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MEASURING THE COST OF AID VOLATILITY

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EXECUTIVE SUMMARY

Flows of official development assistance (ODA) to recipient countries have been highly volatile and this reduces their value. At the macro level, empirical evidence suggests that volatile ODA can negatively impact growth through several channels. At the micro level, volatility can affect fiscal planning and the level and composition of investment. This working paper develops a simple financial metric that policy makers can use to estimate (and reduce) the cost of aid volatility. Unlike other estimates, our measure does not depend on parameter estimates from cross-country regressions, nor on country-specific model simulations.

We treat aid flows as the uncertain return on an unobserved asset of "global goodwill" held by developing countries. We then calculate the certainty equivalent value of the volatile aid flows as well as an associated dead weight loss, using a capital asset pricing model. Our measure of the deadweight loss per dollar provided in aid permits a comparison of costs across donors and over time. We find that the costs of volatility rose steadily until 2002, and have since fallen.

Aid volatility is similar for low and middle income countries; weak states and strong states; aid dependent and low-aid countries; and across regions. Aid volatility differs substantially, however, by donor. We infer that donor policies contribute to volatility and that they should make reducing volatility a strong priority.

Key Findings

- ODA is much more volatile than major macro variables: five times as volatile as GDP and three times as volatile as exports for the average recipient. ODA typically magnifies real business cycles in recipient countries.
- The aid system generates massive negative income shocks to some developing countries (on rare occasions). These large negative shocks account for the high cost of volatility. The impact of aid shocks has been as large and as frequent as income shocks faced by developed countries during the two World Wars, the Great Depression and the Spanish Civil War.
- The deadweight loss associated with aid volatility is between 15 and 20 percent of the total value of aid in recent years. At current aid levels, this loss is about $16 billion.
- From the average recipient's perspective, the deadweight loss is about 1.9 percent of GDP.
- Volatility costs between $0.07 and $0.28 per dollar of aid, depending on the donor.

INTRODUCTION

Recent work has shown that aid flows to developing countries are highly volatile, much more so than other macroeconomic variables such as public sector revenues, consumption or Gross Domestic Product (GDP) (Pallage and Robe 2001, Bulir and Hamann 2006, Fielding and Mavrotas 2005). This volatility has been of great concern to researchers and policy makers: it is well known that volatility has a cost. Bulir and Hamann cite references going back nearly 40 years decrying aid volatility. More recently, the Paris Declaration on Aid Effectiveness—an agreement in March 2005 of more than 100 ministers and senior aid agency officials—underscored the determination of aid donors to make aid more predictable.

Despite this determination, there has not been much progress in actually reducing aid volatility and some researchers, like Bulir and Hamann (2006), have argued that aid volatility has actually become worse in recent years. This is disappointing as the benefits from reducing volatility and using aid as a smoothing device are thought to be very high. Pallage, Robe and Berube (2006) conclude that the welfare gain from improving the timing of aid flows could reach 5.5 percent of permanent consumption in aid-recipient countries. Because aid provides an exogenous instrument for directly influencing consumption volatility in recipient countries, it serves to overcome Lucas's (2003) observation that regardless of cost one should only worry about volatility if there is a mechanism for reducing it. In this paper we propose a metric for measuring aid volatility with a focus on aid as a smoothing device for developing countries.

Several studies have documented the cost of aid volatility and the channels through which this operates.[1] At a macroeconomic level, aid volatility has been shown to cause volatility in some aggregate variable such as inflation (Fielding and Mavrotas 2005), real exchange rates (Schnabel 2007), or fiscal policy (Fatas and Mihov 2008). Volatility in these variables, in turn, has been shown to reduce aggregate growth. An alternative approach is to directly estimate reduced form equations linking volatility in macroeconomic aggregates or aid volatility to lower growth.[2] This literature systematically suggests that volatility is costly, particularly in less developed countries with weak institutions.

Despite this evidence, aid volatility has not been taken seriously by policymakers. There are several explanations as to why. First, the policy conclusion from the finding that high aid volatility reduces growth is blurred. One can try to minimize aid volatility, or develop mechanisms to break the link between aid volatility and the policy variable of choice, or develop institutions to limit the impact of volatility on growth. For example, foreign exchange reserve management could in theory be used to address issues of aid and exchange rate volatility. Thus, it is hard to establish that dealing with aid volatility is in fact the priority or first best response.[3]

A second problem is that not all aid volatility is bad. When aid responds to natural disasters, like in the aftermath of the December 2004 Indian Ocean tsunami, or the successive droughts in Ethiopia between 2002 and 2004, it can generate volatility in disbursements; this kind of volatility is regarded as a good thing. In other words, aid volatility can have a smoothing or insurance function, depending on whether it is procyclical or countercyclical. For some donors, the ability to reduce aid to corrupt governments or increase aid to reformist governments after a major conflict or crisis is also considered to be a good form of volatility. Hence differentiating between good and bad volatility is required.

A third problem is that the nature of evidence on the costs of aid volatility is often questioned. Some policymakers dismiss estimates based on cross-country empirical work because of well-known issues with low robustness of results. In other cases, costs are based on simulated parameters for a welfare function (which can be debated) or on a computable general equilibrium model with stylized coefficients.[4] The few examples of country case studies tend to document subjective costs, like "difficulties in planning and budgeting," which are important but hard to quantify. Donors are increasingly working at the country level and want an answer to the question "how much does volatility cost country X."

In this paper, we try to overcome these problems by applying a new approach based on a capital asset pricing model (CAPM) to calculate the deadweight loss from aid volatility. Such an approach provides a simple, quantitative measure of the cost of aid volatility in a framework that differentiates between "good" and "bad" volatility for each recipient country and that is decomposable in terms of the contribution of each donor country to volatility.[5] In this way, policymakers can understand both the aggregate inefficiencies of the current system, the distribution of costs across recipient countries and the contribution of major donors to these costs.

The remainder of the paper is organized as follows. We sketch out why a basic CAPM approach, and Sharpe's risk-adjusted performance measure, can be usefully applied to thinking about aid volatility.

The next section looks at the nature of aid shocks. The use of a Sharpe ratio as the price of risk in applying the CAPM presumes that a developed capital market properly values risk. There is no *a priori* reason to believe that this should be the case, and this has given rise to what is known as the "equity premium puzzle." Recently, Barro (2006) develops an argument made by Rietz (1988) that suggests that the risk premium on US markets can be rationally explained by the frequency and size of major disasters. As Barro notes, with diminishing marginal utility of consumption, bonanzas do not count nearly as much as disasters for the pricing of assets and he shows that the frequency of major disasters is high enough to explain the risk premium on US stocks. The frequency of major aid shortfalls, computed in this section, is if anything even higher than the frequency of major income shortfalls in a developed country. It is probably reasonable to believe that developing countries are likely to place an even higher discount on risk than investors in the US stock market. Thus, the computed deadweight losses can be taken as a lower bound of the cost of aid volatility.

We compute the deadweight loss from aid volatility and apportion this to each major donor. The cost appears high, reaching around 15 percent of actual aid flows. This translates into a deadweight loss of around $16 billion annually in the current system. We also show that the cost of aid volatility has been growing over time, although it may have peaked in 2000 and improved slightly since then.

Section 4 looks at aid as insurance, separating "good" volatility from "bad" volatility. We look at the role of aid in smoothing or exaggerating cycles in foreign exchange earnings and income.[6] Using portfolio valuation approaches, the deadweight loss from aid and the apportionment of this loss to individual donors is adjusted accordingly. Taken together, our results suggest that aid volatility is a high priority issue, that some donors are more responsible than others for this, and that measures to reduce volatility would significantly enhance the value of aid.

Approach

The approach of this study is to measure the cost of aid volatility using a Markowitz mean-variance framework that is the basis of modern finance theory. The CAPM is particularly well suited to valuing a stream of uncertain cash flows and provides a natural way to value international aid flows. In this framework, we treat aid flows as if they are the uncertain returns on an (unobserved) asset held by a developing country (its "global goodwill"). The "return" to the asset, the observed annual flow of aid, has a mean and variance that are summary statistics that suffice to measure the value of the underlying asset. The procedure is conceptually simple: first convert the uncertain flow of aid into a certainty equivalent amount; second, discount the certainty equivalent amount by the risk-free interest rate to obtain the value of "global goodwill."

One advantage of finance theory is that it provides a mechanism for computing the certainty equivalence which does not require information on the degree of risk-aversion of the aid recipient country. Instead, it prices risk using data from international financial markets. In this paper, we use the price of risk as determined in markets in the United States—the so-called Sharpe ratio. The Sharpe ratio—also called the reward-to-variability ratio—is the premium over a benchmark risk-free return demanded by investors per unit of risk associated with a cash-flow. Investors commonly use Sharpe ratios to compute the certainty equivalence of cash flows and derive the value of the underlying asset.

Sharpe (1966, 1994) developed his ratio to compare performance between investment managers based on the risk they took as well as the realized return. He proposed a simple "risk-adjusted performance measure" to compare portfolios, equal to the premium of the return over a risk-free rate, divided by the volatility of the portfolio, where the volatility is calculated as the standard deviation of the simple return. In the same fashion, if aid portfolios have different volatilities, they should have different "returns" to compensate the recipient country.

Once the certainty equivalent amount for aid flows are derived, we can treat the difference between expected aid receipts and the certainty equivalent amount as a measure of the "deadweight loss" associated with aid volatility. That is, we define the deadweight loss as the avoidable loss that would be eliminated if aid was stable or perfectly predictable. The deadweight loss is something that can be removed by a policy change. It can also be construed as the cost of activities undertaken by the country to mitigate the effects of aid volatility. When these deadweight losses are aggregated across all aid recipient countries, we obtain a measure of the global deadweight loss from aid volatility. Unlike other estimates of the cost of volatility (that require complex country-by-country modeling and assumptions about macroeconomic parameters and behavioral equations) this methodology is simple and permits a ready comparison about losses across aid recipient countries.

Another advantage of finance theory is that it can be easily extended to consideration of a portfolio as well as any single stream of cash flows. Each aid recipient country can be thought of as having such a portfolio—the elements are "goodwill from the USA," "goodwill from Japan," etc. Standard finance allows us to decompose the deadweight loss of aid volatility into contributions associated with each donor. This can then be aggregated across countries to obtain each donor's contribution to global deadweight losses from aid volatility. Such a decomposition might be useful in spurring action to reduce volatility as each donor can clearly identify the impact of their own

behavior. In fact, this decomposition permits situations of individual volatility, but collective stability to arise. Each donor can individually have volatile aid (perhaps because of its own procedures) but this may not contribute to any loss if aggregate aid is stable. The size of the deadweight loss then depends not only on donor behavior, but also on behavior of all other donors. If there is coordinated action or herd behavior (resulting in the so-called donor darlings and donor orphans), then collective volatility can be accentuated by multiple donors. If each donor's volatility stems from uncorrelated factors like project specific issues, then aggregate volatility can be reduced by multiple donors and projects.

AID SHOCKS

In considering aid shocks, two questions must be answered. What is the type of aid being considered? And how should one measure the "shock?"

Different measures of aid flows

The type of aid considered below is influenced in part by the data availability on aid flows. Data is drawn from the Organization for Economic Co-operation and Development's Development Assistance Committee (DAC).[7] This is a creditor reporting system, under which each donor country reports on its aid to different countries. The DAC data provide us with aid flows for 53 donor countries and multilateral agencies (like the International Development Association), covering 177 recipient countries between 1970 and 2006. Not all donors lend to all countries, however, and not all countries are aid recipients in every year. There are also potentially some points where data is simply missing. The total number of observations therefore consists of 110,636 donor-recipient-year points.

The advantage of using net ODA is that it is the most comprehensive measure of support to a country. The disadvantage is that it is actually a composite measure of two different items: gross disbursements less repayments on past aid credits.

The DAC statistics allow us to define aid in a number of different ways. First, the amount of net Official Development Assistance (ODA) received by a country can be determined. This is the broadest measure of aid, including such diverse items as food aid, humanitarian assistance, technical assistance, and debt relief as well as amounts given for projects and programs in aid recipient countries. Net ODA is defined to include all transfers with a grant equivalent amount of more than 25 percent, so it adds together pure grants and credits on highly concessional terms. It is the headline number for official aid targets.

The advantage of using net ODA is that it is the most comprehensive measure of support to a country. The disadvantage is that it is actually a composite measure of two different items: gross disbursements less repayments on past aid credits. But repayment obligations are known with certainty (bar minor exchange rate valuation effects). So the variation in net ODA really comes from a variation in gross disbursements. This is the second measure we use. Some analysts feel that donors might adjust their giving in response to repayment obligations –so-called defensive lending—in order to maintain a degree of stability in net transfers. To the extent that this is an accurate portrayal of donor behavior (and there is some evidence to support this[8]) then net ODA is to be preferred as a measure of aid. But if donors do not respond to repayment obligations then gross disbursements is preferred.

Much of the aid included in net ODA or gross disbursements does not actually involve a cross-border transaction. For example, technical assistance typically involves a consulting contract between a donor agency and a consulting firm in its own country. The aid recipient receives a service (the consulting report), but the valuation of the service is out of its control. There are no cash flows involved. Volatility in these kinds of transactions may be less important than volatility in cash that supports development projects and programs. At the same time, some have argued that humanitarian assistance should also be discounted on the grounds that it is "good" volatility. Following Kharas (2007), we develop a measure of aid, called country programmable aid (CPA), which excludes from the total non-cash flow items like techni-

cal assistance, debt relief, food aid, and humanitarian assistance. We also subtract interest payments made, so as to arrive at a true figure of cash flow received by the recipient country. This concept of aid is closest in spirit to the concept of a "dividend" payout on global goodwill.

Rather than arbitrarily choosing between these measures, we report results using all three. While the magnitudes of the deadweight losses differ, the same pattern emerges.

Aid shocks

Aid shocks can be best understood as the difference between aid amounts and some expected value. Because we are using finance techniques, the absolute amount of aid is used.[9] These aid flows are obtained in constant dollar terms. It is now widely recognized that aid flows are non-stationary so it is appropriate to work in first differences (Bulir and Hamman 2006). Thus, the basic model is that the change in aid from donor *i* to recipient *j* at time *t*, A_{ijt}, is driven by a constant term reflecting the donor-recipient relationship, a_{ij}, and a random error, e_{ijt}:

$$\Delta A_{ijt} = a_{ij} + e_{ijt} \quad (1)$$

Summing this across all donors yields

$$\Delta A_{jt} = \sum_i a_{ij} + u_{jt} \quad (2)$$

Equation (2) gives the amount of aid each recipient country receives over time. In essence, this process assumes that aid has a linear trend, with the trend estimated separately for each recipient country. It is then simple to obtain a time series for expected total aid in each period. Aid shocks are defined as the difference between actual aid flows in each period and the expected value.

Table 1 provides summary information on the volatility of aid, as measured by the coefficient of variation of the aid shock. For comparison, the table also provides equivalent statistics for gross domestic product and export earnings of aid recipient countries. It is clear that aid is more volatile than these major macroeconomic aggregates. Aid volatility is five to six times as large as volatility in GDP and three times as large as export volatility.

It is also interesting to note that the measure of aid cash flows (i.e., CPA) is more volatile than total aid, despite the fact that the latter includes debt relief and humanitarian assistance, both of which are thought of as being highly volatile. The intuition is simple. If aid is a fixed aggregate, then more humanitarian assistance also implies less money for projects and programs. Thus CPA will also exhibit high volatility when it is a substitute for humanitarian assistance.

Table 1 also breaks down volatility into a number of aid recipient sub-groups: geographic region, degree of aid dependency, income level, and strength of the state. None of these broad characteristics appears to have a sizeable impact on aid volatility.[10] There is minor support for the notion that weaker states have more volatile aid (perhaps because of a higher risk of policy reversal), but this is not statistically significant.[11] There is no evidence to support the idea that sub-Saharan Africa, aid dependent countries, or low-income countries receive a more volatile stream of aid than other countries.

Aid "shortfalls" and "fat tails"

How big and frequent are negative aid shocks? Recall that the explanation for high-risk premiums in developed country stock markets hinges on the idea that investors care a lot more about very bad outcomes compared with bonanzas. Thus, high volatility only

Table 1: Coefficient of variation (detrended data, 1970-2005/6)

Sample (mean CV reported)		Gross Disburse-ments	Net Disburse-ments	Country Program-mable Aid	GDP (lcu)	Exports (US$)
		n=177	n=177	n=177	n=157	n=115
All Countries	n ≤ 177	0.545	0.586	0.742	0.111	0.220
SSA	n ≤ 51	0.531	0.476	0.523	0.110	0.245
LAC	n ≤ 41	0.493	0.575	0.696	0.083	0.209
EAP	n ≤ 36	0.559	0.657	0.777	0.114	0.266
Aid Dependent (75th percentile)	n ≤ 38	0.430	0.389	0.457	0.108	0.266
Aid Dependent (90th percentile)	n ≤ 15	0.514	0.494	0.546	0.109	0.315
Non-dependent	n ≤ 111	0.537	0.607	0.787	0.116	0.211
Lower Income Countries	n ≤ 53	0.553	0.496	0.553	0.110	0.255
Non LIC	n ≤ 124	0.541	0.624	0.823	0.111	0.203
Weak States (1st quintile)	n ≤ 26	0.748	0.728	0.742	0.132	0.318
Weak States (1st and 2nd quintile)	n ≤ 53	0.574	0.542	0.588	0.112	0.255
Strong States	n ≤ 73	0.532	0.604	0.809	0.110	0.203

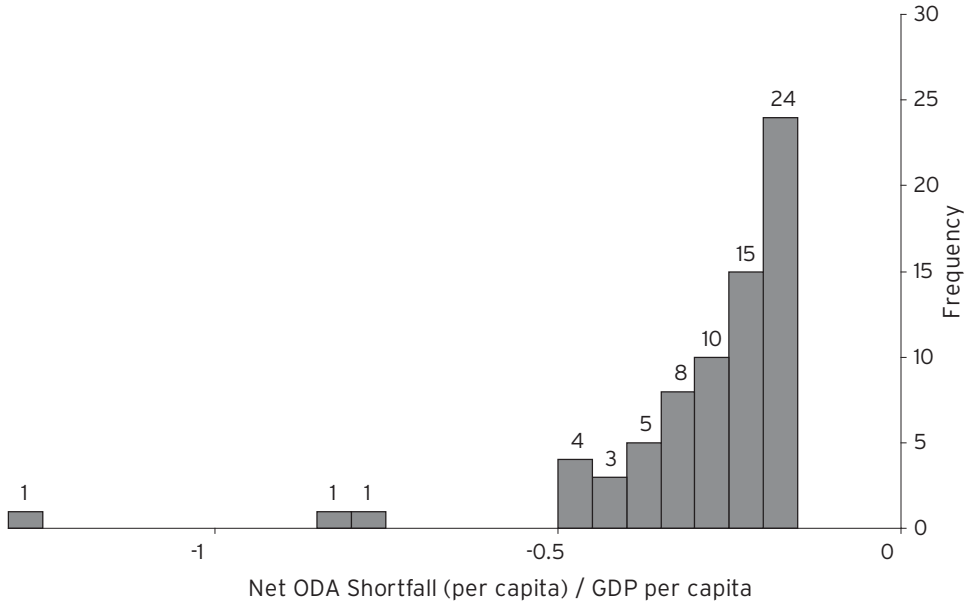
has a high cost if the size of the potential shocks is large.

Figure 1 presents the data on the size of major aid shortfalls between 1970 and 2006, expressed as a percentage of recipient country GDP per capita. An aid shortfall is simply the difference in aid per capita between two years. We define major aid shortfalls as those which involve a loss of per capita income of more than 15 percent, the same criterion as used by Barro (2006) and it is only these that are shown in Figure 1. We look at shortfalls over two years, on the grounds that it may take time between the policy decision to reduce aid and actual aid flows.

For two year aid differences, we find 72 episodes of large shortfalls out of 4,192 country-year observations. That is, the probability of an aid shortfall producing a negative shock of 15 percent of GDP per capita or more, has historically been 1.72 percent in the period 1970-2006. This compares to Barro's observation that the risk of a 15 percent decline in real per capita income in a developed country during the 20th century was 1.65 percent.[12]

Barro's "low probability disaster" scenarios largely resulted from the two World Wars, the Spanish Civil War and the Great Depression. Those episodes are the only ones in the 20th century with falls in per

Figure 1: Large aid shortfalls, 1970-2006



capita income of more than 15 percent in developed countries. What is striking about the data is that in the 1970-2006 period, characterized by unprecedented prosperity and growth in the world, there have been episodes of equivalent shortfalls in per capita income in developing countries due solely to reduced aid receipts. In other words, the aid system has generated the same negative shocks to per capita income in per capita incomes in developing countries, and with more frequency, as the two World Wars and the Great Depression generated in developed countries.

Table 2 lists the country-year observations of major aid shortfalls for net ODA. Twenty-six developing countries have witnessed at least one major aid shortfall, and of these 15 countries have had more than one such episode. More than half are in Africa, and the remainder are from across the world. Unsurprisingly, most are small economies. This follows because an aid shock of this magnitude requires both high volatility (numerator) and high aid dependence (low denominator). The broad range of countries experiencing a major aid shock, however, suggests that many countries might realistically be concerned about a major shortfall at some point in time.[13]

The frequency of major aid shortfalls is at least as large as the frequency of major income shortfalls in developed countries. Barro (2006) argues that such income collapse episodes are the underlying rationale for the equity market premium for volatility. If this line of reasoning is accepted, then it is reasonable to suppose that the discount associated with aid volatility would be at least as high as the discount for volatility in developed country equity markets.

Table 2: Large net ODA shortfalls, 1970-2006

Two Year Difference

		% GDP	
Recipient	Shortfall Count	Maximum Shortfall	Average Shortfall
Burundi	2	-35.8	-33.9
Cambodia	4	-84.7	-40.9
Cape Verde	1	-25.5	-25.5
Central African Rep.	1	-15.9	-15.9
Chad	1	-31.1	-31.1
Congo, Dem. Rep.	1	-78.6	-78.6
East Timor	2	-45.7	-40.0
Gambia	3	-25.4	-19.6
Guinea-Bissau	8	-47.5	-28.5
Guyana	2	-30.9	-25.2
Kiribati	8	-42.6	-25.5
Liberia	4	-49.8	-35.3
Madagascar	1	-16.3	-16.3
Mali	1	-17.9	-17.9
Marshall Islands	3	-21.0	-19.0
Mauritania	2	-20.9	-18.9
Micronesia, Fed. Sts.	1	-16.9	-16.9
Mozambique	4	-30.3	-22.5
Nicaragua	1	-23.6	-23.6
Rwanda	2	-49.2	-37.9
Sao Tome & Principe	10	-125.6	-35.7
Sierra Leone	1	-15.3	-15.3
Solomon Islands	4	-31.8	-23.8
Suriname	3	-25.1	-21.1
Viet Nam	1	-18.6	-18.6
Zambia	1	-44.6	-44.6
All Large Events	72	-125.6	-28.8

THE CERTAINTY EQUIVALENT AMOUNT OF AID

Consider the following thought experiment. Two finance ministers from aid recipient countries are comparing their aid flows. Each suffers from volatility but they wonder which of their countries' has the higher "global goodwill." They decide to use Sharpe's risk adjusted performance measure to assess their portfolios. They agree to use the international price of risk as measured on the New York Stock Exchange as the relevant price for risk as the large adverse shocks in aid appear to be similar in size and frequency as the large adverse shocks affecting mature financial markets. The two ministers each compute their risk-adjusted aid flows to see who is getting the better deal from donors in terms of risk-adjusted aid flows per capita.

The capital asset pricing model applied to aid

The finance ministers would make a calculation based on a CAPM. The CAPM is a simple mechanism for associating the required return on an asset with its risk. The higher the risk, the higher the return required for an asset to be held in an efficient portfolio. The CAPM shows that this relationship is a straight line.

The CAPM can be used to compute the value of the underlying unobserved asset, "global goodwill" (G_j) which provides a claim over a dividend flow (the amount of aid received by country *j*) in the next period. Global goodwill is an asset which does not depreciate and in which there is no investment. Its value remains constant over time if the expected amount of aid and the variance of aid and the risk free rate remain constant.

Figure 2 illustrates the premise. It shows volatility on the horizontal axis and expected asset returns on the vertical axis. The straight line shows the market trade-off between required returns and risk. It connects two points: the risk-free return, with zero volatility by definition, and the expected market return $E(r_m)$ which has a volatility of σ_m. The slope of this line is the Sharpe ratio. Figure 2 indicates that the return required on global goodwill $E(r_a)$ is far larger than $E(r_m)$, because the volatility of aid has been higher than the volatility of equity returns on the New York Stock Exchange.

The value of global goodwill in period *t* is, by definition, the expected value of the aid flow in period *t+1*, $E(A_{jt+1})$, discounted by a risky return that compensates for the volatility of aid, $E(r_{at+1})$:

$$(3) \quad G_{j(t)} = \frac{E(A_{jt+1})}{(1 + E(r_{at+1}))}$$

From Figure 2, it is easy to compute the risky return to be used in discounting the aid flow:

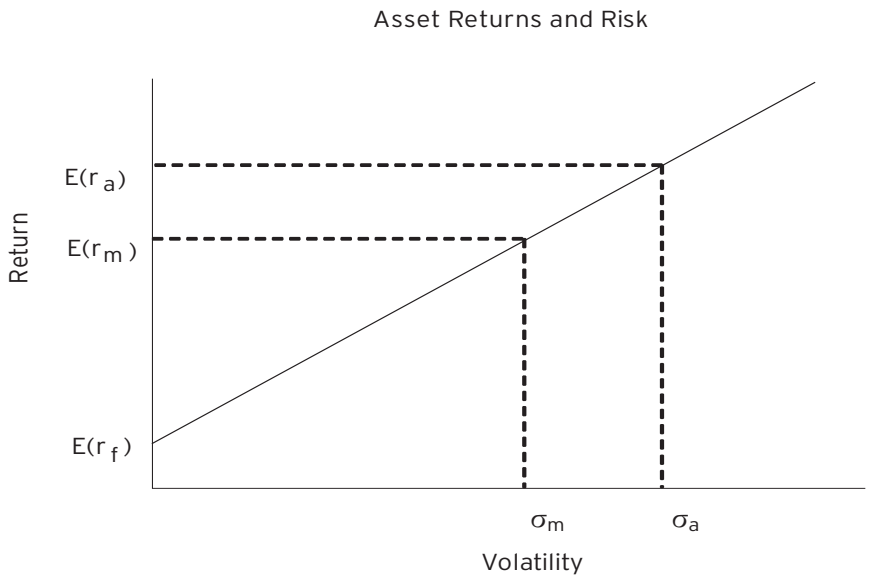
$$(4) \quad E(r_a) = E(r_f) + S\sigma_{aj}$$

where *S* is the Sharpe ratio, or the difference between the market return and the risk free rate divided by the difference between the standard deviation of the risky asset and the risk free rate. *S* is simply the slope of the line in Figure 2.[14] σ_{aj} is the coefficient of variation of the annual aid flows for the country *j*, namely the standard deviation per unit of aid.

The certainty equivalent amount of aid, $CE(A_{t+1})$, is simply the risk free rate times the value of the global goodwill.

$$(5) \quad CE(A_{t+1}) = (1 + r_f)G_t$$

Figure 2: Asset returns and risk



The deadweight loss (DWL_t) suffered by the aid recipient country is defined to be the difference between the expected aid flow and the certainty equivalent amount.

$$(6)\quad DWL_{jt} = E(A_{jt}) - CE(A_{jt}) = E(A_{jt}) \left(\frac{S\sigma_{aj}}{1 + r_{ft} + S\sigma_{aj}} \right)$$

Equation (6) gives a simple way of computing the deadweight loss in each period *t* for each country *j*. It shows that the discount between expected aid and its certainty equivalent amount depends on three key variables. The discount gets larger as the coefficient of variation of the aid flows goes up, as the market price of risk (the Sharpe ratio) goes up and as the real risk free interest rate falls.

Calculating the deadweight loss from aid volatility

Equation (3) is a basic formula for computing global goodwill. For each aid recipient country *j* we can compute the expected level of aid [based on the trendline derived from equation (2)]. The Sharpe ratio is calculated using the equity returns on the S&P 500 (dividends plus capital gains) and the annualized six month US Treasury bill rate. Both of these are deflated with the US Consumer Price Index (CPI) to obtain values in real terms. The Sharpe ratio for 1970-2006 is .388. The mean difference between the equity return and the risk free return over the period is 6.4 percent. We have computed the Sharpe ratio for the same time period as the aid data, namely 1970-2006. Many other analysts use a Sharpe ratio for the post-WWII period which is slightly higher than our estimates. If any-

thing, our procedure biases the estimated deadweight losses downwards.

Global goodwill for 2002-2006 is shown in Figure 3. For each country, the expected aid plus or minus one standard deviation (truncated at zero) is shown. Two small economies—Cape Verde and the Palestinian areas—clearly receive higher amounts of aid than others, with only modest uncertainty. Other high aid recipient countries also seem to have high volatility. But there is no simple relationship to identify clearly which countries have the greatest global goodwill. For many country pairs there is a trade-off between the amount of aid and the degree of volatility.

To measure the cost of aid volatility more specifically, we can use Equation (6) to compute the deadweight loss in constant dollars for each aid recipient country for each year. These absolute amounts are summed across recipient countries to give the global deadweight loss per year, and divided by total aid for that year to give the ratio of the deadweight loss to actual aid for the world as a whole.

The procedure is repeated for each of the three measures of aid discussed in section 2. The results are graphically depicted in Figure 4. This aggregation procedure is equivalent to one which weights each country-specific deadweight loss by the distribution of aid across countries to get a global total. Thus, if more aid is channeled towards countries which historically have had relatively stable aid flows, then the global deadweight loss will decline, and vice versa.

Figure 4 shows that deadweight losses are high, running between 15 and 20 percent since 1995. Losses grew steadily from 1970 until about the year 2000.[15] They then stabilized at a high level but do appear to have fallen in the last two years. This cannot be attributed to a fall in the real risk free rate—that has remained at about its long-run average level in the last few years, and was the same in 2006 as in 1970. Nor can it be attributed to aid flows shifting towards countries where aid has historically been more volatile; with some important exceptions, like Iraq, East Timor and Cambodia, the aid share of countries with the greatest volatility in aid actually fell between 1970 and 2000 (Table 3). Instead, the rise in deadweight losses as a share of aid reflects the movement of aggregate aid volumes themselves, the denominator in the ratio. When actual aid falls, as it did between 1985 and 2000, the ratio of deadweight losses to aid rose, and when aggregate aid went up as it has recently done in 2005 and 2006, the ratio fell.

Table 3 shows the changing share in global aid of countries where aid has been most volatile. It includes aid recipients, like Iraq, Afghanistan and Cambodia which are receiving substantially more assistance than in 1970. But it also includes recipients like Turkey, Chile and Malaysia where aid volatility has come from sharply reduced flows as these countries came closer to graduation from development assistance. In between there are a number of African countries, which historically have had high aid volatility. The second and third columns in Table 3 show the change in the country's share of aid between 1970 and 2000, the period during which the measure of computed deadweight losses grew, and between 2000 and 2006, when deadweight losses as a percent of aid fell.

Table 4 presents deadweight losses according to different country groupings as a share of each country's GDP. Recall that aid volatility between these country groupings did not show any marked differences in terms of recipient country characteristics (Table 1). But because countries receive different amounts of aid, the impact of the deadweight losses from aid vola-

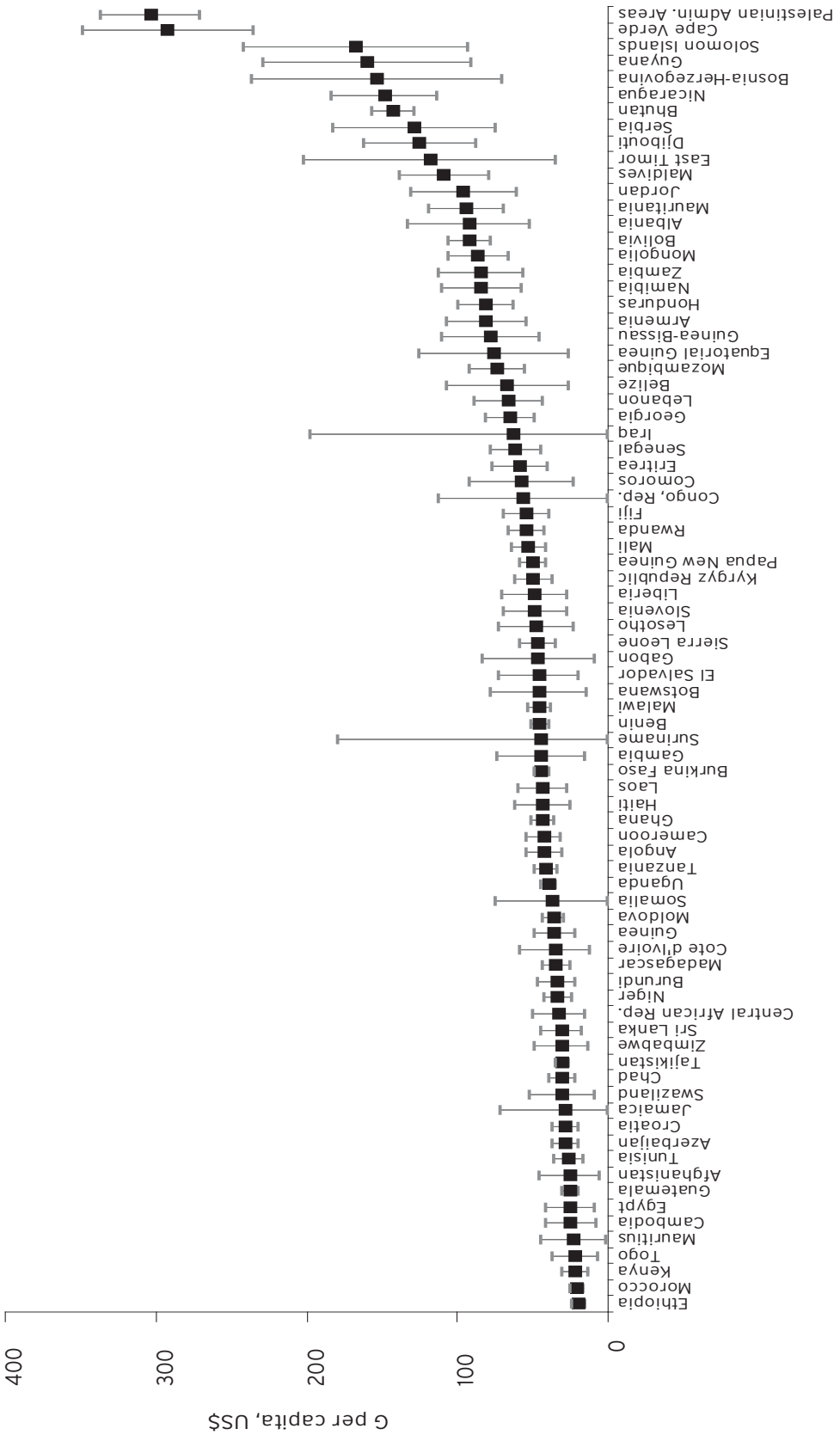


Figure 3: Global goodwill (G) per capita, 2002-2006

FIgure 4: Aid volatility over time

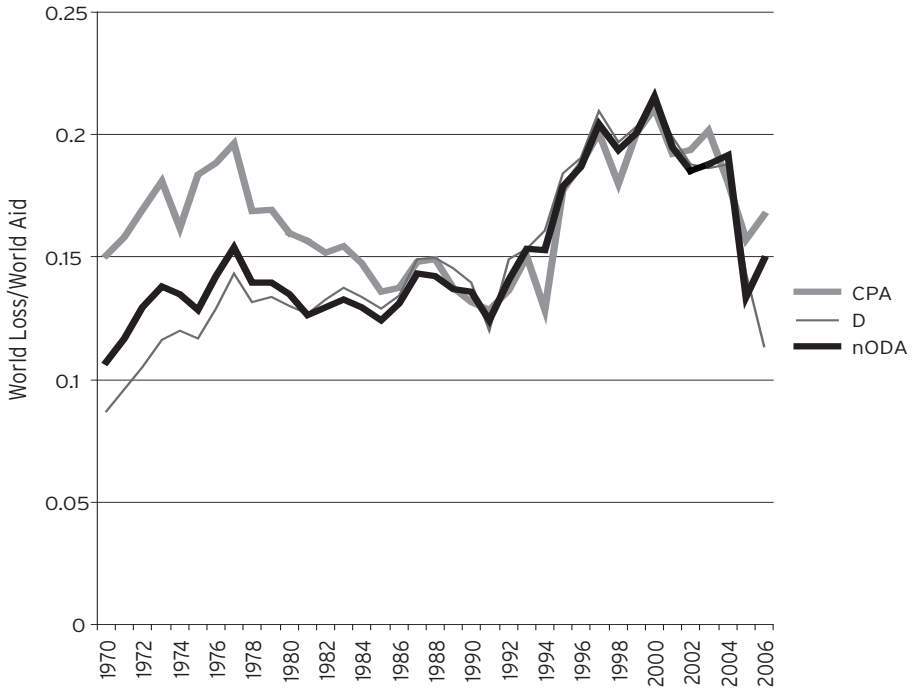


Table 3: A snapshot of aid volatility

		Change in share of world Net ODA, percentage points	
Recipient	**CV**	**1970-2000**	**2000-2006**
Iraq	3.07	0.16	10.91
Nigeria	2.66	-1.52	13.91
East Timor	1.33	0.72	-0.46
Afghanistan	1.30	-0.04	3.27
Congo, Dem. Rep.	1.07	-1.16	2.02
Congo, Rep.	1.04	-0.20	0.22
Costa Rica	0.98	-0.16	-0.04
Chile	0.93	-0.95	-0.03
Malaysia	0.81	-0.44	0.20
Cambodia	0.76	0.65	-0.39
Turkey	0.75	-2.07	-0.11
Somalia	0.74	-0.21	0.18
Jamaica	0.73	-0.13	0.00
Thailand	0.73	0.11	-1.76

Table 4: Dead weight loss as percent GDP, 1970-2006

	Average DWL as percent GDP, 1970-2006		
Sample	nODA	D	CPA
All Countries	1.92	1.78	1.12
SSA	2.38	3.00	1.69
LAC	0.59	0.68	0.45
EAP	2.70	2.69	2.00
Aid Dependent (75th percentile)	3.98	4.46	2.90
Aid Dependent (90th percentile)	6.60	6.92	4.79
Non-dependent	0.74	0.86	0.51
Lower Income Countries	2.64	3.23	1.85
Non-LIC	1.04	1.07	0.76
Weak States (1st quintile)	2.54	2.88	1.63
Weak States (1st and 2nd quintile)	1.92	2.22	1.33
Strong States	1.19	1.31	0.90

tility in terms of their GDP does differ significantly. On average, our results suggest that countries lose about 2 percent of GDP because of aid volatility. But sub-Saharan African countries and small Pacific island economies are much more sensitive to volatility because of low levels of GDP and high aid dependency. For the most aid dependent countries, the losses total almost 7 percent of GDP. Low income countries and weak states also have much higher losses from aid volatility.

Interpreting the deadweight losses from aid volatility

The deadweight losses computed above are financial and hypothetical in that no actual market transactions are taking place, so we do not observe any values for "global goodwill" that would permit us to compute deadweight losses directly. The computations reflect comparisons of aid portfolios. But would a finance minister really take less aid totals in return for reduced volatility? The answer is probably "yes." Countries incur substantial real costs from volatility so welfare could be raised by accepting a smaller total amount in return for lower volatility.

To see how deadweight losses manifest themselves in the real world, it is useful to make an analogy to corporate finance. There, it is common to analyze the problems faced by a firm raising finances for investment. Typically, such analysis focuses on the transaction costs of raising money and the uncertainty as to how much money needs to be raised. If there were no transaction costs to raising money, firms would sim-

ply wait to see what they needed and then raise that amount. In practice they do not do this because there are fixed costs of negotiating with bankers so they want to minimize the number of transactions. This gives rise to a decision to maintain financial slack, or to preserve a certain amount of liquidity by raising resources even before they are required. These idle resources have an opportunity cost that, coupled with the transaction costs of raising money, becomes a deadweight loss for the firm.

In the case of a country, many of the same issues arise. The financial planning problem can be thought of as a two-stage process (Martin and Morgan 1988). In the first stage, there is an evaluation of how much money will be required in the next period. In the second stage, a decision is made about how much to finance in the current period and how much to finance in the next period. The decision to pre-finance in the initial period is driven by the desire to minimize transaction costs in financing and to give a signal about firms' investment opportunities. Optimum firm financing behavior can best be interpreted as a decision to smooth the amount of financing needed so as to minimize the need to negotiate with additional lenders. The decision is also driven in part because the signal associated with deviating from a financial plan is mixed. It can be positive if it reflects the emergence of good new investment opportunities; or it can be negative if it reflects a shortfall of expected revenues. The combination of these effects pushes a firm (or a finance minister) to develop a predictable financing plan, even if that entails some real costs compared to the "finance-as-you-go" alternative.[16]

For a developing country, aid can be uncoordinated and fragmented. Donors support one sector for a year and then move towards a different sector. They are unaware of each others' operations and often duplicate analytical work. The whole system produces volatility, waste and overlap of activities because of an inability to predict and plan resource flows over the medium term.

Note that in this model the deadweight losses depend on transaction costs in the market for finance as well as on uncertainty over the required finance. This theme is further developed by Aghion *et al.* (2005). In that model, there are two types of investment: short-term investment which generates output relatively fast; and long-term investment which contributes more to productivity growth but which carries the risk that it will be interrupted by an exogenous credit shock. When long-term investment is interrupted, it produces a zero return. In such a world, Aghion *et al.* show that volatility in domestic liquidity results in a change in the composition of domestic investment away from growth-enhancing long-term investment, and that this effect is largest when domestic financial markets are less developed. As most of the countries in our "high aid shock" cases indeed have rudimentary domestic financial markets, the deadweight loss due to aid volatility can be ascribed to sub-optimal decisions being made in the composition of investment due to risk-aversion by investors. A finance minister would care about such losses.

Optimum firm financing behavior can best be interpreted as a decision to smooth the amount of financing needed so as to minimize the need to negotiate with additional lenders.

Other channels for deadweight losses from aid volatility have also been proposed. Because aid is often linked with fiscal spending (indeed, much aid is disbursed only after budget expenditures have actually been made), volatility in aid is linked with volatility in fiscal spending and hence with volatility in the real exchange rate. Real exchange rate volatility, in turn, has been linked to lower growth by Schnabel (2007) and

by Tressel and Prati (2006), presumably through the impact on behavior of exporters.

Fatas and Mihov (2008) present evidence that countries where governments extensively use discretionary fiscal policy experience lower growth. To the extent that aid volatility responds to and facilitates such discretionary fiscal policy, it directly contributes to a loss. For example, many studies have documented the presence of a political electoral cycle in determining changes in discretionary fiscal spending.[17] Aid can be used to amplify this kind of opportunistic, non-economic behavior and the deadweight loss comes from such "political spending." In this literature, the likelihood of such political opportunism rises when the benefits from staying in power rise (when economic rents are high, for example) and when there are few institutional checks and balances. Such a scenario is likely to be the case in aid dependent low-income countries.

When aid takes the form of a concessional credit (rather than a grant), then there can be an additional deadweight loss associated with excessive debt build-up. Persson and Tabellini (2001) argue that excessive spending can result when the costs of debt are not fully internalized by the authorities who may have a short time horizon. The deadweight losses again arise from inefficient spending.

To summarize this discussion, the deadweight losses from aid volatility are observed directly in the actions taken to mitigate such losses. They can accrue in the form of high costs of financial management, lost "good" investment opportunities and a sub-optimal composition of investment, accommodation of non-economic policies which are detrimental to long-term growth, the amplification of real business cycles, and other elements of inefficient public spending. From the perspective of a country and of the welfare of its citizens, there appears to be a substantial body of empirical literature suggesting that these deadweight losses are substantial. Just as many firms try to securitize their revenue streams to obtain predictable financing for investors, so countries would perhaps want to securitize aid receipts and generate more predictability if this option was made available.

It must be emphasized that the welfare losses described above are not the welfare losses associated with a simple constant relative risk aversion utility function. They are far higher because they involve changes in intertemporal choices by firms and individuals when faced with uncertainty. This is consistent with the ideas put forward by behavioral economists that suggest there is an asymmetry in gains and losses that is much higher than what can be derived from any reasonable parameters for risk aversion in a conventional constant relative risk aversion utility.[18] As Rabin (2002, p.9) notes: "the sensation of loss relative to status quo looms very large relative to gains". He cites experiments indicating the existence of a significant endowment effect, namely that when something is taken away it is more highly valued than the benefit when it is first received. Other experiments suggest reference-based utility—that people care about changes in consumption as well as about absolute levels. In these circumstances, the response of people to uncertainty is likely to be quite different from the predicted response. Indeed, behavioral theory would suggest that a rational response to uncertainty over aid is to accumulate aid in the form of international reserves, and not make significant change in consumption or investment for fear that these decisions may need to be reversed at a later date if there is an aid shortfall. Some recent empirical work suggests that indeed much aid is saved in this fashion.[19]

Table 5: Dead weight loss / aid, average 1970-2006

Donor	nODA	D	CPA
USA	0.283	0.274	0.602
Japan	0.179	0.120	0.206
France	0.149	0.115	0.230
Germany	0.147	0.116	0.200
UK	0.145	0.136	0.148
IDA	0.144	0.320	0.157
Netherlands	0.118	0.093	0.124
EC	0.108	0.095	0.128
Norway	0.105	0.075	0.120
Sweden	0.077	0.065	0.073
Other DAC	0.161	0.142	1.394
Other Bilateral	-0.053	0.033	7.055
Other Multilateral	0.097	0.323	3.984
World	0.148	0.151	0.166

Donor contribution to deadweight losses from aid volatility

Total aid to a country is simply the sum of each donor's aid to that country. This identity permits a decomposition of the deadweight losses from aid volatility into deadweight losses associated with each donor. Denote each donor's share of aid to country *j* as x_{ij} and the total aid received as X_j. Equation (7) is a statistical identity which provides a measure of the contribution of each donor to total aid volatility. The contribution (*C*) is proportional to the standard deviation of each donor's aid and to the correlation between each donor's aid and the sum total of aid. Note that if a donor has a high correlation of its aid flows with other donors ("herd" behavior) its contribution to volatility gets magnified.

$$(7) \qquad C_{ij} = \frac{\rho x_j x_{ij} \sigma x_{ij}}{\sigma x_j}$$

$$(8) \qquad DWL_{ij} = C_{ij} * DWL_j$$

Equation (8) apportions the deadweight loss for each recipient country to each donor. This can then be summed across all recipient countries to give the donor's contribution to global deadweight loss in every time period. The results of the deadweight loss per dollar given by each donor are shown in Table 5 for the period 1970-2006.

Table 5 shows a considerable variation across donors in the degree to which they contribute to losses from aid volatility. Broadly speaking there are three groups of donors. At one extreme is the United States, which systematically has the highest losses per dollar

lent. The European donors, Japan and International Development Association (IDA) have more or less average volatility losses, while Scandinavian donors and the European Commission have the lowest volatility losses.

Donors can reduce their contribution to deadweight losses in three ways. They can devote a greater share of their aid to countries where total aid has tended to be more stable over time. They can attempt to run counter to the overall aid cycle. And they can try to reduce the volatility of their own contributions to each country. Unfortunately, the common practice is the opposite. Several studies have documented donors' tendency to "herd," implying that the correlation between each donor's aid flow and the total received by a country is high. Donors also actively promote harmonization, which again contributes to high correlations among their aid flows.[20] They have moved slowly in expanding instruments such as long-term budget support which could reduce the volatility of their own contributions to aid recipient countries. Not surprisingly, the largest contributions to deadweight losses per dollar lent come from donors who have linked aid most closely to conditionality, eschewing long term commitments.

AID AS INSURANCE

Not all aid volatility is bad. Indeed, as others have pointed out, "the volatility of aid is often an inescapable by-product of characteristics of aid frequently seen as beneficial, in particular its ability to respond to a crisis or exert good policy leverage over a recipient country."[21] If the cost of aid stems from its influence on key macroeconomic variables, then it is natural to ask whether aid is related to how these variables evolve. For example, if the cost of aid volatility operates through an induced volatility in the real exchange rate, then one might want to ask if aid is correlated with other variables that affect the real exchange rate, such as exports. Or if aid volatility causes volatility in people's incomes and hence affects their choices about saving and investment, then one should look at how aid is correlated with income or consumption. This section explores these issues in more detail.

The basic model is a simple extension of equation (8) which relates the volatility of a portfolio to the volatility of the constituent sums. Here, consider the portfolio to be foreign exchange earnings (the sum of exports plus aid), or total income (the sum of GDP and aid).[22] The deadweight loss associated with aid volatility becomes aid's share of the deadweight loss associated with volatile foreign exchange earnings or the deadweight loss associated with output volatility.

Because exports and GDP are much less volatile than aid, the portfolio of foreign exchange earnings and national income is also much less volatile. The risky discount rate used for computing the certainty equivalent amount of aid therefore falls when this kind of portfolio approach is taken. The contribution of aid itself to this lower aggregate depends on the correlation between aid and the portfolio. To the extent that aid is procyclical with exports or GDP we would expect its share of the deadweight losses to be positive. On the other hand, if aid reduces volatility in the portfolio, then the volatility of aid actually has an insurance benefit, rather than a cost to the country.

This approach differentiates between "good volatility" and "bad volatility." If aid responds to natural disasters, for example, which negatively affect GDP and perhaps exports, the correlation between aid and the portfolio (total income or foreign exchange earnings) will be negative. Aid volatility then becomes a benefit rather than a cost. But to the extent that aid shocks are positively correlated with GDP shocks, then aid accentuates volatility and the deadweight losses are even higher than for aid taken by itself. For example, if government projects are implemented more rapidly when GDP shocks are higher and counterpart funds are readily available, and if a large portion of aid is linked to projects, then one might expect aid shocks and GDP shocks to be positive. The balance between these positive and negative correlated aid-GDP shocks is an empirical question.

The results are shown in Figures 5 and 6 which look at the losses attributable to aid volatility just from their contribution to foreign exchange volatility and income volatility, respectively. As before, the net effect is negative. That is, on average, volatility in aid tends to exacerbate the problems associated with volatility in foreign exchange or volatility in income. However, because aid is a small component of these aggregates, and because the volatility of the aggregate is much lower than the volatility of aid, the absolute magnitude of the loss attributable to aid volatility goes down. That is, if the only channel through which aid volatility of aid contributes to losses is through the volatility it causes in foreign exchange earnings or in total income, then the size of the loss is smaller than our earlier estimates.

Figure 5: Aid + export volatility over time

Figure 6: Aid + GDP volatility over time

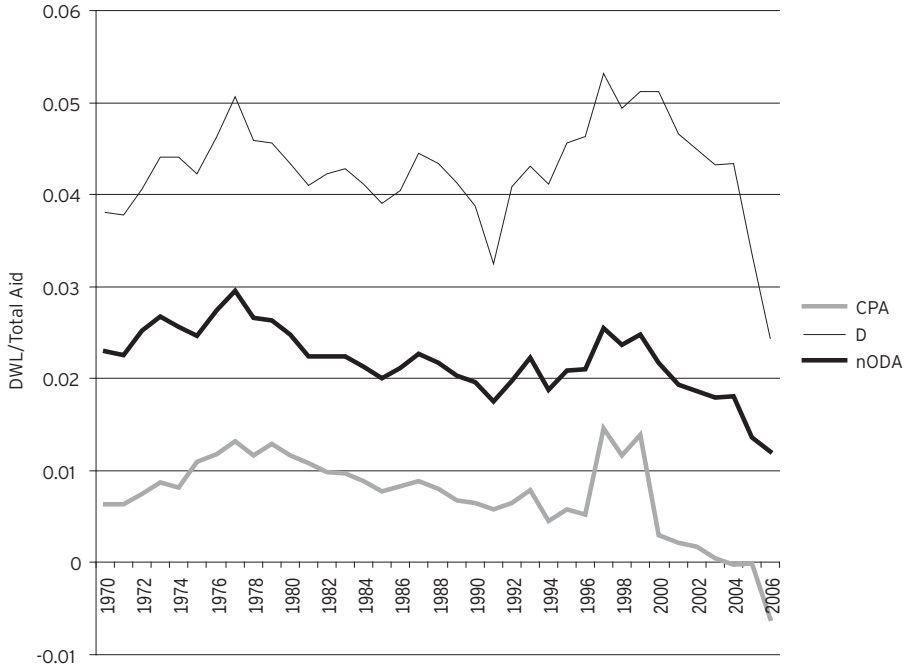


Table 6: Positive correlation of aid and macroeconomic variables

	Percent of Sample Countries		
	Net Aid	Gross Aid	CPA
Exports	54%	64%	44%
	0.46	*0.45*	*0.47*
GDP	56%	63%	46%
	0.59	*0.57*	*0.61*

Ratio of world aid in italics

The lower values for losses attributed to aid volatility are also the result of the insurance element that aid can provide in some countries. Table 6 shows that aid tends to be procyclical with respect to exports and GDP, a finding that others have previously reported on.[23] In the sample, 54 percent of countries had net ODA which was positively correlated with exports. The correlations for gross disbursements and CPA are within +/- 10 percentage points. A similar pattern holds for correlations of aid with GDP. The amount of aid going to countries with positive correlations is shown in italics in Table 6. That is, just under half of aid goes to countries with a positive correlation with exports, and around 60 percent of aid goes to countries where aid is positively correlated with GDP. The implication is that for a significant fraction of countries (and aid flows), there is an insurance element to aid that is valuable. However, on average, aid worsens volatility in major macroeconomic variables in developing countries.

As before, we can attribute the losses by donor to see if some donors provide more "insurance" than others. The results are shown in Tables 7 and 8. There is again a substantial difference across donors. Japan now stands out as a country whose aid has the lowest losses (or the highest share of insurance), both with respect to exports and income. IDA and the other multilaterals have the highest losses when gross disbursements are considered, but do well on other measures. Other bilateral donors are in between. Scandinavian countries again show relatively modest losses. The United States, which has the most volatile aid of any donor, now looks to have the same size losses as most European countries, suggesting that a portion of US aid volatility is responsive to negative shocks in aid recipient countries.

Overall, these results suggest that aid does not have a net insurance role in development, but aggravates real cycles. The different size of losses when different measures of aid are computed suggests that volatility can be made less harmful by better choice of instruments by donors. The different size of losses across donors suggests that volatility losses are also linked to donor behavior, perhaps with regard to conditionality and to coordination with other donors.

Table 7: Exports portfolio, DWL from aid / aid, average 1970-2005

Donor	nODA	D	CPA
France	0.120	0.094	0.070
USA	0.055	0.095	0.076
UK	0.053	0.046	0.016
EC	0.052	0.039	0.038
Germany	0.046	0.043	0.014
Norway	0.042	0.027	0.016
Netherlands	0.039	0.033	0.016
Sweden	0.037	0.029	0.013
IDA	0.026	0.121	0.022
Japan	-0.015	0.002	-0.018
Other DAC	0.066	0.056	0.433
Other Bilateral	0.026	0.031	1.208
Other Multilateral	0.177	0.221	1.673
World	0.038	0.050	0.020

Table 8: GDP portfolio, DWL from aid / aid, average 1970-2006

Donor	nODA	D	CPA
UK	0.093	0.089	0.053
France	0.063	0.058	0.013
Germany	0.032	0.035	-0.010
Netherlands	0.027	0.035	0.027
EC	0.018	0.020	0.015
USA	0.018	0.029	0.056
IDA	0.010	0.173	0.011
Sweden	0.009	0.015	-0.002
Norway	0.006	0.010	0.001
Japan	-0.004	0.014	-0.013
Other DAC	0.035	0.040	-0.348
Other Bilateral	0.040	0.038	1.093
Other Multilateral	0.146	0.291	1.380
World	0.022	0.043	0.006

CONCLUDING REMARKS

We have presented evidence to show that aid volatility results in substantial deadweight losses for aid recipient countries. These losses could amount to as much as 15 percent of total aid, or around $16 billion annually at current aid levels. We have also shown that aid tends to aggravate major macroeconomic variables, worsening real business cycles in developing countries. Reducing the harmful effects of aid volatility should be a priority for donors.

In reaching this conclusion, we are consistent with mainstream development thinking. The idea that policy measures to reduce volatility should be a priority for development is now common. The most evident example of this is the growing use of "fiscal rules" for large commodity exporters. Countries such as Chile and Nigeria have established off-shore funds and budget rules to smooth government spending in the face of large government revenue fluctuations coming from copper and oil price fluctuations respectively. These measures enjoy universal support among development policy advisers.[24] So it seems incongruous that rules for smoothing aid, which is even more volatile that exports in developing countries, are not given more attention.

This paper provides a simple quantitative formula for measuring the deadweight losses associated with aid volatility. We recommend that official aid donors agree on a target for reducing these losses over the next five years. Unlike other estimates of losses from aid volatility, the formula can be updated annually and does not depend on complex country-by-country models, on assumptions about key country parameters, or on cross-sectional regression results. Instead it is based on parameters that are commonly used in financial markets.

The formula has one other advantage. It is decomposable into contributions from individual donors. We would recommend that large donors, in particular, pay close attention to the impact of their activities on aggregate aid volatility. There are already agreements and targets among donors as to the size of aid contributions and limits on the degree to which aid should be tied. In the same spirit, we recommend that there should be a target for each donor on the losses associated with volatility from its aid donations. With the formula developed in this paper, the targets for each donor would be transparent and easily monitorable.

If policymakers should choose to respond, there are a number of technical proposals that could be implemented to help limit volatility. Cohen *et al.* (2008) suggests automatically linking repayment on soft credits with an export shock, using a countercyclical loan instrument, and implicitly targeting net foreign exchange at some level. Berg *et al.* (2007) proposes that the IMF should permit countries to draw down foreign exchange reserves when there are aid shortfalls and that this option should be built into financial programming models. That would reduce the aggregate losses from aid volatility. Others have argued that the size of budget support should be adjusted to target net ODA, by having one donor (perhaps IDA) act as a "donor of last resort."[25] Countries may also make more use of special accounts.[26]

Donors could also coordinate aid better to smooth aggregate volatility. The current system of proliferating donors and projects with lumpy shifts in aid is too clumsy to achieve smooth resource transfers. Donors are unwilling to make individual long-term commitments to aid recipient countries because of their domestic budget procedures. But they could perhaps do considerably better in indicating amounts they would support as a collective over the medium term.

Already, some donors are moving towards multi-year commitments to individual countries. That is a good start. Finally, donors may want to consider institutional arrangements that would make aid less volatile. Scandinavian countries, that appear to have the lowest volatility among bilateral donors, have parliamentary approval of priority countries for aid allocations and an explicit discussion on aid strategies. Such institutional lock-in can limit executive discretion in a desirable way.

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ENDNOTES

1. See Cassen, et al. (1994) for a complete summary.
2. Hnatkovska and Loayza (2003), Ramey and Ramey (1995).
3. In this spirit, Newbery and Stiglitz (1981) show foreign exchange reserve management and fiscal rules can be better instruments for managing commodity price risk than commodity stockpiling.
4. Agenor et al. (2005) is an excellent example of a computable general equilibrium model applied to Ethiopia. Turnovsky and Chattophadhay (1998) develops a stochastic general equilibrium growth model.
5. I am grateful to Owen Barder from the UK's Department for International Development for his insistence that without such a measure the prospects for significant change in the system are not good.
6. We also looked at aid and government revenues but found (to our surprise and disappointment) that revenue data are not readily available without loss of a significant portion of the data set. It also proved impossible to break down aid into its on-budget and off-budget components.
7. See www.oecd.org/dac/stats/idsonline.
8. Cf. Bulow and Rogoff (1990), Geginat and Kraay (2007).
9. Some analysts look at aid/capita or aid/GNP but there is little reason to consider such transformations. We are interested in the total value of aid and the discount associated with its volatility.
10. This finding was confirmed through a cross-country regression analysis. The independent variables are not significant determinants of aid volatility.
11. The definition and measure of weak states is taken from Rice and Patrick (2008). This finding supports Levin and Dollar (2005).
12. Barro (2006) finds 33 "disasters" for 20 OECD countries in the twentieth century, that is in 2000 possible country-years.
13. Many countries witnessing aid shocks have had internal or external conflicts. But this does not necessarily justify high volatility. Donors could anticipate vulnerable situations and limit the degree of aid dependency for volatile countries. There is also a recognition that donors might be withdrawing aid too rapidly from post-conflict environments, as in East Timor, leading to cycles of large aid inflows, withdrawals and renewed aid as a country cycles through conflict periods.
14. $S = \frac{E\,(r_m - r_f)}{\sqrt{Var\,(r_m - r_f)}}$, following Sharpe (1994).
15. The losses for the CPA do not show the same pattern, but some caution is in order as the data on the breakdown of aid between its various components is not thought to be complete or accurate in early years. Thus, we believe the CPA to be poorly measured before 1990.
16. Agenor and Aizenmann (2007) model this formally in terms of an optimal contingency fund to counteract aid volatility.
17. For example, Shi and Svensson (2001).
18. Kahneman and Tversky (2001); Rabin (2002).
19. IMF (2005) looked at 5 African countries and found an average absorption rate of only 23 percent for aid surges. That is, 77 percent of aid increases between the late 1990s and early 2000s was saved in reserves. However, much of the aid was spent by government, resulting in an offsetting reduction in spending by the private sector.
20. Khamfula, Mlachila and Chirwa (2006), DESA (2005).
21. Department for International Development (2006), p.21.
22. We also attempted to look at a portfolio of total revenues comprised of aid plus domestic revenues. Unfortunately, domestic revenue data is very incomplete. We would have had to drop more than half the countries from the sample. The time

series data, required to produce robust volatility calculations, also appears to be incomplete, with changes in methodology in the IMF's Government Financial Statistics creating short series that cannot be linked. For some countries, we find that aid is actually greater than reported total revenues including aid! This is clearly impossible and is probably due to significant underreporting of aid in budget data. We therefore reluctantly abandoned the extension of the calculations to revenue.

23. Pallage and Robe (2001).
24. Cf. Flyvholm (2007), IMF (2007), Ter-Minassian (2007).
25. Eifert and Gelb (2006).
26. Special Accounts are revolving funds that reduce the time for processing reimbursable expenses on a project and help borrowers overcome cash flow problems.

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