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The Potential of Foreign Aid as Insurance

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This paper quantifies the potential of foreign aid as an insurance mechanism against macroeconomic shocks. Within a dynamic model of aid flows between two endowment economies, we show that at least three-fourths of the large welfare costs of macroeconomic fluctuations in poor countries could be alleviated by a simple reallocation of aid flows across time. In developing countries subject to persistent macroeconomic shocks, the resulting welfare improvement is of first-order magnitude. [JEL F35, E32, E60]

Developing countries are subject to strong macroeconomic shocks. Excluding countries affected by civil wars, the percentage volatility of per capita consumption has typically been two to six times greater in these countries than in industrialized countries over the past three decades. Figure 1 provides a vivid illustration of this fact, by plotting the cyclical component of consumption in several African countries against its counterpart in the United States between 1970 and

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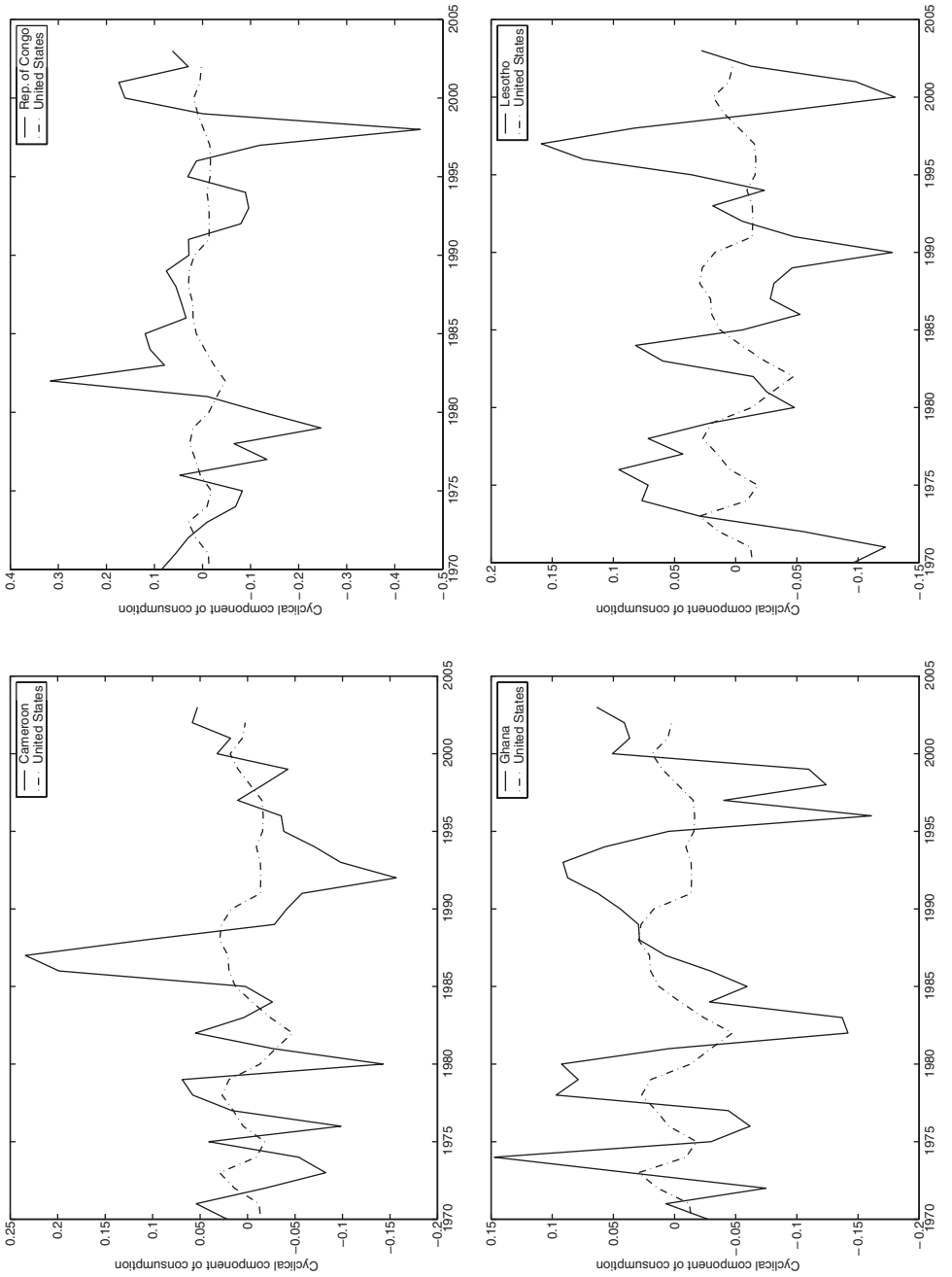
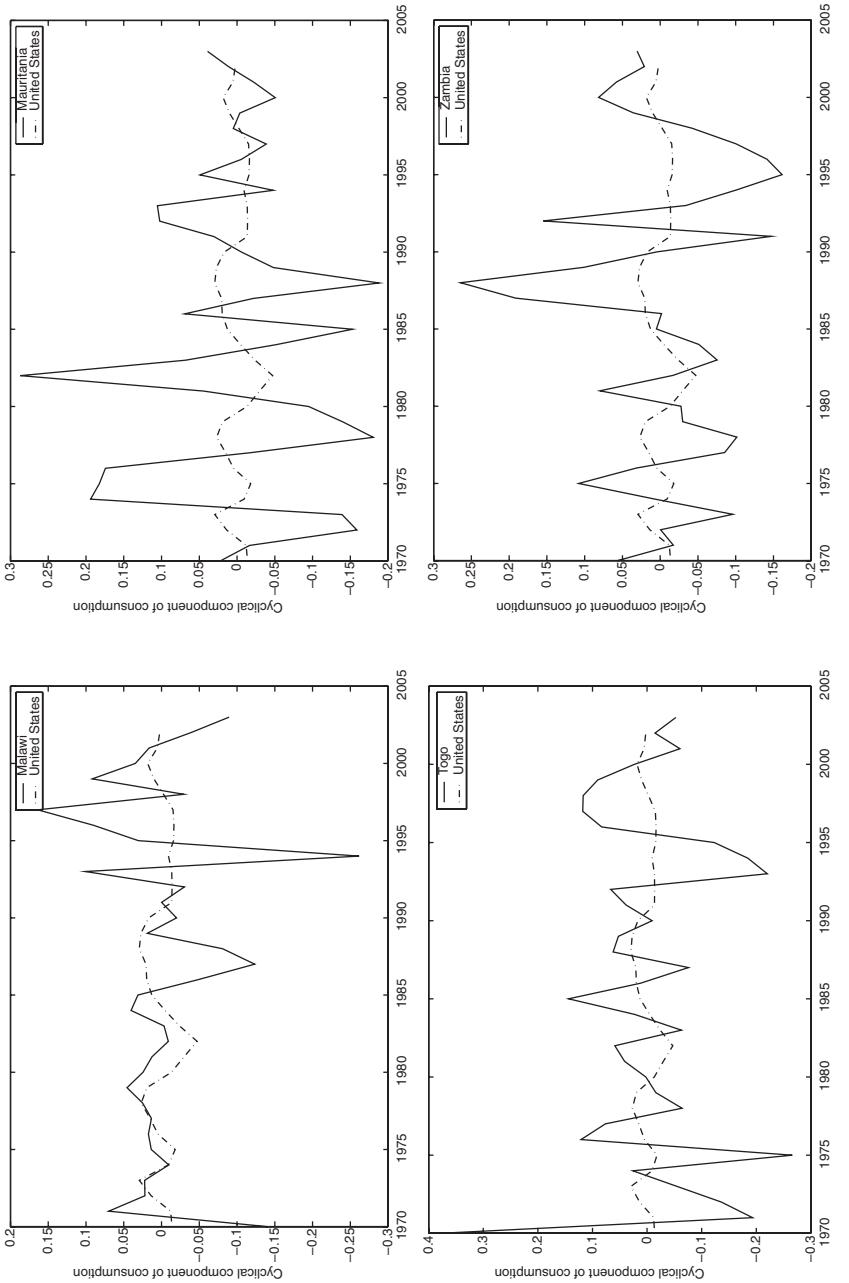


Figure 1. Cyclical Component of Per Capita Consumption



Sources: World Bank, World Development Indicators database, 2005; and authors' computations.

Notes: The figure depicts the cyclical components of consumption for the United States and several aid recipient countries: Cameroon, Republic of Congo, Ghana, Lesotho, Malawi, Mauritania, Togo, and Zambia. Natural logarithms of annual per capita consumption are detrended, using the Hodrick-Prescott filter with a weight of 100. Annual consumption data are in constant local currency terms (base year 2000) and population figures are from the 2005 World Development Indicators.

2003. Based on Obstfeld (1994), Dolmas (1998), and Pallage and Robe (2003), the welfare cost of such consumption volatility should be one to two *orders of magnitude* greater than in industrialized countries.

Recent evidence suggests that the shocks experienced by developing countries are mostly exogenous (Köse, 2002) and that developing countries' access to private international financial markets typically dries up precisely when their economies hit the doldrums (Kaminsky, Reinhart, and Végh, 2004). Under such circumstances, changing the timing of foreign aid flows that average 10 percent of recipient gross national income—the representative figure for African countries (see Table 1)—has the potential for a first-order welfare impact.[1] Our objective is to prove this conjecture and to provide a measure of the welfare gain from switching to an aid policy that would aim at consumption smoothing in recipient countries.

In practice, aid has historically been given out by a large number of imperfectly coordinated donors, whose motives for providing aid range from poverty alleviation to disaster relief to growth promotion to political alliances (Alesina and Dollar, 2000). In most developing countries, the resulting mix of foreign aid strategies is associated with procyclical net foreign aid inflows (Pallage and Robe, 2001; and Bulíř and Hamann, 2003 and 2006).[2] In this paper, we quantify the welfare benefit that would accrue to recipients if donors could coordinate on a single objective—consumption smoothing. Our question is whether using the current foreign aid budgets as an insurance device could indeed yield first-order welfare improvements in the recipient country.

Precisely, we quantify the potential welfare gains from changing the timing of foreign aid disbursements while keeping their average level constant. To keep the analysis transparent, we build a simple dynamic model of aid flows between two endowment economies with symmetric information sets: an altruistic donor country and a much poorer recipient country. Consistent with empirical evidence that foreign aid may not boost economic growth in practice (Easterly, 2003), we take each country's endowment growth path as independent of the aid flows. We approximate the fact that much of the aid to poor countries comes as outright grants by positing that aid is given out with no expectation of repayment. Finally, we assume that the donor adjusts aid flows each period to maximize a weighted average of its own expected utility and that of the recipient.

In this environment, the optimal aid policy is countercyclical. It does not merely dampen the variability of the recipient's consumption, it massively reduces it. For a poor recipient country, this policy brings the very large percentage volatility of per capita consumption down to the much lower level prevailing in the donor country. The effect of this policy on volatility in the donor country itself is negligible.

[1]Net aid inflows are a key source of external capital for poor countries. Over the past 20 years, official development assistance has made up between 10 and 60 percent of net capital flows to all developing nations; for the poorest countries, the average ratio has ranged from 50 to 90 percent (World Bank, 2002).

[2]Gupta, Clements, and Tiongson (2004) document that food aid is countercyclical, but only in countries with the greatest need for such aid. In most countries that receive food aid, food aid flows are acyclical.

Table 1. Importance of Aid, 1975–2003
(In percent)

	Average Aid-to-GNI Ratio
Benin	10.32
Botswana	5.94
Burkina Faso	13.25
Burundi	17.42
Cameroon	4.7
Cape Verde	26.94
Central African Republic	12.58
Chad	12.63
Congo, Democratic Republic of	8.15
Congo, Republic of	7.69
Côte d'Ivoire	4.86
Equatorial Guinea	22.71
Gabon	1.95
Gambia	22.54
Ghana	7.83
Guinea	10.47
Guinea-Bissau	46.67
Kenya	7.32
Madagascar	9.41
Malawi	20.52
Mali	17.2
Mauritania	26.15
Morocco	2.94
Niger	14.05
Nigeria	0.51
Senegal	11.82
Seychelles	8.85
Swaziland	5.34
Tanzania	18.15
Togo	10.47
Tunisia	2.45
Zambia	17.13
Average	12.78
Median	10.47
Population-weighted mean[1]	7.70

Source: World Bank, World Development Indicators database, 2005.

Notes: Each number corresponds to the average annual ratio of foreign aid to gross national income (GNI) over the period 1975–2003. Ratio data are from the 2005 World Development Indicators.

[1]Population-weighted mean, with weights based on 2000 population data.

To obtain quantitative estimates of the effects of this aid policy on a typical recipient's welfare, we calibrate the model and numerically simulate it. We find that altering the timing of aid disbursements would be worth at least 0.2 percent, and quite possibly more than 8 percent, of permanent consumption in the recipient country. The magnitude of the recipient's welfare gain varies with the assumed

level of risk aversion, the mean growth rate of consumption, and the magnitude and (especially) persistence of aggregate shocks. Strikingly, however, the fraction of the welfare costs of macroeconomic fluctuations that could be alleviated by merely changing the timing of aid flows always exceeds 75 percent. In short, changing the intertemporal pattern of foreign aid inflows does have the potential to create first-order welfare improvements through better risk sharing and increased consumption smoothing.

We deliberately abstract from the possibility of informational asymmetries or agency conflicts between donor and recipient or between various constituencies in the donor or recipient countries.[3] This approach allows us to keep the analysis simple despite the dynamic nature of foreign aid relationships. More important, it allows us to provide a quantitative sense of the full potential of using foreign aid as an insurance device, which has been advocated in both academic and policy circles in recent years.[4]

We are fully aware that the presence of moral hazard would likely reduce the extent to which it is desirable to offer insurance against macroeconomic shocks. We are also fully aware that implementing a countercyclical aid policy may be fraught with practical difficulties. Issues related to informational imperfections, however, arise with any insurance policy. What matters is that the insurance benefits be large enough. Our analysis shows that, in the presence of persistent macroeconomic shocks, these benefits could be of first-order magnitude.[5]

In the context of the ongoing debate about the apparent ineffectiveness of foreign aid in boosting growth and alleviating poverty, our results do not imply that donors should stop examining why some aid programs have worked and why many others have not. Neither do we suggest that donors should give up on growth and poverty altogether and instead focus on consumption smoothing. Rather, our results demonstrate that donors cannot ignore the insurance implications of foreign aid.

This paper is related to the large literature on the welfare gains from international risk sharing, which finds scope for additional risk sharing between different countries, mainly through financial markets and fiscal policy.[6] Estimates of the unrealized welfare gains from such opportunities range from moderate to massive, depending on the risk-sharing channel and on the modeling assumptions. Our contribution is to show

[3]Several recent papers study how heterogeneous information sets or conflicts between parties can influence foreign aid contracts. Those papers' main focus is on the use of foreign aid to promote specific policies in the recipient country (Murshed and Sen, 1995; Casella and Eichengreen, 1996; Lahiri and Raimondos-Møller, 1997a and 1997b; Asiedu and Villamil, 2002; Azam and Laffont, 2003; and Svensson, 2003) or on the optimal allocation of a given amount of foreign aid between potential recipients (Lahiri and Raimondos-Møller, 2000; and Svensson, 2000).

[4]For example, Collier and Dehn (2001); Caballero (2003); and "The Poor Man's Curse: Civil Wars," 2003, *The Economist,* Vol. 367, No. 8325.

[5]In that sense, our results are related to the literature on the welfare benefits of unemployment insurance programs, which has shown that, despite the possibility of moral hazard, it is optimal to offer generous unemployment benefits in a variety of model economies (Pallage and Zimmermann, 2001; and Wang and Williamson, 2002).

[6]See van Wincoop (1999) for a comprehensive review.

that an existing policy instrument—foreign aid—has the *potential* to achieve very large additional welfare gains in recipient countries.

Closely related to our analysis is a contemporaneous study by Arellano and others (2005). These authors quantify the impact of exogenously given foreign aid flows on the production of tradable goods in developing countries. They also measure the welfare implications of observed aid patterns by contrasting welfare levels when aid is volatile and procyclical versus when aid is kept constant at the mean. Like us, they choose not to model issues related to possible informational asymmetries between aid donors and recipients. Our focus, however, is different. We do not seek to identify the impact of foreign aid on a particular sector of the economy. Instead, our goal is to highlight the consumption-smoothing potential of foreign aid. Therefore, rather than take the aid policy as exogenous and then compute its impact on the recipient country's economy, we take the recipient country's aggregate consumption process as given and then quantify the welfare gain from fine-tuning aid disbursements to smooth out that consumption stream.

I. Model

To study the insurance potential of foreign aid in a recipient country, we build a model of aid flows between two endowment economies—a rich donor and a poor recipient. Each country's endowment growth path is taken as exogenous. We abstract from modeling any impact that aid might have on GDP or on GDP growth.

Of course, development assistance is the largest component of foreign aid, and the welfare effects of even small improvements in growth prospects are generally very large. One might therefore worry that, by abstracting from the development objective of aid, we may underestimate the cost of reallocating funds from growth promotion and overestimate the net benefits from a reduction in consumption volatility. Such should not be the case, however, for the following reasons.

First, our approach reflects the fact that, after decades of empirical research, there is little consensus on whether foreign aid directly affects economic growth in practice (Easterly, 2003).[7] Accordingly, we focus on another direct effect of aid flows on welfare, through consumption smoothing. That is, we ask whether foreign aid could have a first-order welfare impact on recipients in spite of the fact that the growth channel is weak. Still, we do not assume that poor countries will forever experience low levels of consumption; in view of the empirical evidence, we simply assume away the possibility that aid helps increase their growth rate.

[7]Hansen and Tarp's (2000) review of the early literature, for example, concludes that most empirical studies show that aid benefits growth. Yet, according to the widely cited studies by Boone (1994 and 1996), foreign aid is not invested but is instead fully consumed. In the same vein, Easterly (1999) and Dollar and Easterly (1999) argue that the links between aid and investment, and between investment and growth, are both tenuous. On the question of whether good economic stewardship by recipient governments might be key to foreign aid's fostering growth (Burnside and Dollar, 2000), several recent studies based on very similar data end up with conflicting conclusions; see, in particular, Hansen and Tarp (2001); Easterly, Levine, and Roodman (2004); and the discussion and references in Easterly (2003). In sum, nothing is as sure as the fact that the aid-growth relation is at best unclear.

Second, several recent papers (Epaulard and Pommeret, 2003; Krebs, 2003; and Barlevy, 2004) have shown that accounting for the deleterious effects of volatility on growth (Ramey and Ramey, 1995; and Mobarak, 2005) substantially raises estimates of the welfare cost of business cycles. If anything, by abstracting away from this indirect link between aid and growth, we may thus underestimate the net welfare effect of using aid to reduce the impact of macroeconomic volatility.

Ours, then, is a simple infinite horizon model of a donor country and a recipient country (respectively, $i = D, R$) with time-varying endowments of a single, non-storable consumption good. Each country's harvest of the good at time t, $y_{i,t}$, is a random variable that follows a known stochastic process Φ_i. The donor country is strictly richer than the recipient country. We assume that Φ_R and Φ_D are independent processes, which reflects empirical evidence that there has been very little co-movement between consumption levels in rich and developing countries in any of the past four decades (Köse, Otrok, and Whiteman, 2003; and Köse, Prasad, and Terrones, 2003).

The representative agents in both countries are infinitely lived. Throughout the paper, we assume that they have constant relative risk averse (CRRA), time-separable preferences over their own consumptions, c_R and c_D. This assumption makes analytical solutions to the donor's problem possible. Furthermore, because one would expect macroeconomic fluctuations to bring about massive welfare costs under the alternative assumption of time-nonseparable preferences (Otrok, 2001), this assumption guarantees that the large welfare gain estimates we obtain in Section IV are not merely due to our choice of utility functions. There is no evidence suggesting that residents of developing, emerging, and developed economies exhibit different intensities of relative risk aversion (Ostry and Reinhart, 1992), so we posit that the donor and recipient agents have the same constant level of risk aversion γ; that is,

$$u_i(c_{i,t}) \equiv \begin{cases} \dfrac{c_{i,t}^{1-\gamma} - 1}{1-\gamma} & (\gamma \neq 1) \\ ln(c_{i,t}) & (\gamma = 1) \end{cases} \qquad (i = D, R).$$

The recipient country's representative agent derives utility solely from his own total consumption c_R over time:

$$U_R = \sum_{t=0}^{\infty} \beta_R^t u_R(c_{R,t}), \tag{1}$$

where $\beta_R \in [0,1]$ is that agent's discount factor. In contrast, the donor country's representative agent is altruistic in that he cares about both his own consumption c_D and that of the recipient country's resident, c_R. We posit that this altruism takes the form:

$$U_D = \sum_{t=0}^{\infty} \beta_D^t \left[A u_D \left(c_{D,t} \right) + \left(1 - A \right) u_R \left(c_{R,t} \right) \right], \tag{2}$$

where $\beta_D \in [0,1]$ is the donor agent's discount factor and $A \in (0,1)$ is the weight assigned by the donor agent to his own utility.[8, 9]

The donor country can allocate part of its time t endowment $y_{D,t}$ to foreign aid a_t. We approximate the fact that much of the aid to poor countries comes as outright grants by positing that aid is given with no expectation of repayment.[10] We assume, as is typically the case in practice (Prati, Sahay, and Tressel, 2003; and Eifert and Gelb, 2006), that the recipient country cannot save any part of these aid flows. With no possibility of storage, the periodic consumption levels in each country are, respectively, $c_{D,t} = y_{D,t} - a_t$ and $c_{R,t} = y_{R,t} + a_t$.

The donor's generosity is financially constrained in two ways. First, for each period, $0 \leq a_t \leq y_{D,t}$. Second, we shall calibrate the altruism parameter A in Section IV so that the lifetime average $a_t/y_{R,t}$ ratio is in line with its empirically documented counterpart. This second restriction leads to the following remarks. One, by calibrating A to past data, we are in effect positing that the donor's preferences are time-invariant. Two, our analysis may not apply in the long run to recipient countries that are growing at a much faster clip than the donor is. Accordingly, we shall assume that $y_{R,t}$ grows at the same rate as does $y_{D,t}$. This simplification is without much loss of generality, in that our qualitative results are even stronger if we assume instead that the recipient's growth rate is lower than the donor's (which has been empirically true for most of the world's poorest countries).

II. Optimal Aid Policy

The donor's problem is recursive and can be written as follows:

$$V\left(y_{D,t}, y_{R,t} \right) = \max_{a_t} \left(A u_D \left(y_{D,t} - a_t \right) + \left(1 - A \right) u_R \left(y_{R,t} + a_t \right) + \beta_D E \left[V \left(y_{D,t+1}, y_{R,t+1} \right) \right] \right) \tag{3}$$

s.t. $0 \leq a_t \leq y_{D,t}$.

[8]Our analysis implicitly assumes that the two countries have equal populations or, alternatively, are abstractions for two groups of donors and recipient nations whose respective total populations have equal sizes. At first glance, this assumption might seem restrictive. In fact, it covers many individual donor-recipient pairs, because the model is readily generalized to cases in which the recipient country's population is smaller than the donor country's. It also applies to an aggregate of the Organization for Economic Cooperation and Development's (OECD's) donor economies (that is, the 22 nations that belong to the OECD's Development Assistance Committee) on the one hand, and an aggregate of all African recipients on the other hand.

[9]All our results are robust to using Cobb-Douglas $\left(U_D = \sum_{t=0}^{\infty} \beta_D^t \left[c_{D,t}^{\mu} \, c_{R,t}^{1-\mu} \right] \right)$ or Constant Elasticity of Substitution $\left(U_D = \sum_{t=0}^{\infty} \beta_D^t \left[A c_{D,t}^{\mu} + \left(1 - A \right) c_{R,t}^{\mu} \right]^{1/(1-\mu)} \right)$ specifications of the donor's utility.

[10]For example, 1975 to 1995 data from Chang, Fernandez-Arias, and Servén (1999) indicate that the median grant element in official development assistance loans to non-oil-producing African countries exceeded 90 percent.

Aid does not affect future realizations of $y_{D,t}$ and $y_{R,t}$, so the optimal aid rule is straightforward:

Proposition 1: *It is optimal for the donor to transfer to the recipient, each period, an amount as follows:*

$$a_t^* \equiv a_t^*\left(y_{D,t}, y_{R,t}\right) = \max\left[0, \frac{\left(1-A\right)^{\frac{1}{\gamma}} y_{D,t} - A^{\frac{1}{\gamma}} y_{R,t}}{\left(1-A\right)^{\frac{1}{\gamma}} + A^{\frac{1}{\gamma}}}\right]. \tag{4}$$

Proof: The first-order condition for an interior optimum to the donor's problem (equation (3)) is

$$\frac{u_R'\left(y_{R,t} + a_t\right)}{u_D'\left(y_{D,t} - a_t\right)} = \frac{A}{1-A}. \tag{5}$$

With logarithmic utility ($\gamma = 1$), equation (5) simplifies to $\frac{y_{D,t} - a_t}{y_{R,t} + a_t} = \frac{A}{1-A}$, which implies the following optimal rule for foreign aid disbursements: $a_t^* = (1 - A)y_{D,t} - Ay_{R,t}$. This is a special case of equation (4) with $\gamma = 1$. If $\gamma \neq 1$, then the first-order equation (5) becomes $\left(\frac{y_{D,t} - a_t}{y_{R,t} + a_t}\right)^{\gamma} = \frac{A}{1-A}$, which, given the nonnegativity condition on a_t, again yields the predicted optimal aid rule (equation (4)). ■

In the remainder of the paper, we focus on aid-dependent countries, that is, countries for which aid flows are always positive ($a_t^* > 0 \ \forall \ t$). From equation (4), it is evident that aid is positive as long as a simple condition is met: the donor's endowment must be sufficiently bigger than the recipient's. Accordingly,

Definition 1 (Aid Dependency): *We say that the recipient country is aid-dependent if*

$$\frac{y_{D,t}}{y_{R,t}} > \left(\frac{A}{1-A}\right)^{1/\gamma} \ \forall \ t. \tag{6}$$

Corollary 1: *For aid-dependent countries, the optimal aid policy is countercyclical from the recipient's viewpoint.*

Proof: By definition, an aid-dependent country has $a_t^* > 0 \ \forall \ t$. Because Φ_R and Φ_D are independent processes by assumption, it follows that $\frac{\partial a_t^*}{\partial y_{R,t}} = -\frac{A^{\frac{1}{\gamma}}}{\left(1-A\right)^{\frac{1}{\gamma}} + A^{\frac{1}{\gamma}}} < 0$. ■

Of particular relevance to our study is the extent to which the aid $a^* \equiv \{a_t^*\}_{t=1,2,\ldots}$ can reduce consumption volatility in the recipient country. Intuitively, the donor should provide insurance to the recipient to an extent that reflects the donor's income (relative to the recipient's), altruism, and risk aversion. Proposition 1 and Corollary 1 together confirm this intuition. Our next proposition goes further. It shows that, if the recipient is aid-dependent, then the optimal aid policy does not merely reduce the volatility of the recipient's consumption stream, it goes as far as equalizing the variability of per capita consumption in the donor and recipient countries.

Precisely, Proposition 2 focuses on a logical volatility benchmark that is familiar from the literature on business cycles (Kydland and Prescott, 1982, for example): the standard deviation of per capita consumption expressed as a percentage of its mean. Let $\mu[X_t|\Omega_{t-1}]$ and $\sigma[X_t|\Omega_{t-1}]$ denote, respectively, the mean and standard deviation of any random variable X_t conditional on the donor's and recipient's common information set at time $t-1$, Ω_{t-1}. Then,

Proposition 2: *In aid-dependent countries, the optimal aid policy drives the conditional volatility of per capita consumption down to that in the donor country.*

Proof: Again, by definition of an aid-dependent country, $a_t^* > 0 \ \forall \ t$. Given an optimal policy of strictly positive aid flows a_t^*, let $\dfrac{\sigma\left[y_{R,t}+a_t^*\middle|\Omega_{t-1}\right]}{\mu\left[y_{R,t}+a_t^*\middle|\Omega_{t-1}\right]}$ and $\dfrac{\sigma\left[y_{D,t}-a_t^*\middle|\Omega_{t-1}\right]}{\mu\left[y_{D,t}-a_t^*\middle|\Omega_{t-1}\right]}$ denote, respectively, the percentage volatility of per capita consumption in the recipient and donor countries in period t conditional on the information set Ω_{t-1}. Given that any strictly positive optimal aid policy can be written as $a_t^* = (1-\delta)y_{D,t} - \delta y_{R,t}$, where $\delta \equiv A \quad (\gamma = 1)$ or $\delta \equiv \dfrac{A^{1/\gamma}}{(1-A)^{1/\gamma}+A^{1/\gamma}}$ $(\gamma \neq 1)$, we have

$$\frac{\sigma\left[y_{R,t}+a_t^*\middle|\Omega_{t-1}\right]}{\mu\left[y_{R,t}+a_t^*\middle|\Omega_{t-1}\right]} = \frac{\sigma\left[(1-\delta)(y_{D,t}+y_{R,t})\middle|\Omega_{t-1}\right]}{\mu\left[(1-\delta)(y_{D,t}+y_{R,t})\middle|\Omega_{t-1}\right]} = \frac{\sigma\left[\delta(y_{D,t}+y_{R,t})\middle|\Omega_{t-1}\right]}{\mu\left[\delta(y_{D,t}+y_{R,t})\middle|\Omega_{t-1}\right]} = \frac{\sigma\left[y_{D,t}-a_t^*\middle|\Omega_{t-1}\right]}{\mu\left[y_{D,t}-a_t^*\middle|\Omega_{t-1}\right]}$$

The last equality proves the claim. ■

III. Discussion

Although intuitive, Proposition 2 sends a powerful message to policymakers. We know that the massive volatility of private consumption in developing countries has a deleterious effect on their residents' welfare (Pallage and Robe, 2003). Proposition 2 states that, without changing the actual amounts of foreign aid given on average, a simple reallocation of these aid flows across time has the potential to bring this volatility down to the much smoother ride enjoyed by rich countries. Given that the percentage volatility of consumption in poor countries is three to six times that in their developed counterparts, there is scope for cutting the former by at least two-thirds. This rough estimate already suggests that one cannot overlook the insurance power of current foreign aid budgets. We provide more precise estimates in Section IV.

Because the volatility reduction is so massive, it is worth discussing the conditions under which Proposition 2 holds. The analysis in Section II assumes that the donor and recipient countries are of equal size and grow at the same rate. It is easy to show, however, that our results carry through as long as the recipient country is poor, its population is not huge, and its economy is growing at most at the same rate as the donor country's. Much of Africa, plus most of the poor countries in other regions of the Southern Hemisphere, meet these three conditions. What is more, even if the recipient economy eventually started catching up with the donor's, our proposed aid policy would remain optimal for any time interval in which that recipient remains aid-dependent.

Our results show that donors could use foreign aid to drastically reduce consumption volatility in developing countries. What if this volatility were caused by poor policy choices in the recipient country? Our results do not imply that residents in donor countries should subsidize policy mistakes by recipient governments. Whether aid should be conditioned on good recipient policies is beyond the scope of this paper, and our model is not appropriate to discuss this issue. However, in the poor countries for which our analysis is most relevant, our abstracting from aid conditionality is without much loss of generality in that most of the observed macroeconomic fluctuations are due to exogenous shocks, such as terms-of-trade or world-price changes.[11]

It should be noted that adopting the aid policy a^* has a negligible impact on the volatility of consumption in the donor country. If we focus on aid to African countries, to which our analysis plainly applies, the median ratio of foreign aid to donor GDP was less than 0.1 percent in the previous three decades (Pallage and Robe, 2001). Clearly, any change in the sequencing of aid disbursements while maintaining that ratio in the long run will have only a minimal impact on the volatility of consumption in the donor countries. We know from the literature on the welfare cost of business cycles that, in industrialized countries, larger changes in aggregate consumption volatility have only trivial consequences on local residents' welfare, regardless of the model economy used to assess these welfare effects (Lucas, 1987; and Dolmas, 1998). Thus, even if donors had purely selfish preferences ($A = 0$), adopting policy a^* or sticking to their current aid policy would make no difference quantitatively.[12]

Finally, we assume that aid cannot be stored by the recipient. Arguably, if aid could be saved, then the welfare benefits from the donor's changing the timing of aid flows would fall. We think that our abstracting from the possibility of storage is sensible. First, there are a good number of practical reasons why recipient governments may choose not to save any part of the aid. For example, recipients who do not spend all the aid they receive in any given period can expect to see future aid flows reduced, because they have just demonstrated a lack of absorption capacity (Prati, Sahay, and

[11]Köse and Riezman (2001) show that world price shocks account for 82 percent of total consumption volatility in African countries. In the average developing country, that figure is 92 percent (Köse, 2002). These findings reinforce earlier evidence that terms-of-trade shocks are the main source of macroeconomic fluctuations in these countries (Mendoza, 1995).

[12]These welfare effects, already minor if the donor's entire aid goes to a single recipient country, should be even smaller if the donor gives aid to many countries—each subject to imperfectly correlated macroeconomic shocks.

Tressel, 2003; and Eifert and Gelb, 2006). Second, and more important, if aid can indeed be saved in practice, then observed patterns of consumption (inclusive of aid) already account for storage. That is, whatever aid storage takes place in reality is already reflected in the observed volatility of consumption. Yet, as will become clear in Section IV, a policy such as the one identified in our paper (which assumes away the possibility of savings) yields substantial welfare gains over observed aid policies. We take this as further evidence that substantial amounts of aid are not being saved in practice.

IV. Computing the Welfare Implications of Aid Patterns

The optimal aid rule a^* of Propositions 1 and 2 is obtained under the assumption that donors act as a single agency and can perfectly coordinate their efforts toward the sole objective of providing insurance to the recipient country. In contrast, aid is given out in practice by many imperfectly coordinated donor agencies with a variety of motives for providing aid. In most developing countries, the resulting mix of foreign aid strategies is associated with procyclical net foreign aid inflows. In this section, we measure the welfare gain that would accrue to a typical recipient country's representative resident if the actual aid process, denoted $\tilde{a}$, were replaced by the aid rule a^*.

Clearly, the volatility of consumption in developing countries might have been much larger if foreign aid had not been received in the first place. We are not questioning the benefits of aid per se, but rather consider the insurance potential of current aid budgets. In other words, the question we ask is how much one can improve on current aid practices. Proposition 2 suggests that, under the aid policy derived in Proposition 1, the volatility of consumption in the recipient country would equal that in the donor country. The welfare gain we wish to capture is thus the percentage increase in consumption necessary for the representative agent in the recipient country to be indifferent between (1) a consumption stream inclusive of current aid, with volatility calibrated to the recipient's observed consumption stream; and (2) another stream, with the volatility of donor consumption.

We follow the usual compensating variation approach and measure this welfare gain as the percentage consumption increase, in all states of the world and for all dates, that would make the recipient country's representative agent indifferent between the two reference environments. In the context of our model, this computation amounts to computing the welfare effects of providing the agent with two alternative consumption series that have a similar mean but different volatilities: $c^*_{R,t} = y_{R,t} + a^*_t(y_{D,t}, y_{R,t})$ at the optimum, versus $\tilde{c}_{R,t} = y_{R,t} + \tilde{a}_t$ in practice.

In order to carry out these computations, we must make some assumptions about the stochastic processes that govern each country's consumption stream per capita, $\tilde{c}_{i,t}$ ($i = D, R$). We consider in turn two processes that are familiar from the literature on the welfare costs of business cycles. Because we are interested in percentage deviations from trend, we work throughout with the logarithms of the relevant series.

In the first process, the natural logarithm of real per capita consumption fluctuates randomly, and shocks to consumption levels are temporary:

$$ln\tilde{c}_{i,t} = lnc_{i,0} + z_{i,t}, \quad \text{with} \quad z_{i,t} \to N\left(0, \sigma^2_{z_i}\right). \tag{7}$$

We parameterize $\sigma^2_{\varepsilon_i}$ in equation (7) to the standard deviation of the cyclical component of the Hodrick-Prescott (HP)-filtered logarithms of real per capita private consumption. This approach is the same as that taken by Lucas (1987) and many others and provides a floor for the welfare cost of macroeconomic fluctuations in an economy (Dolmas, 1998). This first process, thus parameterized, likewise provides a lower-bound estimate of the welfare gains from using foreign aid as insurance.

Let λ_{RtoD} denote the welfare gain to the recipient agent of a change in the timing of aid flows that reduces the percentage volatility of his periodic consumption, σ_{Z_R}, down to the donor's consumption volatility, σ_{Z_D}. Likewise, let λ denote the welfare gain to the same recipient of eliminating all macroeconomic fluctuation, that is, of getting σ_{Z_R} down to zero. Given that our economies are characterized by isoelastic preferences and consumption equation (7), and given our parameterization of σ_{Z_D} and σ_{Z_R}, both λ_{RtoD} and λ have closed-form solutions (Lucas, 1987):

$$\begin{cases} \lambda_{RtoD} = e^{\frac{\gamma\left(\sigma^2_{z_R} - \sigma^2_{z_D}\right)}{2}} - 1 \\ \lambda = e^{\frac{\gamma\sigma^2_{z_R}}{2}} - 1 \end{cases}. \tag{8}$$

To the extent that the exogenous shocks that affect developing economies are persistent (Cashin, McDermott, and Pattillo, 2004) and that their impact on domestic consumption is not easily smoothed out (Köse, Prasad, and Terrones, 2003), equation (8) will significantly underestimate the welfare gain that could be achieved by using foreign aid to reduce consumption volatility in poor countries. A simple way to account for shock persistence is to consider an alternative consumption process, in which both the level and the growth rate of per capita consumption are stochastic:

$$ln\tilde{c}_{i,t} = ln\tilde{c}_{i,t-1} + \left(1 + g_i - \frac{1}{2}\sigma^2_{\in_i}\right) + \in_{i,t}, \quad \text{with } \in_{i,t} \to N\left(0, \sigma^2_{\in_i}\right)(i = D, R), \tag{9}$$

where g_i is the mean growth rate of the series in country i. This second process assumes that shocks to consumption levels are persistent but shocks to the growth rate of consumption are not.

In a recipient economy characterized by CRRA utility and consumption equation (9), the aid policy a^* effectively reduces the conditional standard deviation of shocks to per capita consumption from $\sigma_{\in_R}$ to $\sigma_{\in_D}$. Let η_{RtoD} and η denote the welfare gains to the recipient of reducing $\sigma_{\in_R}$ to $\sigma_{\in_D}$ or to zero, respectively. Both η_{RtoD} and η have closed-form expressions (Obstfeld, 1994):

$$\eta_{RtoD} = \begin{cases} \left(\dfrac{1 - \beta e^{(1-\gamma)\left(g_R - \gamma\sigma^2_{\in_R}/2\right)}}{1 - \beta e^{(1-\gamma)\left(g_R - \gamma\sigma^2_{\in_D}/2\right)}}\right)^{\frac{1}{1-\gamma}} - 1 & (\gamma \neq 1) \\ \left(e^{\frac{\gamma\left(\sigma^2_{\in_D} - \sigma^2_{\in_R}\right)}{2}}\right)^{\frac{\beta}{1-\beta}} & (\gamma = 1) \end{cases} \tag{10}$$

$$\eta = \begin{cases} \left(\dfrac{1-\beta e^{(1-\gamma)\left(g_R - \gamma\sigma^2_{\epsilon_R}/2\right)}}{1-\beta e^{(1-\gamma)g_R}} \right)^{\frac{1}{1-\gamma}} - 1 & (\gamma \neq 1) \\ \left(e^{\frac{-\gamma\sigma^2_{\epsilon_R}}{2}} \right)^{\frac{\beta}{1-\beta}} & (\gamma = 1) \end{cases} . \tag{11}$$

Calibration

To further calibrate the two representative agents' preferences, we need values for the recipient's discount factor, $\beta \equiv \beta_R$, and the common coefficient of relative risk aversion, γ. Only annual consumption data are available for most developing countries, so we set $\beta = 0.96$ (which implies an annual discount rate of 4 percent). Our main conclusions are robust to using the alternative values $\beta = 0.98$ and $\beta = 0.945$. For the coefficient of relative risk aversion γ, we concentrate on values from 1 to 5—on the conservative end of the ranges suggested for countries in the Northern and the Southern Hemispheres (Mehra and Prescott, 1985; Ostry and Reinhart, 1992; and Reinhart and Végh, 1995). Using higher values for γ only strengthens our results.

We choose an intensity for the donor's altruism parameter, *A,* such that foreign aid's certainty equivalent equals 5 percent of the recipient's permanent consumption. This figure is conservative in light of the following facts. First, as seen in Table 1, the aid-to-GNI ratio in Africa has averaged almost 13 percent over the past three decades. Even the population-weighted average, which is lower because countries with large populations get relatively less aid, is close to 8 percent.[13] Second, between 1965 and 1994, the gross saving rate in aid-dependent countries has seldom exceeded 20 percent (Loayza and others, 1998), so that the population-weighted average aid-to-consumption ratio is approximately 10 percent. Third, in practice, aid flows are procyclical. Hence, expressed as a fraction of the recipient's permanent consumption, the certainty equivalent of the actual foreign aid inflows is much less than the average aid-to-consumption ratio. To be conservative, we set this certainty equivalent at half the latter, or 5 percent.

To calibrate the parameters of consumption equations (7) and (9), we use estimates from Pallage and Robe (2003). These figures are based on annual, 1968–96 local-currency real private-consumption data for 36 aid-dependent countries in Africa from the World Bank's World Development Indicators database. For equation (7), the σ_{z_i}'s are parameterized to the standard deviation of the cyclical component of HP-filtered logarithms of real per capita consumption. For the donor country, we use $\sigma_{Z_D} = 1.36$ percent, the estimate for the United States. We want results for a representative recipient country, so we set $\sigma_{Z_R} = 5$ percent, which is the mean estimate for the developing country sample, and check robustness to values from $\sigma_{Z_R} = 4$ percent to

[13]The data in Table 1, which focuses on Africa, are also in line with estimates for other periods and for poor countries on other continents. For example, including grants, the value of technical assistance, and concessional loans, Pallage and Robe (2001) document a median aid-to-GDP ratio of 8 percent for 63 aid-dependent countries over the period 1969–95. Bulíř and Lane (2004) report a similar mean aid-to-GDP ratio for all aid-recipient countries based on a survey of IMF country desk economists for 1998.

$\sigma_{Z_R} = 10$ percent. The latter figure might seem very high but is typical for a third of the African countries in the sample.[14] For equation (9), we need not only consumption volatility estimates for the donor and the recipient but also a mean growth rate estimate for the recipient. Pallage and Robe have estimates ranging from zero percent to 3 percent for g_R and from 3 percent to 6 percent for σ_{ϵ_R}. We therefore pick $g_R = 1$ percent and $\sigma_{\epsilon_R} = 5$ percent as central values, and carry out robustness checks with σ_{ϵ_R} ranging from 3 percent to 6 percent. In contrast, estimates of σ_{ϵ_D} do not vary much across donors. Consequently, we take only one value: the estimate for the United States, $\sigma_{\epsilon_D} = 1.35$ percent.

Quantitative Results

Table 2 summarizes our quantitative findings for the central parameter values discussed in the calibration section: $\beta = 0.96$; $\gamma = 1.5$, 2.5, or 5; $\sigma_{Z_R} = \sigma_{\epsilon_R} = 5$ percent; $\sigma_{\epsilon_D} = 1.36$ percent and $\sigma_{Z_D} = 1.35$ percent. Table 2 has two panels, to differentiate between situations in which aggregate economic shocks are transitory (left panel) and cases in which these shocks are persistent (right panel).

As other papers have shown (Obstfeld, 1994; Pemberton, 1996; Dolmas, 1998; Otrok, 2001; and Pallage and Robe, 2003), the welfare gains from reducing consumption volatility vary greatly depending on whether consumption shocks are temporary, as in equation (7), or persistent, as in equation (9). It is therefore useful to provide a benchmark for the maximum possible welfare gains from changing the pattern of aid flows in a typical recipient country by first quantifying, for each consumption process, the welfare gain that would accrue to the recipient country's representative agent if all consumption volatility were eliminated.

The first row in Table 2 shows that, when the coefficient of risk aversion is $\gamma = 2.5$ [$\gamma = 5$], the cost of macroeconomic volatility is $\lambda = 0.31$ percent [$\lambda = 0.63$ percent] of permanent consumption in the first model economy (in which shocks to consumption levels are transitory) but that same cost skyrockets to $\eta = 5.86$ percent [$\eta = 9.36$ percent] of permanent consumption in the second model economy (in which shocks are persistent). Even when $\gamma = 1.5$, a low value for the risk-aversion coefficient, the cost η is still more than 4 percent of permanent consumption.

The second row in Table 2 gives the welfare gain from optimizing the timing of foreign aid flows (λ_{RtoD} and η_{RtoD}), again expressed in terms of the recipient's permanent consumption. The third row, which gives the ratio of the first two rows, shows that, in both model economies, more than nine-tenths (92 percent) of the costs of macroeconomic volatility could be eliminated by reallocating aid flows through time in a manner consistent with Propositions 1 and 2.

Taken together, the data in Table 2 establish that the cyclical properties of foreign aid flows are of first-order importance. Policymakers should be pleased to know that foreign aid has the potential to make a huge difference in at least one key aspect of life in developing countries—coping with the impact of strong aggregate shocks. Indeed, given empirical evidence that a less volatile economy has better growth pros-

[14] All these volatility estimates were computed with a weight of 10 for the HP filter and, as in other papers on the cost of business cycles, under the assumption that the shocks in equation (7) are independently and identically distributed.

Table 2. Consumption Volatility, Aid Timing, and Welfare

	Temporary Shocks			Persistent Shocks		
	$\gamma=1.5$	$\gamma=2.5$	$\gamma=5$	$\gamma=1.5$	$\gamma=2.5$	$\gamma=5$
Consumption volatility costs (percent of permanent consumption)	0.19	0.31	0.63	4.12	5.86	9.36
Gain from timing aid optimally (percent of permanent consumption)	0.17	0.29	0.58	3.82	5.44	8.76
Fraction of volatility costs eliminated by optimal aid timing (percent)	92.6	92.6	92.6	92.6	92.8	93.6

Source: Authors' computations.

Notes: The first row shows the welfare costs of aggregate consumption volatility in a typical recipient country, expressed in terms of permanent consumption. The second row shows the welfare gain from replacing the actual foreign aid stream, $\tilde{a}_t$, with the optimal aid process, a_t^* of Propositions 1 and 2 (that is, by foreign aid flows with the same mean but different cyclical properties). That gain is also measured in terms of permanent consumption in the recipient country. The third row gives the ratio of the previous two; that is, it shows the fraction of the welfare costs of aggregate consumption volatility that could be eliminated by replacing the actual foreign aid stream, $\tilde{a}_t$, with the optimal aid process, a_t^*. The data in all rows are provided for three levels of risk aversion in the recipient country ($\gamma=1.5$, 2.5, 5), under the assumption that the percentage annual volatility of consumption (σ_{Z_i} if shocks are assumed temporary, or σ_{ϵ_i} if they are assumed persistent) is 5 percent in the recipient country ($i=R$) and 1.35 percent (σ_{Z_D}) or 1.36 percent (σ_{ϵ_D}) in the donor country ($i=D$).

pects (Ramey and Ramey, 1995; and Mobarak, 2005), the welfare benefits of optimizing the timing of aid disbursement could be substantially bigger still.

Robustness Checks

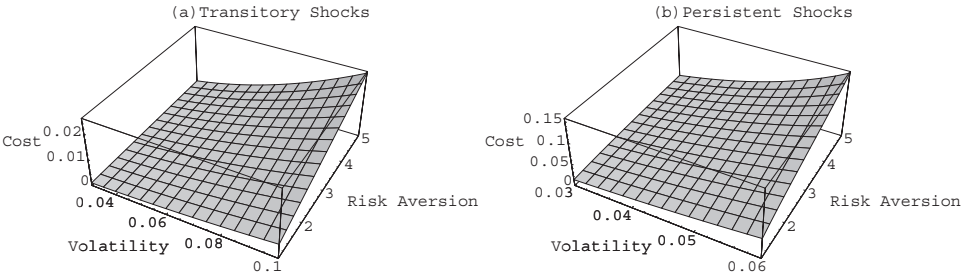
The results from Table 2 are robust to a wide range of alternative values for the key parameters, σ_{Z_R}, σ_{ϵ_R}, and γ. Figures 2, 3, and 4 provide a concise illustration of this robustness.

Figure 2.a plots λ and Figure 2.b plots η, for various values of the recipient agent's risk aversion and of the volatility of his consumption (respectively, σ_{Z_R} and σ_{ϵ_R}). As anticipated, the cost estimates in Figure 2 are often substantial. They are especially large when macroeconomic shocks are persistent—reaching, for example, a massive $\eta = 15$ percent of permanent consumption when consumption volatility is $\sigma_{\epsilon_R} = 6$ percent and the level of risk aversion is $\gamma = 5$.

Across the entire range of parameter values considered, Figure 3 shows that typically well over four-fifths, and always more than three-fourths, of the large welfare costs of aggregate consumption volatility could be eliminated by replacing the actual foreign aid stream $\tilde{a}_t$ with the aid process a_t^* (that is, by a foreign aid stream of the same average magnitude but different intertemporal properties).

Figure 4 provides another benchmark for the potential costs of ignoring the insurance implications of foreign aid. It expresses the welfare gains from replacing the actual foreign aid stream $\tilde{a}$ with the aid process a^* of Propositions 1 and 2 (that is, λ_{RtoD} in Figure 4.a or η_{RtoD} in Figure 4.b) as a fraction of the gain from providing

Figure 2. Welfare Costs of Macroeconomic Volatility
(Fraction of recipient permanent consumption)

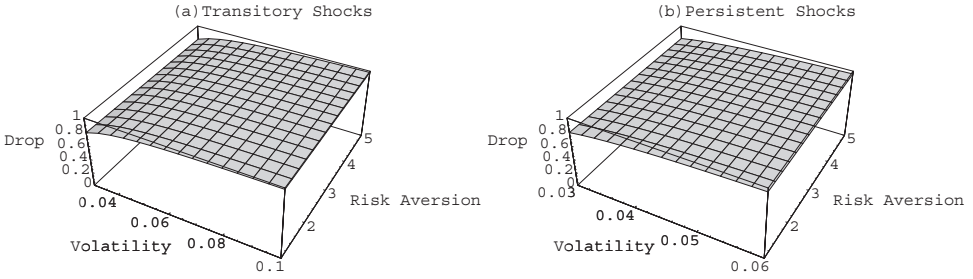


Source: Authors' computations.

Notes: The figure plots the welfare costs of macroeconomic volatility (λ in Figure 2(a) and η in Figure 2(b)) in the recipient country as a percentage of permanent consumption, for typical levels of risk aversion (γ) and consumption volatility (σ_{Z_R} in Figure 2(a) and $\sigma\varepsilon R$ in Figure 2(b)). A value of 0.01 (1%) on the vertical axis means that the country's representative resident would be indifferent between seeing all consumption volatility removed and getting an extra 1 percent of consumption in all states and at all dates. Figure 2(a) plots the value taken by λ in equation (8), when consumption shocks are not persistent. Figure 2(b) plots the value taken by η in equation (10), when consumption shocks are persistent, for a mean growth rate of per capita real consumption gR = 1%.

$\tilde{a}$ in the first place. We conservatively assumed in the calibration section that $\tilde{a}$ is worth 5 percent of permanent real per capita consumption in the recipient country. Thus, a value of 1 on the vertical axes of Figures 4.a or 4.b means that changing the timing of aid is worth as much to the recipient as increasing its per capita consumption by 5 percent at all dates and in all possible states of the world. Figure 4.b

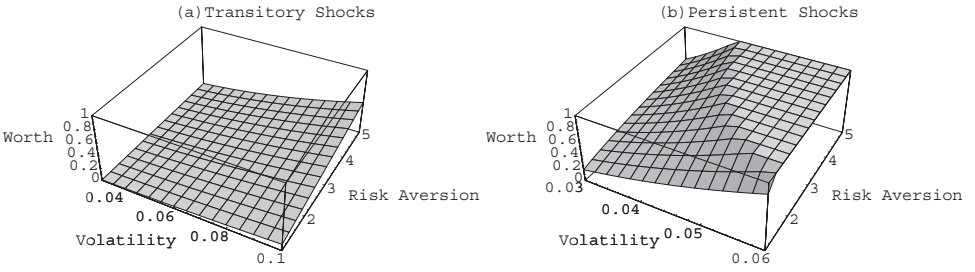
Figure 3. Fraction of Macroeconomic Volatility Costs Eliminated by Timing Aid Flows Optimally



Source: Authors' computations.

Notes: The figure plots, for typical levels of risk aversion and consumption volatility in recipient countries, the fraction of the welfare costs of macroeconomic volatility that could be eliminated by replacing the actual foreign aid stream $\tilde{a}_t$ with the optimal aid process a_t^* of Propositions 1 and 2 (that is, by foreign aid flows with the same mean but different cyclical properties). A "drop" value of 0.8 on the vertical axis means that 80 percent of the cost λ (in Figure 3(a), when consumption follows equation (7)) or η (in Figure 3(b), when consumption follows equation (9)) could be eliminated by reallocating aid flows optimally through time. Figures 3(a) and 3(b) are drawn under the assumption that the percentage volatility of consumption in the donor country (respectively σ_{Z_D} or σ_{ε_D}) is 1.36 percent. Figure 3(b) assumes a mean growth rate of per capita real consumption in the recipient country of g_R = 1%.

Figure 4. What Is Improving the Timing of Aid Worth, Compared with Getting Aid in the First Place?



Source: Authors' computations.

Notes: The figure displays, for typical levels of risk aversion and consumption volatility in recipient countries, the welfare gain that would accrue to residents of a recipient country if the actual foreign aid stream $\tilde{a}_t$ were replaced by the optimal aid process a_t^* of Propositions 1 and 2 (that is, by foreign aid flows with the same mean but different cyclical properties). A value of 1 on the vertical axis means that changing the timing of aid is worth as much as increasing the recipient's per capita consumption by 5 percent at all dates and in all possible states of the world. Figure 4(a) plots the value taken by the ratio $\lambda_{RtoD}/5\%$ in equation (8), when consumption shocks are not persistent. Figure 4(b) plots the value taken by the ratio $\eta_{RtoD}/5\%$ in equation (10), when consumption shocks are permanent. Figures 4(a) and 4(b) are drawn under the assumption that the percentage volatility of consumption in the donor country (respectively σ_{Z_D} or σ_{ε_D}) is 1.36 percent. Figure 4(b) assumes a mean growth rate of per capita real consumption in the recipient country of $g_R = 1\%$.

shows that, when consumption shocks are persistent, improving the timing of foreign aid flows is often worth more to the recipient than receiving aid in the first place.

V. Conclusions

> *"Rich countries must [. . .] pay more attention to the sudden economic shocks to which poor countries are vulnerable. Sudden plunges in the price of coffee or cotton pluck fewer heartstrings than floods or earthquakes, but can be much more destabilising and [make civil war] more likely. Aid should take such shocks into account."*[15]

When designing its foreign aid policy, a donor must tackle two broad questions. The first, from which we abstract, is the optimal allocation of aid budgets across potential recipients. The second, on which we focus, is the optimal path of disbursement of a given aid budget to a given recipient country. Although the first issue is probably very important, we demonstrate that the second issue cannot be dismissed.

We show that, even ignoring the possibility that economic shocks may bring about political mayhem or worse, merely changing the timing of aid flows could provide recipient countries with substantial insurance against macroeconomic fluctuations. At least three-fourths of the large welfare costs of aggregate consumption volatility in developing countries could potentially be eliminated by using current aid budgets to smooth aggregate consumption in these countries.

[15]"The Poor Man's Curse: Civil Wars," 2003, *The Economist,* Vol. 367, No. 8325, p. 11.

In the context of the ongoing, vigorous debate about the apparent ineffectiveness of foreign aid in boosting growth and alleviating poverty, our results do not imply that donors should stop examining why some aid programs have worked and why many others have not. Neither do we suggest that donors should give up on growth and poverty altogether and instead focus on insurance. Rather, our results have three implications for policy and further research.

First, the insurance potential of current aid budgets is of first-order magnitude. Second, foreign aid is given out in practice by many donors, for many reasons. Chief among the latter are growth promotion and poverty reduction, plus political alliances and disaster relief. In most developing countries, the resulting mix of aid strategies is associated with procyclical net aid inflows. If the strategies that bring about aid procyclicality could be replaced by others that do not (for example, through better donor coordination), then the resulting welfare gains might be as large as the gains from receiving aid in the first place. Third, if the observed aid patterns are the outcome of aid contracts designed to alleviate conflicts between donors and recipients under asymmetric information, then our results give an estimate of the deadweight losses brought about by these agency conflicts.

In sum, our point is simple. We know that the welfare costs of consumption volatility are very large in developing countries. Most of that volatility is the direct consequence of exogenous macroeconomic shocks. Lucas (2003) rightly argues that, regardless of the size of its costs, one should care about consumption volatility only to the extent that it can be reduced by feasible policies. In this paper, we focus on a policy that is both feasible and widely used: foreign aid. We show that altering the timing of aid flows has the potential to eliminate between 75 percent and 95 percent of the welfare cost of the massive macroeconomic fluctuations that affect developing countries. The impact on consumption volatility in donor countries would be negligible. In light of these results, we submit that the role of foreign aid as an insurance device deserves to receive much consideration.

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