipient country. Only the share $\gamma^P = 1 - \gamma^R$ goes to the goal for which it is earmarked. This certainly reduces the donor's willingness

[8]See for example World Bank (1998a).

to give in our simple example. The first-order condition determining $A$ may now be written as

$$\frac{dW^R}{dA} = \frac{\rho^P \theta^P \gamma^P}{V^P} - \frac{\rho^D \theta^D}{V^D} = 0$$

and the results are

$$\begin{aligned}
A &= \rho^P \frac{Y^D}{\theta^D} - \rho^D \left( \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P} \right) \\
T &= \left(1 - \gamma^R \rho^P\right) \frac{Y^R}{\theta^R} - \gamma^R \rho^P \left( \frac{Y^D}{\theta^D} + \frac{Y^P}{\theta^P} \right) \\
V^P &= \theta^P \gamma^P \rho^P \left[ \frac{Y^D}{\theta^D} + \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P} \right] \\
V^R &= \theta^R \gamma^R \rho^P \left[ \frac{Y^D}{\theta^D} + \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P} \right] \\
V^D &= \theta^D \rho^D \left[ \frac{Y^D}{\theta^D} + \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P} \right]
\end{aligned}$$

These results have been indicated as point $b$ in figure 1. It is clear that the amount given by the leader donor is lower than the amount given in the Nash-Cournot case above and that the expenditures of the recipient government is higher. The burden of providing for $V^P$ has been changed in favour of the donor. Accordingly, taxpayers' consumption in the donor country has increased and taxpayers' consumption in the recipient country has been reduced. However, the aggregate supply of the public good, for example consumption for the poor, has been somewhat reduced ($\gamma^P \rho^P \ll \frac{\gamma^P \rho^P}{1-\rho^D \gamma^R}$). The donor government ends up being better off (see the indifference curve $W_b^D$) while the recipient government is worse off (the indifference curve $W_b^R$).

Again, we see that there are many combinations of $A$ and $T$ where both the donor and the recipient government are better off. However, the recipient goverment is on its reaction curve, so that its indifference curve is vertical - indicating that a unilateral increase of $T$ will reduce its welfare level. The donor government's indifference curve has negative slope (from the first-order condition we know that $\frac{\rho^P \theta^P}{V^P} - \frac{\rho^D \theta^D}{V^D} \gg 0$) indicating that a unilateral increase of $A$, if it goes to the public good in its entirety, will cause its welfare level to increase. It knows, however, that if $A$ is increased by one unit the recipient government will reduce $T$ by $\gamma^R$ units along its reaction function so that only the share $\gamma^P$ in reality ends up contributing to the public good. As a result, from the donor's perspective the welfare level will be reduced.

### 2.2.2 The recipient government as the leader and the donor as the follower

In this case the donor government takes the recipient government's effort, $T$, as given and is, therefore on its reaction curve. The recipient government, however, knows that the donor will give less the more itself contributes to $V^P$. Using the donor government's reaction function above it calculates the "production" of the public good as a function of its own contribution as $V^P = Y^P + \theta^P (T + A) = \theta^P \rho^P \left[\frac{Y^D}{\theta^D} + \frac{Y^P}{\theta^P} + T\right]$. It knows that only a share $\rho^P$ of $T$ ends up contributing to $V^P$. The rest, $\rho^D = 1 - \rho^P$ ends up in the pockets of the donor country's tax-payers. The first-order condition determining $T$ is

$$\frac{dW^D}{dT} = \frac{\gamma^P \theta^P \rho^P}{V^P} - \frac{\gamma^R \theta^R}{V^R} = 0$$

and the results in this case are

$$\begin{aligned}
A &= \left(1 - \rho^D \gamma^P\right) \frac{Y^D}{\theta^D} - \rho^D \gamma^P \left(\frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right) \\
T &= \gamma^P \frac{Y^R}{\theta^R} - \gamma^R \left(\frac{Y^D}{\theta^D} + \frac{Y^P}{\theta^P}\right) \\
V^P &= \theta^P \gamma^P \rho^P \left[\frac{Y^D}{\theta^D} + \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right] \\
V^R &= \theta^R \gamma^R \left[\frac{Y^D}{\theta^D} + \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right] \\
V^D &= \theta^D \rho^D \gamma^P \left[\frac{Y^D}{\theta^D} + \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right]
\end{aligned}$$

These results have been indicated as point c in figure 1. It is interesting to observe that letting the donor become the follower and the recipient the leader does not affect the aggregate amount spent on the public good in our simple example, i.e., the level of $V^P$ is independent of whether it is the donor or the recipient who is the leader. The burden-sharing, however, has changed. Now the amount spent on $V^D$ is lower that in the Nash-Cournot situation, while the amount spent on $V^R$ is higher, i.e., taxpayers in the donor country are worse off and taxpayers in the recipient country are better off. The recipient government is undoubtedly better off (see the indifference curve $W_c^R$) while the donor is worse off (the indifference curve $W_c^D$).

Again we see that there exist many combinations of $A$ and $T$ where both actors are better off and the aggregate supply of the public good is higher. From the donor's point of view, however, since the indifference curve is horisontal in point c, a unilateral increase of $A$ will cause the welfare level to go down. The slope of the recipient government's indifference curve is negative (from the first-order condition it follows that $\frac{\gamma^P \theta^P}{V^P} - \frac{\gamma^R \theta^R}{V^R} \gg 0$). As a result a one unit increase of $T$ ending up as increased supply of the public good in its entirety, means higher welfare. The donor government, however, reduces its contribution along its reaction curve, so that in reality the recipient government's welfare goes down if it increases $T$ unilaterally.

Answers to the neutrality question are the same when the two governments play a Stackelberg game as when they are engaged in a game of the Nash-Cournot type discussed above. Given the results derived in Jayarman and Kanbur (1999) in a situation where the the cost of public funds equals unity this is no surprise. Similar results can also be found in Cornes and Sandler (1996).

*A digression on fungibility*: Neutrality presupposes that the donor's contribution is perfectly fungible, in the sense that it is considered as a general increase of the recipient's aggregate funds. Perfect fungibility, as usually defined, means that it is up to the recipient to determine how the donor's contribution is actually used, no matter how it is earmarked initially. In the aid literature the debate on fungibility goes back at least to Singer (1965) who considered fungibility at the micro or project level; aid earmarked for a specific project may easily end up financing another (less valuable) project within the same program (for example education). Later contributions have considered what might be called fungibility at the program level and fungibility at the macro level. Fungibility at the program level refers to situations where aid earmarked for one program (for example education) may be transferred to another program (for example health). As long as both programs contribute to the supply of goods or services from which the donor derives some utility such fungibility is not necessarily a problem leading to reduced effectiveness of aid. What we call fungibility at the macro level, however, is meant to capture situations where aid may be trensferred to purposes from which the donor derives no utility (for example a new palace for the political leaders or in the model above: consumption for the (rich) tax-payers). Actual diversion at the macro level may have dramatic and negative effects on the effectiveness of aid as perceived by the donor and may turn out to be the main reason for the apparent lack of effectiveness of development aid, see Boone (1996) and Burnside and Dollar (2000).

Whether aid is fungible or not is not the important question. The important questions from the donor's point of view must be whether diversion of funds away from the purpose for which it is earmarked actually takes place and his perception of the value of its actual use[9]. Actual diversion and the purpose for which it is used of course depends on the recipient's preferences, competence, etc. but what is important to notice in our context is that it also depends critically on the nature of the interaction pattern between the two actors. In many ways the focus of this paper could be said to be actual diversion of aid at the macro level. Hagen (2002) discusses fungibility at the program level within a similar game-theoretic context. He claims that we lack a good definition of fungibility. His suggestion is that such a definition should focus on the relative distribution of influence - between the donor and the recipient - over the actual outcome.

## 2.3 The active Stackelberg leaders

The difference between the active and the passive Stackelberg leaders is that the active leader intervenes directly in the follower's decision-making. The leader becomes the principal and the follower becomes the agent operating more or less on behalf of the principal. In this situation it becomes crucial for the principal to figure out how much he can get out of the agent. That depends on the agents' reservation utility or welfare level, i.e., his perception of the worst scenario the principal can possibly put him in. The principal offers a contract based on the maximization of his own welfare and the agent accepts the contract because he would be worse off if he did not.

The analyses below presuppose that the agent's actions can be monitored by the principal[10] and that he is able to enforce the contract.

### 2.3.1 The donor as the principal and the recipient government as the agent

Let $W_d^R$ symbolize the recipient government's perception of the worst case, here assumed to reflect a welfare level which is lower than the one obtained in a situation where the donor government is a passive Stackelberg leader,

[9]See Devarajan and Swaroop (2000) for a short survey of the fungibility literature.

[10]Se Pedersen (1995) for a discussion of asymmetric information in this context.

$W_b^R$ above. The donor government will now simply "buy" extra domestic expenditures on the public good in return for aid along the recipient government's indifference curve $W_d^R$ in figure 1. The problem is simply to maximize $W^D = \overline{W}^D + \rho^D \ln\left(Y^D - \theta^D A\right) + \rho^P \ln\left(Y^P + \theta^P\left(A+T\right)\right)$ with respect to $A$ and $T$ given the constraint that $W^R = \overline{W}^R + \gamma^R \ln\left(Y^R - \theta^R T\right) + \gamma^P \ln\left(Y^P + \theta^P\left(A+T\right)\right) \geqslant W_d^R$. Letting $\lambda$ represent the Lagrange multiplier the contract offered by the donor (and accepted by the recipient government) is characterized by the following first-order conditions:

$$\begin{aligned}
\overline{W}^R + \gamma^R \ln\left(Y^R - \theta^R T\right) + \gamma^P \ln\left(Y^P + \theta^P\left(A+T\right)\right) - W_d^R &= 0 \\
\frac{\rho^P\theta^P}{V^P} - \frac{\rho^D\theta^D}{V^D} + \lambda\left[\frac{\gamma^P\theta^P}{V^P}\right] &= 0 \\
\frac{\rho^P\theta^P}{V^P} + \lambda\left[\frac{\gamma^P\theta^P}{V^P} - \frac{\gamma^R\theta^R}{V^R}\right] &= 0
\end{aligned}$$

It follows that $-\frac{\frac{\rho^P\theta^P}{V^P} - \frac{\rho^D\theta^D}{V^D}}{\frac{\rho^P\theta^P}{V^P}} = -\frac{\frac{\gamma^P\theta^P}{V^P}}{\frac{\gamma^P\theta^P}{V^P} - \frac{\gamma^R\theta^R}{V^R}}$, i.e., that the slopes of the two actors' indifference curves must be the same. The resulting combination of $A$ and $T$ has been illustrated as point $d$ in figure 1. Now we see that no Pareto-improvements exist: there are no combination of $T$ and $A$ where both actors are better off.

In many ways the situation just described is closely related to the relationship between a donor and a recipient when the donor tries to impose some kind of conditionality. In the resulting contract the donor government "buys" contributions to the public good from the recipient government, $T$. The reward is its own contribution, $A$. This is undoubtedly the best possible result for the donor government.

In the next section the recipient government has the upper hand and designs a contract where conditionality is imposed on the donor.

### 2.3.2 The recipient government as the principal and the donor as the agent

Assume that the recipient government is able to keep the donor at the welfare level, $W_e^D$, that is lower than the welfare level obtained when the recipient government is a passive Stackelberg leader, $W_c^D$. The government will "buy" extra aid in return for domestic contributions along the indifference curve $W_e^D$ in figure 1. The recipient government's problem is to maximize $W^R = \overline{W}^R + \gamma^R \ln\left(Y^R - \theta^R T\right) + \gamma^P \ln\left(Y^P + \theta^P (A+T)\right)$ with respect to $T$ and $A$ provided that $W^D = \overline{W}^D + \rho^D \ln\left(Y^D - \theta^D A\right) + \rho^P \ln\left(Y^P + \theta^P (A+T)\right) \geqslant W_e^D$. The first-order conditions are

$$\begin{aligned}
\overline{W}^D + \rho^D \ln\left(Y^D - \theta^D A\right) + \rho^P \ln\left(Y^P + \theta^P (A+T)\right) - W_e^D &= 0 \\
\frac{\gamma^P\theta^P}{V^P} - \frac{\gamma^R\theta^R}{V^R} + \mu\left[\frac{\rho^P\theta^P}{V^P}\right] &= 0 \\
\frac{\gamma^P\theta^P}{V^P} + \mu\left[\frac{\rho^P\theta^P}{V^P} - \frac{\rho^D\theta^D}{V^D}\right] &= 0
\end{aligned}$$

Again the slopes of the indifference curves must be equal so that no Pareto-improvements exist. The results have been illustrated in figure 1, as point $e$. This time it is the recipient who imposes conditionalities on the donor government and obtains, thereby, the best possible result from his point of view.

*A digresssion on the Samaritan's dilemma.* Donor-imposed conditionality does not always work[11]. In reality, often the active Stackelberg leader (i.e., principal) donor may seem to end up as a follower in a game where the recipient behaves as a passive Stackelberg leader. One plausible way of explaining that observation is based on insights about time inconsistency from Buchanan (1975), in a situation where there is no way of enforcing a contract, see Pedersen (1996, 1997, 2001) and Svensson (2000) for applications of relevance in this context.

Given a more realistic time structure the main argument may be spelled out in the following way. *Step 1*: The leader donor government offers a contract specifying the amount of aid to be given *and* the amount expected to be spent on the public good by the recipient government. If the donor believes that the recipient will not cheat, the terms of the contract will be those chosen by the active leader donor, see point d in figure 1. *Step 2*: The recipient government determines how much actually to take from the taxpayers and spend on the public good. Since the donor government has

[11] See for example Hopkins, Powell, Roy and Gilbert (2000) for a World Bank perspective on conditionality.

no way of enforcing the contract the recipient government knows it will not be punished for non-compliance but in addition - and this is what actually traps the donor - it anticipates that there will be a third step where the donor government will come in with additional contributions once it has seen the actual contribution of the recpient, i.e. the recipient government anticipates the donor government to end up on its reaction curve[12]. As a result, given that the recipient government is rational it will behave as our passive Stackelberg leader, spending much less on the public good than specified in the contract. *Step 3*: Once the donor government has observed the actual contribution of the recipient, the best it can do, according to its own preferences, is actually what the recipient government has anticipated it to do, see point c in figure 1. *Ex post* it is optimal to give more aid then specified in the contract *ex ante*.

The donor does not have to be a Samaritan, i.e., have altruistic motives, to be confronted with this problem. It may be relevant no matter the exact nature of the public good[13]. To avoid the problem the donor has to develop credible commitments, making it in his own interest not to re-enter the stage in step 3 but this may be very difficult.

# 3 COOPERATION

From the discussions above we see that only the situations where one of the actors is what we have called an active Stackelberg leader and the other a follower do we find Pareto-optimal allocations (or at least Pareto-optimal contracts), characterized by the the fact that the two actors' indifference curves are tangential to each other. That is no accident, because in many ways the principal and the agent cooperate and in equilibrium it is impossible to increase the welfare level of one of them without reducing that of the other.

The two situations where one of the actors is an active Stackelberg leader are the extremes, in the sense that the two actors cooperate but the burden is shared in a way that leads to maximum inequality in the distribution of the burden of contributiong to the public good. In principle, any other

[12] Without this anticipation the recipient government would take the donor's contribution in step 1 as given and, accordingly, end up on its own reaction curve.

[13] Of course, an active Stackelberg leader recipient may be confronted with a similar dilemma.

distribution between the two extremes is also possible. Let us, therefore, try to characterize such outcomes.

## 3.1 Centralized decision-making

Assume that the two actors agree to cooperate, in the sense that they agree to maximize, with respect to $T$ and $A$, the weighted sum of the donor's and the recipient's welfare, $W = \beta^D W^D + \beta^R W^R$. The weights, $\beta^D$ and $\beta^R = 1 - \beta^D$ will equal 0.5 if the cooperation is on equal terms[14]. When $\beta^D$ tends to 1 (and $\beta^R$ to 0), the resulting allocation will be identical to the one discussed above with the donor government as the active Stackelberg leader. If $\beta^R$ tends to 1 (and $\beta^D$ to 0) we are back to the situation where the recipient government is the active Stackelberg leader.

The first-order conditions:

$$\begin{aligned}\frac{dW}{dA} &= \beta^D \frac{\partial W^D}{\partial A} + \beta^R \frac{\partial W^R}{\partial A} = 0 \\ &= \beta^D \left( -\frac{\rho^D \theta^D}{V^D} + \frac{\rho^P \theta^P}{V^P} \right) + \beta^R \frac{\gamma^P \theta^P}{V^P}\end{aligned}$$

$$\begin{aligned}\frac{dW}{dT} &= \beta^R \frac{\partial W^R}{\partial T} + \beta^D \frac{\partial W^D}{\partial T} = 0 \\ &= \beta^R \left( -\frac{\gamma^R \theta^R}{V^R} + \frac{\gamma^P \theta^P}{V^P} \right) + \beta^D \frac{\rho^P \theta^P}{V^P}\end{aligned}$$

Disregarding the $\beta s$ the main difference from a situation where there is no cooperation is that it is the aggregate welfare effects that counts, i.e., the sum of the two actors' perception of the gains from increased supply of the public good[15].

[14] We do not ask where the weights in this aggregate welfare function come from. Realistically speaking they would have to come as the result of some international political process within a global governance system. Kaul, Grunberg, and Stern (1999) contains interesting discussions of related questions.

[15] If we let $\beta^D = \beta^R = 0.5$ the first-order conditions can be expressed as $\left(\rho^P + \gamma^P\right) \frac{\theta^P}{V^P} =$

These first-order conditions give us two equations to determine the resulting level of $A$ and $T$. In order to understand the consequences of cooperation, we illustrate the two equations graphically in figure 2 as

$$A\left(T\right)_C = \frac{1}{\beta^D + \beta^R\gamma^P}\left[\left(\beta^D\rho^P + \beta^R\gamma^P\right)\frac{Y^D}{\theta^D} - \beta^D\rho^D\left(\frac{Y^P}{\theta^P} + T\right)\right]$$

and

$$T\left(A\right)_C = \frac{1}{\beta^R + \beta^D\rho^P}\left[\left(\beta^R\gamma^P + \beta^D\rho^P\right)\frac{Y^R}{\theta^R} - \beta^R\gamma^R\left(\frac{Y^P}{\theta^P} + A\right)\right]$$

They should, of course, not be interpreted as individual reaction functions unless both actors internalize the effect of their actions on the other's welfare. The resulting levels of $A$ and $T$ can be found where the two curves intersect, see point $f$ in figure 2 for a situation where $\beta^R = \beta^D = 0.5$. That is also where the two actors' indifference curves are tangential to each other, $\frac{dT}{dA}\Big|_{W^R} = \frac{1}{\frac{dA}{dT}\big|_{W^D}}$ :

$$-\frac{\frac{\gamma^P\theta^P}{V^P}}{\frac{\gamma^P\theta^P}{V^P} - \frac{\gamma^R\theta^R}{V^R}} = -\frac{\frac{\rho^P\theta^P}{V^P} - \frac{\rho^D\theta^D}{V^D}}{\frac{\rho^P\theta^P}{V^P}} = \frac{\beta^R}{\beta^D}\frac{\gamma^P}{\rho^P} \gg 0$$

and no Pareto improvements exist.

It is possible to calculate the resulting levels of $A$ an $T$, and once that is done, it is straight-forward to divide the aggregate income among the three competing purposes. Contributions to the public good:

---

$\frac{\rho^D\theta^D}{V^D} = \frac{\gamma^R\theta^R}{V^R}$. The sum of the two actors' perception of the welfare gain of the last unit of income spent on the public good should equal the welfare cost of the last unit of income collected from tax-payers in the donor country (as perceived by the donor dovernment) *and* the welfare cost of the last unit collected in the recipient country (as perceived by the recipient government). Expressed in this way our results can be interpreted as an international version of Samuelson's (1954) theory of public goods in a world without lump-sum taxation. A more direct generalization of Samuelson's theory can be found in Sandmo (2002).

$$
\begin{aligned}
A &= \left(\beta^R + \beta^D \rho^P\right) \frac{Y^D}{\theta^D} - \beta^D \rho^D \left[\frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right] \\
&= \frac{Y^D}{\theta^D} - \beta^D \rho^D \left[\frac{Y^D}{\theta^D} + \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right] \\
T &= \left(\beta^D + \beta^R \gamma^P\right) \frac{Y^R}{\theta^R} - \beta^R \gamma^R \left[\frac{Y^D}{\theta^D} + \frac{Y^P}{\theta^P}\right] \\
&= \frac{Y^R}{\theta^R} - \beta^R \gamma^R \left[\frac{Y^D}{\theta^D} + \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right]
\end{aligned}
$$

The resulting aggregate contribution to the public good and taxpayers' consumption in the two countries:

$$
\begin{aligned}
V^P &= \theta^P \left(\beta^R \gamma^P + \beta^D \rho^P\right) \left[\frac{Y^D}{\theta^D} + \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right] \\
V^R &= \theta^R \beta^R \gamma^R \left[\frac{Y^D}{\theta^D} + \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right] \\
V^D &= \theta^D \beta^D \rho^D \left[\frac{Y^D}{\theta^D} + \frac{Y^R}{\theta^R} + \frac{Y^P}{\theta^P}\right]
\end{aligned}
$$

We see that *ceteris paribus* the weights $\beta^D$ and $\beta^R = 1-\beta^D$ now determine how the burden related to the "production" of the public good, $V^P$, is divided between the tax-payers in the donor and the recipient countries. If $\gamma^P \neq \rho^P$ these weights also determine the aggregate level of $V^P$. If $\gamma^P \ll \rho^P$ the aggregate level of $V^P$ depends positively on $\beta^D$. This is the case where the donor government cares more for the public good, for example consumption for the poor, than the recipient. If $\gamma^P \gg \rho^P$ and the recipient government cares more for the public good than the donor, $V^P$ depends negatively on $\beta^D$. If $\gamma^P = \rho^P$ the level of $V^P$ is independent of those weights.

**Figure 2 about here**

Disregarding any internalization of external effects, we see from figure 2 that if the alternatives are cooperation with weights $\beta^D = 1 - \beta^R = 0.5$ (point $f$) and non-cooperation of the Nash-Cournot type (point $a$) both actors would try to cheat if we start in point $f$. Both will see their welfare level increase if they unilaterally reduce their contribution to the public good. If they take each other's actions as given the new stable equilibrium will be in point $a$, where they both are worse off and the aggregate contribution to the public good much lower. Cooperation will not survive if it is not backed by institutions or credible sanctions, i.e., if the contract resulting from the maximization of the weighted sum of the two actors' welfare cannot be enforced. It is difficult to see how such free-rider problems can be solved without a well functioning global governance system. We have assumed that the free-rider problems at the national level has been solved in both the countries involved in the supply of public goods in our set-up. As a description of the real world that may be an exaggeration but in many ways one of the greatest achievements of the nation-state has been the provision of collective action rules to overcome such problems. Similar rules are in short supply at the international level.

## 3.2 Decentralized decision-making and (partial) internalization

Of course, if as mentioned above both actors fully internalize the benefits their own action has for the other, then $A(T)_C$ and $T(A)_C$ should be considered as individual reaction functions. Then point $f$ would be just as stable as any non-cooperative equilibrium discussed above. Actually, in that case it is a Pareto-optimal non-cooperative equilibrium.

It is also possible to think of some partial internalization, leadig to reaction functions between those with subscript $N$ (with absolutely no internalization) and those with subscript $C$ (with full internalization), resulting in a stable equilibrium where the two lines intersect.

Observe that if $\beta^D = 1$ (and $\beta^R = 0$) in the $A(T)_C$ -equation and $\beta^R = 1$ (and $\beta^D = 0$) in the $T(A)_C$ -equation, we are back to the non-cooperative reaction functions $A(T)_N$ and $T(A)_N$ used above. Partial internalization would mean than the donor lets $\beta^R$ be positive and, accordingly, lets $\beta^D$ fall below unity while the recipient government lets $\beta^D$ be positive and sets $\beta^R$ below unity. Once the degree of internalization, i.e., parameter values of the $\beta$s for the two actors, has been specified, the two equations $A(T)_C$ and $T(A)_C$, can easily be used to derive the resulting levels of $A$ and $T$.

Maybe an interesting special case could be the one where the donor government fully internalizes the benefits of its actions for the recipient government but where the recipient does not internalize the consequenses for the donor at all. Then the actual reaction function for the donor would be $A(T)_C$ while the recipient's reaction function would be $T(A)_N$. The equilibrium has been illustrated as point $g$ in figure 2 where, of course, the donor's contribution to the public good is very high compared to the contribution of the recipient.

Maybe Scandinavian aid to Tanzania, under President Nyerere, could be interpreted in this way. Scandinavian social democrats obviously considered him as their close relative and ideological spear-head in Africa.

## CONCLUDING COMMENTS

In this paper we have considered a stylized model where two governments (a donor and a recipient) derive utility from a public good (for example poverty reduction) in addition to a private good each (for example their own tax-payers' consumption). The main point has been to show how the aggregate provision of funds for the public good and the distribution of the cost depend on the interaction pattern between the two governments. We have considered both non-cooperative and cooperative interaction patterns. Even though we have focused on foreign aid, the exercises may also be read as an introduction to strategic behavior in the provision of international public goods in a wider sense.

Realistically speaking, without an international governance system Pareto-efficient cooperation of the type discussed in this paper is ruled out. The same may be true for what we have called active Stackelberg leadership, at least if we stick to our rather macro-economic frame of reference. As a result, we are left with non-cooperative interaction patterns in most cases and, accordingly, undersupply of international public goods in the Paretian sense. How the non-cooperative game is actually played may vary from case to case. To the extent that questions related to incentives and strategic behavior are taken up in the literature on foreign aid or international public goods, usually a Nash-Cournot type of game is assumed. There is, however, no *a priori* reason to disregard Stackelberg type of behavior, especially in situations where the number of actors are relatively few. The actual type of behavior really matters. As shown in this paper, Stackelberg interaction patterns tend to keep down the actual supply of the public good and make the distribution of the cost more uneven compared to the Nash-Cournot interaction pattern.

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**APPENDIX**

This appendix is meant for readers who are not familiar with indifference curves of the type used in this paper.

**The donor government's indifference curves**

The welfare or utility function of the donor government is expressed as

$$W^D = \overline{W}^D + \rho^D \ln V^D + \rho^P \ln V^P ( \text{ with } \rho^D + \rho^P = 1)$$

where

$$\begin{aligned} V^D &= Y^D - \theta^D A \text{ and} \\ V^P &= Y^P + \theta^P (T + A) \end{aligned}$$

In order to derive an indifferenc curve - which by definition illustrates the combinations of $A$ and $T$ which give the same utility or welfare level - we differentiate the welfare function with respect to the two interesting variables and set the total differential equal to zero.

$$dW^D = \frac{\partial W^D}{\partial A} dA + \frac{\partial W^D}{\partial T} dT = 0$$

where the partial derivatives are

$$\begin{aligned} \frac{\partial W^D}{\partial A} &= -\frac{\rho^D}{V^D}\theta^D + \frac{\rho^P}{V^P}\theta^P \\ \frac{\partial W^D}{\partial T} &= \frac{\rho^P}{V^P}\theta^P \end{aligned}$$

The partial derivative with respect to $T$ is always positive: The donor government will always be better off if the recipient government increases its contribution to the public good. The sign of the partial derivative with respect to $A$, however, depends on the level of $A$: For any given level of $T$ (say $T_0$) there is a level of $A$ (let us call it $A_0$) which will make the partial derivative equal to zero. This is the situation where the distribution of resources between domestic consumers (consuming $V^D = Y^D - \theta^D A$) and the public good ($V^P = Y^P + \theta^P (T + A)$ ) is optimal - in the sense that the welfare gain resulting from the last dollar spent on the public good equals the welfare loss resulting from the last dollar taxed away from domestic consumers. As long as $A \ll A_0$ the partial derivative is positive because the welfare gain resulting from an extra dollar spent on the public good exceeds the welfare loss caused by an extra dollar taxed away from domestic consumers. The opposite will be true if $A \gg A_0$ and the partial derivative will be negative. An exogenous increase in the contribution to the public good from the recipient government, $T$, means that $V^P$ goes up and the welfare gain caused by the last dollar spent on $A$ is reduced. As a result, the level of $A$ giving $\frac{\partial W^D}{\partial A} = 0$ is reduced as well.

The slope of the indifference curve can now be found as

$$\left.\frac{dA}{dT}\right|_{W^D} = -\frac{\frac{\partial W^D}{\partial A}}{\frac{\partial W^D}{\partial T}} = -\frac{\frac{\rho^P \theta^P}{V^P}}{\frac{\rho^P \theta^P}{V^P} - \frac{\rho^D \theta^D}{V^D}}$$

or more convenient in the $(T, A)$ plane:

$$\left.\frac{dT}{dA}\right|_{W^D} = \frac{1}{\left.\frac{dA}{dT}\right|_{W^D}} = -\frac{\frac{\rho^P \theta^P}{V^P} - \frac{\rho^D \theta^D}{V^D}}{\frac{\rho^P \theta^P}{V^P}}$$

**Figure A1 about here**

Three indifference curves have been drawn in figure A1. We start in a situation where $T = T_0$ and let $A = A_0$ be the level of $A$ where $\frac{\partial W^D}{\partial A} = 0$. Let $W_0^D$ symbolize the relevant indifference curve. Its slope equals zero when $A = A_0$. Assume that the recipient government's contribution to the public good increases by $\Delta T$. There will be a welfare gain from the donor government's point of view. As a result, if the level of $A$ remains unchanged its welfare level will increase, meaning that another (higher and better) indifference curve will be reached, symbolized by $W_1^D$. For the welfare level to remain unchanged, the level of $A$ has to go either up ( by $\Delta A_+$ - meaning that the welfare gain derived from the last dollar spent on the public good will become lower than the welfare gain obtained from the last dollar spent on domestic consumption) or down (by $\Delta A_-$ - and the welfare gain derived from the last dollar spent on the public good will become higher than the gain derived from the last dollar spent on consumption). As a result, the slope of the indifference curve in the $(T, A)$ plane is negative when $A \ll A_0$ and positive when $A \gg A_0$.

From the donor's point of view the exogenous increase of $T$ represents an increase of $V^P$, bringing the marginal utility of the last dollar spent on the public good below the last dollar spent on domestic consumption. As a result, it is optimal to reduce the spending on the public good; $A$ will be reduced and the indifference curve $W_2^D$ is reached.

**The recipient government's indifference curves**

Using the welfare function

$$W^R = \overline{W}^R + \gamma^R \ln V^R + \gamma^P \ln V^P (\text{with } \gamma^R + \gamma^P = 1)$$

the indifference curves of the recipient government can be derived in a similar way as those of the donor government.

$$dW^R = \frac{\partial W^R}{\partial A} dA + \frac{\partial W^R}{\partial T} dT = 0$$

where the partial derivatives are

$$\begin{aligned} \frac{\partial W^R}{\partial T} &= -\frac{\gamma^R}{V^R}\theta^R + \frac{\gamma^P}{V^P}\theta^P \\ \frac{\partial W^R}{\partial A} &= \frac{\gamma^P}{V^P}\theta^P \end{aligned}$$

The slope of the indifference curve

$$\left.\frac{dT}{dA}\right|_{W^R} = -\frac{\frac{\partial W^R}{\partial A}}{\frac{\partial W^R}{\partial T}} = -\frac{\frac{\gamma^P\theta^P}{V^P}}{-\frac{\gamma^R\theta^R}{V^R} + \frac{\gamma^P\theta^P}{V^P}}$$

**Figure A2 about here**

For a given level of $A$, for example $A_0$, the slope tends to infinity when $T$ tends to $T_0$ and $\frac{\partial W^R}{\partial T}$ tends to zero. The indifference curve has been illustrated in figure A2 as $W_0^R$. If $A$ is increased by $\Delta A$ the welfare level goes up, see $W_1^R$. For the welfare level to remain the same, $T$ has to increase (by $\Delta T_+$) or decrease (by $\Delta T_-$). As a result, the slope of the indifference curve is positive for $T \gg T_0$ and negative if $T \ll T_0$.It will now be optimal for the recipient government to reduce its contribution to the public good, see the indifference curve $W_2^R$.

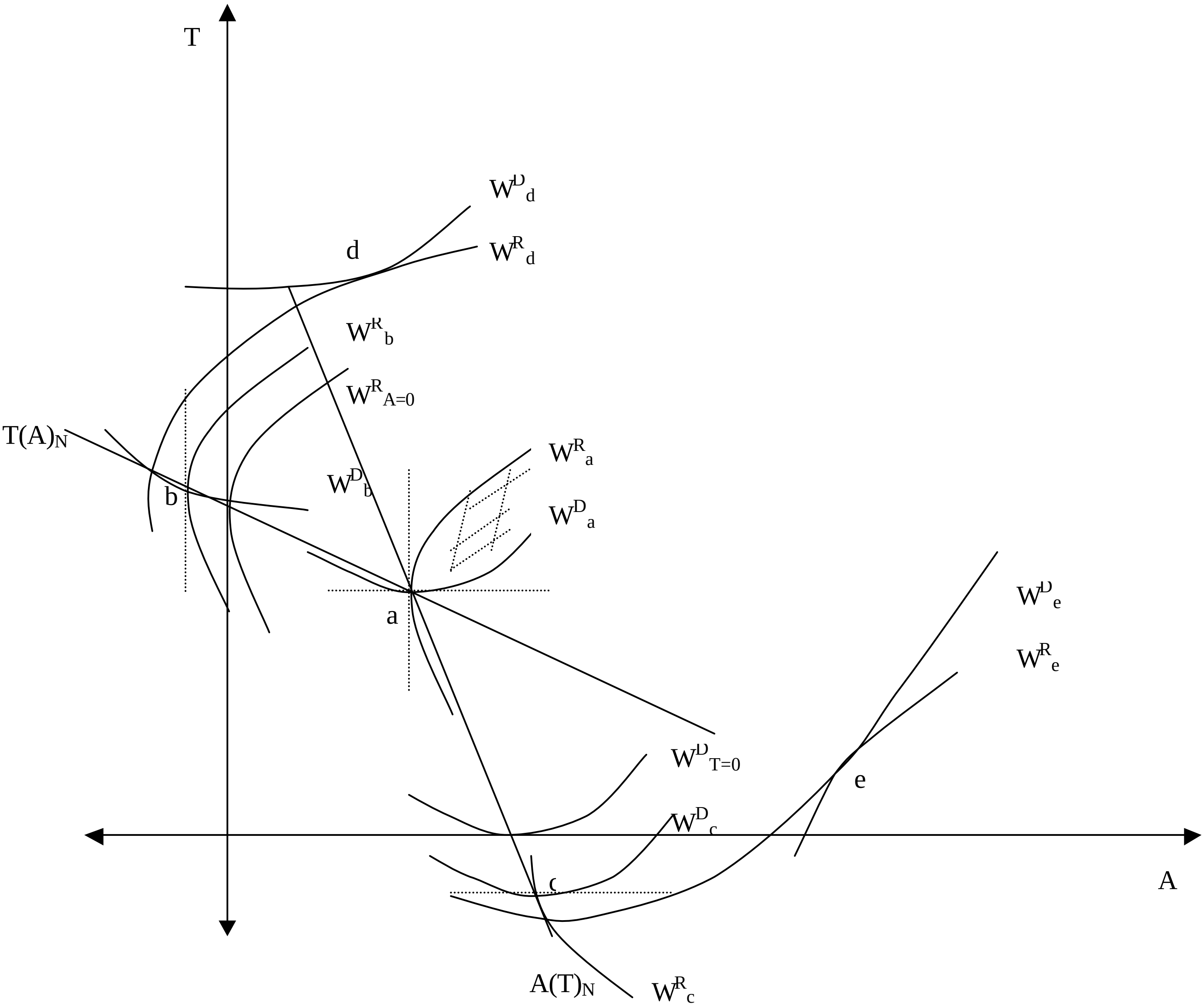
T
$W^D_d$
d
$W^R_d$
$W^R_b$
$W^R_{A=0}$
$T(A)_N$
$W^R_a$
$W^D_b$
b
$W^D_a$
a
$W^D_e$
$W^R_e$
$W^D_{T=0}$
e
$W^D_c$
c
A
$A(T)_N$
$W^R_c$

**Figure 1**

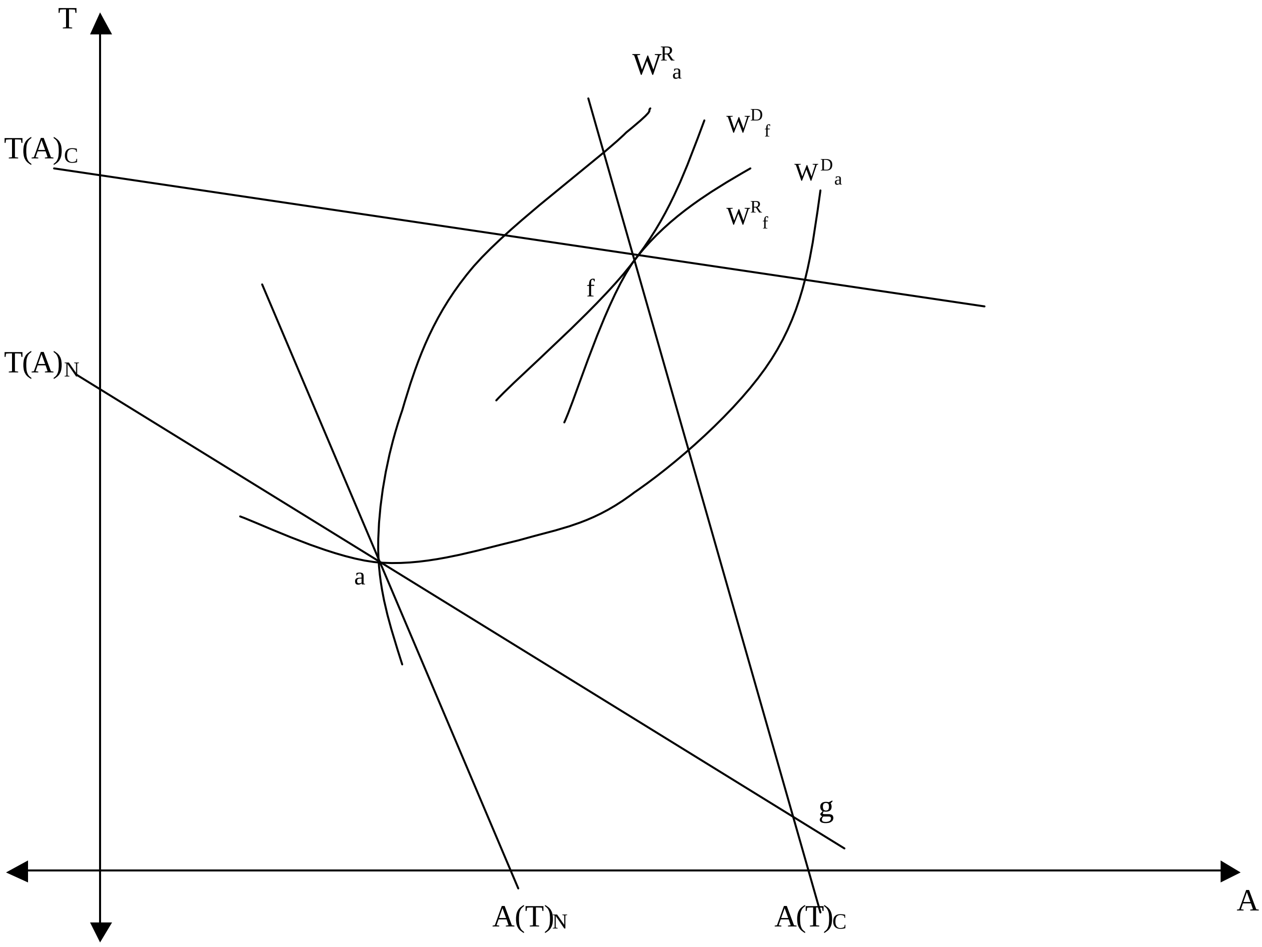


**Figure 2**

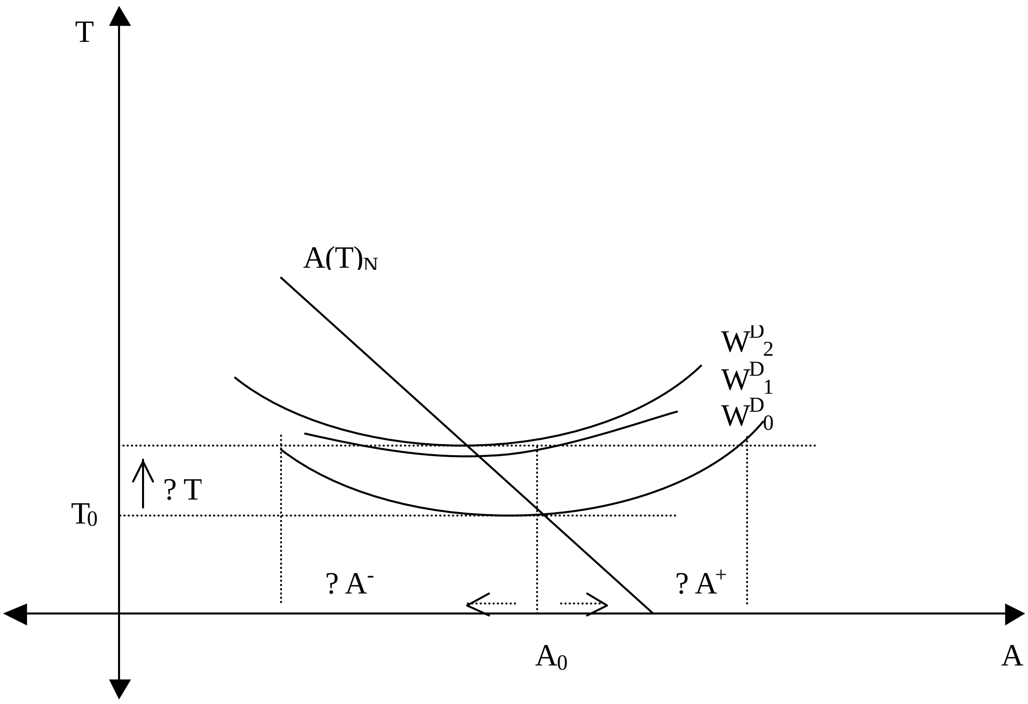


**Figure A1**

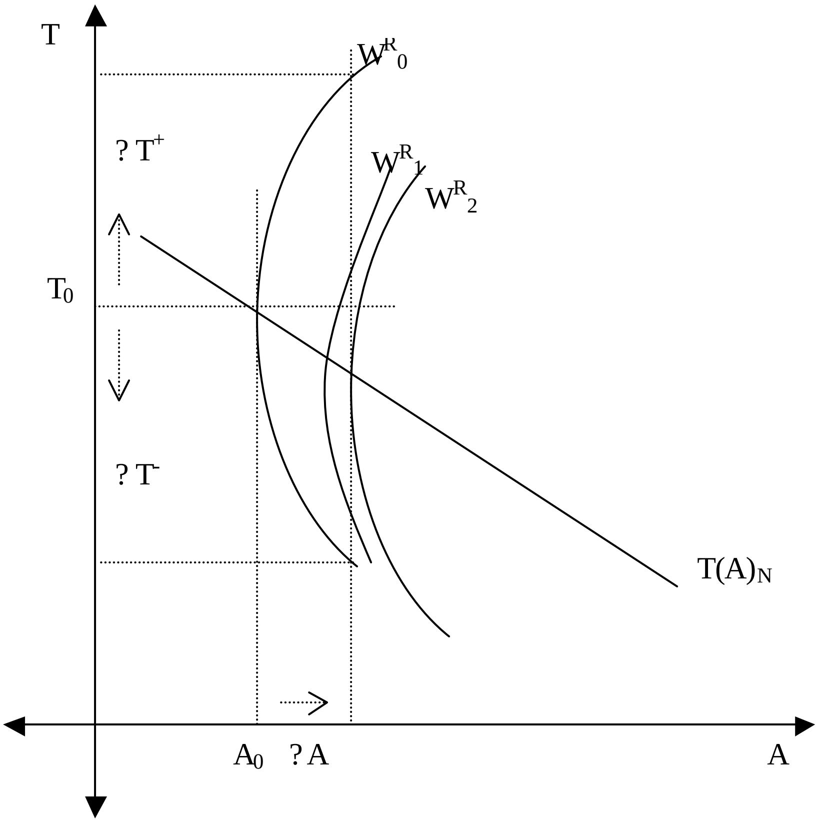


**Figure A2**