

# Aid and Fiscal Instability

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**Abstract:** We show that a combination of temporariness and spending pressure is intrinsic to the aid relationship. In our analysis, recipients rationally discount the pronouncements of donors about the duration of their commitments because in equilibrium they know that some donors will honor those commitments while others will not. Donor types pool in equilibrium; in sharp contrast to conventional signaling situations, there is no separating equilibrium in pure strategies. Moreover, pooling necessarily creates what we call *ex ante* fiscal instability: expenditure smoothing is perfect *ex post* if the donor proves permanent, but if the donor is temporary the recipient faces an aid collapse and a fiscal adjustment problem. The Samaritan's dilemma is at work here, in the guise of a use-it-or-lose-it restriction on spending out of aid. This restriction can produce *ex ante* fiscal instability even when information is symmetric.

**Keywords:** Aid, Fiscal instability, Use it or lose it, Samaritan's dilemma, Pooling

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*The key problem for fiscal vulnerability is not short-term volatility but the danger that the large increase in aid which occurred after 1998/9 will not prove sustainable.*  
[Brownbridge and Tumusiime-Mutebile (2007, p 208)]

## **1. Introduction**

Since the late 1990s, and most recently at the 2005 G8 summit in Gleneagles, donor countries have repeatedly pledged themselves to substantial increases in aid flows to Sub-Saharan African countries, in an effort to meet the Millennium Development Goals. The expenditure programs designed to meet these goals are ambitious. In most cases they envisage a substantial growth in the size of the public sector and entail expenditures that would be difficult to scale down rapidly if required, on political grounds if not otherwise. For this reason, even when the public expenditure profiles advocated by donors are consistent with their own long-term preferences, recipient governments may be reluctant to scale up expenditure as far or as fast as donors would wish, unless donors can make credible commitments to provide predictable long-term support.

A prudent fiscal response to temporary aid, from the recipient's perspective, would mimic the public spending profile donors have long advocated for countries facing commodity export booms. Expenditure would rise roughly by the annuity value of aid, not by its current value (Obstfeld 1999). But in practice, aid packages come with strong pressures to spend. Spending pressures from the recipient's side are familiar from the commodity boom case, but are of limited relevance in the present context; the candidates for scaled-up aid – countries like Uganda, Tanzania, and Mozambique – have earned a reputation for sober fiscal management. Our interest, instead, is in spending pressures from the donors' side. Put simply, donors want their money to be spent. As Eifert and Gelb (2005) and Berg *et al.* (2007) observe, recipient governments that ignore such donor sentiment for too long may face a suspension of aid. As Adam (2001) puts it, "treating [an] increased aid inflow as temporary may well make it so."

The combination of temporariness and pressure to spend creates what we call *ex ante* fiscal instability: a situation in which a surge in aid creates the anticipation of a fiscal adjustment problem. In a companion paper (Buffie *et al.* 2008b) we develop a fully articulated dynamic macroeconomic model to study this problem from the perspective of a country facing a surge in aid. The analysis captures a puzzling feature of recent country experience, namely the tendency for aid surges to be accompanied by private capital outflows (Berg *et al.* 2007, Killick and Foster 2007). In our analysis,

these outflows are driven by private-sector expectations of higher future seigniorage. We show that managing these expectations requires a coordinated fiscal and monetary policy response, with the fiscal authorities exercising spending restraint as the surge is received and the monetary authorities accumulating a buffer stock of international reserves and/or domestic assets.

In the Buffie *et al.* (2008b) analysis the threat of *ex ante* fiscal instability is novel, in the sense of being unrelated to familiar fiscal pitfalls including imprudence on the part of the recipient.<sup>2</sup> Yet it remains exogenous to the analysis. Our aim in the current paper is to endogenize fiscal instability by showing that a combination of temporariness and spending pressure is intrinsic to the aid relationship. In our analysis, recipients rationally discount the pronouncements of donors about the duration of their commitments because in equilibrium they know that some donors will honor those commitments while others will not. Donors know their own intentions, and if these were also known by recipients, *ex ante* instability would be avoided. But binding commitments are off the table. This is obvious for temporary donors, who are unwilling to tie their own hands. The situation is more complicated for permanent donors, who care about the recipient's future utility as well as its present utility. These donors face a Samaritan's Dilemma (Buchanan, 1975): they cannot make a credible commitment not to adjust future aid to the recipient's demonstrated need. Signaling is the natural means of separation, but temporary donors have an incentive to masquerade as permanent, in order to discourage under-spending by the recipient. We show that the donor types pool in equilibrium; in sharp contrast to conventional signaling situations, there is no separating equilibrium in pure strategies. Moreover, pooling necessarily creates *ex ante* fiscal instability. Smoothing is perfect *ex post* if the donor proves permanent, but if the donor is temporary the recipient faces an aid collapse and a fiscal adjustment problem.

In our signaling model recipients treat aid as temporary because they are unable to distinguish donors with a short-run interest in aid from those with a long-run interest. In an extension of the main analysis, we show that *ex ante* fiscal instability can emerge even when a surge in aid comes from a donor of known type. We do this by eliminating the temporary donor altogether and focusing instead on the implications of uncertainty regarding the donor's opportunity cost of funds. Information is symmetric but incomplete: neither the donor nor the recipient knows exactly how political and/or economic developments affecting donor constituencies will alter their

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<sup>2</sup> The aid literature cites a variety of elementary pitfalls, including the counterpart fallacy (Roemer 1989) and the reputed unwillingness of donors to support the recurrent cost implications of capital projects. For the more favorable case, in which aid creates an expectation of fiscal stability, see Buffie *et al.* (2008a).

enthusiasm for aid over time. The empirical relevance of such uncertainty is well established in the aid literature; O'Connell and Soludo (1999), for example, show that aid flows are affected by business-cycle conditions within donor countries, while Fleck and Kilby (2006a, 2006b) show that party transitions in the US presidency affect not only bilateral US flows but also the allocation of World Bank aid. We show that *ex ante* fiscal instability can readily arise when the opportunity cost of aid is expected to rise, as would likely be the case during a surge. The Samaritan's Dilemma is at work here: an otherwise identical anticipated decline in commodity revenues, for example, would not produce instability.

The remainder of the paper is organized as follows. Section 2 places our analysis in the context of recent work on the macroeconomics of aid surges. We introduce a simple strategic model of the aid relationship in section 3, and in section 4 we show that there is no fiscal instability problem when the donor's type is known. Our main results then appear in section 5, where we impose asymmetric information and analyze the resulting signaling model. In section 6 we study the case of symmetric but incomplete information, and show that the implication of *ex ante* fiscal instability survives. Section 7 concludes.

## **2. The reliability of aid**

Econometric evidence suggests that concerns about the reliability of aid flows may be warranted. In a pair of influential papers, Buliř and Hamann (2003, 2006) find that aid disbursements to low-income countries display a high degree of short-run volatility, both in comparison to domestic revenue and in comparison to the prior commitments of donors. This relative volatility is highest for the lowest-income countries, and has been increasing over time.<sup>3</sup> Of course, volatility *per se* does not imply a reliability problem on the part of donors, since aid agreements often include performance-related triggers for disbursement. Interruptions may therefore reflect the exercise of incentive clauses by donors, in response to events over which recipients have some direct control and in the context of an ongoing aid relationship. This component of volatility may be non-trivial; Eifert and Gelb (2005), for example, cite a 2005 donor-group study of budget support to African countries which indicated that around two-thirds of non-disbursements could be attributed to recipient government delays in meeting administrative or other policy conditions. But budget

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<sup>3</sup> The latter impression may be overstated; Gupta, Pattillo and Wagh (2006) note that part of the elevated volatility in recent years may reflect the contribution of one-off debt relief grants arising from the HIPC initiative.

support is only one component of aid, and little is known about the relative importance of contractual versus non-contractual fluctuations in overall disbursements. Other evidence suggests, moreover, that the exercise of disbursement triggers may itself be highly unreliable. Birdsall (2004) and many others, for example, have emphasized the defensive-lending pressures that undermine the enforcement of program conditions by donors. Celasun and Walliser (2008) distinguish predictability from volatility by purging aid flows to African countries of predictable movements associated with past aid patterns or with observable policy lapses. A large residual component remains, suggesting that aid movements remain highly unpredictable at the country level.

Our opening quote suggests, moreover, that measures of short-run volatility may miss a key dimension of the *ex ante* volatility now confronting recipients. The Buliř and Hamann papers follow common practice in discarding low-frequency trends before examining volatility. But the low-frequency component of aid is what is at stake in recent donor commitments. What matters in the context of a scaling-up of aid is whether recipients can interpret initial disbursements as a change in the underlying trend, when expenditures are difficult to reverse. This low-frequency component is in fact highly variable in country-level data. This is consistent with historical narratives of donor behavior, which suggest a high degree of *ex ante* uncertainty around the duration of aid. With a small number of exceptions, the international community has a long record of failing to honor major international commitments on aid flows (see Easterly 2006, Chapter 2). The Gleneagles Declaration called for a doubling of aid inflows between 2005 and 2010, and aid flows have risen substantially for some countries. But aggregate aid disbursements have hardly increased (Gupta *et al* 2006, IMF 2008), giving credence to the concerns expressed in our opening quote.

Donors are aware of their credibility gap. Effort to install commitment technologies range from ‘cheap talk’ exhortations like the *Paris Declaration on Aid Effectiveness* (The Paris High Level Forum, 2005), which calls for multi-year aid commitments, to the quasi-legal memoranda of understanding used by the UK to underpin its recent 10-year aid commitments to Rwanda, Ethiopia and Malawi (see Heller *et al.*, 2006), to the ill-fated International Finance Facility (IFF) proposed by the UK government in advance of the 2005 G8 meeting. The IFF was conceived partly as a mechanism for leveraging higher aid flows in the short run, but also – and arguably more importantly – as a way of protecting aid flows from political vagaries within donor countries.<sup>4</sup>

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<sup>4</sup> Though the IFF was ultimately sunk by a lack of support from the US and some other donors, its principles have been adopted by the Global Alliance on Vaccination and Immunization (GAVI) with the creation of the International Finance

Faced with less than fully credible donor funding commitments and recognizing the intrinsic inertia in their own expenditure commitments, the rational response of an aid recipient is to hold some portion of any surge in aid aside, as a buffer stock of liquid assets. Donor agencies routinely counsel such prudence, for example, in the management of natural resource booms. But aid flows come with strong pressures to spend. In effect, a ‘use-it-or-lose-it’ constraint hangs over aid flows, such that a recipient that spends cautiously in the current period risks a reduction in future flows (Eifert and Gelb 2005). In our analysis, spending pressures are intrinsic to the aid relationship, as are uncertainties about the duration of aid. The two make for a dangerous combination: scaled-up aid carries with it an expectation of macroeconomic disarray.

### 3. The aid relationship

We consider a world in which a donor provides resources to augment public spending in a low-income country. The recipient has access to domestic revenues (e.g., from taxation of a commodity export), but cannot borrow commercially. For simplicity we ignore uncertainty about domestic revenues, which arrive at a constant rate of  $\bar{G}$  per period. There are 2 periods, and the recipient begins with no assets. The recipient’s current and future budget constraints, given aid flows  $A_1$  and  $A_2$ , are

$$G_1 = \bar{G} + A_1 - B, \quad G_2 = \bar{G} + B + A_2, \quad B \geq 0, \quad (1)$$

where  $B$  is a financial buffer stock accumulated in period 1, and where the final inequality follows from the recipient’s no-borrowing constraint. Without loss of generality, we set the discount rates of both players, and the return on the buffer stock, equal to zero.

The donor seeks to maximize the recipient’s expected utility from public spending, net of its own opportunity cost of aid. This specification accommodates pure altruism but is general enough to capture a range of other donor motivations, provided that the recipient’s utility is of value to key actors on the donor side. We intentionally abstract, however, from conflicts of interest over what

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Facility for Immunization (IFFm). The IFFm aims to generate a long-term flow of predictable funding for immunization programs and health system development up to and beyond the MDG target date of 2015 by using global capital markets to annuitize front-loaded donor contributions (currently from UK, France, Italy, Norway, Sweden, South Africa, Spain and Brazil).

recipients should purchase with aid; these were important for understanding the motivations and limitations of conditionality during its heyday in the 1980s and early 1990s (Adam and O’Connell 1999, Azam and Laffont 2004), but nearly two decades of political and economic reforms have narrowed the relevant conflicts between donors and the contemporary recipients of big aid. In our analysis conflicts may arise over the level of spending, but not over its composition.

Donors differ according to the duration of their concern for the recipient’s welfare. A ‘temporary’ (T) donor cares only about the recipient’s current spending, and maximizes

$$W^T(A_1, B) = u(\bar{G} + A_1 - B) - \delta \cdot A_1, \quad (2)$$

where  $u$  displays positive and diminishing marginal utility and  $\delta > 0$ . We will refer to  $\delta$  as the donor’s opportunity cost of funds, but note that it reflects the *relative* weight the donor places on the recipient’s utility and its own spending. The more compelling are the donor’s competing priorities, relative to its concern for the recipient’s welfare, the larger is  $\delta$ .

A ‘permanent’ (P) donor cares also about the recipient’s future spending, and maximizes

$$W^P(A_1, B, A_2) = W^T(A_1, B) + u(\bar{G} + B + A_2) - \delta \cdot A_2. \quad (3)$$

A necessary condition for aid to flow from either type of donor is the existence of potential *gains from aid*. The condition for this is  $u'(\bar{G}) > \delta$ , and we assume in what follows that this condition holds. A natural measure of the *aid gap* is  $\phi$ , where  $u'(\bar{G} + \phi) = \delta$ : this is the amount of resources required in each period to reduce the recipient’s marginal utility of spending to the donor’s marginal cost. Given the concavity of  $u$ , the gains-from-aid condition is a necessary and sufficient condition for  $\phi > 0$ .

#### 4. Spending pressures and fiscal stability

When the donor’s type is known, we can characterize the equilibrium by starting with the 2<sup>nd</sup>-period behavior of the donor and working backwards. The T-type case is simple. Since the donor receives no utility from the recipient’s future spending, second-period aid is zero regardless of the buffer stock the recipient chooses to carry over from the first period. Thus  $A_2^T(B) = 0$ . Knowing this, the

recipient smooths its marginal utility over time by setting aside exactly half of the current aid flow as a buffer stock. The recipient's reaction function is therefore  $B(A_1) = A_1 / 2$ , and the donor's choice of first-period aid solves

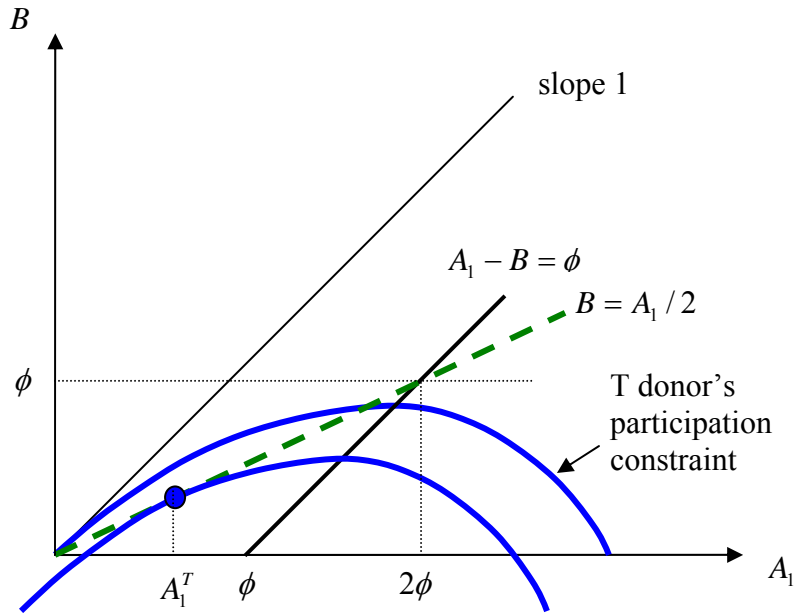
$$A_1^T = \arg \max_{A_1 \geq 0} W^T(A_1, A_1 / 2). \quad (4)$$

Figure 1 shows the equilibrium for the case of a known T donor. The donor's indifference curves over combinations of aid and buffer stock (derived from (2)) are inverted U-shapes, with maxima along the straight line  $B = A_1 - \phi$ . Lower indifference curves denote higher donor welfare. We show two indifference curves: the higher one is the T donor's participation constraint, which takes the form  $W_T \geq W^T(0, 0) = u(\bar{G})$ . The gains-from-aid condition guarantees that this constraint has positive slope at the no-aid point  $A_1 = B = 0$ , while the condition  $c'(0) > 0$  guarantees that its slope is below 1. The area enclosed by the participation constraint and the horizontal axis shows the potential gains from aid.

The donor's participation constraint is satisfied automatically once we impose the non-negativity constraint  $A_1 \geq 0$ . This constraint is binding if the slope of the participation constraint is  $\frac{1}{2}$  or less at the no-aid point. In such a case, the aid relationship collapses – the donor chooses  $A_1^T = 0$  – even though there are potential gains from aid. Figure 1 shows the case in which aid is strictly positive in equilibrium. This holds when the slope of the participation constraint exceeds  $\frac{1}{2}$  at the no-aid point, so that equilibrium takes place at an interior point of tangency between a T-donor indifference curve and the recipient's buffer stock reaction function.

Aid is positive in Figure 1 but smaller than the first-period aid gap ( $0 < A_1^T < \phi$ ). If the gains from aid are sufficiently strong, the tangency can take place at an aid level that exceeds  $\phi$ . We show in the Appendix, however, that  $A_1^T < 2\phi$ : given the T donor's lack of interest in future spending, a portion of the 2-period aid gap ( $= 2 \cdot \phi$ ) remains unfilled in equilibrium.

**Figure 1.** Interior equilibrium with a known T donor



Notice that if the T donor could discourage the accumulation of a buffer stock, it would do so, since it gets no utility from the recipient's future spending. But both parties know that the relationship will not carry past the current period. A T donor therefore has no credible way to discourage under-spending of aid in the first period. The recipient, in turn, has no credible way to commit to spending more than half of what it receives.

The P-donor case is more complicated, because each player's behavior in the first period depends on the donor's behavior in period 2. The donor's choice of  $A_2$  satisfies

$$A_2^P(B) = \arg \max_{A_2 \geq 0} u(\bar{G} + B + A_2) - \delta \cdot A_2. \quad (5)$$

Given this function, we can locate the equilibrium as in the T-donor case, by constructing the donor's indifference curves over  $A_1$  and  $B$  and characterizing the recipient's buffer-stock behavior. The result appears in Figure 2. The solution to (5) takes the simple form

$$A_2^P(B) = \begin{cases} \phi - B & \text{if } B \leq \phi \\ 0 & \text{otherwise,} \end{cases} \quad (6)$$

and the P donor's welfare, from (3), can be written

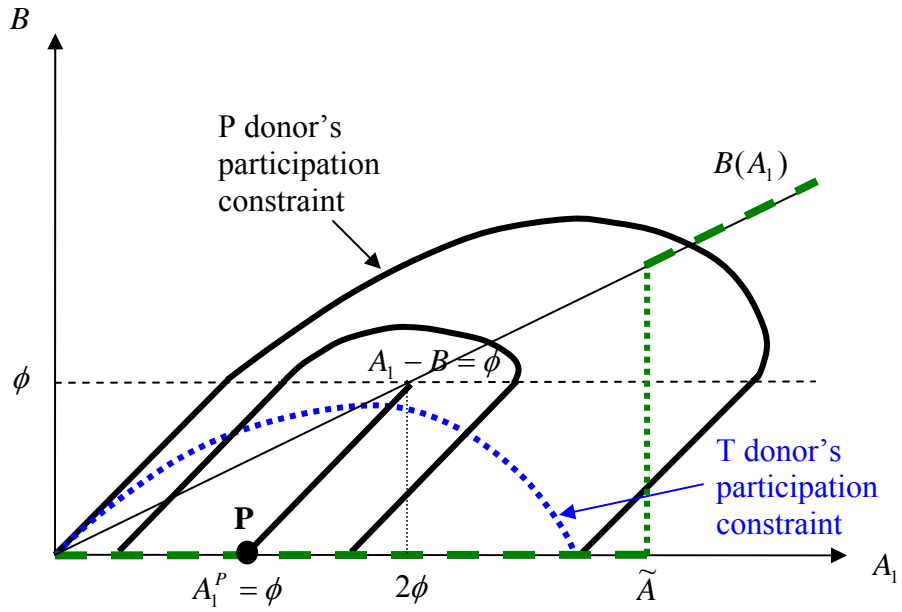
$$W^P(A_1, B) = \begin{cases} u(\bar{G} + A_1 - B) + u(\bar{G} + \phi) - \delta(\phi + A_1 - B) & \text{if } 0 \leq B < \phi \\ u(\bar{G} + A_1 - B) + u(\bar{G} + B) - \delta \cdot A_1 & \text{if } B \geq \phi. \end{cases} \quad (7)$$

For  $B \leq \phi$ , indifference curves of this function have a slope of 1. The P donor's utility is highest (and is constant) along the line segment  $A_1 = \phi - B$ ; at all points on this locus, the total value of aid in the two periods is  $2\phi$  and the recipient's spending profile is flat at  $[\bar{G} + \phi, \bar{G} + \phi]$ . The P donor's utility falls as the allocation moves either to the left or to the right of this locus, or to a point with  $B > \phi$ . Figure 2 illustrates three indifference curves for the P donor: the maximal curve, a curve with lower welfare that lies to the left and right of the maximal curve as well as above it; and the participation constraint, which takes the form  $W^P \geq W^P(0, 0)$  and is everywhere above the T-donor's constraint, except at its endpoints on the horizontal axis.

In contrast to the T case, the recipient has a strong incentive to spend aid fully when it knows the donor is permanent. In Figure 2, this spending pressure takes the form of a *use-it-or-lose-it* restriction on the path of aid:

**Proposition 1** (*Use-it-or-lose-it*) As long as the gains from future aid are positive, the future aid provided by a P donor falls by a dollar for every dollar of additional buffer stock accumulated by the recipient in period 1.

**Figure 2.** *Equilibrium with a known P donor*



*Proof:* For  $A_2 > 0$ , the first-order condition for (5) is  $u'(G_2) - c'(A_2) = 0$ . Implicit differentiation yields

$$\frac{dA_2^P}{dB} = \begin{cases} -1 & \text{if } A_2 > 0 \\ 0 & \text{otherwise.} \end{cases}$$

Since the buffer stock equals the amount of un-spent aid, this expression confirms the proposition. **Q.E.D.**

The recipient's optimal buffer stock satisfies

$$B(A_1) = \arg \max_{B \geq 0} u(\bar{G} + A_1 - B) + u(\bar{G} + B + A_2^P(B)).$$

The function  $B(A_1)$  appears as the dashed line in Figure 2. At low to modest levels of aid, the use-it-or-lose-it restriction generates a one-for-one spending response by the recipient – and therefore a

zero buffer stock. This prevails until first-period aid gets so large that the recipient is willing to give up an amount  $\phi$  of second-period aid in order to achieve a smooth spending profile. At this point the buffer stock jumps from zero to  $A_1 / 2$ . In detail:

**Proposition 2** (*Full spending response*) A recipient facing a permanent donor holds no buffer stock in equilibrium, unless first-period aid is above a cutoff level that exceeds  $2\phi$ . For aid above this level, the recipient allocates aid half-and-half to spending and the buffer stock.

*Proof:* Given the use-it-or-lose-it property, a buffer stock of  $\phi$  or less is dominated by consuming aid fully in period 1 and having the donor provide  $\phi$  in period 2. If an optimal buffer stock exists, therefore, it must exceed  $\phi$  and drive second-period aid to zero. Since second-period aid is zero, the recipient will choose  $B$  to smooth marginal utility across periods:  $B = A_1 / 2$ . It follows that  $A_1 > 2\phi$ : the buffer stock can become positive only at an aid level that exceeds the two-period aid gap. We therefore look for an aid level  $\tilde{A} > 2\phi$  such that the recipient is just indifferent between a full-spending response and a buffer-stock/smoothing approach that sets  $B = \tilde{A} / 2$ . This cutoff level satisfies

$$u(\bar{G} + \tilde{A}) + u(\bar{G} + \phi) = 2u(\bar{G} + \tilde{A} / 2).$$

By concavity,  $u'(\bar{G} + A_1) < u'(\bar{G} + A_1 / 2)$ , implying that the recipient prefers the smoothing response to the full-spending response for any  $A_1 > \tilde{A}$ . The recipient's optimal buffer stock therefore takes the form

$$B(A_1^P) = \begin{cases} 0 & \text{if } A_1^P < \tilde{A} \\ A_1^P / 2 & \text{if } A_1^P > \tilde{A} > 2\phi. \end{cases}$$

**Q.E.D.**

Notice that for aid levels below  $\phi$ , the spending pressure associated with a permanent donor is in the interest of both parties. At higher values of aid, however, the donor faces a Samaritan's Dilemma (Buchanan 1975): the donor would be better off if any aid in excess of  $\phi$  were held over as a buffer stock, but its own future altruism discourages such a response. For  $A_1 \in (\phi, \tilde{A})$ , the recipient consumes 'too much' from the donor's perspective.

The P donor's choice of aid in period 1 solves

$$A_1 = \arg \max_{A_1 \geq 0} u(\bar{G} + A_1 - B(A_1)) - \delta \cdot A_1 + u[\bar{G} + B(A_1) + A_2(B(A_1))] - \delta \cdot A_2(B(A_1)).$$

Equilibrium occurs at point P in Figure 2, where the donor chooses its preferred point on the recipient's buffer-stock function. Notice that the two parties succeed in fully exploiting the gains from aid. The recipient receives a constant stream of aid that fills the aid gap each period ( $A_1^P = A_2^P = \phi$ ). *Ex post* inefficiencies are avoided here despite the Samaritan's Dilemma.

Allowing for the possibility of *ex ante* uncertainty about future spending (this will become relevant below), a simple measure of fiscal instability from the recipient's perspective is the proportional gap between the current and expected future marginal utility of public spending.

$$f \equiv \left| \frac{E[u'(G_2)] - u'(G_1)}{u'(G_1)} \right| \geq 0. \quad (8)$$

Lacking creditworthiness, the recipient would normally use financial assets to limit fiscal instability. While we have seen that donors have little interest in encouraging buffer-stock behavior, this conflict of interest does not create fiscal instability when the donor's type is known in advance. The reason for this differs according to the type of donor. A T donor would like to discourage buffer-stock accumulation by the recipient, but is powerless to do so. Realizing this, the recipient chooses its buffer without constraint, and ends up smoothing marginal utility completely across periods. A P donor, in contrast, strongly discourages asset accumulation by taxing wealth in the second period. At the same time, however, this donor provides a superior intertemporal smoothing mechanism, in the form of a credible commitment to future aid. Smoothing is again complete, and takes place at a higher spending level than provided by the temporary donor.

In summary, aid is consistent with fiscal stability when the recipient knows the donor's type:

**Proposition 3** (*Fiscal stability with a known donor*) When the donor's type is known in advance,  $f = 0$  in equilibrium.

*Proof:* When the donor is known to be T, the equilibrium path of aid is  $[A_1 > 0, 0]$  and the recipient sets  $B = A_1 / 2$ . Spending therefore satisfies  $G_1 = G_2 = \bar{G} + (A_1 / 2)$ , which implies  $f = 0$ . When the donor is known to be P, aid follows  $[\phi, \phi]$  and the buffer stock is zero. Spending therefore satisfies  $G_1 = G_2 = \bar{G} + \phi$ , which again implies  $f = 0$ . **Q.E.D.**

## 5. Pooling and fiscal instability

In practice, recipients are unlikely to be able to determine the donor's type *ex ante*. Thus while donors may understand their own intentions, recipients can at best assign a prior probability to the donor's being temporary or permanent. In this section we analyze the aid relationship as a dynamic game of asymmetric information. We start with a prior probability  $p$  that the donor is temporary and ask whether the recipient will have any basis for updating this probability before choosing its buffer stock. We limit our attention to perfect Bayesian equilibria, in which the players implement best responses to the actions of other players in all subgames and use Bayes' Rule to update their information whenever possible. For most of the analysis we focus on pure strategy equilibria, in which each donor type offers a single aid level in each period.

Given the information potentially conveyed by the donor's choice of  $A_1$ , the players' strategic interaction takes the form of a signaling game (Kreps and Sobel 1994). We will use the notation  $q(A_1 | p)$  to denote the posterior probability formed by the recipient after observing first-period aid. We refer to  $q$  as the recipient's *beliefs*:  $q$  is the probability that the donor is temporary, and  $1 - q$  is the probability that the donor is permanent. In a pooling equilibrium,  $q(A_1 | p) = p$  for an equilibrium choice of  $A$ , while in a separating equilibrium equilibrium choices must induce  $q(A_1^T | p) = 1$  and  $q(A_1^P | p) = 0$ . Beliefs must satisfy Bayes' Rule whenever the choice of first-

period aid conveys information about the donor's type, and must be defined not just for equilibrium actions by the donor but also for off-equilibrium actions.

It will be useful to define the buffer-stock reaction function  $B(A_1, q)$  as the recipient's optimal choice given an aid level  $A_1$  and a posterior probability  $q$  that the donor is temporary:

$$B(A_1, q) = \arg \max_{B \geq 0} u(\bar{G} + A_1 - B) + q \cdot u(\bar{G} + B) + (1 - q) \cdot u(\bar{G} + B + A_2^P(B)). \quad (9)$$

The recipient's best response takes the form  $B(A_1, q(A_1 | p))$ , so that the choice of buffer stock depends ultimately on  $A_1$  and  $p$ .

**Definition:** A *perfect Bayesian equilibrium* is a pair of aid levels  $A_1^T \geq 0$  and  $A_1^P \geq 0$ , a set of revised probabilities  $q(A_1 | p)$ , and a buffer-stock strategy  $B(A_1, q(A_1 | p))$  such that:

- $A_1^j$  maximizes the welfare of the type- $j$  donor given optimal behavior by the P donor in period 2;
- The probabilities  $q(A_1 | p)$  satisfy Bayes' Rule wherever possible; and
- The buffer-stock choices  $B(A_1, q(A_1 | p))$  represent best responses to first-period aid.

The structure of the problem makes it difficult to rule out either separation or pooling as a potential equilibrium. At least for low values of aid, the P donor would prefer to face  $B(A_1, 0)$  than  $B(A_1, q)$  for any strictly positive  $q$ , because the recipient spends too little of  $A_1$  from the P donor's perspective if it thinks the recipient may be temporary. This donor therefore has a preference for separation. The T donor, in contrast, has a potentially powerful incentive to masquerade as permanent. This donor faces a conflict of interest if its type is revealed, because once the recipient understands the temporary nature of aid, it will again spend too little of it in the current period. By adopting the P donor's behavior, a T donor can benefit from the P donor's use-it-or-you-lose-it policy and the corresponding increase in first-period spending out of aid. The T donor therefore has an interest in pooling.

Multiplicity of perfect Bayesian equilibria tends to be the rule rather than the exception in signaling games, because off-equilibrium beliefs affect equilibrium play and the structure of the

game places few restrictions on these beliefs (Kreps and Sobel 1994). The configuration of Figure 2 is unconventional, however, in the sense that the indifference curves of the two types intersect more than once, violating the single-crossing property that is central to the main results of the signaling literature. Perhaps surprisingly, subgame perfection turns out to be a stronger selection criterion in the aid case than in the conventional situation. As we show below, when an equilibrium exists it is unique, and we can characterize it without appealing to further refinements.

For concreteness we use the CRRA utility function

$$u(G) = -\frac{G^{1-\tau^{-1}}}{1-\tau^{-1}}, \quad (10)$$

where  $\tau > 0$  is the elasticity of intertemporal substitution (the inverse of the coefficient of relative risk aversion). The aid gap,  $\phi$ , is given by  $\phi \equiv \delta^{-\tau} - \bar{G} > 0$ , where  $\bar{G}$  is the recipient's own resources; this is strictly positive given the gains-from-aid condition.

### *Pooling equilibria*

In a pooling equilibrium,  $q(A_1 | p) = p$  and the recipient's choice of buffer-stock must lie along  $B(A_1, p)$ . This function is zero for aid below a cutoff level  $\hat{A}(p)$  that is between 0 and  $\tilde{A} > 2\phi$  and is a decreasing function of  $p$ . Once aid reaches this cutoff value, the buffer stock rises linearly with further increases in aid, until it reaches  $\phi$  or aid reaches  $\tilde{A}$ . Either of these events converts the P donor into the equivalent of a T donor. Second-period aid goes to zero, and buffer stock behavior jumps onto the  $B = A_1 / 2$  schedule. The full buffer-stock function is

$$B(A_1, p) = \begin{cases} 0 & \text{if } A_1 \in [0, (1-p^{-\tau})\bar{G}] \\ (1+p^{-\tau})^{-1}[A_1 + (1-p^{-\tau})\bar{G}] & \text{if } A_1 \in [(1-p^{-\tau})\bar{G}, \text{Min}[\hat{A}(p), \tilde{A}]] \\ B(A_1, 1) & \text{if } A_1 > \text{Min}[\hat{A}(p), \tilde{A}], \end{cases} \quad (11)$$

where  $\hat{A}(p) = [(1+p^\tau)/p^\tau] \cdot \phi + [(1-p^\tau)/(1+p^\tau)] \cdot \bar{G}$ . Note that the slope of the middle portion is an increasing function of  $p$ : it goes from 0 when  $p = 0$  to  $1/2$  when  $p = 1$ .

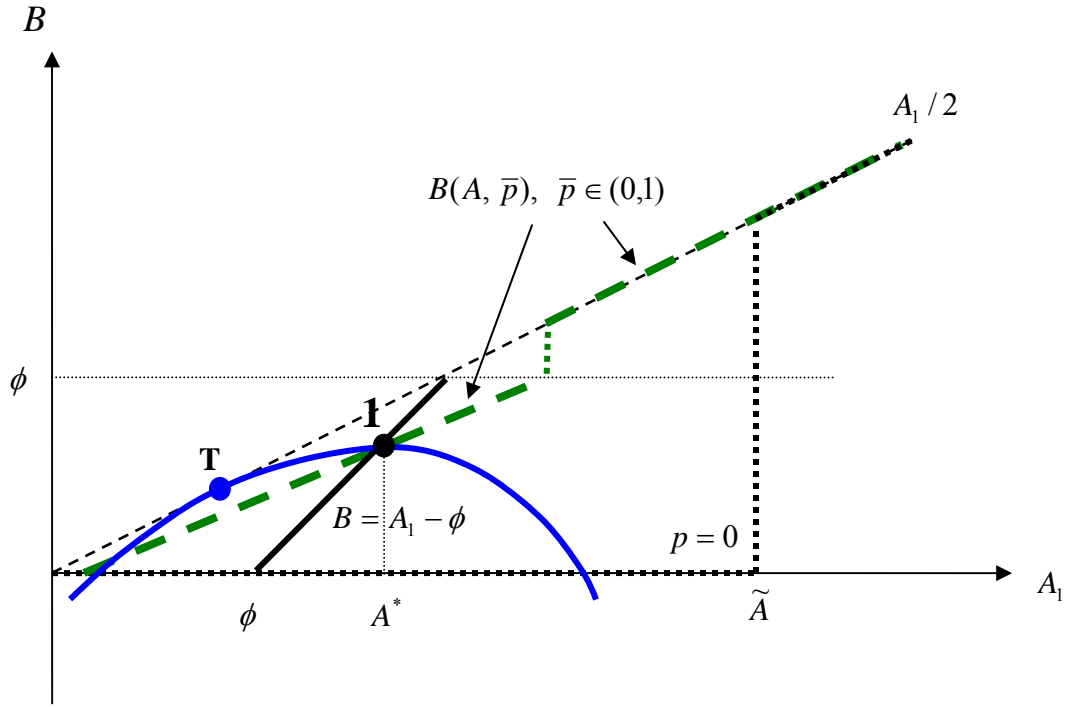
The  $B(A_1, p)$  function for interior  $p$  is given by the heavy dashed line in Figure 3. Note that as long as  $\hat{A}(p) < \phi$ , there is an intersection between the  $B(A_1, p)$  function and the P donor's maximal indifference curve.

In Figure 3, we denote by  $\bar{p}$  the value of  $p$  that makes the T donor indifferent between its full-information equilibrium at  $\mathbf{T}$  and the P donor's preferred point on the  $B(A, p)$  locus (we solve for  $\bar{p}$  below). For this value of  $p$ ,  $A_1 = A^*$  is a pooling equilibrium, supported by beliefs of the form

$$\begin{aligned} q(A_1 | \bar{p}) &= 1 && \text{for } A_1 < A^* \\ q(A_1 | \bar{p}) &= \bar{p} && \text{for } A_1 \geq A^*. \end{aligned} \tag{12}$$

Consider now an alternative pooling equilibrium, at an aid level that is slightly above  $A^*$  and supported by beliefs similar to (12). Starting from this alternative equilibrium neither player will wish to deviate to a still-higher aid level; but since the T donor is on a higher indifference curve (with lower welfare) than it was at  $A^*$ , there will now be an interval of lower off-equilibrium aid values the T donor strictly prefers to the pooling level regardless of the posterior probability the recipient assigns to these levels. Pooling therefore cannot occur above  $A^*$ . But we can also rule out pooling below  $A^*$ , because from the viewpoint of any such equilibrium the P donor will always be able to find a preferable point along  $B(A_1, \bar{p})$  above  $A^*$ . It follows that there is no other pooling equilibrium that can be supported by beliefs of the form (12). Since off-equilibrium beliefs are restricted to  $q = 0, p$ , or  $1$ , we can show by elimination that there is in fact no set of beliefs capable of supporting a pooling equilibrium with  $A_1 \neq A^*$ .

**Figure 3. Pooling equilibrium**



For values of  $p$  below  $\bar{p}$ , similar logic establishes the intersection of  $B(A_1, p)$  and  $B = A_1 - \phi$  as a unique pooling equilibrium, supported as in (12). For  $p$  below the value that satisfies  $(1 - p^{-\tau})\bar{G} = \phi$ , the  $B(A_1, p)$  function remains zero up to an aid level that exceeds  $\phi$  (see equation (12)), and the pooling equilibrium therefore occurs at  $A_1 = \phi$ , independently of the precise value of  $p$ .

For values of  $p$  above  $\bar{p}$ , a pooling equilibrium that places the P donor on its maximal indifference curve puts the T donor again on a higher indifference curve – with lower welfare – than the one through point **T**. The T donor will prefer  $A_1^T$  regardless of the value of  $q(A_1^T | p)$ . As before, a P donor that is off its maximal indifference curve in a pooling equilibrium will always be able to locate a deviation that makes it strictly better off. Pooling is therefore ruled out for  $p > \bar{p}$ .

**Proposition 4** (*Existence and uniqueness of pooling equilibrium*) For each  $p \leq \bar{p}$ , a unique pooling equilibrium  $A^*(p)$  exists at the intersection of  $B(A_1, p)$  and  $B = A_1 - \phi$ . The equilibrium aid level

is a non-decreasing function of  $p$  and is strictly increasing in  $p$  for probabilities above the level that satisfies  $(1 - p^{-\tau})\bar{G} = \phi$ . For  $p > \bar{p}$ , no pooling equilibrium exists.

Pooling therefore exists for  $p \leq \bar{p}$ , where  $\bar{p}$  is the prior probability for which the recipient's buffer-stock function runs through point 1 in Figure 3, where the T-donor's full-information indifference curve intersects the P-donor's maximal indifference curve. We show in the appendix that  $\bar{p}$  is given by

$$\bar{p} = \left[ \frac{1 - 2^{1-\tau}}{\tau - 1} \right]^{1/\tau}. \quad (13)$$

The range of pooling is therefore independent of the recipient's resources  $\bar{G}$  and the donor's cost of funds  $\delta$ . It does depend on the coefficient of relative risk aversion ( $= 1/\tau$ ), but as indicated in Figure 4, this dependence is very slight. A coefficient of relative risk aversion of 2, for example, yields  $\bar{p} = 0.6863$ , and for the entire empirically relevant range for developing countries – values of  $1/\tau$  between roughly 1.25 and 5 –  $\bar{p}$  remains between 0.6822 ( $1/\tau = 5$ ) and 0.6904 ( $1/\tau = 1.25$ ). The case of quadratic utility yields a similar but even more striking result:  $\bar{p} = 2/3$ , independent of all parameters of the problem.

\*\*\* Figure 4 here \*\*\*

**Proposition 5** (*Pooling and fiscal instability*) The time path of expected spending is falling over time in any pooling equilibrium, and the index of fiscal instability is an increasing function of  $p$ .

*Proof:* Pooling equilibria take place along the P donor's maximal indifference curve. The recipient's buffer stock in a pooling equilibrium is therefore either zero or a positive number strictly between zero and  $\phi$ , and first-period spending is correspondingly equal to  $\phi$  regardless of the value of  $p \leq \bar{p}$ . The value of second-period spending depends on whether the donor proves permanent or temporary. With probability  $1 - p$  the donor is permanent,

and in this case the donor chooses second-period aid to fill whatever aid gap remains after accounting for the recipient's buffer stock. Thus  $G_2 = G_1$  and marginal utility is smoothed over time. But if the donor proves temporary, then  $G_2 = \bar{G} + B < G_1 = \phi$ . Thus with probability  $p$ , future spending is lower than current spending. From the perspective of period 1, therefore, the recipient's marginal utility of spending is expected to rise:  $f > 0$ . **Q.E.D.**

### *Separating equilibria*

In a separating equilibrium, the donor types choose different aid levels and these choices reveal their type. The T donor's choice of buffer stock must therefore lie along  $B(A_1, 1) = A_1 / 2$ , and the P donor's along  $B(A_1, 0)$ . We can state our main result succinctly:

**Proposition 6** (*Non-existence of a separating equilibrium*) The aid relationship has no separating equilibria in pure strategies.

*Proof.* We construct the proof with reference to the T-donor's indifference curve through point **T** in Figure 3, which shows the T donor's maximal possible welfare in a separating equilibrium. Denote by  $0 \leq A_{LO} < \phi$  and  $A_{HI} > A_{LO}$  the two aid levels at which this indifference curve cuts the aid axis. Note first that  $A_1^P$  cannot lie on the endpoints or strictly outside the interval  $[A_{LO}, A_{HI}]$  spanned by this indifference curve. The reason is that there are values of aid strictly inside this interval (such as  $A_1 = \phi$ ) that would give the P donor a higher welfare regardless of the posterior probability assigned by the recipient. Separation therefore cannot be a best response for the P donor. But we can also show that the P donor's choice in a separating equilibrium cannot lie strictly inside  $[A_{LO}, A_{HI}]$ . Consider first the case in which  $A_{HI} \leq \tilde{A}$ , as in Figure 3; in this case  $B = 0$  for any  $A_1^P \in (A_{LO}, A_{HI})$ . But this means that the T donor is strictly better off by imitating the P donor than by making a choice that reveals its own type. Separation is therefore not a best response for the T donor. The final case is where  $A_{HI} > \tilde{A}$  ( $> 2\phi$ ), so that  $B(A_1, 0)$  jumps up to  $A_1 / 2$  at a value of aid inside the interval  $[A_{LO}, A_{HI}]$ . The T donor may not have an incentive to imitate, but since

the P donor's welfare must be below its maximal welfare, there is no way to specify the off-equilibrium probabilities that does not induce the P donor to deviate to an aid level somewhere on  $[\phi, 2\phi]$ . There is therefore no choice of  $A_1^P$  that can survive as a separating equilibrium.

**Q.E.D.**

Taken together, Propositions 4 and 6 imply that for  $p > \bar{p}$  the aid relationship has no perfect Bayesian equilibrium in pure strategies. The intuition for this result is straightforward. Pooling fails for conventional reasons: as  $p$  rises, the T donor gains less and less from imitating. Separation fails because the Samaritan's Dilemma plays into the hands of the T donor whenever the recipient believes the donor to be permanent.

It follows from this analysis that if the aid relationship is to have a perfect Bayesian equilibrium for  $p > \bar{p}$ , that equilibrium must involve mixed strategies. Not surprisingly, in the simplest such equilibrium the players pool most of the time:

**Proposition 7** (*Pooling above  $\bar{p}$* ) For any  $p > \bar{p}$ , a perfect Bayesian equilibrium exists in which the P donor chooses  $A^*$  with probability one and the T donor adopts a mixed strategy, choosing  $A^*$  with probability  $x$  and  $A_1^T$  with probability  $1 - x$ , where  $x = \bar{p} / p$ .

*Proof.* On observing  $A^*$ , the donor uses Bayes' Rule to calculate a posterior probability of  $q(A^* | p) = x \cdot p = \bar{p}$  that the recipient is temporary. All remaining aid levels, including the T donor's choice of  $A_1^T$  with probability  $1 - x$  and all off-equilibrium choices, produce posterior probabilities  $q(A_1 \neq A^* | p) = 1$ . Given these beliefs, the equilibrium allocation takes place either at point T (which occurs with probability  $p - \bar{p}$ ) and at the pooling equilibrium (with probability  $1 - (p - \bar{p})$ ). Notice that since these yield the same utility to the T donor, that donor's welfare is independent of  $x$  in equilibrium. **Q.E.D.**

In this mixed-strategy equilibrium, the T donor is indifferent between separating itself, which it does some fraction of the time, and imitating the P donor by offering a higher aid level, which it does most of the time. The higher aid level is associated with fiscal instability.

## 6. Symmetric but incomplete information

In our pooling equilibria, the combination of use-it-or-lose-it pressures and uncertainty about duration produces *ex ante* fiscal instability. We extend the analysis here by showing that, under weak restrictions, the same elements operate and produce a similar outcome in a game of symmetric but incomplete information.

Suppose, then, that there is only one type of donor, but that this donor's future cost of funds,  $\delta_2$ , is uncertain *ex ante*. Its distribution, however, is known to both players, and is given by

$$\delta_2 = \begin{cases} \delta_H > \delta & \text{with probability } p \\ \delta_L = \delta & \text{with probability } 1 - p \end{cases} \quad (14)$$

Second-period aid now depends not just on  $B$  but also on  $\delta_2$ :  $A_2 = A_2(B, \delta_2)$ . Since the period-1 cost of funds is  $\delta$ , (15) says that with probability  $p$  the donor will be less enthusiastic about aid in the future than it is in the present. Consistent with the donor's underlying permanence, we require that the future aid gap remain positive even if the cost of funds is high. The condition for this is  $u'(\bar{G}) > \delta_H$ , which guarantees that  $\phi = \phi_L > \phi_H > 0$ .

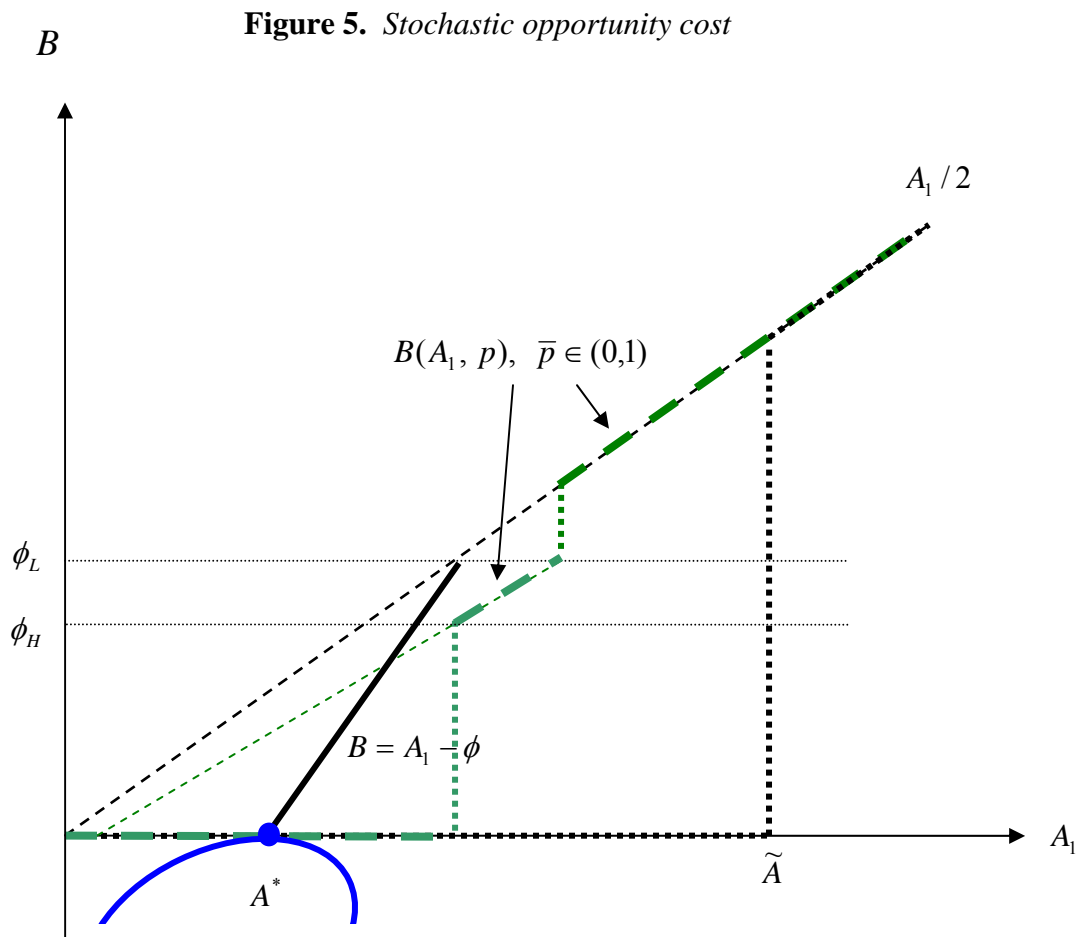
If aid were like commodity revenues, the recipient would deal with the uncertainty in (15) by accumulating a buffer stock. The choice of buffer would satisfy  $u'(G_1) = e[u'(G_2)]$ , ruling out fiscal instability. But the Samaritan's Dilemma operates when the revenue comes in the form of aid.

To characterize the recipient's response we combine elements from our previous analysis. The recipient's first-order conditions for the choice of  $B$  are

$$u'(G_1) = p \cdot u'(G_{2H}) \cdot (1 + dA_2 / dB|_H) + (1 - p) \cdot u'(G_{2L}) \cdot (1 + dA_2 / dB|_L) + \lambda, \quad \lambda \cdot B = 0, \quad (15)$$

where  $\lambda$  is the Lagrange multiplier on the constraint  $B \geq 0$ . For buffer stocks between zero and  $\phi_H$ , the use-it-or-lose-it property holds in both future states:  $dA_2 / dB|_H = dA_2 / dB|_L = -1$ , and we

therefore have  $u'(G_1) = \lambda > 0$ . The buffer stock therefore zero for low aid levels, and jumps to  $\phi_H$  only when aid becomes large enough to justify a buffer stock of  $\phi_H$  or greater. For buffer stocks between  $\phi_H$  and  $\phi$ , aid is zero in the high-cost state but the use-it-or-lose-it continues to hold in the low-cost state. Equation (16) therefore becomes  $u'(G_1) = p \cdot u'(G_{2H})$ , which yields the interior portion of the  $B(A, p)$  buffer-stock function from our pooling analysis (equation 11). The remainder of the buffer-stock function follows equation (11). Figure 5 shows the full reaction function as a piecewise dashed line.



The donor now chooses a point on the  $B(A_1, p)$  locus to maximize

$$E[u(\bar{G} + A_1 - B) - \delta \cdot A_1 + u(\bar{G} + B + A_2(B, \delta_2)) - \delta \cdot A_2(B, \delta_2)]. \quad (16)$$

As before, indifference curves are concave functions with maxima lying along the straight line  $A_1 - B = \phi$ . Under the reasonable restriction  $\phi_H > \phi/2$ , the equilibrium takes place at  $A_1 = \phi$  regardless of the value of  $p$ . Responding to spending pressures, the recipient holds a zero buffer stock. With probability  $1 - p$  the donor's cost of funds remains unchanged and the second-period equilibrium is identical to the first. But with probability  $p$ , the donor's cost of funds rises and aid falls from  $\phi$  in period 1 to  $\phi_H$  in period 2. Spending falls accordingly, from  $\bar{G} + \phi$  to  $\bar{G} + \phi_H$ , implying *ex ante* fiscal instability.

## 7. Conclusions

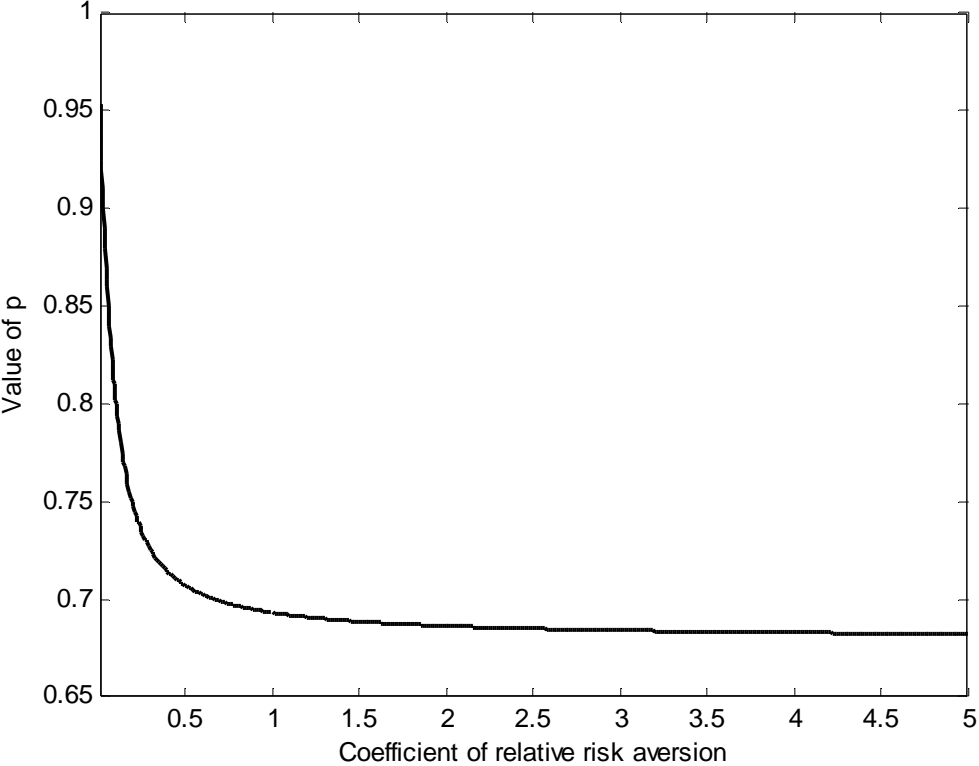
The macro-development literature contains a set of familiar warnings for aid recipients. Beware of the opportunism of domestic lobbies, because aid may be temporary and fiscal adjustment is costly. Watch out for the recurrent-cost implications of spending commitments, if these are not covered by donors. Subject public expenditure projects to rigorous cost-benefit analysis. Don't waste resources through corruption or patronage.

Our analysis suggests a novel concern for the contemporary recipients of big aid: donors cannot commit themselves to adequately rewarding prudence in the management of aid. A surge in aid therefore conveys a striking combination of temporariness and spending pressure. This combination carries the seeds of macroeconomic instability even if recipient governments are strong enough to avoid conventional pitfalls in managing aid.

*Ex ante* fiscal instability is a remarkably robust feature of the aid relationship as we have characterized it. Under asymmetric information, pooling emerges as a perfect Bayesian equilibrium for a wide range of plausible parameters, and *ex ante* fiscal instability is a feature of all such equilibria. Moreover, in sharp contrast to the conventional signaling situation, the pooling equilibrium is unique as a function of the prior distribution of types, without further appeal to refinements of equilibrium; and no separating equilibrium exists at all in pure strategies. The result is equally troubling when information is symmetric but the donor's future enthusiasm is unknown to both parties *ex ante*. In this case a surge in aid creates the expectation of a future decline; and again,

in contrast to the situation with commodity rents or other sources of public revenue, pressures to spend discourage the recipient from providing adequately for its future spending.

Figure 4: Maximal p for pooling equilibrium



## References

- Adam, Christopher S. (2001), "Uganda: Exchange Rate Management, Monetary Policy and Aid" Kampala: Bank of Uganda and London: DFID
- Adam, Christopher S. and Stephen A. O'Connell (1999), "Aid, Taxation, and Development in Sub-Saharan Africa" *Economics and Politics* 11(3), November: 225-53
- Azam, Jean-Paul and Jean-Jaques Laffont (2003), "Contracting for Aid", *Journal of Development Economics* 70(1): 25-58
- Berg, Andrew, Shekhar Aiyar, Mumtaz. Hussain, Shaun Roache, Tokhir Mirzoev and Amber Mahone (2007), "The Macroeconomics of Scaling Up Aid: Lessons from Recent Experience" *IMF Occasional Paper* No 253.
- Birdsall, Nancy (2004) "Seven Deadly Sins: Reflections on Donor Failings" *Centre for Global Development Working Paper* 50
- Brownbridge, M. and E. Tumusiime-Mutebile (2007), "Aid and Fiscal Deficits: Lessons from Uganda on the Implications for Macroeconomic Management and Fiscal Sustainability" *Development Policy Review* 25(2): 193-213
- Buchanan, James M. (1975), "The Samaritan's Dilemma", in Edmund Phelps, ed, *Altruism, Morality, and Economic Theory*. New York: Russell Sage
- Buffie, Edward, Christopher Adam, Stephen O'Connell and Catherine Pattillo (2008a) "Riding the Wave: Monetary Responses to Aid Surges in Low-Income Countries" *European Economic Review*, forthcoming
- Buffie, Edward, Christopher Adam, Stephen O'Connell, and Catherine Pattillo (2008b), "Aid Reversals, Credibility, and Macroeconomic Policy" in *New Monetary Policy Frameworks for Emerging Markets: Coping with the Challenges of Financial Globalization*. London: Edward Elgar, forthcoming
- Buliř, Aleř and Javier Hamann (2003) "Aid Volatility: An Empirical Assessment" *IMF Staff Papers* 50(1): 64-89
- Buliř, Aleř and Javier Hamann (2006) "Volatility of Development Aid: From the Frying Pan into the Fire?" *IMF Working Paper* 06/65.
- Celasun, Oya and Jan Walliser (2008), "Predictability of Aid: Do Fickle Donors Undermine Aid Effectiveness?" *Economic Policy* 55, July: 545-594
- Easterly, William (2006) *The White Man's Burden: Why the West's Efforts to Aid the Rest Have Done So Much Ill and So Little Good* (New York: The Penguin Press)

- Eifert, Benn and Alan Gelb (2005), “Improving the Dynamics of Aid: Towards More Predictable Budget Support” *World Bank Policy Research Working Paper 3732*, October
- Fleck, Robert K. and Christopher Kilby (2006a), “How Do Political Changes Influence US Bilateral Aid Allocations? Evidence from Panel Data” *Review of Development Economics* 10(2), May: 210-23
- Fleck, Robert K. and Christopher Kilby (2006b), “World Bank Independence: A Model and Statistical Analysis of US Influence” *Review of Development Economics* 10(2), May: 224-40
- Foster, Mick and Tony Killick (2006), “What Would Doubling Aid Do for Macroeconomic Management in Africa?” London: Overseas Development Institute
- Gupta, Sanjeev, Catherine Pattillo and Smita Wagh (2006) “Are Donor Countries Giving More or Less Aid” *IMF Working Paper 06/1*
- Heller, Peter S. (2005) “‘Pity the Finance Minister’: Issues in Managing a Substantial Scaling Up of Aid Flows” *IMF Working Paper WP/05/180*, September
- Heller, Peter S., Menachem Katz, Xavier Debrun, Theo Thomas, Taline Koranchelian, and Isabell Adenauer (2006), “Making Fiscal Space Happen: Managing Fiscal Policy in a World of Scaled-Up Aid” *IMF Working Paper WP/06/270*, December
- IMF (2008), *Regional Economic Outlook: Sub-Saharan Africa* (Washington, DC: International Monetary Fund)
- Killick, Tony and Mick Foster (2007), “The Macroeconomics of Doubling Aid to Africa and the Centrality of the Supply Side” *Development Policy Review* 25(2): 167-192
- Kreps, David M. and Joel Sobel (1994), “Signalling”, Chapter 25 in Robert J. Aumann and Sergiu Hart, eds, *Handbook of Game Theory with Economic Applications* (Amsterdam: Elsevier Science B.V.): 850-67
- Obstfeld, Maurice (1999), “Foreign Resource Inflows, Saving, and Growth” in Klaus Schmidt-Hebbel and Luis Servén, eds, *The Economics of Saving and Growth: Theory, Evidence, and Implications for Policy* (Cambridge, England: Cambridge University Press).
- O’Connell, Stephen A. and Charles C. Soludo (1999), “Aid Intensity in Africa” *World Development* 29(9): 1527-1552.
- Paris High Level Forum (2005), “Paris Declaration on Aid Effectiveness: Ownership, Harmonisation, Alignment, Results and Mutual Accountability” Paris: February 28 – March 2, [www.oecd.org/dataoecd/11/41/34428351.pdf](http://www.oecd.org/dataoecd/11/41/34428351.pdf)
- Roemer, Michael (1989), “The Macroeconomics of Counterpart Funds Revisited” *World Development* 17(6), June: 795-807

## Appendix.

1. *Proof that  $A_1^T < 2\phi$ .*

For an interior equilibrium in the T-donor case we need  $u'(\bar{G} + A_1^T / 2) = 2\delta$  for some  $A_1 > 0$ . By definition of  $\phi$ ,  $u'(\bar{G} + \phi) = \delta < 2\delta$ . We therefore need  $u'(\bar{G} + A_1^T / 2) > u'(\bar{G} + \phi)$ . By concavity of  $u$ , this requires  $A_1^T < 2\phi$ .

2. *Derivation of  $\bar{p}$*

Denote by  $A_1^P(p)$  the P donor's best choice of first-period aid if it faces the buffer-stock function  $B(A_1, p)$ . This takes place at the intersection of the interior portion of the buffer-stock function,  $B = (1 + p^{-\tau})^{-1}[A_1 + (1 - p^{-\tau})\bar{G}]$ , and the P donor's maximal indifference curve  $B = A_1 - \phi$ . Eliminating  $B$  from these two equations,  $A_1^P(p)$  is given by

$$A_1^P(p) = (1 + p^\tau)\delta^{-\tau} - 2\bar{G}. \quad (\text{A1})$$

We seek the value of  $p$  that makes the T donor indifferent between its full-information solution (equation (4)) and what it would receive if it imitated the P donor's behavior at  $A_1^P$ . This value of  $p$  solves  $W^T(A_1^T, A_1^T / 2) = W^T(A_1^P(p), B(A_1^P(p), p))$ , or

$$u(\bar{G} + A_1^T / 2) - \delta \cdot A_1^T = u(\bar{G} + \phi) - \delta \cdot A_1^P, \quad (\text{A2})$$

where the full-information optimum has

$$A_1^T = 2^{1-\tau} \delta^{-\tau} - 2\bar{G}. \quad (\text{A3})$$

Combining (A1)-(A3) and solving, we get  $\bar{p}^\tau = (1 - 2^{1-\tau})/(\tau - 1)$ , or

$$\bar{p} = \left[ \frac{1 - 2^{1-\tau}}{\tau - 1} \right]^{1/\tau}.$$