Have External Shocks Become More Important for Output Fluctuations in African Countries? *

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Abstract

This paper quantifies and compares the role of external and internal shocks as sources of macroeconomic fluctuations in a sample of 38 African countries during 1963-1989 and 1990-2003. It documents that the relative importance of external shocks as sources of output instability in African countries has increased in the last 15 years, and that this increase is the result of two forces: (i) a decline in the variance of internal shocks, and (ii) an increase in the vulnerability of output to external shocks. Contrarily to the importance attributed to oil prices in policy circles, this paper finds that oil price shocks are not particularly important for output volatility in the typical African country, but only among those countries that are net oil exporters.

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1. Introduction

African countries are highly dependent on the volatile prices of primary commodities and aid flows. During the period 1985-2000, primary commodities accounted for 73 percent of total exports of African countries and aid flows averaged 13 percent of GDP (compared with only 3 percent for the rest of the world). Coincidentally, the economic performance of African countries is also highly volatile. It seems therefore intuitive to blame this volatility on the impact of commodity prices, aid, and other external shocks, such as the droughts and famines that have hit these countries with some periodicity.

The intuitive appeal of external shocks as an explanation for the unstable performance of African countries is, however, not fully borne out by the data. In a recent paper, Raddatz (2006) shows that external shocks accounted for only a small fraction of the variance of real per-capita GDP in a sample of low-income countries that includes most sub-Saharan African countries during the period 1963-1997, which implies that focusing on the mitigation of the impact of these shocks, while important, is unlikely to result in large reductions in output volatility.

Since the early 1990s, however, African countries have experienced several important changes that may affect the applicability of conclusions derived from earlier data. On the domestic front, for instance, the volatility of real GDP per-capita growth in African countries (measured by its standard deviation) has decreased and the median growth rate has shown some improvement since the mid nineties. Standard indicators of democratic accountability, economic management, and control of corruption, such as those produced by ICRG, have also improved during the last 15 years. On the international front, commodity prices have experienced an unusual increase since the mid 90's, especially the price of oil, whose average during the 1995-2005 period has been twice as high as in the 1985-1994 period, accompanied by a decline in volatility (as measured by the standard deviation of commodity price indexes). The international business cycle has also shown signals of moderation since the mid 80s, with exceptionally tranquil times in the U.S. and OECD countries.

All these ingredients suggest that the relative importance of external shocks as a source of output volatility may be different in the last 15 years compared to the earlier period. For instance, everything equal, a reduction in policy instability may increase the role of external shocks as sources of fluctuations. On the other hand, a reduced volatility of external shocks may signal a smaller role in the determination of macro fluctuations. As the potential gains of mitigating the impact of external shocks depend on their importance as sources of fluctuations, determining whether there have been changes in the role of these shocks and the sources of these changes is an important task from a policy perspective.

This paper undertakes this task by quantifying and comparing the importance of external and internal shocks as sources of macroeconomic fluctuations in African countries in the 1963-1989 and 1990-2003 periods. In particular, it decomposes changes in the relevance of each type of shock across periods between changes in the underlying variance of the shock (changes in *exposure*) and changes in the response of output to a shock of a given size (changes in *vulnerability*). This is achieved by extending the methodology and time coverage of Raddatz (2006) to estimate a panel VAR model in which external shocks can have a different impact in these two sub-periods, and using these estimates to perform a series of variance decomposition exercises. The paper also explores whether oil is a special commodity in either of these two periods by treating fluctuations in oil prices separately from variations in other commodity prices. The empirical model, therefore, includes as external shocks changes in the international business cycle, the international real interest rate, (weighed) oil prices, commodity prices, natural disasters, and aid flows.

The results show an increase in the relative importance of external shocks as sources of output instability in African countries in the last 15 years. This increase is the result of two factors: (i) a decline in the variance of internal shocks, and (ii) an increase in the vulnerability of output to external shocks. These two factors are partly mitigated by a decline in the exposure of these countries to external shocks, but this third effect is insufficient to compensate for their impact. Looking at individual shocks, the variances of shocks to the international business cycle, oil prices, and commodity prices are found to be lower in the 1990-2003 than in the 1960-1989 period, and only the volatility of shocks to real aid flows seems to have increased.

Regarding the role of oil prices, treating them separately from measures of commodity price indexes does not increase the relative importance of external shocks for the typical African country in any period, which suggests that the average country does not have a special sensitivity to changes in oil prices compared to other commodities. However, oil prices do play a special role among oil exporting African countries, where including oil prices separately from other commodity prices increases significantly the ability of external shocks to account for output volatility, especially during the period 1990-2003. For these countries, oil has become different from other exporting commodities. This paper also documents that oil exporters experience a larger decline in volatility during 1990-2003, resulting from a greater reduction in the variance of internal shocks.

The rest of the paper is structured as follows. Section 2 presents a brief theoretical framework that clarifies the concepts of exposure and vulnerability used throughout the paper and illustrates why a structural empirical approach is needed to determine the differences in exposure and vulnerability across time periods. Section 3 describes the data and takes a first look at the differences in volatility across the various groups of countries considered in the paper. Section 4 discusses the empirical methodology used to estimate the impact and relative importance of the various external shocks for the different groups of countries. Section 5 reports the results for the decomposition of the change in output volatility in African countries between changes in exposure and vulnerability to external and internal shocks, and on the differential role of oil prices versus other commodities. Section 6 concludes with some final remarks.

2. A simple theoretical framework

Consider a country whose macroeconomic behavior is described by the following structural model

$$\mathbf{x}_t = \Psi(L)\varepsilon_t,$$

where $\mathbf{x} = (x_1, \ldots, x_N)$ is a vector that includes the country's GDP and all other relevant macroeconomic variables, both internal and external to the country, $\Psi(L)$ is a matrix of distributed lags coefficients, and ε is a vector that comprises all fundamental, orthogonal shocks that affect this economy, which may also be internal or external to the country. The index t denotes the time period.

This is a very general description of the macro behavior of an economy. The only assumptions required to obtain this kind of expression are that the macroeconomic variables considered are stationary, and that the relations among the variables are linear.[1]

It is straightforward to show that, in this kind of framework, the variance of any variable included in the vector $\mathbf{x}$ is a linear combination of the variances of the fundamental shocks. In particular, the variance of the country's GDP, denoted by $\sigma_Y{}^2$, can be written as

$$\sigma_Y{}^2 = \alpha_1\sigma_1{}^2 + \ldots + \alpha_K\sigma_K{}^2 + \beta_1\sigma_{K+1}{}^2 + \ldots \beta_{N-K}\sigma_N{}^2,$$

where σ_i^2 represents the variance of the *i*-th structural shock, the α and β coefficient capture the sensitivity of output variance to each one of those shocks, and I have assumed, without loss of generality, that the *K* first shocks correspond to "external shocks" (i.e. shocks to variables outside

[1] Of course, the linearity may come from a log linearization of a non-linear model.

of a country's control) and the other *N-K* to "internal shocks". Thus, the α coefficients measure output's sensitivity to different external shocks and the β coefficients its sensitivity to various internal shocks.

This expression states that differences in output volatility across periods (or groups of countries) can in principle result from changes in the variances of the fundamental shocks that hit the countries and from changes in the response of output volatility to these various shocks.

A simple example with only one external and internal shock is useful to define and clarify some concepts that will be used throughout the paper. In this case, output variance corresponds to

(1) $$\sigma_Y{}^2 = \alpha\sigma_X{}^2 + \beta\sigma_I{}^2.$$

Thus, controlling for the role of internal shocks ($\beta\sigma_I{}^2$) differences in volatility across periods result from differences in the variance of the external shocks that hit the countries ($\sigma_X{}^2$), associated with their degree of *exposure* to these external shocks, and from changes in their *vulnerability* to those shocks (α).

3. A first look at the data

Table 1 displays the sample of countries used in the empirical analysis. It includes 38 sub-Saharan African countries where there is sufficient coverage of all relevant measures of external shocks and economic performance described below.

The main variables are the following. Real GDP per-capita is measured in constant 2000 U.S. dollars and was obtained from the WDI. This series is used instead of the PPP adjusted one, despite its reduced international comparability because it has more recent coverage than the measures from the Penn World Tables and longer coverage than the PPP series produced by the World Bank. Given the emphasis of this paper on exploring the differential impact of external shocks since the early 1990s, the trade-off between international comparability versus coverage favors the latter.

Commodity price fluctuations are captured by the Deaton-Miller commodity-based terms-of-trade index (henceforth DM index; see Deaton and Miller, 1996). I updated the data for this index until the year 2004 using weights data from Dehn (2001) and recent commodity price data from IFS. Also using IFS data on oil prices, [2] I construct a measure that weights the evolution of (log) real

[2] I use the average price. Series 00176AAZZF....

oil prices by each country's net share of oil on total commodity exports and imports. This measure corresponds to the oil component of a standard terms-of-trade index.[3] The reason to use net trade weights is that most Sub-Saharan African countries do not export oil but instead import it. Thus, using only export weights assumes that changes in oil prices have no effect on importing countries. The series for the share of oil exports on total exports and oil imports in total imports were obtained from WEO.

To capture the role of aid flows shocks I use data on real per capita aid flows, which include the flows of official development assistance (ODA) and official aid in constant 2000 U.S. dollars, obtained from the WDI.

Data on the occurrence of disasters come from the Emergency Disasters Database (EM-DAT) maintained by the Center for Research on the Epidemiology of Disasters (CRED). This is a comprehensive database compiled from a variety of sources that includes data on the occurrence and effects of over 12,800 mass-disasters in the world since 1900. As a general principle, an event enters into the database if it meets any of the following conditions: there are ten or more people reported killed; there are 100 or more people reported affected; a state of emergency is declared; or there is a call for international assistance. I classify disasters into three categories to increase the parsimony of the analysis. Geological disasters include earthquakes, landslides, volcano eruptions, and tidal waves. An important characteristic of this type of events is their unpredictability and relatively fast onset. The second category is Climatic disasters. This category includes floods, droughts, extreme temperatures, and windstorms (e.g. hurricanes). Compared to the previous category, some of these disasters can be forecasted well in advance (so precautions can be undertaken) and have a relatively long onset. The final category is Human disasters, which includes famines and epidemics. The main difference with the previous two categories is that these types of disasters affect mainly human capital instead of physical capital. For each category, I measure the incidence of disasters by counting the number of events in a given year that classify as large disasters according to the following criteria established by the International Monetary Fund (see IMF, 2003): the event affects at least half a percent of a country's population, or causes

[3] The index corresponds to $(w_X - w_M)\log(P_{OIL,t} / MUV_t)$ where w_X is the average share of oil exports in total exports during 1970-2003, w_M is the average share of oil imports on total imports during the same period, $P_{OIL,t}$ is the price of oil at time *t*, and MUV_t is the manufacturing unit value at *t*, which is used as a deflator for the oil price.

damages of at least half a percent of national GDP, or results in more than one fatality in every 10,000 people.[4]

In addition to commodity price fluctuations, natural disasters, or aid flows, African countries can be affected by fluctuations on international demand or credit market conditions. As mentioned above, exports of African countries tend to be heavily concentrated on primary commodities, whose total demand is largely determined by high-income countries. In addition, African countries tend to be heavily indebted and dependent on foreign capital, so they are potentially vulnerable to changes in international credit conditions. Changes in international interest rates may affect significantly the borrowing conditions faced by African countries for two reasons. First, although the actual interest rates that African countries can obtain in private international credit markets will of course be higher than the observed international market rates (e.g. LIBOR), the evolution of these rates should be correlated as long as the country premium paid by African countries is not very cyclical. Second, even if African countries obtain most of their financing from international financial institutions, for a given amount of concessionality the rate obtained by these countries should move one to one with the rate at which IFIs can finance their portfolio. Therefore, as long as the concessionality is not highly cyclical, the evolution of international interest rates should be associated with the actual cost of borrowing. The variables used to capture these potential sources of external shocks are the real GDP of high-income countries, and the real international interest rate measured as the six-month LIBOR in US dollars minus the change in the U.S. Producers' Price Index (PPI). The different columns of Table 1 show some summary statistics for each of these variables across the sample countries. The table also shows the sample period for which there is data available for each country.

Table 2 summarizes the volatility of these variables (measured by their standard deviation) among African countries in each of the two periods considered (1963-1989 and 1990-2003). Each of the entries shows the median standard deviation of each variable across the sample of countries

[4] Although there may be a concern that, given the criteria used to enter an event in the CRED database, disasters may be more frequent in poorer countries (see for example the evidence in Kahn, 2005), this issue is unlikely to affect the results for two reasons. First, the sample is composed exclusively of sub-Saharan African countries, and selection bias among these countries is less likely to be a significant concern. Second, and most importantly, the model controls for the average income level of a country, and the identification will be provided mainly by the time variation of the data. Selection bias will therefore be only a problem if the probability of registering an event in the database is larger in a year with relatively low income with respect to each country's average. This is clearly much less likely than having a relation between a country's average income and the probability of registering a disaster. Still, as mentioned above, one of the criteria used in IMF (2003) to classify a disaster as "large" is that it has an impact of half a percentage point of GDP, which can of course bias the measured impact of disasters. This concern is unlikely to be important because data on the economic impact of disasters are scant, so, the classification of a disaster as large is typically based on other criteria. Nevertheless, it is important to keep in mind that this issue would tend to bias upwards the estimated impact of a disaster.

in each sub-period. The figure in parenthesis is the standard deviation of volatility measure across African countries. It is apparent in the table that the volatility of output and external shocks has typically experienced a small decline since 1990. Although the figures reported in parentheses suggest that there are important variations across countries, it is the case that the typical declines suggested by the median values are a relatively robust pattern of the data. This can be seen in Figure 1, which plots the standard deviation of each relevant series in the pre and post 90 periods, as well as a 45-degree line to facilitate the comparison. It is apparent that, except for the panel showing this relation for the shocks to real aid flows, across panels most of the points fall below the 45-degree line, implying that the decline in volatility of the different series is a robust pattern of the data across countries.

The figures reported in Table 2 suggest that the decline in output volatility between the two sub-periods may be to the consequence of a decline in the volatility of external shocks (i.e. a decline in the exposure to these shocks). However, as illustrated in equation (1) this conclusion would be true only if the role of internal shocks and the vulnerability to external shocks had not changed between these periods. If, for instance, the vulnerability to external shocks had increased enough to compensate for the lower exposure, then the lower output volatility would necessarily to be the result of a smaller effect of internal shocks. To disentangle these different components it is necessary to go beyond the stylized facts described in Table 2 and take a structural approach.

4 A Semi-structural approach

The building block of this paper's empirical approach is a panel vector auto-regression (panel VAR) model used to estimate the impact of different shocks on a country's GDP growth. For a given country, this semi-structural model corresponds to:

$$A_0 x_{i,t} = D_{it} + \sum_{j=1}^{q} A_{j,t} x_{i,t-j} + \varepsilon_{it} \qquad (2)$$

where $x_{i,t} = (z_{i,t}', y_{i,t}')'$, $z_{i,t}' = (GDPH_t,\ POIL_{i,t}, DMTT_{i,t},\ R_t,\ GEO_{i,t},\ CLIM_{i,t},\ HUM_{i,t})$ is a vector of exogenous variables that includes the GDP of high income countries ($GDPH$), the real price of oil weighed by the importance of oil in a country's trade (*POIL*), the real DM commodity based terms-of-trade index ($DMTT$), the international real interest rate (R), and three indicator variables capturing the occurrence of geological, climatic, or human disasters (*GEO, CLIM,* and *HUM* respectively). $y_{i,t}' = (AID_{i,t},\ GDP_{i,t})$ is a vector of "endogenous" variables, where *GDP* corresponds to the real GDP per capita (PPP adjusted) and *AID* is real aid per capita. In the benchmark specification, all the variables (except for those capturing the disasters) correspond to the change in the logarithm of the underlying variable, and the matrix D_{it} contains country-specific constants.

The main identification assumption is that the variables in z do not respond to those in y at any lags, which is equivalent to imposing the following block diagonal structure in all the A matrices:

$$A_{j,t} = \begin{bmatrix} A^{j}{}_{11} & 0 \\ A^{j,t}{}_{21} & A^{j,t}{}_{22} \end{bmatrix}$$

where the size of the sub-matrices conforms to the dimensions of z and y. In terms of the actual variables included within each group, this assumption implies that neither the terms of trade faced by a low income country, the price of oil, the GDP of rich countries, the incidence of natural disasters, nor the international interest rate are affected by the present or past economic performance of any particular sub-Saharan African country, but all this variables probably have a contemporaneous and lagged effect on this performance. Aid is included in the vector y because, although it is not determined by any particular African country, it likely responds to a country's economic performance. Notice that including aid among the y also assumes that the amount of aid flowing to a particular country does not affect its terms of trade, the occurrence of natural disasters or the conditions of the international economy, but all these variables do affect the amount of aid a country is receiving.

Although the block-diagonality assumption identifies the effect of the set of variables in z on each y variable, identifying the impact of an individual z variable or the output effect of aid shocks (which are part of the y vector) requires three further assumptions. First, the occurrence of natural disasters is assumed fully exogenous, that is, unrelated not only to the y variables, but also to the rest of the z variables. Second, the matrix of contemporaneous relations among the rest of the z variables is assumed to have a lower-triangular structure, such that in the benchmark case the contemporaneous causal order runs from the GDP of rich countries to the oil price, to the terms of trade faced by African countries, and to the international interest rate. This ordering permits the international interest rate to react contemporaneously to the state of the global economy, but imposes that the feedback from the international interest rate to global output operates only with a lag. As pointed out by Ahmed (2003), this assumption is standard in studies of U.S. monetary policy that use quarterly or monthly data, but may be overly strong when using annual data as in this case. Placing the price of oil and the terms-of-trade below the GDP of rich countries assumes that changes in the demand for commodities resulting from changes in the state of the international economy translate into changes in the relative price of these products contemporaneously, but changes in commodity prices affect rich countries' output only with a lag. This assumption is also common in VAR studies of U.S. monetary policy that control for the price puzzle by including indexes of commodity prices (see, for example, Christiano et al., 1998, and references therein). Since the price of oil is included in the DM index, the assumption that it precedes the DM index in the ordering is natural. The ordering of the terms-of-trade index and the international interest rate also follows the typical ordering of commodity price indexes and interest rates in these studies. Finally, a block triangular structure is also assumed for the matrix of contemporaneous relations between the y variables, ${A_{22}}^0$, which implies that output responds contemporaneously to changes in aid, but aid flows to a country respond to changes in its economic conditions only after a year. Given the usual delays in the process of aid allocation (see Odedokun, 2003), this is probably a sensible assumption.

Several aspects of the model deserve further discussion. The benchmark specification assumes that the vector y_{it} is first difference stationary. This contrasts with the benchmark specification used in Raddatz (2006) for two reasons. First, for most series standard tests cannot reject the null hypothesis of a unit root when performed on a country-by-country basis, and for some series this hypothesis can neither be rejected using more powerful panel unit-root tests (Levin-Lin-Chu, 2002). This is particularly the case for the series of oil prices and real GDP per capita. Second, the specification in differences behaves better across periods. In several cases, the impulse responses produced by the model in levels predict that after 1990 the impact of some shocks persists beyond 20 years, which is not surprising considering the short length of the time dimension in this period and suggests that the series are not stationary. For these reasons I estimate the model as a panel VAR in differences after checking that the Pedroni (1999) panel cointegration test cannot reject the null of no cointegration among the variables.[5] Nevertheless, results obtained for the model in levels (not reported) are qualitatively similar.

The model corresponds to a *panel VAR* that assumes that the dynamics, represented by the A matrices, are common across cross-sectional units. The advantage of this assumption is that it increases the degrees of freedom of the estimation permitting the inclusion of more variables and increasing the precision of the estimates. The obvious disadvantage is that the model is

[5] I focus on the results of the "panel-rho" test, which according to Pedroni (2004) has better size properties in a sample of the size used in this paper.

incorrectly specified if the slope parameters are heterogeneous across cross sectional units. There are however, good reasons to believe that this issue is of no first order importance in this case (see Raddatz, 2006, for a discussion). The model includes two annual lags in the benchmark specification, as indicated by standard lag selection tests using the Schwartz Information Criterion (SIC), but I also estimated the model including three lags as a robustness check and found no important changes in the results.

Finally, the *t* index in the $A_{j,t}$ matrices shows that these matrices can vary with time. This is because, as shown in equation (2), the coefficients that capture the effect of the exogenous and lagged endogenous variables on the endogenous ones, ${A_{2i}}^{j,t}$ can be different before and after 1990:

$$
{A_{2i}}^{j,t} = \begin{cases} {A_{2i}}^{1} & t < 1990 \\ {A_{2i}}^{2} & otherwise \end{cases} \quad i = 1,2
$$

although the dynamics of external shocks (the ${A_{11}}^{j,t}$ matrices) are assumed identical across periods. This assumption is necessary because of the small number of observations available to estimate the role of common shocks. The only exception is that the variances of the variables in the external block, and their contemporaneous relations can change across periods.

Under the identification assumptions described above, the parameters of the model can be estimated using a two-step procedure that first estimates the parameters of each of the following systems of reduced form equations by Seemingly Unrelated Regressions (SUR)

$$
\begin{aligned}
{z_{i,t}}^{1} &= D_i + \sum_{j=1}^{q} B_j {z^1}_{i,t-j} + {u^z}_{i,t}, \\
y_{i,t} &= D_i^y + \sum_{j=0}^{q} {B_{j,t}}^z z_{i,t-j} + \sum_{j=1}^{q} {B_{j,t}}^y y_{i,t-j} + {u^y}_{i,t}
\end{aligned} \qquad (2)
$$

where ${z^1}_{i,t} = (GDPH_t, POIL_{i,t}, DM_{i,t}, R_t)$, and the reduced form matrices $B_{j,t}$ that capture the impact of the exogenous shocks vary with time according with the variation in the ${A_{2i}}^{j,t}$ matrices previously discussed. After this first step, the impulse-response functions (IRF) for each of the structural shocks (the ε in equation (2)) are recovered using the reduced form coefficients and the Cholesky decompositions of the corresponding variance-covariance matrices of errors.

5. Results

5.1 The impact of external shocks

The dynamic responses of output growth to the different external shocks considered in the benchmark specification are depicted in Figure 2 for the whole period, and Figure 3 distinguishing between the periods 1963-1989 and 1990-2003.

Figure 2, which also displays the 90 percent confidence bands in broken lines, shows that the dynamic responses have the expected signs. A positive shock to commodity prices, world's GDP, or aid has a positive impact on growth, a positive shock to the international real interest rate or the incidence of disasters tends to have a negative impact (with the exception of the response to Geological disasters), and a positive shock to oil prices has a positive impact on net exporters. The various panels also show that, except for natural disasters, the response of output growth to the external shocks considered is economically significant. For instance, a one standard deviation shock to both the GDP of OECD countries and the oil price index increases the growth rate of output in half a percent at their peak. It is important also to remember that the temporary effects on the growth rate reported in the figures imply permanent effects on the level of output.

Figure 3 compares the dynamic responses to a one standard deviation shock (except for disasters in which case is one event) to each external variable in the period 1963-1989 (broken line) and 1990-2003 (continuous line) respectively. Thus, differences in the responses across periods result from differences in the dynamics and differences in the size of the shocks across periods. The figure shows that the pattern and output impact of signs is similar across periods, except for natural disasters, whose effect is imprecisely estimated, and the shocks to aid flows whose output impact is much larger in the latter period.

5.2 Accounting for the decline in output volatility

The dynamic responses of output to the various external shocks and the variances of these shocks estimated for the different periods can be used to compute the predicted output volatility in each period and decompose its change among changes in exposure and vulnerability to external and internal shocks. This is done by performing a series of counterfactual exercises to isolate the role of the different components of output volatility as described below.

As discussed in section 2, output volatility depends on the variance of external and internal shocks and on the vulnerability of output to these shocks, so that the ratio of output variance across periods of time corresponds to

(3) $$\left(\frac{\sigma_{Y,1}}{\sigma_{Y,0}}\right)^2 = \frac{\alpha_1 \sigma_{X,1}{}^2 + \beta_1 \sigma_{I,1}{}^2}{\alpha_0 \sigma_{X,0}{}^2 + \beta_0 \sigma_{I,0}{}^2},$$

where the indexes 0 and 1 represent the initial and final periods, respectively. The estimates of the dynamic responses of output to external and internal shocks provide information on α and β, and the estimates of the size of the external an internal shocks are akin to estimates of $\sigma_X{}^2$ and $\sigma_I{}^2$, respectively. For instance, the proportional change in vulnerability to external shocks across periods is the ratio of the output variances obtained after computing the dynamic responses of output to a common shock in the first and second period. This calculation focuses on the first term in the numerator and denominator of equation (3) because it is based only on the response to an external shock (i.e. sets $\sigma_I{}^2$ to zero), controls by the variance of the external shocks by using a common shock. Thus, the resulting ratio of output variances corresponds to the ratio of vulnerabilities (α_1 / α_0). The relative exposure to external and internal shocks ($\sigma_{X,1}{}^2 / \sigma_{X,0}{}^2$ and $\sigma_{I,1}{}^2 / \sigma_{I,0}{}^2$), and the relative vulnerability to internal shocks (β_1 / β_0) are estimated similarly.

Table 3 reports the estimated standard deviations of the various structural shocks for the different sub-periods. It shows that the variance of shocks to the GDP of rich countries, oil price index, commodity price index, and own GDP have significantly declined in the latter period; the variance of shocks to the real interest rate exhibits a small increase, and the only important increase is experienced by the volatility of aid-flows shocks.[6]

The estimated variances of output, their components, and the relative variances and vulnerabilities to internal and external shocks across periods are presented in Table 4. Column (1) shows the long-run variance of output predicted by the model in each sub-period. The model is able to predict the significant decline in output volatility observed in the data, although the predicted proportional decline is somewhat smaller (25 percent in the model compared with 31 percent in the data).[7] This is shown in the row labeled *Ratio across periods* that reports the ratio between the magnitudes reported in each column for the period 1990-2003 to those reported for the period 1963-1989. The reason for reporting the ratios (proportional change) instead of the

[6] Given the low frequency of occurrence of disasters, I do not attempt to estimate their incidence separately for the two sub-periods.
[7] The decline in the data corresponds to the proportional decline in the average variance across countries. Thus, it is different from the one that can be obtained from Table 2, which reports the medians. The reason to compare it with the decline in average variances is that the estimation methods (OLS) are more appropriate to fit the behavior of mean variables than medians.

difference is that the counterfactual experiments do not quantify the level of vulnerabilities and exposures in each period, but only their relative change (see below). Thus, I maintain this convention for all the magnitudes reported in this table and henceforth. This row also reports the significance levels of the (one-sided) test that the reported ratio is different from one. The significance levels indicate whether the confidence interval of the empirical distribution includes one at that particular level.

Columns (2) and (3) decompose the predicted variance into the components associated with external and internal shocks respectively ($\alpha\sigma_{X,}{}^2$ and $\beta\sigma_I{}^2$). They show that most of the predicted decline in output volatility results from the reduced effect of internal shocks. The effect of external shocks exhibits a small, almost negligible, increase, which is not statistically significant (the ratio is not significantly different from one). This small increase may seem paradoxical given the decline in the variance of these shocks reported in Table 3. The explanation lies in Column (4), which reports the output variance that would have been observed in each period if: (i) only external shocks hit African countries, and (ii) these shocks had maintained the size they had during the 1960-1989 period. As explained above, the ratio of these predicted variances measures the proportional increase in the vulnerability of output to external shocks in African countries. The results suggest that the output variance associated with external shocks expected under those conditions is twice as large in the 1990-2003 period than in the 1960-1989, and that this increase is significant at the 10 percent level. This means that African countries have been more vulnerable to external shocks since the 1990s. This higher vulnerability compensates for the decline in the variance of external shocks yielding a slightly *higher* role of external shocks in the 1990-2003 period. Column (5) shows a similar exercise for the case of internal shocks and indicates that the vulnerability to these shocks has experienced no change across periods. Column (6) summarizes this information by reporting the counterfactual output variance that should have been observed in both periods if all the shocks had maintained their pre-1990 size. Had that been the case, output volatility would have significantly increased by 7 percent instead of declining by 25 percent because of the higher vulnerability of African countries to external shocks during the 1990-2003 period.

Columns (7) and (8) summarize the proportional decline in exposure to external an internal shocks, respectively. They present the ratio of the output variances obtained for the period 1990-2003 using the shocks estimated for this period and those estimated for the 1960-1989 period, respectively (the second rows of column (2)/column (4), and column (3)/column (5), respectively). The results indicate that the exposure of African countries to external and internal shocks has declined importantly. Although the decline in exposure is larger for external shocks, the higher relative importance of internal shocks across periods and the increase in the vulnerability to external shocks, means that the more tranquil internal environment is the main responsible for the observed decline in output volatility.

The proportional changes in the vulnerability of African countries to each external shock are reported in Table 5, which presents the ratio of the vulnerability in the period 1990-2003 to the vulnerability in the period 1963-1989. The vulnerability to all external shocks, except natural disasters, has increased since 1990. The largest statistically significant increases correspond to the vulnerability to shocks to aid flows and to the GDP of rich countries, suggesting that African countries have become more sensitive to the international business cycle and aid flows. The relative vulnerability estimated for oil prices is also not statistically different from one, indicating that for the typical sub-Saharan African country the vulnerability to these shocks has not increased.

Taking stock, the results suggest that the decline in output volatility in African countries observed since the early 1990s is largely due to a more stable internal environment. On the external front, there has been a decline in overall exposure, but this decline has been compensated by an increase in African countries' vulnerability to external shocks, especially to shocks to aid flows and the international business cycle. Within this sample of countries, these broad patterns are robust to several modifications in the baseline specification, such as changing the number of lags and estimating the model in levels.

5.3 The role of oil prices

Oil is typically considered a special commodity in policy and academic circles, mainly because its price tends to experience periods of particularly large fluctuations.[8] It is therefore important to determine whether oil is indeed especially relevant to account for the fluctuations of output in African countries versus other commodities. Although in principle the Deaton-Miller index of commodity based terms-of-trade includes oil and fluctuations in oil prices are reflected in

[8] Although Table 3 showed that the volatility of the oil price related terms-of-trade for a typical African country is actually smaller than that of its commodity price index, this is due to the fact that most African countries are net oil importers and oil represents a relatively small fraction of their trade, which means that the weights associated with oil prices are also relatively small. The high volatility of oil prices is again evident when comparing the coefficient of variations of the oil price terms-of-trade and commodity price indexes (87 versus 17). This difference cannot be explained by aggregation only. Assuming that all commodity prices are equally volatile, the standard deviation of the DM index would fall with the square root of the number of commodities included. For the typical African country, there are 7 commodities in the basket of the DM index, which can only explain a modest twofold increase in the coefficient of variation between the index and a given independent commodity.

fluctuations in the index, the grouping of oil with other commodities in the index assumes that the response of output to oil price shocks (properly weighed) is similar to its response to shocks of other commodities. If oil is special, this assumption may be incorrect. A second issue is that the DM index uses only exports weights because it assumes that African countries import few commodities. Although for many of the commodities included in the index this assumption is correct, oil is probably the exception, as most countries need to import some amount of oil to account for their energy needs. As explained in section 3, this is why I use net trade weights instead of export weights to construct the country-specific oil price index.

Table 3, which presented the estimated standard deviations of the various structural shocks in this sample of 38 African countries, gave a first indication of the potential role of oil prices for the typical African country. The table showed that, across periods, the trade-weighed oil price index was less volatile than the DM commodity price index among African countries, despite the fact that variance of the latter is smoothed by the averaging of several shocks. The reason for this apparent stability of the oil price index is not that oil prices are less volatile than other commodities, but that the typical net weight of oil in the trade of African countries is small. This suggests that is unlikely that oil will indeed be especially important for African countries as a whole.

Table 6 confirms this intuition. For each period, the table compares the fraction of the output variance explained by external shocks in a model including oil prices separately from the standard DM index with the same fraction in a model where oil prices are part of the DM index only. Including oil prices separately from other commodities increases only slightly the fraction of output variance explained by external shocks, from 6 to 7 percent in the first period, and from 10 to 12 percent in the second. None of these changes is statistically different from zero at conventional levels.[9] The similarity between these results confirms that for the typical African country, fluctuations in oil prices are no significantly special from fluctuations in the prices of other commodities captured by the Deaton Miller index.

One possible concern with this result is that when looking at the impact of oil prices, the homogeneous treatment of oil importing and exporting countries in the panel VAR is inappropriate. A comparison of the actual standard deviation of output and external shocks across periods between oil exporting and importing countries suggests that the separation of these two

[9] The model with and without oil prices are non-nested, so the assessment of the significance of the difference is based on determining whether the 90 and 95 percent confidence intervals of the empirical distributions estimated for each case through parametric bootstrapping intersect.

groups may be relevant (see Tables 7 and 8). Table 7 shows that oil exporter countries are indeed more volatile than oil importing countries, although the difference is considerably larger and significant only in the pre-90 period. On the other hand, Table 8 shows that, although the pattern of standard deviations of the various structural shocks across periods is similar for oil importers (Panel A) and oil exporters (Panel B), there are two main exceptions. First, the decline in the volatility of internal shocks is much larger among oil exporters. Second, the oil price index is always significantly more volatile among oil exporters and experiences a larger decline across periods and commodity prices are always more volatile for oil importers.

Based on this evidence, I explore the possibility that oil prices have different effects across these two groups by estimating the baseline model separately in each of them, performing a series of variance decomposition, and computing the incremental effect that considering oil prices separately from the DM index has on the relative importance of external shocks in each group. The results of these exercises are summarized in Table 9, which shows the relative importance of external shocks across periods and groups when oil prices are included (columns (2) and (5)) and excluded from the model (columns (1) and (4)). The left side of the table presents the results for the period 1963-1989, the right side those for the period 1990-2003, and the two rows report the results for oil importer and exporter countries. The pattern for oil importers is similar to the one documented for the whole sample; including oil prices has little impact on the ability of external shocks to account for output volatility in either period. However, for oil exporters including oil prices separately increases significantly the role of external shocks since 1990. Thus, the evidence indicates that oil price shocks may indeed be special compared to other commodities, but only among oil exporters.[10]

6. Final Remarks

Quantifying the importance of external shocks as sources of output volatility are is crucial to assess the potential gains from helping countries to smooth these shocks. This paper has looked at the role of a broad set of external and other, likely internal, shocks in the decline in output volatility among African countries since 1990, and explored whether the changing role of the different components of output variance has resulted in a larger role for external shocks.

The results indicate that external shocks have indeed become more important relative to other causes of instability during the period 1990-2003. The reason for this increased importance lies on several events. First and most important, the variance of output not explained by external

[10] The tables decomposing the variance of output and the proportional changes in vulnerabilities for each group and period are available upon request.

shocks, which likely comes from internal factors, has decreased importantly in sub-Saharan African countries. This decline alone would mean that, all things being equal, external shocks mechanically would become more important. Second, there is an important increase in the vulnerability of output to external shocks, especially to those associated with aid flows and the international business cycle. Again, this higher vulnerability itself would result in an increased role for external shocks in the latter period. Third, there is a countervailing force to the increase in vulnerability: the exposure of African countries to external shocks has declined. Therefore, although the external environment has become more tranquil, compared with that of the 1960-1989 period, the sensitivity of African countries to external shocks has increased enough to compensate for the reduced exposure.

This paper also documents that, for the typical Sub-Saharan African country, oil price fluctuations do not play a special role compared to fluctuations in other commodities when properly weighed. However, for the small group of countries that are oil exporters, oil does seem to play a special role, especially during the 1990-2003 period, in the sense that a 1 percent fluctuation in (properly weighed) oil prices has a different impact than a 1 percent fluctuation in the (properly weighed) price of other commodities they produce.

These results indicate that the potential proportional gains in terms of reducing output volatility that can be achieved by smoothing the impact of external shocks are larger now than in the earlier part of the post-independence period. However, the importance of these shocks is still small for the typical African country: the point estimates put the magnitude at around 13 percent of total output variance (21 percent for the 95th percentile). This is something to keep in mind when setting expectations regarding the potential gains on stability from programs targeted to reduce the impact of these shocks. Together with the finding that most of the reduction in output volatility between the two periods analyzed is likely the result of the internal shocks, this suggests that focusing on internal causes of instability is still where the bigger payoffs probably are.

As discussed above, the methodological approach followed in this paper is semi-structural. This means that neither the set of potentially relevant macro variables nor the links between them is fully described. The model focuses on a relatively broad set of variables that can be reasonably argued to be exogenous or require relatively uncontroversial identification assumptions, but there are other variables, such as the real exchange rate, that were not included as external shocks because they are more likely to be endogenous. To the extent that these variables have an important external component, the model may attribute it to the other causes that are currently associated with internal factors. Nevertheless, it seems unlikely that the inclusion of other external shocks may change the qualitative findings of this paper. With respect to the links among variables, external and internal causes of instability may be linked in ways that cannot be captured by the model, and that may lead to underestimate the role of external shocks. This could happen, for instance, if there were non-linearities in the response of output to shocks. My conjecture is that it is unlikely that these second order effects could result in a qualitative change (i.e. order of magnitude) in the results, but I cannot disregard this possibility, which I leave for future research. Finally, it should be emphasized that the finding about the higher importance of external shocks in the period 1990-2003 does not guarantee that this will remain to be the case in the future. The periods of analysis were chosen in an ad-hoc manner motivated by the perceived recent changes in performance for African countries after the lost decade of the eighties, and the need to have a reasonable number of years in each sub-sample, but I am agnostic to whether this corresponds to a structural break or a cyclical phenomenon. Given the limited data available, testing this proposition is difficult.

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Table 1. Summary Statistics for Sample of Sub-Saharan African Countries

The various columns report summary statistics for various aspects of macroeconomic performance of the 38 African countries included in the sample during the period 1963-2003. Column (1) shows the number of observations for each country based on the availability of data on all relevant series used to estimate the panel VAR model described in the paper. Columns (2) and (3) show the average and standard deviation of real GDP per capita growth, respectively. Columns (4) and (5) show similar statistics for the trade weighed real oil price index; and columns (6) and (7) do the same for the Deaton-Miller commodity price index. Columns (8) to (10) show the average level of aid flows (ODA) as a fraction of GDP, and the average growth rate and standard deviation of real per capita aid flows. Columns (11) to (13) show the incidence of Geological, Climatic, and Humanitarian disasters, computed as the average number of disasters of each category per year. All figures in percentage points.

Country Name	Number of available obs.	Average real GDP growth	Standard deviation real GDP growth	Average growth trade weighed real oil price index	Std deviation growth trade weighed real oil price	Average growth DM index	Std deviation growth DM index	Average aid as a % of GNI	Average growth of real per capita aid	Standard deviation of real per capita aid growht	Average number of large Geological disasters per 100 year	Average number of large Climatic disasters per 100 year	Average number of large Human disasters per 100 year	Oil exporter
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Angola	20	0.1	9.0	2.81	22.44	-5.7	25.4	6.1	5.2	37.6	0.0	35.0	0.0	Yes
Benin	44	0.8	3.2	0.02	0.15	-1.2	15.5	8.2	18.3	80.1	0.0	29.5	0.0	
Botswana	45	6.1	4.6	-0.29	2.31	-1.2	13.7	7.4	-1.6	26.8	0.0	26.7	2.2	
Burkina Faso	45	1.3	3.1	-0.34	2.70	-1.0	16.3	10.2	20.3	77.1	0.0	22.2	11.1	
Burundi	45	0.3	6.0	-0.40	3.17	-1.6	23.8	13.0	5.5	30.0	0.0	6.7	4.4	
Cameroon	45	0.8	6.0	0.96	7.66	-0.7	10.0	4.2	12.2	55.1	2.2	2.2	4.4	Yes
Cape Verde	18	2.6	2.0	-0.19	1.53	-0.7	12.4	27.4	-3.5	15.3	5.6	0.0	16.7	
Central African Rep.	44	-0.9	4.0	-0.26	2.09	-1.4	21.7	11.1	11.8	60.4	0.0	6.8	0.0	
Chad	44	-0.3	7.6	-0.04	0.31	-1.1	17.6	9.7	16.7	82.4	0.0	36.4	9.1	
Congo, Dem. Rep.	45	-2.9	6.1	0.20	1.61	-0.2	15.1	3.8	5.8	47.6	0.0	4.4	2.2	
Congo, Rep.	45	1.0	5.8	2.00	16.01	1.9	25.5	7.4	12.3	78.6	2.2	8.9	0.0	Yes
Cote d'Ivoire	44	0.3	5.4	-0.11	0.84	-2.2	11.2	4.2	14.7	94.2	0.0	0.0	0.0	
Djibouti	18	-3.7	3.8	-0.17	1.39	0.8	16.4	15.1	-9.2	31.9	0.0	50.0	0.0	
Ethiopia	24	0.4	7.5	-0.45	3.58	-2.4	20.0	11.4	7.0	27.2	0.0	66.7	25.0	
Gabon	45	1.9	10.1	1.86	14.85	1.3	22.3	2.9	14.7	84.8	0.0	2.2	0.0	Yes
Gambia, The	39	0.7	3.5	-0.29	2.32	-0.3	19.9	19.0	3.1	42.0	0.0	12.8	5.1	
Ghana	41	-0.1	4.6	-0.47	3.74	-2.1	9.7	6.1	5.9	34.1	0.0	9.8	2.4	
Guinea	19	1.2	1.4	-0.25	1.97	-3.3	19.0	10.6	-0.5	28.9	0.0	5.3	0.0	
Kenya	45	1.1	4.6	-0.58	4.67	-2.1	17.0	6.5	1.7	30.1	0.0	22.2	4.4	
Madagascar	45	-1.1	4.3	-0.14	1.13	0.0	12.6	7.3	6.3	43.2	0.0	62.2	2.2	
Malawi	44	1.2	5.4	-0.37	2.95	-1.1	9.1	16.7	6.8	30.5	2.3	25.0	4.5	
Mali	37	0.9	5.4	-0.45	3.60	-1.2	18.6	15.6	3.0	22.8	0.0	16.2	8.1	
Mauritania	44	1.5	5.6	-0.25	2.00	-2.5	9.7	19.4	19.0	84.6	0.0	36.4	6.8	
Mauritius	24	4.3	1.6	-0.29	2.28	0.1	5.0	2.2	-3.4	39.4	0.0	25.0	0.0	
Namibia	20	0.5	2.5	-0.13	1.07	0.0	9.5	3.9	11.6	37.7	0.0	35.0	5.0	
Niger	45	-1.4	6.3	-0.29	2.32	-0.5	15.7	10.5	16.8	64.3	0.0	20.0	6.7	
Nigeria	45	0.5	7.3	2.93	23.42	1.8	25.4	0.6	-0.3	41.3	0.0	4.4	0.0	Yes
Rwanda	41	0.4	8.7	-0.38	3.05	-0.8	19.6	16.2	3.8	32.9	0.0	12.2	4.9	
Senegal	45	0.0	4.2	-0.21	1.67	-0.4	14.9	10.9	19.6	85.4	0.0	24.4	0.0	
Seychelles	44	2.4	6.2	-0.13	1.02	-1.8	27.3	10.9	-2.0	41.1	0.0	4.5	0.0	
Sierra Leone	45	-0.1	7.5	-0.53	4.20	-1.5	13.1	11.7	5.7	41.8	0.0	4.4	0.0	
Sudan	45	1.0	5.5	1.00	7.96	-1.0	14.7	4.1	1.8	54.2	0.0	35.6	4.4	Yes
Swaziland	35	1.9	4.0	-0.40	3.23	1.0	9.5	5.5	-2.1	43.8	0.0	25.7	2.9	
Tanzania	16	1.3	2.4	-0.45	3.62	-1.6	19.0	18.3	-0.1	20.0	0.0	56.3	0.0	
Togo	44	1.0	6.5	-0.34	2.75	-1.3	11.9	9.0	11.8	75.2	0.0	11.4	2.3	
Uganda	23	2.2	3.1	-0.39	3.15	-2.6	26.0	11.9	6.5	25.4	4.3	30.4	0.0	
Zambia	45	-0.8	4.7	-0.32	2.55	-0.6	19.7	11.8	9.7	59.5	0.0	20.0	0.0	
Zimbabwe	36	0.2	6.2	-0.39	3.08	-1.2	7.7	3.0	11.7	64.7	0.0	22.2	2.8	

Table 2. Output Volatility and External Shocks Among African Countries

Each row reports the median and standard deviation (in parenthesis) of the volatility of the variable described in that row during the periods 1963-1989 (Column (1)) and 1990-2003 (Column (2)), across the sample of 38 Sub-Saharan African countries. The volatility of each variable in each country corresponds to its standard deviation during a given period.

	1963-1989 (1)	1990-2003 (2)
Output volatility		
Real per capita GDP growth	0.05	0.04
	(0.02)	(0.03)
External shocks volatility		
Real p.c. GDP growth high inc. OECD countries	0.02	0.01
	--	--
Real Deaton-Miller commodity price index	0.03	0.02
	(0.07)	(0.04)
Trade weighed real oil price	0.16	0.14
	(0.07)	(0.07)
Real international interest rate	0.03	0.03
	--	--
Real Aid Flows	0.35	0.32
	(0.14)	(0.19)

Table 3. Volatility of Structural Shocks in African Countries

The entries correspond to the standard deviations of the structural shocks associated with the variables described in the different columns, estimated for the periods 1963-1989 (first row) and 1990-2003 (second row). The exception are the entries reported in columns (5) to (7) corresponding to the standard deviations associated with various types of natural disasters, which were computed directly from the data assuming the occurrence of these disasters follows a Bernoulli process. For these variables I estimated the implicit standard deviations using data for the whole period, so there is no time variation across columns. The row labeled *Difference* reports the difference between the standard deviations estimated for the 1990-2003 and 1963-1989 periods. A star (*) indicates that the difference is significantly different from zero at the 10 percent level, and two stars (**) indicate significance at the 5 percent level. The significance levels were assessed based on whether the confidence interval of the empirical distribution obtained by parametric bootstrapping contain zero at each specified level.

Period	GDP rich countries	Oil Price Index	Commodity Price Index	Real Interest rate	Geological disasters	Climatic disasters	Humanitarian Disasters	Aid Flows	GDP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1963-1989	0.015	0.081	0.162	0.023	0.056	0.398	0.200	0.311	0.057
1990-2003	0.009	0.052	0.121	0.025	0.056	0.398	0.200	0.371	0.048
Difference	-0.006**	-0.029**	-0.041**	0.002479**	--	--	--	0.06048**	-0.009104**

Table 4. Decomposition of Output Variance in African countries

The various columns of the table present the output-variance predicted by the panel-VAR model estimated in the paper, its decomposition among external and internal factors, and estimated changes in vulnerability and exposure to each of these factors. Column (1) reports the long-run variance of output predicted by the model for the 1963-1989 and 1990-2003 periods (rows (a) and (b) respectively). Columns (2) and (3) decompose the predicted variance into the components associated with external and internal shocks respectively. Column (4) reports the output variance that would have been observed in each period if only external shocks hit African countries, and these shocks had maintained the size they had during the 1960-1989 years. Column (5) shows a similar exercise than the one reported in column (4), but this time for internal shocks. Column (6) reports the counterfactual output variance that would have been obtained in both periods if all the shocks had maintained the size they had before 1990. Columns (7) and (8) summarize the proportional decline in exposure to external an internal shocks respectively by presenting the ratio of the output variances estimated for the last period obtained with the second and first period shocks respectively (the second rows of column (2)/column (4), and column (3)/column (5), respectively). At the bottom of each column, the row labeled *Ratio across periods* reports the ratio of the value reported in that column for the period 1990-2003 to the one reported for the period 1963-1989 (row (b) divided by row (a)). The values thus correspond to the proportional increase (decrease) in the role of each particular component across periods. A star (*) indicates that the ratio is significantly different from one at the 10 percent level, and two stars (**) indicate significance at the 5 percent level. The significance levels were assessed based on whether the confidence interval of the empirical distribution obtained by parametric bootstrapping contains the value one (1) at each specified level.

	Periods	Predicted variances	External component	Internal component	External component with pre 90 shocks	Internal component with pre 90 shocks	Predicted variance with pre-90 shocks	External exposure ((b.2)/(b.4))	Internal exposure ((b.3)/(b.5))
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(a)	1963-1989	0.0036	0.0003	0.0034	0.0003	0.0034	0.0036	–	–
(b)	1990-2003	0.0027	0.0003	0.0024	0.0005	0.0033	0.0039	–	–
	Ratio across periods ((b)/(a))	0.7476**	1.3395	0.7023**	2.0169*	0.9922	1.065*	0.6641*	0.7079*

Table 5. Relative vulnerability of African countries to various shocks

The table reports the estimated ratio of the vulnerability of African countries to each of the structural shocks described in the various rows during the 1990-2003 period to the 1963-1989 period. Thus, a value larger than one indicates an increase in vulnerability. The relative vulnerabilities were obtained by computing the ratio of the response of output variance to a shock of a given size across periods. A star (*) indicates that the ratio is significantly different from one at the 10 percent level, and two stars (**) indicate significance at the 5 percent level. The significance levels were assessed based on whether the confidence interval of the empirical distribution obtained by parametric bootstrapping contains the value one (1) at each specified level.

Shock	Relative vulnerability (90-03 to 63-89)
GDP rich countries	3.66**
Oil Price Index	1.48
Commodity Price Index	2.51*
Real Interest rate	2.55
Geological disasters	0.73
Climatic disasters	0.66
Humanitarian Disasters	0.06
Aid Flows	4.3*
GDP	0.99

Table 6. Relative importance of external shocks in models including and excluding oil price index

Each entry corresponds to the fraction of the long-run variance of output (the variance of the 20 year ahead forecast error) that can be explained by shocks to the GDP of rich countries, trade weighed oil price index (only in column (2)), commodity prices, real international interest rate, natural disasters (Geological, Climatic, and Human) and aid flows. Columns (1) and (2) present the figures obtained from estimating the panel VAR model described in the paper excluding (including) the trade weighed oil price index.

Period	Model without oil (1)	Model with oil (2)
1963-1989	0.06	0.07
1990-2003	0.10	0.13

Table 7. Output Volatility among oil exporters and importers African countries

Each entry corresponds to the mean output volatility during the periods 1963-1989 (Column (1)) and 1990-2003 (Column (2)) in the group of African countries indicated in the corresponding row. The volatility of output corresponds to the standard deviation of real GDP per capita growth during a given period. The row labeled *Difference* reports the difference in the mean volatilities across the two groups. A star (*) indicates that the difference is significantly different from zero at the 10 percent level, and two stars (**) indicate significance at the 5 percent level. The significance levels are based on a t-test of equality of means across groups.

Group	1963-1989 (1)	1990-2003 (2)
Oil Importer countries	0.048	0.041
Oil Exporter countries	0.071	0.049
Difference	0.023**	0.008

Table 8. Volatility of structural shocks among oil importing and exporting African countries

The entries correspond to the standard deviations of the structural shocks associated with the variables described in the different columns, estimated for the periods 1963-1989 (first row) and 1990-2003 (second row). The exception are the entries reported in columns (5) to (7) corresponding to the standard deviations associated with various types of natural disasters, which were computed directly from the data assuming the occurrence of these disasters follows a Bernoulli process. For these variables I estimated the implicit standard deviations using data for the whole period, so there is no time variation across columns. Panel A reports the estimates for *Oil Importing African countries,* and Panel B the estimates for *Oil Exporting African countries.* The rows labeled *Difference* report, for each group of countries, the difference between the standard deviations estimated for the 1990-2003 and 1963-1989 periods. A star (*) indicates that the difference is significantly different from zero at the 10 percent level, and two stars (**) indicate significance at the 5 percent level. The significance levels were assessed based on whether the confidence interval of the empirical distribution obtained by parametric bootstrapping contain zero at each specified level. The rows labeled *Ratio* report the ratio of the estimated standard deviations for the 1990-2003 period and 1963-1989 periods. The significance levels refer now to the hypothesis that the ratio is significantly different from one, and were obtained in a similar manner as those reported for the difference. The section labeled *Differences among groups* shows the within period difference in estimated standard deviations between oil exporter and importer countries. As the results for the two groups were estimated separately, the significance levels reported in this section of the table were obtained by checking whether the confidence intervals of the estimates for each group overlapped. A 5 percent confidence level then indicates that the 95th percentile of the empirical distribution in one group did not overlap with the 5th percentile of the empirical distribution in the other group.

Period	GDP rich countries	Oil Price Index	Commodity Price Index	Real Interest rate	Geological disasters	Climatic disasters	Humanitarian Disasters	Aid Flows	GDP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Oil Importer countries									
1963-1989	0.015	0.029	0.154	0.019	0.045	0.427	0.191	0.295	0.048
1990-2003	0.008	0.019	0.125	0.021	0.045	0.427	0.191	0.326	0.042
Difference	-0.006**	-0.010**	-0.029**	0.002**	–	–	–	0.031**	-0.006**
Ratio	0.583**	0.648**	0.814**	1.111**	–	–	–	1.104**	0.876**
Panel B. Oil Exporter countries									
1963-1989	0.015	0.160	0.091	0.019	0.090	0.332	0.127	0.351	0.077
1990-2003	0.008	0.115	0.069	0.021	0.090	0.332	0.127	0.420	0.044
Difference	-0.006**	-0.045**	-0.022**	0.002**	–	–	–	0.070	-0.033**
Ratio	0.583**	0.717**	0.761**	1.111**	–	–	–	1.198*	0.568**
Differences across groups									
1963-1989	–	0.131**	-0.063**	–	–	–	–	0.056	0.029**
1990-2003	–	0.096**	-0.056**	–	–	–	–	0.095	0.001

Table 9. Relative importance of external shocks in models including and excluding oil price index. Oil Importing and Exporting countries

Each entry corresponds to the fraction of the long-run variance of output (the variance of the 20 year ahead forecast error) that can be explained by shocks to the GDP of rich countries, trade weighed oil price index (only in columns (2) and (5)), commodity prices, real international interest rate, natural disasters (Geological, Climatic, and Human) and aid flows. Columns (1) and (2) present the figures obtained from estimating the panel VAR model described in the paper excluding and including the trade weighed oil price index, respectively, for the 1963-1989 period. Column (3) reports the difference between columns (2) and (1). Columns (4) to (5) report similar figures for the 1990-2003 period. . A star (*) indicates that the difference is significantly different from zero at the 10 percent level, and two stars (**) indicate significance at the 5 percent level. The significance levels were assessed based on whether the confidence interval of the empirical distribution obtained by parametric bootstrapping contains the value one (1) at each specified level.

Group	1963-1989			1990-2003		
	No Oil (1)	Oil (2)	Difference (3)	No Oil (4)	Oil (5)	Difference (6)
Oil Importers	0.15	0.18	0.03	0.14	0.2	0.06
Oil Exporters	0.18	0.15	-0.03	0.2	0.57	0.37**

Figure 1. Volatility of Output and External shocks in African countries before and after 1990

The various panels of the figure plot the standard deviation of real per capita GDP, trade weighed real oil price index, the Deaton-Miller commodity price index, and real per capita aid flows computed during the period 1960-1989 (x-axis) against the same magnitude computed during the period 1990-2003 for the sample of 38 Sub-Saharan African countries.

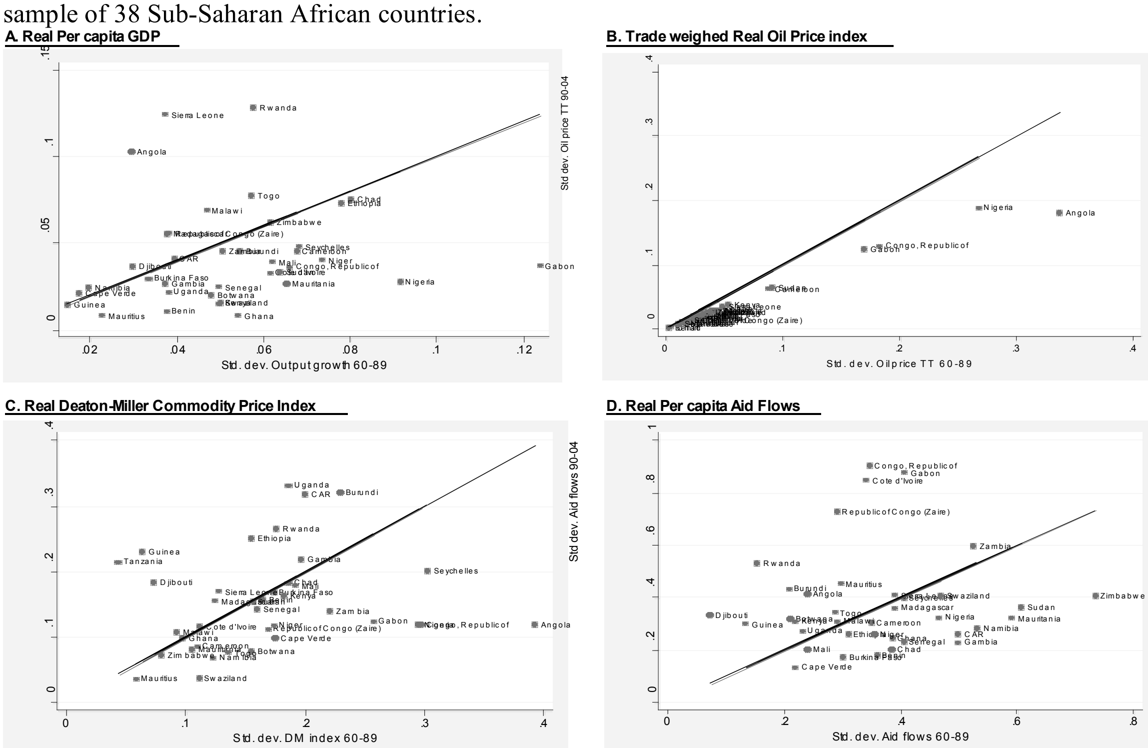

Figure 2. Dynamic responses of output growth to different external shocks (1963-2003)

The various panels report the impulse-response function of output growth to a one standard deviation structural shock to each of the variables indicated in each panel, except in the cases of Geological, Climatic, and Humanitarian disasters, where the figure reports the impulse-response function to the occurrence of one event. The thick line corresponds to the point estimate of the IRF and the broken lines to the 90 percent confidence interval.

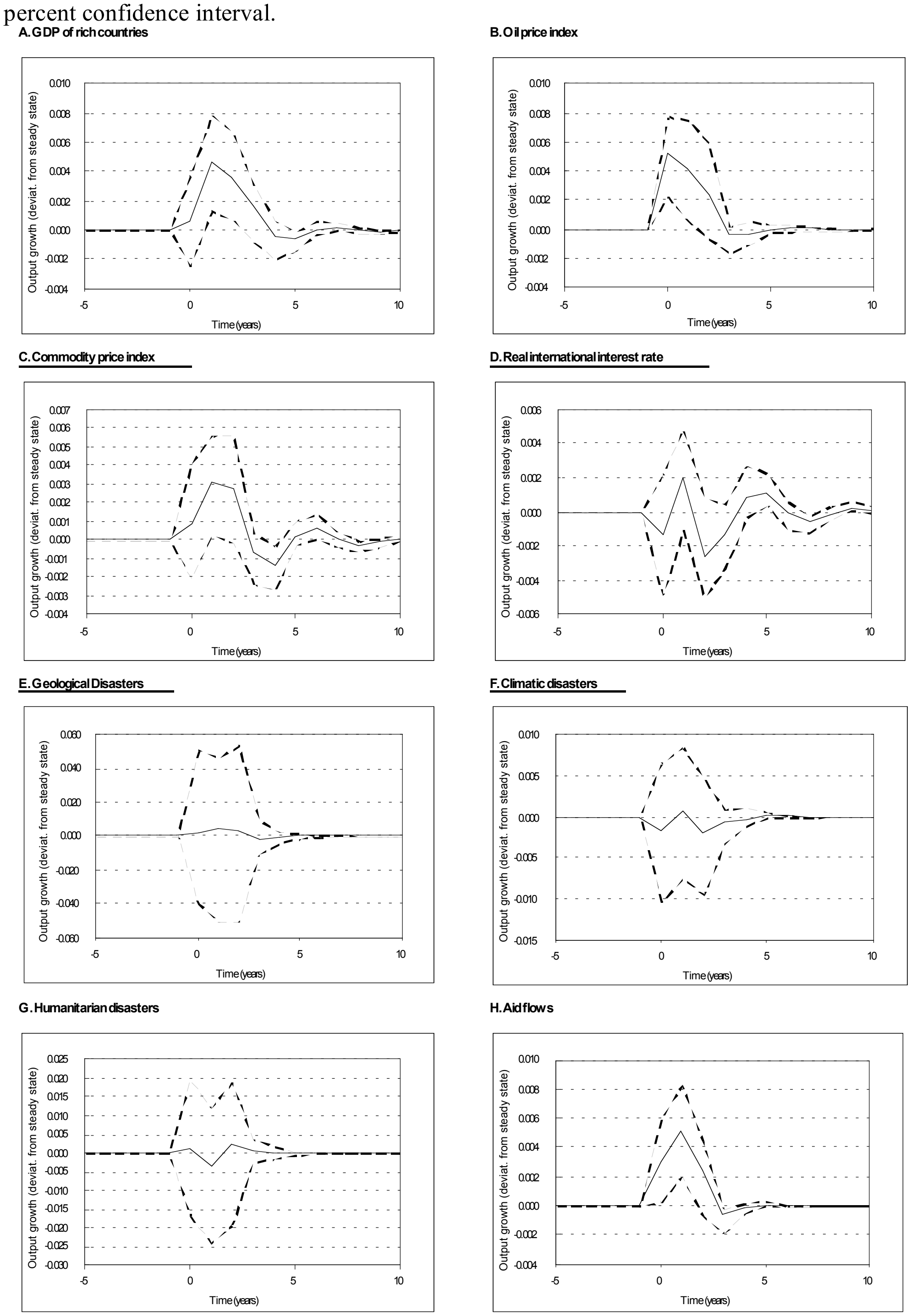

Figure 3. Dynamic responses of output growth to different external shocks: 1963-1989 versus 1990-2003

The various panels report the estimated impulse-response function of output growth to a one standard deviation structural shock to each of the variables indicated in each panel, except in the cases of Geological, Climatic, and Humanitarian disasters, where the figure reports the impulse-response function to the occurrence of one event. In each panel the thin line reports the impulse response estimated for the 1963-1989 period, and the thick line the IRF estimated for the 1989-2003 period.