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ABSTRACT

In Favour of a Fund to Stabilize Commodity Exporters' Income*

Commodity prices are usually very slow to recover from adverse shocks. This is one of the reasons why it has proven so difficult either to smooth their effect or to stabilize them, and why it is sometimes argued that they should behave as if shocks were permanent. There is no reason however why countries should not find ways to protect themselves. This paper develops one practical idea on how this could be done. Our goal is not to stabilize prices, but to smooth the income of the producers. Countries, we assume, should get protection against deviation of commodity prices from a moving average of past prices. This avoids the pitfalls of past stabilization that attempted to stabilize around a single price and yet our scheme gives countries time to adjust to permanent shocks. Over a period of a 50 years time horizon, we simulate that the median cost would be worth about six months of exports.

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Introduction

Poor countries are and will remain for some time vulnerable to external shocks, be it shocks to export prices or from natural disasters. It is now well documented that the lowest income countries have a higher incidence of shocks than other developing countries and tend to suffer larger damages when shocks occur. For the poorest countries, the annual number of disasters between 1997 and 2001 has been one every 2.5 years. Commodity price shocks are also more severe for poor countries. Low income countries experienced this type of shock on average every 3.3 years. About 26 highly indebted countries have an export concentration of more than 50% in three or fewer commodities, while 62% of the total exports of the least developed countries are unprocessed primary commodities. There has been a secular downward trend for commodity prices for a considerable period of time, and particularly since the 1970s. In addition, short term variability in commodity price can be substantial. Poor countries also rely on climate dependent sectors such as agriculture and tourism for creating output and employment. Low income countries also have relatively more people living in marginal areas that are particularly vulnerable in the event of natural disasters.

Exogenous shocks have significant direct adverse effects on growth and the secondary effects of negative terms of trade shocks can be large. Collier and Sewn show, for a sample of cases where the direct income loss averaged 6.8% of GDP, the total correlated loss of income amounted to about twice that much, to 14% of GDP. The impact is asymmetric: positive price shocks were not found to increase the rate of growth significantly. Research shows that these negative shocks also increase the incidence of poverty. The shocks have significant impact on fiscal and external balances. An IMF study shows that terms of trade shocks and adverse weather conditions have played an important role in creating debt problems[3]. An 11% decline in export earnings in 1999/2000 added 20 percentage points to Uganda's NPV-of-debt-to-export ratio that year.

[3] *Brooks et al.* "External Debt Histories of Ten Low Income Developing Countries", IMF Working paper 98/72.

In theory, the adjustment to a shock should depend on the nature of the shock. It is not the same thing to respond to a permanent and to a transitory shock. In fact, even if a shock is deemed to be transitory, there can be considerable uncertainty about how long it will take to be reversed. Over-optimism concerning the pace of a recovery has been a key factor behind the excessive occurrence of debt by poor countries. If a negative shock is expected to be reversed by a positive shock, it makes sense to finance the bad years out of savings. Poor harvests associated with poor weather can be expected to be matched by good harvest later on. Commodity prices, however, are usually very slow to recover from adverse shocks. This is one of the reasons why it has proven so difficult either to smooth their effect or to stabilize them. Countries that borrow when the prices are low are bound to face financial difficulties before the prices recover their previous levels. Similarly, any attempt to stabilize prices at a given level is bound to fail. Either there is a positive shock and the stabilization Fund becomes so well-endowed that the temptation to expropriate it becomes irresistible, or there is a negative shock and soon the Fund becomes insolvent. This explains why most people have concluded that not much can or should be done to stabilize commodity prices. Exporting countries, it is then argued, should behave as if any commodity shock was bound to be permanent, and adjust accordingly.

This is too extreme a conclusion. There is no reason why countries should not find ways to protect themselves, if not indefinitely at least temporarily, against adverse shocks. The idea that we develop in this paper builds upon this intuition. Our goal is not to stabilize prices, but to smooth the income of the producers. Countries, we assume, can however get protection against deviation of commodity prices from a moving average of past prices. The reference price upon which the income of the producers is calculated is known in advance to the producers and yet is allowed to follow smoothly market trends. This avoids the pitfalls of past stabilization that attempted to stabilize around a single price and yet gives countries time to adjust to permanent shocks. The question that we then ask in this paper is: how much would it cost to create a Fund that would protect producers against deviations from a five-year moving average? The answer is twofold. The worst case scenario, first, is one in which it would cost 2.7 times the (initial) value of the exports that one seeks to protect (on a yearly basis). In average, however, the cost is much less. Over a period of 50 years, we simulate that the median cost would be worth about six months of exports.

There are clearly many ways by which the ideas involved in this mechanism could be applied. One is indeed to create a Fund in which producers would be free to participate and which would be endowed accordingly. Another would be to modulate traditional ODA according to the moving average idea that we propose. Commodity exporters would receive ODA that would vary inversely with deviations of commodity prices from past averages. Our computation would then help donors assess what is the extra cost to proceed along the lines that we suggest.

In what follows, we first explain how we calibrate our results and then proceed to a few simulations of their sensitivity to various parameters. Finally, we turn to policy implications.

Empirical Investigation

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We seek to analyze how a stabilization agency could guarantee a price p_t^* to an exporting country, where p_t^* is a moving average of the price at time *t* and its previous values $p_{t-d-1}, p_{t-d-2}, \ldots, p_{t-d-h}$, in which *h* is the time horizon over which the average is taken and *d* is the delay between the spot and the moving average.

The stabilization is done through a Fund, which is initially endowed with an amount $F_0 > 0$ in period t>0. The quantity exported by the country is normalized to unity. Subsequently, for t>1, the Fund evolves according to the following rule:

$$F_t = (1+r)F_{t-1} + (p_t - p_t^*)$$

The real interest rate *r* is assumed to be constant over time. The aim of this paper is to determine the probability of depletion of the Fund and to investigate how much resources are needed to avoid (with various degrees of probability) its bankruptcy.

In order to calibrate our results, we use monthly commodity price data reported in the International Monetary Fund's *International Financial Statistics*, for the period January 1957 to December 2003. The commodities used for the study are presented in Table 1. For each selected commodity, it presents the sample period used for the study, the spot price in July 2003, then a figure which can be regarded as a rough estimate of the total exports of developing countries in 2003. In the following analysis, all prices will be real prices, deflated by a US producer price index, taking July 2003 as the reference.

Table 1: Selected commodities

Commodities	Sample period	Price 7/2003	Annual Value (million US$)
Bananas	1/75-12/2003	296.30 US$/ton	3,438
Cocoa Beans	1/1957-12/2003	1,556.87 US$/ton	43,287
Cotton	1/1957-12/2003	60.19 US cts/lb	4,248
Rice	1/1957-12/2003	199.48 US$/ton	3,970

Figures 1 to 4 plot monthly spot prices, along with monthly moving averages over 2, 5 and 10 years, with an initial lag of 1 year (in other words, $n \in \{24, 60, 120\}$ and $d = 12$). With the exception of bananas, one striking feature of price movements is that the peaks would appear to be more accentuated than the troughs, a feature that is analyzed in Deaton and Laroque (199?).

Figure 1: Bananas

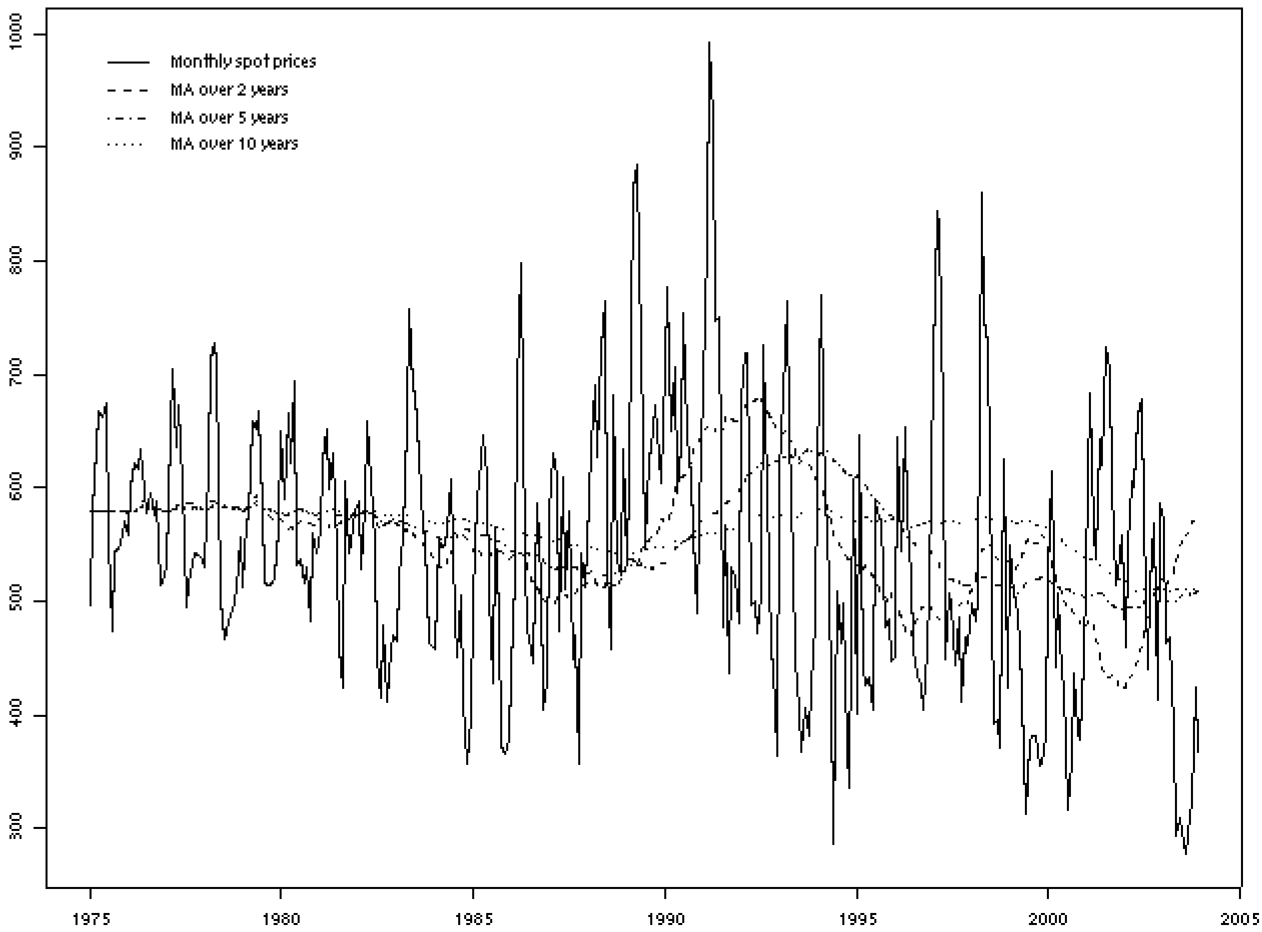


Figure 2 : Cocoa Beans

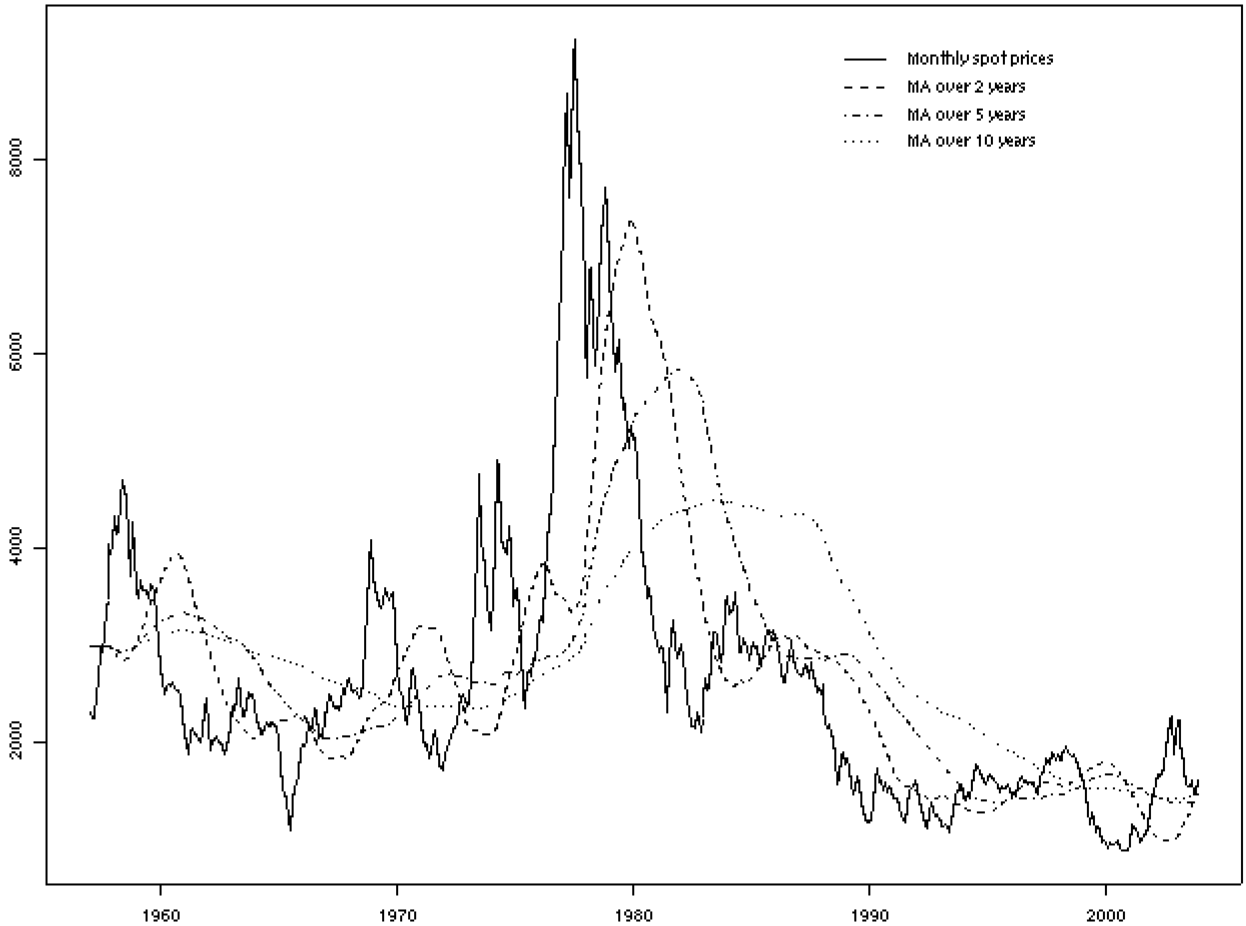


Figure 3 Cotton

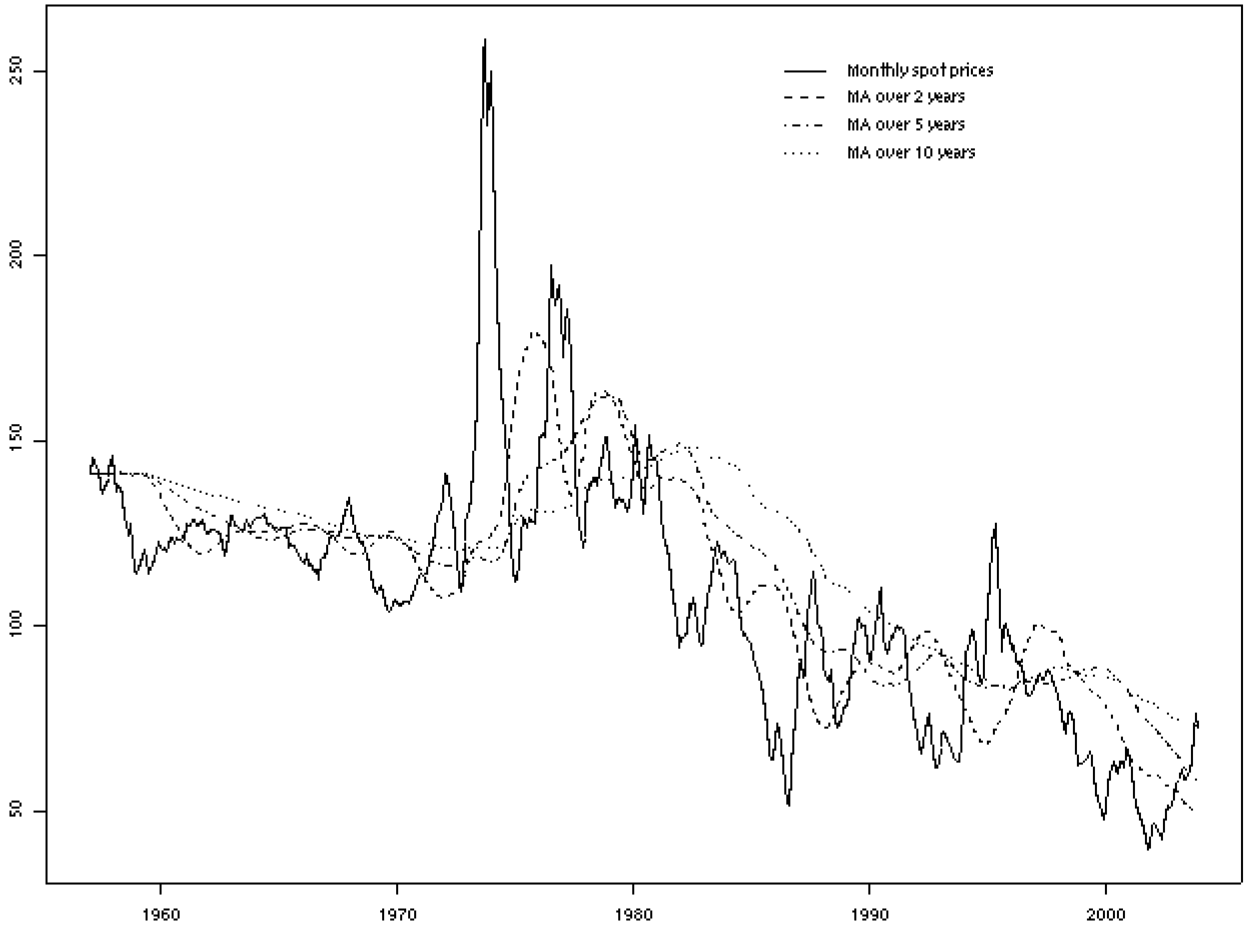
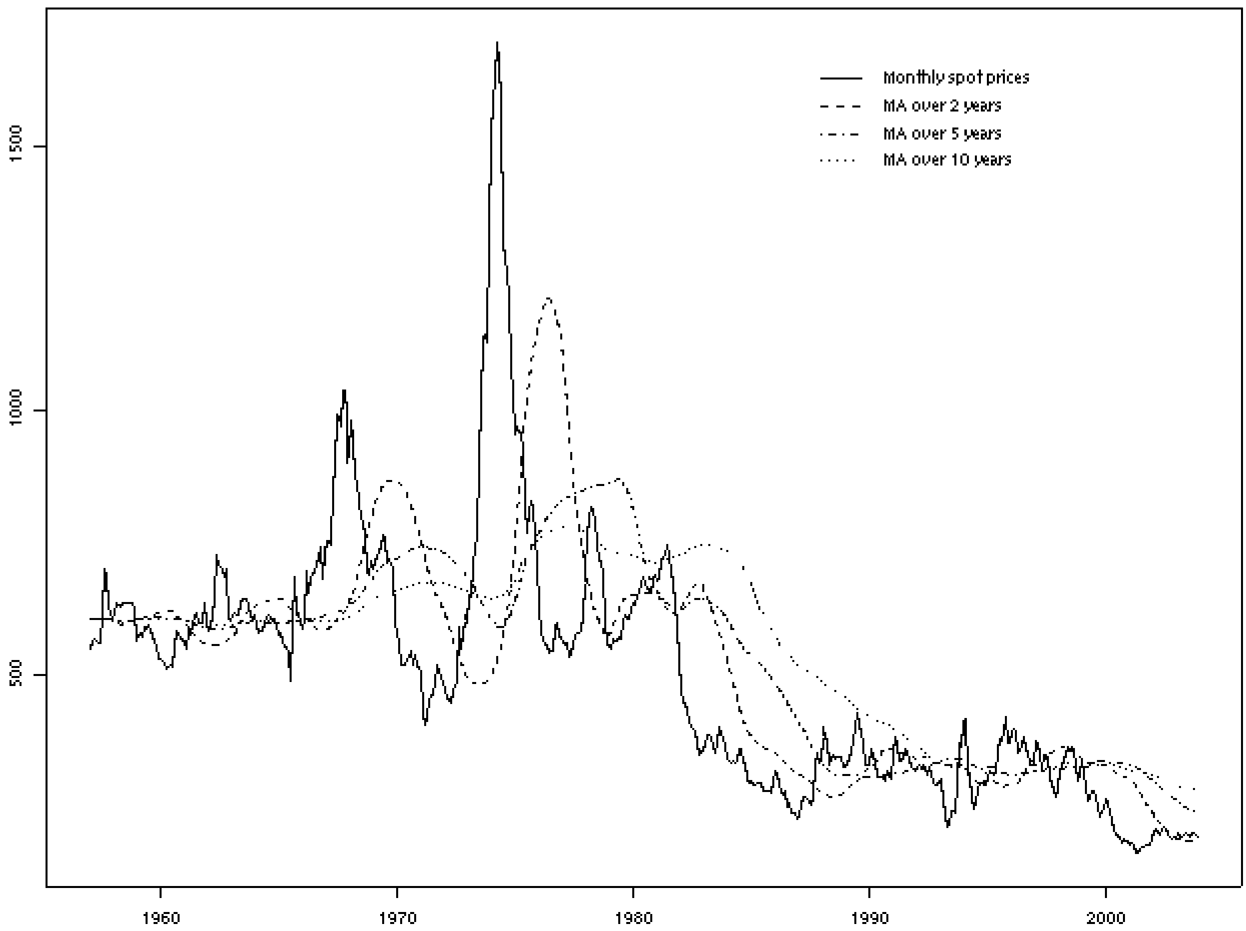


Figure 4 Rice



Statistical model

We compute tests to fit a statistical model for each of the price series. We restrict ourselves to ARMA models for the price series, either stationary around a linear trend, or difference-stationary. Formally, if p_t are the monthly prices, we choose the following model if $\ln p_t$ is trend stationary:

$$\ln p_t = \mu + \beta t + e_t \qquad (1)$$

If $\ln p_t$ is difference stationary, then:

$$\Delta \ln p_t = \beta + e_t \qquad (2)$$

The zero-mean stationary term, e_t, is given by a standard ARMA process:

$$e_t = \sum_{j=1}^{p} \phi_j e_{t-j} + \varepsilon_t + \sum_{k=1}^{q} \theta_k \varepsilon_{t-k} \qquad (3)$$

where ε_t a white noise term, p *is* the autoregressive order, q is the moving average order, $\phi_p \neq 0$, and $\theta_q \neq 0$ (with the convention $\phi_0 = \theta_0 = 1$). In both equations, the scalar β represents the deterministic linear trend.

Following the Box-Jenkins methodology, we first test whether the price series are trend stationary (TS) or difference stationary (DS), i.e. whether they are best represented by (1) or (2). The literature on this topic has proposed many statistical tests, among which we have selected the PP [Phillips/Perron:1988] and KPSS [Kwiatkowski/Phillips/Schmidt/Shin:1992] tests. The null hypothesis for the PP test is non-stationarity, while for the KPSS test it is stationarity.

Table 2 Stationarity test results

Commodities	PP lags	PP p-val.	KPSS lags	KPSS p-val	Stationary?
Bananas	16	<0,01	13	0,09	Yes
Cocoa	18	29	16	<0,01	No
Cotton	18	0,09	16	<0,01	No
Rice	18	0,13	16	<0,01	No

We then run these two tests on the logarithms of the monthly price series[4]. The number of lags used for computations and the p-values obtained are reported in Table 2, along with the status of the series – whether stationary or not. Both a constant and a linear trend term were included in the test procedures.

ARMA fit

Having chosen between TS and DS models, we then remove the deterministic parts: $(\mu + \beta t)$ for model (1), β for model (2). This is done by running OLS on either equation. This gives unbiased mean estimates for β (and possibly μ); however the estimated standard errors are wrong (see section 3 for a discussion). This is not a serious problem, given our objectives, so we do not correct for this. The estimated deterministic part is then subtracted from the original

[4]Using functions **pp.test()** and **kpss.test()** of the R **tseries** package.

process. The remaining, e_t, is a zero-mean process for which we calibrate an ARMA model, using maximum likelihood estimation[5]. The pair $(p,\ q)$ is selected using the Akaike information criterion (AIC), with the constraint $p + q \le 10 \cdot \log_{10}(N)$ (where N is the number of observations).

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Table 3 gives the results of the computations. It reports the type of model used (TS or DS), the number of observations, the (monthly) logarithmic deterministic trend (with the associated standard error), the AR and MA orders selected, and finally the Box-Pierce Q(24) statistic[6] and the associated p-value.

The only significant negative trend is for bananas (about -0.75% each year), but given the previous discussion on standard error estimates, this result should not be taken into account. (On previous calibrations, see the rich literature exemplified by Borensztein *et al.* (1994), Cashin and McDermott (2002) or Gilbert and Varangis (2004).

Fitted ARMA models

Commodities	Model	N	Trend (β)	.p	q	Q(24)
Bananas	TS	348	-6.24.10-4	8	7	23.3
Cocoa	DS	564	-6.26.10-4	0	1	13.1 (0.965)
Cotton	DS	564	-11.8.10-4	11	1	12.6 (0.972)
Rice	DS	654	-18.5.10-4	10	3	28.1 (0.254)

Simulating the Fund

The statistical models we have fitted now enable us to simulate the behavior of the commodity prices (using Monte-Carlo simulations), and therefore the behavior of the stabilization fund. We have tried to make these simulations as insensitive as possible to initial

[5]Using function **arima0()** of the R **stats** package.

[6]It has a chi-square distribution with 24 degrees of freedom under the null hypothesis of no serial correlation from order one to 24 in the residuals of the estimated models.

conditions, since they seem to play an important role. One point should be noted regarding time intervals: the models fitted for price series are monthly ones, but it seems more sensible to simulate the fund with a one-year periodicity. Put another way, the *t* stands for months in equations (1) and (2), while it stands for years in our simulations. To solve this, we have simulated the price series on a monthly basis, and then extracted data for the month of July in order to get yearly data. In the following, all given times will be in years.

One important point should be noted. All results are expressed as a proportion of the value of output that the Fund seeks to stabilize. As Fally (2004) demonstrates theoretically, one should not seek to protect the entirety of the producers' income. Indeed, in that case, the scheme would be open to manipulation. In year *t* for instance the producers could reduce production so as to let prices go up and then in year *t+1* flood the market at the stabilized price. If instead they receive a protection for only the first *x* tons of their output, then the incentive to manipulate prices disappear.

There are many parameters which can be adjusted for the simulations. The most important are n (the number of years over which the moving average is calculated), r (the yearly interest rate) and F_0 (the initial endowment of the fund). Others include d (the initial delay in the MA), and h (the time horizon over which the simulation is done). In the following, we will assume that *d=1* and *h=50*, which means that the simulations will have a 50-year horizon.

For each commodity, and for a given set of parameters, we have done 100,000 Monte-Carlo simulations, assuming a Gaussian distribution for the innovations of the price processes. For TS models, no initial conditions need be given. For DS models, which are by definition only specified in differences, p_0 was set equal to the real value of July 2003.

When computing moving averages, p_t is supposed to be equal to p_0 for $t < 0$. For each simulation, we have computed the minimum value $F_0^{\min}$ needed to have the fund constantly positive during the simulation period, that is $t = 0 \ldots h$. We express the results as a fraction of total volumes.

Key results

Table 4 reports our key results, for a given set of parameters. We explore in appendix 1, the sensitivity of our results to these parameters. For example, the line for cocoa refers to price stabilization for cocoa beans. With an initial endowment of 1.8 times the annual value of trade (7.5 bn. 2003 US$), the fund will remain always positive with 90% probability. With an initial endowment worth 2.6 times the volume of trade, the fund will never become negative, even at an infinite time horizon. This is in fact a general statistical property: it never takes more than 2.68 times the flows of trade volume to stabilize commodities along the lines of our proposal. The intuition is in fact quite simple. The worst case scenario is one in which the price of the commodity collapses to zero indefinitely. In that case the fund has to pay the exporters one full year of exports during the first year, then 0.75, then 0.5 then 0.25 then nothing. That makes 2.5 years, given the interest on the Fund borrowed, that makes a bit more.

Table 4: Endowment needed to stabilize prices (as a fraction of trade volumes)

Commodity	50%	90%	95%	99%	Upper Bound
Bananas	0.39	1.12	1.36	1.87	2.68
Cocoa	0.78	1.80	1.97	2.19	2.68
Cotton	0.65	1.26	1.40	1.62	2.68
Rice	0.93	1.75	1.90	2.11	2.68

(n= 5 years lag, r=interest rate=5%, h=50 years of simulations)

Clearly, however, the numbers in table 4 are worst case scenarios. In average, the Fund is much less costly. Downs and up usually alternate, around the moving average, so that the Fund do recapture sometimes part of the transfers. We simulated the median cost of the Fund, when it is allowed to run for a period of 50 years. The results are shown in table 5 below.

Table 5: Median cost needed to stabilize prices

(as a fraction of trade volumes over a 50 years life)

Commodity	
Bananas	0.30

Cocoa	-0. 14
Cotton	0.65
Rice	0.58

(n= 5 years lag, r=interest rate=5%)

In the case of Cocoa, the cost would actually be negative: in average one would gain at offering this scheme to exporters. In the other cases, Bananas would cost, in the median case, one quarter of the exports, in the case of cotton and rice about 6 months. Sensitivity analysis are presented in appendix over the choice of the parameters.

Other options

We also have tested two alternative options. One is the cost of a Fund which would pool all five commodities together. In the case of a 90% scenario, and for a five-year moving average, we find a cost corresponding to 0.88 times the volume of trade to be insured. This is quite significantly less than the amounts obtained for each individual fund, which varied from 1.12 to 1.75 times the trade flows. This shows that there would be some merit to form a mega Fund rather than individual ones.

We have also tested how large a fund of resources would be needed to stabilise commodities on an asymmetric basis, that is: how much would it cost to transfer resources in case of a bad shock but not to collect them in case of a positive one. We only present the results for the 90% case.

Table 6: Endowment needed to stabilize prices with asymmetrical payments (as a fraction of trade volumes)

Commodity	
Bananas	2.22
Cocoa	6.56
Cotton	1.87
Rice	3.67

(n= 5 years lag, r=interest rate=5%, h=50 years of simulations)
(90% probability of success)

We see that the asymmetrical scheme is much more expensive than the symmetric one. In the case of cocoa, for instance, the Fund would need to contain more than 6 times the flows to be insured, while, under the symmetric case, the amount was only 1.81 times the volume to be insured.

Policy implications

Debt

Because poor countries remain afflicted by exogenous shocks, everyone agrees on the need to find flexible instruments to address contingencies. There is a wide array of institutions and issues implicated in this problem. The relevant institutions – whether IDA or the IMF or other members of the international donor community could respond to destabilizing commodity price shocks to low-income countries (LICs) by evening out revenue spikes with contingency financing facilities. The HIPC Initiative’s post-completion point “topping up” facility is, in part, a recognition that LICs are highly prone to exogenous contingencies and therefore in need of compensatory arrangements. Currently, LIC government finances absorb alone the risks and shocks associated with a range of economic, geopolitical, epidemiological and climatic uncertainties.

One could also think of creating new debt instruments that explicitly take account of exogenous risks. This would gear debt service directly to commodity prices and index the debt service profile to a commodity price index, such that commodity price declines could trigger postponement or adjustment in debt service. In September 1999, the World Bank introduced risk management products linked to its loan exposure. These hedging products are: interest rate swaps, caps and collars; currency swaps; and commodity price-linked swaps. The Bank decided not to offer specific commodity-based loans at that time because it would have been difficult to undertake the commodity-based funding and liability management to match the disbursement periods of Bank loans while managing associated risks. Our computations could serve as a basis for delivering such commodity-based loans.

Our approach allows one to measure what should be the endowments needed to make these funds operational. One idea would be to set up a Fund aimed at evening the payments made by the debtors. If the average repayment is R every years then one could draw of the Fund to limit the countries repayments to $P_t = R_t + a(p_t - p_t^*)$. Gilbert et al. (2004) have calibrated similar ideas. Note that, in our case, the mechanism that we propose would not extinguish the debt in case of the price falling to zero. It would simply give time to the country or the debtors to adjust. On the other hand, this would not be very costly. For a loan of 100 whose repayment is 5, all that would be needed is a Fund endowed with say 15. Rather than subsidizing loans with lower interest rates, the creation of such compensatory mechanism could be another way of helping debtor countries.

Making ODA counter-cyclical

Natural disasters actually attract more external financing then commodity price shocks. Collier and Dehn (2001) show evidence that aid allocations are not well targeted to commodity price shocks. Commodity price shocks are like “silent crises”. Financial assistance in the event of a terms-of-trade shock is harder to design and target than that for natural disasters assistance. There have been two major compensatory financing programs for terms of trade shocks: the EU Stabex and Sysmin, and the IMF’s Compensatory Financing Facility (CFF). The EU’s programme covered agricultural commodity exports and selected mineral exports. From 1975 to 2000, about Euros 6.1 billion was disbursed. The IMF’s CFF provides financing when a country experiences a “temporary” short fall in exports earnings, or an excess in cereal import costs. A total of SDR 25 billion has been disbursed in response to 344 requests for assistance since 1963. Delays in response are generally so long as to make disbursement pro-cyclical (Brun *et al.* date).

Collier and Dehn conclude with the suggestion that ODA should do the job of protecting the country against adverse commodity shocks. The EU has also long recognized the need to protect ACP countries from vulnerability to external shocks. Again, our numbers suggest ways to compute what it would cost to implement these ideas.

Conclusion

We have presented a scheme which could be used in a variety of fashions: either directly to help producers protect themselves against adverse shocks, or to calibrate ODA to a government to dampen the impacts of price volatility on GDP. The scheme could also help tailor new loans to commodity dependent countries, smoothing their repayment pattern accordingly. The orders of magnitude that we present should give some indication of the costs of provisioning a revenue smoothing mechanism.

References

Borenzstein, E. Moshin Kahn and Carmen Reinhart, 1994 “The Macreoecomic determinant of Non-Oil Commodity Prices”, *IMF Occasional Paper* No. 112

Brooks, Ray; Cortes, Mariano; Fornasari, Francesca; Ketchekmen, Benoit; Metzgen, Ydahlia “External Debt Histories of Ten Low Income Developing Countries”, *International Monetary Fund (IMF) Working Papers* , 1998

Brun Jean-François, Céline Carrère, Patrick Guillaumont, Jaime de Melo “Stabex versus IMF Compensatory Financing: Impact in Fiscal Policy”, *Journal for International Development,* 13, p.571-81.

Cashin, P. and C.J. MC Dermott, 1998 “The Long Run Behavior of Commodity Prices: Small Trends and Big Variability”, *IMF Staff Papers*, Vol. 49, No. 2, pp 175-99.

Cuddington J. “Long run trends in 26 primary commodity prices: a disaggregated look at the Prebisch-Singer hypothesis” *Journal of Development Economics*, 1992, 39, 207-227.

Gilbert, C. and P. Varangis “Commodity Prices”, World Bank, mimeo, 2004.

Kellard, N., PC Phillips, P. Schmidt and Y. Shin, “ Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root” *Journal of Econometrics*, 1992, 75, 159-178.

R Development Team,: A language and environment of statistical computing R Foundation for Statistical Computing 2004

Reinhart C. and P. Wickham “Commodity Prices: Cyclical Weakness or Secular Decline?” *IMF Staff Papers*, June 1994, 41(2), 175-213.

Swaray, R. “ Volatility of primary commodity prices: some evidence from agricultural exports in Sub-Saharan Africa” DP in Economics, University of York, June 2002.

Appendix : Sensitivity analysis

The following tables report the results of the simulation for cocoa beans and bananas, when different values of *n* and *r* are chosen. The values reported are the quintiles of $q \cdot F_0^{\min}$ at 90%, in millions of 2003 US$. There is a noticeable decreasing pattern in *r*, along with an increasing pattern in *n*.

Endowment needed to stabilize prices
with 90% probability of success
(as a fraction of trade volumes)

Cocoa

r \ n	1	2	4	5	10
0	0,97	1,45	2,41	2,88	5,23
1%	0,86	1,28	2,1	2,51	4,48
2%	0,79	1,16	1,9	2,26	3,98
3%	0,73	1,08	1,75	2,08	3,59
4%	0,69	1,01	1,63	1,93	3,27
5%	0,66	0,96	1,53	1,8	3,01

Bananas

r \ n	1	2	4	5	10
0	0,78	1,09	1,69	1,97	3,36
1%	0,65	0,91	1,42	1,67	2,84
2%	0,58	0,8	1,25	1,46	2,47
3%	0,54	0,73	1,12	1,31	2,19
4%	0,51	0,69	1,03	1,2	1,98
5%	0,49	0,65	0,97	1,12	1,81

(n= years lag, r=interest rate, h=50 years of simulations)