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Threshold Effects of Foreign Reserve Holdings in Developing Countries

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Abstract

Foreign reserves play an important role in insuring developing countries against exogenous shocks and reducing the probability of panic driven crisis. While the literature on foreign reserves has so far focused on determining the 'required' or 'optimal' level of reserves based on various parameters such as volatility of export revenues, opportunity cost of holding reserves etc., little attention has been paid to the impact of reserve holdings in the event of shocks. This paper tries to bring some insight in to the role of reserves in shaping the response of developing countries to exogenous price and capital flow shocks. We find important threshold effects of reserves on the behavior of key macro variables in the face of exogenous shocks. Ignoring these effects would provide us with misleading results regarding the cost of exogenous shocks and adequacy of reserve levels.

Introduction

Level of foreign reserves of a country has important implications for the macroeconomic stability of a country and its ability to cope with external crisis. This is particularly true for developing countries that are often faced with large external shocks and have limited or no access to international capital markets. Reserves act as an important means of self insurance in these countries.

Literature on reserve adequacy, both theoretical as well as empirical, is vast. However, they mostly look at the question of how much reserves a country should hold. Much less attention is paid to the question - how actual reserve holdings affect the behavior of macro variables in developing countries when faced with exogenous shocks. There is some indirect evidence provided by Aizenman (2006) regarding the impact of reserve holdings in minimizing the real exchange rate volatility in developing countries in the event of exogenous terms of trade shocks. Given that higher real exchange rate volatility is associated with lower growth, this implies higher Apart from the impact this has on growth, higher level of reserves are associated with smoother capital account adjustment indicating their role in buffering price shocks.

Our paper looks at the role of reserves in determining the impact of exogenous shocks on developing countries. Our focus is 34 countries in Sub-Saharan Africa. These countries are commodity exporters and are regularly faced with large shocks to their export prices. They are also subject to shocks to external capital flows in particular aid flows and remittances. In the absence of well developed capital markets reserves play a crucial role in smoothing domestic absorption and also cushioning the impact on output and investment. The structure of our model is similar to the one used by Deaton and Miller (1995) which looks exclusively at the commodity price shocks. Unlike them, however, we include aid shocks and specifically look at the threshold effects of reserves on the response to these shocks.

Main results of our paper are as follows - Reserve levels influence the response of developing countries to exogenous shocks. Unanticipated temporary shocks to commodity prices lower per capita output and the share of domestic absorption while they increase the share of net exports in countries with reserves below 4% of GDP (referred to as the low-reserve countries). In countries with reserves between 4 to 10% of GDP called the medium reserve countries), large declines in commodity prices lead to an increase in the share of consumption and government expenditure while reducing the share of net exports. For these countries large temporary terms of trade declines do not affect the output. Countries carrying reserves above 10% of GDP do not see any significant impact of temporary price declines on any of their key macroeconomic variables. For persistent price shocks (defined as the difference between four year non-overlapping averages) however there is no difference in response between low-reserve, medium-reserve and high reserve countries.

Large temporary shocks to non-food aid lead to a decline in investment share in low reserve countries while they cause the government expenditure share to fall in all the countries. With persistent aid shocks, however, the decline in investment share is no longer confined to the low-reserve countries instead; all the countries experience a decline in their investment share.

These results are important for policy makers trying to estimate optimal level of reserves for various countries. Ignoring threshold effects of reserves on various macro variables can lead one to underestimate or overestimate the level of reserves a country should hold. It also indicates that when assessing the reserve adequacy of a developing country, reserve to GDP ratio should be one of the key indicators apart from others such as reserves in months of imports or reserve to short-term debt.

Commodity Price Behavior:

Appropriate response to commodity price shocks requires some judgment about their impact on future output, investment, consumption etc. It also requires distinguishing between temporary and permanent components of price changes. We therefore use a panel of thirty-four African countries to study the behavior of their commodity export prices. Aggregate Terms of Trade indices are unsuitable as proxies for commodity price movements as they include changes in non-commodity export prices. To address this issue we construct commodity export price indices for each country using commodity price data for 49 commodities. In particular I use the index first suggested by Deaton and Miller (1995). The index is structured as follows:

$$DM = \prod_i P_i^{W_i}$$

W_i is a weighing item and P_i is the dollar international commodity price for the commodity i. Dollar prices measure *cif* border prices and the weighing item W_i .is the value of commodity i in the total value of all commodities, n, for the constant base period j.

$$W_i = \frac{P_{ji} Q_{ji}}{\sum_n P_{jn} Q_{jn}}$$

In our case we use 1990 as the base year. In case of countries for which export data for the year 1990 was not available, we chose the closest year available to 1990. Since W_i is unique for each country, each country has its own commodity price index. Using world commodity prices has the advantage that these prices are not affected by the circumstances in individual countries (except where the exporting country enjoys some amount of market power) and therefore changes in these prices are truly exogenous. Use of constant base year weights does not capture shifts in the structure of trade. However, to the extent that we want to focus on the affects of exogenous price changes alone, this may actually be a good thing. Finally we deflate the commodity export price index for each country with the Unit value index of manufactured goods exports by developed economies (MUVI hereafter) to get the real commodity price index. Details of the countries and data sources are provided in the appendix.

Unit Root in Commodity Prices and Price shocks

As said in the beginning, appropriate response to commodity price uncertainty requires knowledge about the exact nature of that uncertainty. We therefore start by testing for stationarity of the commodity price indices we have constructed. Studies of commodity price behavior have often focused on relative prices of individual commodities and found evidence of

nonstationarity. They disagree however on the exact form of that nonstationarity, i.e. whether there is a deterministic trend, a stochastic trend or structural breaks (Grilli and Yang (1988); Cuddington and Urzua (1989); Reinhart and Wickham (1994); and Leon and Soto (1997)). More recently, Cashin, Liang and McDermott (2000); Cashin and McDermott (2002) study the persistence and volatility in primary commodity prices. Cashin, McDermott and Pattillo (2004) look at the persistence of net barter terms of trade in Africa for a set of 42 countries.

For our purposes we test the stationarity of commodity price indices created above by using the Cross sectionally augmented Dicky-Fuller test (hereafter CADF) for panel data proposed by Pesaran (2004). This test augments the standard DF (or ADF) regressions with the cross section averages of lagged levels and first-differences of the individual series to take care of the cross-sectional dependence in the individual time series. Thus, we estimate the following equation for each cross sectional unit

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + e_{it} \qquad (1)$$

Test for the presence of a unit root is the test of null hypothesis

$$H_0 : b_i = 0 \ \text{for all} \, i$$

Against the alternative

$$H_0 : b_i < 0, \ i = 1,2,....,N_1 \quad b_i = 0, \quad i = N_1 + 1, N_1 + 2,...,N.$$

Panel test statistic is based on the simple average of the individual cross sectionally augmented ADF statistics (t statistic on b_i)

$$CIPS(N,T) = N^{-1} \sum_{i=1}^{N} t_i(N,T), \qquad (2)$$

where $t_i(N,T)$ is the cross-sectionally augmented Dicky-Fuller statistic for the i^{th} cross section unit given by the t-ratio of the coefficient of $y_{i,t-1}$ in the CADF regression defined by equation (1). Critical values for this test are given in Pesaran (2004).

Using the panel of commodity export price indices constructed by us we find that the model with a time trend and a constant gives a CADF statistic of -2.94 which is smaller than the critical value at one percent level of significance (-2.81) hence we can reject the null hypothesis of a unit root in these indices at one percent level of significance.

Having tested for the stationarity of the price index series we use equation (1) to calculate the price shocks as residuals from that equation. Checking for serial correlation in these shocks we find no evidence for that and hence we regard them as *iid.* Price shocks thus calculated can be interpreted as unexpected changes in the commodity price index.

Aid Shocks

Flow of aid is defined as total disbursements of Official Development Assistance to the recipient country less Food Aid and Technical Assistance. Estimating equation (1) for Net ODA to GDP ratio for the same panel of countries we find that the model with no trend and a constant gives a CADF statistic of -2.8 which is smaller than the critical value at one percent level of significance (-2.30) hence we can also reject the null hypothesis of a unit root in the aid flows.

Having tested for the stationarity of aid flows, shocks to aid are calculated as year on year change in the log of Net ODA as a ratio of GDP. As in the case of price index, we define aid shock dummies that take a value of one when the shock is greater than two percent in absolute size and zero otherwise. Finally, we multiply these dummies with the absolute size of the shock to get positive and negative aid shock variables - $DUMAP_t$ $DUMAP_{t-1}$ respectively.

Shocks and Macroeconomic variables

Our next step is to look at the relationship between price [and aid] shocks and changes in output, consumption, investment and government expenditure. Before we begin however, a brief description of the distribution of the two shocks is in order. Figures 1 and 2 show the probability distribution of the two shocks.

Average size of negative commodity price shocks facing Sub-Saharan Africa is 13.9 percent and the average volatility of these shocks is about 10 percent. Price shocks are positively skewed, implying that the probability of a large positive shock is higher than the probability of a large negative shock. More than half of the countries in our sample face a negative price shock of 5 or more with a probability of 25 percent. More than 90 percent of the countries face such a shock with a probability of 10 percent or more.

Aid shocks facing Sub-Saharan Africa have an average size of 4 percent (of GDP) and an average volatility of 29 percent. Shocks to aid are negatively skewed implying that the probability of large negative shocks is higher than the probability of large positive shocks. Average African country in our sample faces a negative aid shock of 2 percent or more with a probability of 25 percent.

For both aid and commodity prices, a large proportion of the shocks are clustered around zero.

The VAR model

In line with Deaton and Miller (1995) we start with an extended Vector Auto Regression in which GDP per capita and its components are each regressed on their own lags and on the contemporaneous and lagged values of price shock specific to each country. The base national-income data comes from the United Nations Statistical Division's database. Data on foreign reserves is obtained from the IMF database while that on aid flows is obtained from Source OECD. We use the GDP deflator for each country to deflate its nominal GDP series. Consumption, investment government expenditure, aid and foreign reserves are expressed as a ratio of the GDP. Again following Deaton and Miller we include four equations in the system, for GDP, consumption, investment and government expenditure. Given that this is a system of dynamic equations (each equation contains the lag of the dependent variable), we estimate each

equation separately using Arellano-Bond GMM estimator for dynamic panel data. The estimates thus obtained are consistent even though they might not be efficient.

Baseline model:

In the baseline model we use the levels of all the endogenous variables except for GDP per capita which is expressed in logs. Apart from the endogenous variables there are four exogenous dummy variables that capture shocks to commodity price index and aid flows. We define commodity price 'shock' as a year-on-year change (positive or negative) in the commodity price index of five percent or more. To create the dummy we multiply the absolute value of the shock with the dummy variable that takes a value of one when the shock happens and zero otherwise. We therefore have two dummy variables; one for a negative price shock and another for a positive price shock. In a similar vein we define an aid shock as a change in aid flows, expressed as a ratio of GDP, of two percent or more. Multiplying the absolute size of the shock with the dummy for the occurrence of a positive or negative aid shock gives us the aid dummies.

Lag lengths

Appropriate lag length for all the endogenous and exogenous variables is selected using AIC and SIC, keeping the length same across all the equations in the system. As a result we get a lag length of one for all the endogenous variables. For the shock dummies we also use the contemporaneous values to capture their immediate effect.

The final model therefore looks as follows:

$$Y_t = \alpha_1 + \beta_1 Y_{t-1} + \beta_2 C_{t-1} + \beta_3 I_{t-1} + \beta_4 G_{t-1} + \beta_5 DUMPN_t + \beta_6 DUMPN_{t-1} + \beta_7 DUMPP_t + \beta_8 DUMPP_{t-1} + \beta_9 DUMPN_t + \beta_{10} DUMAN_{t-1} + \beta_{11} DUMAP_t + \beta_{12} DUMAP_{t-1} + \varepsilon_{1,t}$$

$$C_t = \alpha_2 + \gamma_1 Y_{t-1} + \gamma_2 C_{t-1} + \gamma_3 I_{t-1} + \gamma_4 G_{t-1} + \gamma_5 DUMPN_t + \gamma_6 DUMPN_{t-1} + \gamma_7 DUMPP_t + \gamma_8 DUMPP_{t-1} + \gamma_9 DUMPN_t + \gamma_{10} DUMAN_{t-1} + \gamma_{11} DUMAP_t + \gamma_{12} DUMAP_{t-1} + \varepsilon_{2,t}$$

$$I_t = \alpha_3 + \upsilon_1 Y_{t-1} + \upsilon_2 C_{t-1} + \upsilon_3 I_{t-1} + \upsilon_4 G_{t-1} + \upsilon_5 DUMPN_t + \upsilon_6 DUMPN_{t-1} + \upsilon_7 DUMPP_t + \upsilon_8 DUMPP_{t-1} + \upsilon_9 DUMPN_t + \upsilon_{10} DUMAN_{t-1} + \upsilon_{11} DUMAP_t + \upsilon_{12} DUMAP_{t-1} + \varepsilon_{3,t}$$

$$G_t = \alpha_4 + \phi_1 Y_{t-1} + \phi_2 C_{t-1} + \phi_3 I_{t-1} + \phi_4 G_{t-1} + \phi_5 DUMPN_t + \phi_6 DUMPN_{t-1} + \phi_7 DUMPP_t + \phi_8 DUMPP_{t-1} + \phi_9 DUMPN_t + \phi_{10} DUMAN_{t-1} + \phi_{11} DUMAP_t + \phi_{12} DUMAP_{t-1} + \varepsilon_{4,t}$$

Lagged values of each endogenous variable, including its own, enters every equation. Apart from that there is contemporaneous and lagged value of each dummy variable. Results of this model are presented in Table 1.1.

Results from the Baseline Model

In this section we look at the results of the baseline model presented in Table 1.1.

The first row gives the value for the Sargan's test for over-identifying restrictions. For each of the equations we cannot reject the null of - "instruments as a group are exogenous". Hence, the instruments used by the Arellano-Bond GMM estimator are valid.

We focus on the four endogenous variables first. Starting with the first equation we find that GDP per capita is positively serially correlated with a coefficient close to one. Consumption, investment and government expenditure also show positive serial correlation, with a coefficient less than one, when expressed as a share of GDP. Lagged investment and government expenditure as a share of output do not affect per capita GDP significantly. Lagged consumption expenditure as a share of output, however, has a significant positive impact on GDP per capita (0.061). Higher share of consumption increases the GDP per capita through a consumption multiplier effect. Lagged GDP per capita enters the equation for consumption share significantly but with a negative sign indicating a permanent income type response to the increase in income. A one percent increase in GDP per capita reduces the share of consumption by 4.3 percent. Finally, a one percent increase in the share of government expenditure increases the share of investment in GDP by 4 percent (see the equation for investment).

Next we look at the key variables of interest in this exercise - the shocks to commodity prices and aid. Looking at the coefficient on price dummies we find that negative price shocks affect consumption and government expenditure shares contemporaneously while they affect the output per capita with a lag. Looking at the GDP equation we find that a 10 percent decline in commodity price index leads to a 0.7 percent decline in GDP per capita with a one period lag. A similar sized shock increases the ratio of consumption to GDP by 0.85 percent and the ratio of government expenditure to GDP by 0.34 percent. Increase in the share of consumption in GDP reflects that the fall in consumption as a result of a negative export price shock is smaller than the corresponding fall in output as there is some amount of consumption smoothing. Increase in the share of government expenditure reflects counter-cyclical government expenditure. Investment as a share of GDP does not get significantly affected by a decline in export prices.

From the National income identity it follows that the share of Net Exports in GDP goes down by approximately 1.2 percent due to a 10 percent decline in relative commodity export prices. Positive shocks to commodity prices do not, however, show any significant impact on the key macro variables.

Now we look at the shocks to aid flows. Large negative shocks to non-food-aid cause a decline in the ratio of government expenditure to GDP immediately. This decline continues in the next period; with a total decline of 0.1 percent for a 10 percent decline in commodity prices. A positive shock to aid seems to increase output per capita with a lag but does not affect any other variable.

There are few surprises in the results above. Our main focus in the paper is, however, the impact of reserve holdings on the response to exogenous shocks in developing countries. We therefore

look at the role of reserve level in shaping the response to aid and price shocks in the following section.

In particular, we are interested in the response of economies having a reserve to GDP ratio below a certain threshold level (to be defined later) to large aid and price shocks. The underlying idea is that economies with low levels of foreign reserve would find it harder to adjust to adverse aid or price shocks. Since recent studies on reserve optimality (such as Jeanne and Ranciere (2006)) express the optimal level of reserves as a share of GDP, we use the same normalization and use the bottom 25^{th} percentile of the average reserve-to-GDP ratio during 2000-07 to classify countries as low reserves.

In order to study the impact of foreign reserve levels on response to aid and commodity price shocks we introduce a new set of interaction dummies in to our model. For the sample of countries in question, the average reserve to GDP ratio for the 25^{th} percentile of the distribution was 4 percent. We therefore define a low reserve dummy that takes the value of 1 when reserves are less than 4 percent of GDP and zero otherwise. Multiplying this dummy with the current and lagged shock dummies for negative aid and price shocks, we get the four interaction dummies (Rpsn1, Rpsn2, Raidn1, and Raidn2). Coefficients on these dummies measure how the response to exogenous aid and price shocks changes when countries have very low level of foreign reserves. Table 1.2A presents the results for this exercise.

Model with reserve dummies

Starting with the equation for GDP per capita we find that there is no significant change in the coefficients on endogenous variables in all the four equations.

Looking at the coefficients on negative price shock and their interaction dummies we find that there is a significant difference in the response of key macroeconomic variables to exogenous price shocks in Low-Reserve countries. For countries with reserves less than four percent of the GDP, a 10 percent decline in commodity prices causes GDP per capita to fall by roughly 1.4 percent. For countries with reserves larger than four percent of GDP however, we do not find any significant impact of commodity price shocks on output. Thus, countries carrying reserve levels below the threshold four percent of GDP face a significant decline in their level of per capita output when faced with an exogenous decline in the price of their exports whereas countries with higher reserve levels do not show any such decline. Negative terms of trade shocks also cause a decline in the ratio of consumption to GDP in countries with reserves less than 4 percent of GDP (a decline of 0.35% for a 10 percent decline in commodity prices) compared to an increase in the case of the remaining countries. Fall in consumption to GDP ratio implies that consumption declines by more than the output in countries with less than 4 percent of reserves. This reflects the inability of the low reserve countries to smooth their consumption in the face of large commodity price shocks. Assuming an average consumption share of 75 percent; a 10 percent decline in commodity prices would lead to a decline in the consumption to GDP ratio of about 0.35 percent in low reserve countries. Given that output declines by 1.4 percent in low reserve countries, this implies a decline in consumption of roughly 6 percent in these countries. For countries with higher reserve to GDP ratio, on the other hand, there is a slight increase in the consumption share as before indicating some amount of consumption smoothing.

Investment share is not affected significantly by a decline in commodity export price for high reserve countries but it falls for low-reserve countries by about 1 percent for a 10 percent decline in prices. The share of government expenditure is another variable of interest. Countries with reserves to GDP ratio higher than 4 percent show an increase in the ratio of government expenditure to GDP by 0.53 % during the first period in response to a 10 percent decline in commodity price index reflecting counter-cyclical government expenditure as before. Comparing this to the countries with reserves less than 4% of GDP; the ratio of government expenditure to GDP declines during the first period in response to a negative commodity price shock. The decline is not significant though.

Using the national income identity one can say that while the share of net exports goes down (imports go up relative to exports) in response to a large negative price shock for countries with reserves above the 4% level, opposite happens for countries having reserves below 4% of GDP. In the face of negative terms of trade shock, low reserve countries end up exporting more or (more likely) importing less from abroad whereas the high reserve countries manage to smooth their consumption and maintain their imports from abroad in the face of a decline in their export prices.

Positive commodity price shocks do not have significant impact on GDP and its various components as before.

Moving on to the aid shocks, large negative shocks to non-food aid are positively correlated with an increase in GDP per capita for high reserve countries whereas they are negatively correlated with per capita GDP in countries with reserves below 4%. Positive shocks to aid on the other hand are positively correlated to the GDP per capita in all countries in our sample. Consumption share remains unaffected by shocks to non-food aid. Large negative shocks to aid cause a significant reduction in the share of investment in countries with reserves below 4%. On the other hand there is no impact of a decline in non-food aid on the share of investment in high reserve countries. Finally, a decline in non-food aid is negatively correlated with a slight reduction in government expenditure share in all countries. This is different from the case of negative commodity price shocks that are associated with an increase in the share of government expenditure.

To summarize our results so far, commodity price and aid shocks have differential impact on key macroeconomic variables depending on their level of reserves relative to GDP. Countries with reserves above the threshold of 4 percent manage to absorb terms of trade and aid shocks better with smaller declines in output and consumption etc. The difference is larger in case of price shocks. Clearly, ignoring the threshold effects of reserve holdings in shaping the response of developing countries to exogenous shocks can give misleading results.

We look at the robustness of some of these results in the following sections.

Different Reserve Cut Offs

We extend our line of investigation further by looking at what happens to the abovementioned results as we gradually raise the level of reserve cut off for Low-Reserve countries from 4 percent to 10 percent. Tables 1.2B and 1.2C give the results for this exercise.

As the reserve cut-off is increased from 4% to 6%, output per capita shows no significant change for both the low reserve countries and the high reserve countries. Share of consumption in output actually goes up for the low-reserve countries defined by the new cut-off while that of investment goes down. Government expenditure share increases for countries with reserves above the 6% cut off but declines slightly for countries carrying reserves below 6%. Negative shocks to aid are associated with a decline in government expenditure share (and thus an increase in the share of net exports) while an increase in non-food aid is associated with an increase in output per-capita.

Finally, we increase the reserve cut-off for low-reserve countries to 10 percent. The only significant impact of a negative price shock is an increase in the ratio of consumption to GDP in the low-reserve countries as defined by the new cut off. This once again indicates certain amount of consumption smoothing in the face of decline in export prices. A 10 percent decline in commodity export price index leads to an increase in the share of consumption by 1.45%. For a negative shock to aid, the only significant impact is that on the share of government expenditure which falls slightly as before. A positive shock to non-food aid on the other hand is associated with an increase in the GDP per capita. Clearly, the behavior of key macroeconomic variables in the face of exogenous shocks varies with the level of their reserve holdings and there are significant non-linearities in the relationship between the levels of reserves and the impact of exogenous shocks. To capture these non-linearities we therefore incorporate the different levels of reserve cut offs used above in to one model, using multiple dummies. We call this the 'augmented model'. This is the model we use for the rest of our analysis in the paper.

Augmented Model

In order to incorporate the non-linearities in the impact of exogenous shocks using the augmented model we define a medium reserve dummy that takes the value of 1 when reserves are less than 10 percent of GDP but greater than or equal to 4 percent of GDP and zero otherwise. This, along with the low reserve dummy defined above, is now interacted with the negative price and aid shocks as before. So we have a total of eight interaction dummies - RLpsn1, RLpsn2, RMpsn1, RMpsn2, RLaidn1, RLaidn2, RMaidn1 and RMaidn2. The results from this augmented model are presented below [Table 2]:

Coefficients on the endogenous variables remain unchanged in all the four equations as expected. As we move on to the commodity price shocks we find that large negative price shocks cause a decline in the output per capita, the ratio of consumption to GDP and the ratio of government expenditure to GDP in countries with reserves below 4% of GDP. A 10% decline in commodity export price causes output per capita to fall by 1.6 %, the share of consumption to fall by 2% and the share of government expenditure to fall by 1.3%. For countries with reserve levels between 4 and 10 percent share of consumption and government expenditure go up in response to a large decline in export prices. For rest of the sample, there is no significant impact of a negative price shock on any of the key macroeconomic variables. Thus, countries carrying reserves below 4%

of GDP suffer a loss in output per capita as well as a shrinking of private and public expenditure that is greater than the reduction in output. Corresponding with the reduction in consumption and government expenditure shares is the increase in the share of net exports for low reserve countries. This reaffirms our earlier result about expenditure compression in countries with reserves below 4%. This also has significant welfare implications for countries with low levels of domestic absorption. A sharp decline in the export price of such a country would force it to lower its consumption levels even further if it does not carry sufficient amount of reserves. Countries with reserve levels between 4 to 10 percent of GDP, on the other hand, see an increase in the share of consumption and government expenditure and corresponding decrease in the share of net export when faced with a sharp decline in commodity export prices. For reserves above 10 percent of GDP there is no significant impact of large price shocks. Clearly, higher level of reserves, not only allow countries to smooth their consumption over price shocks; they also help reduce the cost of such shocks in terms of output. Large increases in commodity prices do not have any significant impact on GDP per capita or its components. This asymmetric effect of negative and positive price shocks is consistent with other findings in the literature.

Moving on to the aid shocks, large declines in aid flows are associated with a decline in the share of government expenditure across all the countries in our sample. For countries with reserves below 4% of GDP, large declines in non-food aid also cause a reduction in the share of investment in GDP. Again, there is evidence of difference in the behavior between low-reserve countries (those with reserves below 4%) and the rest though the difference is significant only for investment. Positive shocks to aid are associated with an increase in per capita GDP as before.

Robustness Analysis

In this section we present a few robustness checks for our results. We use different shock sizes, alternative samples and four year non-overlapping averages to check for the robustness of our results.

Different Shock Size:

Tables 3 and 4 present the summary regression results as we increase the size of price and aid shocks. For the endogenous variables the coefficients are the same as before and therefore omitted from the tables. For price shocks, the loss in output in low reserve countries increases steadily as we increase the size of the shock indicating non-linearity in their impact. For shocks above 20 percent, the direct impact of the decline in the share of consumption and government expenditure also increases steadily except for last row where the decline in consumption share becomes smaller as shock size is increased from 15 to 20 percent. This reflects the fact that for price shocks above 20 percent, investment also begins to fall in low reserve countries (as seen by the fall in its share) implying a smaller reduction in the share of consumption.

For medium reserve countries (those with reserves between 4 and 10 percent of GDP), there is no impact of negative price shocks on GDP and investment. Share of consumption and government expenditure in the GDP go up steadily in response to large declines in commodity

export prices. In fact the increase in consumption share in the medium reserve countries is roughly equal to the decline in consumption share in low reserve countries. Thus, if we ignore the role of reserve levels in shaping the response of countries to exogenous price shocks we might miss the effect of such shocks on consumption and other macro variables altogether. Finally, for countries with reserves above 10 percent of GDP there is no effect of large price shocks on any of the key macroeconomic variables

Moving on to the negative shocks to non-food aid we see that low-reserve countries face a decline in their investment share as well as the share of government expenditure in response to a negative aid shock. The decline is roughly proportional to the size of the shock. For medium and high reserve countries we only find a decline in the share of government expenditure while the remaining variables remain unchanged. Impact of negative aid shocks on government expenditure share appears to be strongest in medium reserve countries. This makes sense as for low reserve countries the impact of a decline in aid is distributed across investment and government expenditure whereas for high reserve countries the higher level of reserves allow them to cushion declines in aid flows better. Over all, the impact of an aid shock is highest for the low reserve countries and smallest for the high reserve countries.

Persistent Shocks:

So far we have used annual data in our analysis. However, there is evidence that countries behave differently to persistent price shocks. We, therefore, use four year non-overlapping averages in this section to check for the effects of persistent shocks. We get a total of nine observations for each country. Aid and price shocks are defined as the percentage change between to non-overlapping four year period averages. Results of this exercise are presented in Table 5. Beginning with persistent price shocks we find that the loss in output is now same for all the countries irrespective of their reserve levels (a 10 percent decline in the commodity export price leads to a 2.65% decline in output). Same is true for the share of consumption and government expenditure in GDP both of which go up in response to a persistent negative commodity price shock. Again there is no significant difference between low reserve, medium reserve and high reserve countries. Positive price shocks do not have any impact on GDP etc. as before.

Moving on to aid shocks, as before there is no effect of negative aid shocks on output per capita or consumption when measured over four year non-overlapping periods. However, large declines in aid do lead to a fall in investment share for all the countries in the sample (a 20% decline in aid flow causes investment share to fall by 0.74%). This is same as in the case of annual data. The only other significant impact of persistent aid shocks is on government expenditure in low-reserve countries. Persistent negative aid shocks cause a small but significant decline in the share of government expenditure in low income countries.

The key points from this exercise are the following - with persistent commodity price shocks the behavior of output and its components is identical across countries with different reserve levels. Consumption and government expenditure shares go up while net exports go down with persistent negative commodity price shocks. Loss in per capita output is greater in case of persistent shocks as expected. Consumption and government expenditure fall less than output for

all the countries in the sample. In fact, assuming government expenditure to be around 15% and private consumption to be around 75% of GDP, persistent price shocks do not have any significant impact on the level of consumption while government expenditure declines by about 2%. With persistent price shocks countries have greater ability to adjust their expenditure patterns towards domestic goods. For negative and persistent aid shocks, reserve holdings play a role only so far as the share of government expenditure is concerned. Apart from that, negative and persistent aid shocks lower the share of investment in all the countries. Overall, the behavior of countries with different levels of reserves does not differ a lot when faced with persistent exogenous shocks to aid or commodity prices. Reserve levels are important when it comes to temporary shocks though.

Oil-Exporting Versus Non-Oil Exporting Countries

Dividing our sample in to oil exporting and non-oil exporting countries we find some interesting difference in the behavior of the two groups. Tables 6 and 7 present those results. Oil exporting countries exhibit no significant persistence in their consumption and government expenditure share whereas non-oil exporting countries show strong persistence in all the key macro variables in our system.

More importantly, output loss due to large negative price shocks is confined to low reserve countries in the case of oil exporting nations and is much larger as compared to the output loss in non-oil exporting countries where the loss is same across all the countries and much smaller in size. Thus, reserve accumulation seems to play a much more important role in determining the extent of output cost resulting from negative price shock in countries dependent on oil exports. To what extent this is reflective of the difference in their export structure versus the nature of oil versus non-oil commodity trade is a matter of further investigation.

Looking at the share of consumption in GDP, oil exporting countries face an increase in the share of their consumption in the event of a large negative price shocks across the entire sample. Non-oil exporting countries, however, see a reduction in the consumption share of low-reserve countries and an increase in the consumption share of medium reserve countries. As far as consumption smoothing is concerned, reserves seem to play a more important role in non-oil exporting countries than in the oil exporting countries.

Finally, the share of government expenditure goes up in the medium and high reserve oil exporting countries while it goes down in low reserve oil exporters. Non-oil exporting countries see a significant decline in the government expenditure share for low reserve countries but this decline is much smaller than that in the case of oil exporters. Again, whether this has to do with the difference in the nature of tax revenue base in the two groups needs further investigation.

Moving on to the aid shocks, the few interesting points of difference here between oil exporting and non-oil exporting countries are the following:

Oil exporting countries see a significant decline in their investment share (in low reserve countries) as well as government expenditure share (for all the countries) in response to a large fall in non-food aid. Non-oil exporters on the other hand exhibit a significant reduction in output

per capita for low reserve countries when faced with large negative aid shocks without having any impact on consumption, investment or government expenditure shares.

Positive shocks to aid are associated with an increase in output per capita in non-oil exporting countries and a reduction in the share of government expenditure in oil exporting countries.

Impact of negative aid shocks on investment and government expenditure share varies with the level of reserves in oil exporting countries.

CFA Franc Zone versus Non-CFA Franc Zone

It has often been suggested that countries with more flexible exchange rate are better able to cope with exogenous price shocks. To get some indirect evidence to this effect we divide our sample of countries in to CFA Franc zone countries (countries with a common currency and fixed exchange rate vis. a vis. Euro) and Non-CFA Franc zone countries. Tables 8 and 9 present the results of this exercise. The key points of this exercise are the follows:

While the CFA Franc zone countries face a significant reduction in their output per capita in response to a large negative price shock when reserves are below 4% of GDP; the Non-CFA Franc zone countries do not face any impact of a negative price shock on their output.

Both CFA Franc and Non-CFA Franc zone countries see a reduction in the share of consumption and government expenditure for low reserve case but the reduction is much larger for Non-CFA Franc zone countries.

There is no impact on investment share of negative price shocks in either group of countires.

Conclusion

This paper tries to look at the role of reserves in shaping the response of SSA countries to exogenous shocks. Overall reserves play an important role in determining the cost of temporary exogenous shocks in terms of output as well as their impact on the composition of GDP. For persistent shocks however they make much less of a difference. There is some evidence that countries with fixed exchange rate and those exporting oil face much greater cost in terms of loss of output when faced with exogenous price shocks. The threshold effects of reserves on key macro variables have important implications when it comes to designing reserve management policy or estimating optimal level of reserves. Ignoring these effects might provide us with misleading results about the adequacy and optimality of reserve holdings.

Price and Aid Shocks

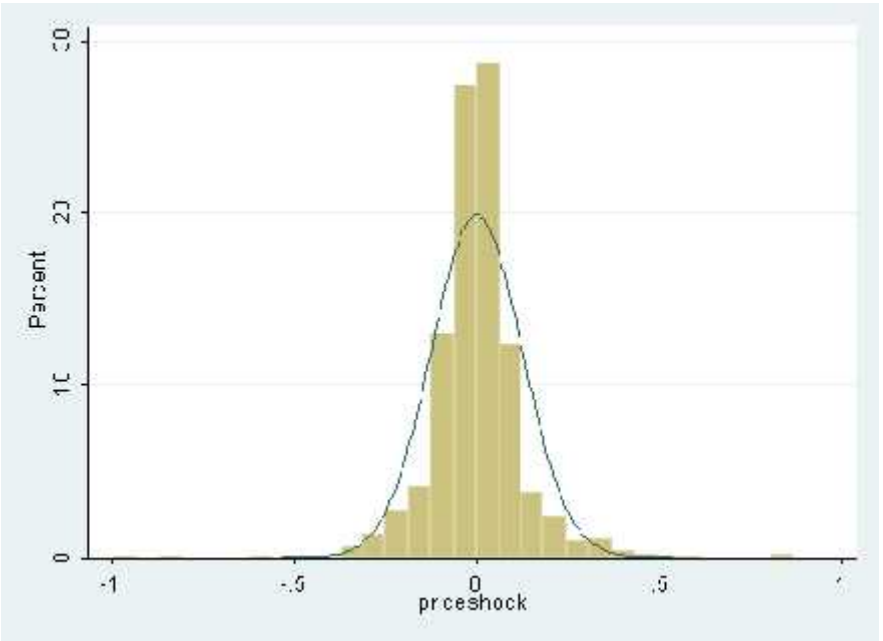

Figure.1

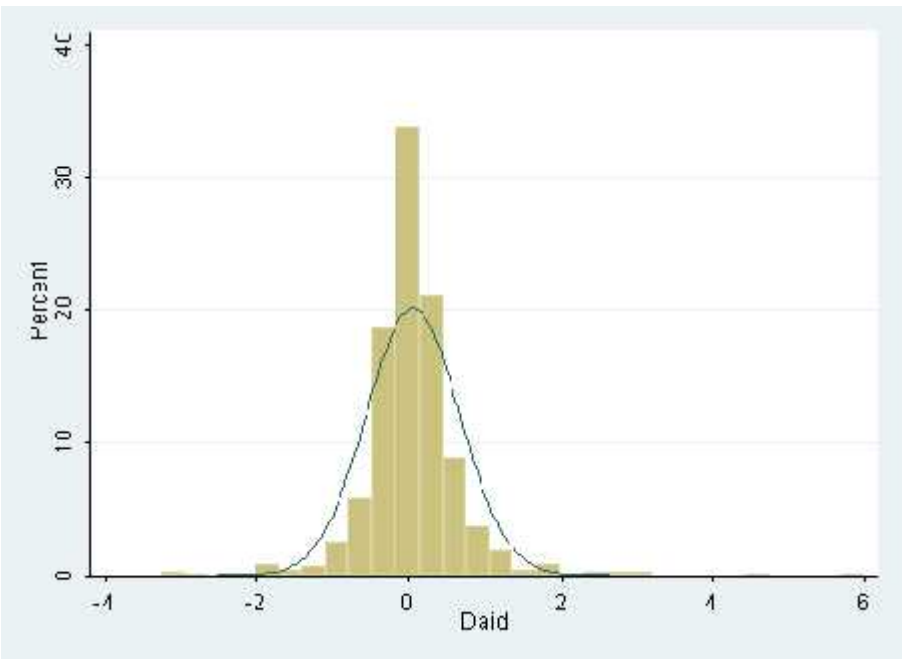

Figure. 2

Table 1.1

Benchmark Model

	Y	C	I	G
Sargan Test	0.0006	0.0004	0.0086	0.0012
L.Y	**0.964 (***)**	**-0.043 (***)**	-0.005	-0.005
L.C	**0.061 (***)**	**0.59 (***)**	0.026	**0.041 (**)**
L.I	0.037	-0.012	**0.70 (***)**	**0.049 (**)**
L.G	-0.046	0.099	0.067	**0.56 (***)**
Psn	-0.002	**0.085 (***)**	0.027	**0.034 (**)**
L.Psn	**-0.07 (**)**	0.026	-0.044	-0.017
Psp	-0.01	-0.016	-0.036	-0.023
L.Psp	-0.017	-0.024	-0.01	-0.01
Aidsn	0.008	-0.002	0.002	**-0.008 (**)**
L.Aidsn	0.009	0.01	-0.002	**-0.009 (**)**
Aidsp	-0.01	-0.04	0.002	0.002
L.Aidsp	**0.017 (***)**	-0.002	0.00	-0.003

Table 1.2A

Model with Reserve Dummies

(Reserve cut off 4%)

	Y	C	I	G
Sargan Test	0.002	0.000	0.005	0.014
L.Y	**0.967 (***)**	**-0.039 (***)**	0.00	-0.005
L.C	**0.069 (**)**	**0.596 (***)**	0.04	**0.04 (**)**
L.I	0.05	-0.004	**0.71 (***)**	**0.047 (**)**
L.G	-0.048	0.099	0.085	**0.56 (***)**
Psn	-0.015	**0.072 (**)**	0.013	**0.053 (***)**
L.Psn	-0.016	0.075	-0.007	-0.035
Psp	-0.016	-0.02	-0.039	-0.023
L.Psp	-0.017	-0.025	-0.008	-0.01
Rpsn	0.03	0.023	0.03	-0.064
L.Rpsn	**-0.136 (***)**	**-0.12 (**)**	**-0.095 (**)**	0.037
Aidsn	0.005	-0.002	0.004	-0.008
L.Aidsn	**0.014 (**)**	0.012	0.006	**-0.009 (**)**
Raidsn	0.009	-0.004	-0.013	0.000
L.Raidsn	**-0.026 (**)**	-0.011	**-0.035 (***)**	0.001
Aidsp	-0.009	-0.003	0.003	0.002
L.Aidsp	**0.017 (***)**	-0.002	0.00	-0.003

Table 1.2B

Model with Reserve Dummies

(Reserve cut off 6%)

	Y	C	I	G
Sargan Test	0.00	0.00	0.019	0.001
L.Y	**0.965 (***)**	**-0.047 (**)**	-0.002	-0.005
L.C	**0.067 (**)**	**0.58 (***)**	0.037	**0.04 (**)**
L.I	0.042	-0.01	0.71 (***)	**0.05 (**)**
L.G	-0.048	0.09	0.082	**0.56 (***)**
Psn	-0.025	0.004	0.018	**0.056 (***)**
L.Psn	-0.019	0.02	0.013	-0.02
Psp	-0.011	-0.008	-0.039	-0.025
L.Psp	-0.016	-0.016	-0.01	-0.011
Rpsn	0.067	**0.22 (***)**	0.018	**-0.06 (**)**
L.Rpsn	-0.10	0.028	**-0.125 (***)**	0.002
Aidsn	0.003	-0.001	0.003	-0.005
L.Aidsn	0.014	0.012	0.001	**-0.012 (**)**
Raidsn	0.01	-0.006	-0.005	-0.006
L.Raidsn	-0.012	-0.009	-0.007	0.006
Aidsp	-0.01	-0.004	0.002	0.002
L.Aidsp	**0.018 (***)**	-0.002	0.001	-0.003

Table 1.2C

Model with Reserve Dummies

(Reserve cut off 10%)

	Y	C	I	G
Sargan Test	0.000	0.000	0.012	0.0012
L.Y	**0.965 (***)**	**-0.043 (***)**	-0.004	-0.004
L.C	**0.065 (**)**	**0.58 (***)**	0.032	**0.041 (**)**
L.I	0.038	-0.018	**0.70 (***)**	**0.049 (**)**
L.G	-0.043	0.102	0.073	**0.56 (***)**
Psn	-0.03	0.016	0.002	0.034
L.Psn	-0.029	0.038	-0.01	-0.026
Psp	-0.01	-0.011	-0.037	-0.023
L.Psp	-0.014	-0.017	-0.006	-0.008
Rpsn	0.065	**0.145 (***)**	0.051	0.001
L.Rpsn	-0.069	-0.003	-0.063	0.012
Aidsn	0.004	-0.01	0.011	-0.002
L.Aidsn	0.015	0.015	-0.005	**-0.012 (**)**
Raidsn	0.006	0.012	-0.017	-0.01
L.Raidsn	-0.009	-0.008	0.003	0.004
Aidsp	-0.01	-0.003	0.002	0.002
L.Aidsp	**0.017 (***)**	-0.001	0.00	-0.003

Table 2

Augmented Model

	Y	C	I	G
Sargan Test	0.000	0.000	0.032	0.001
L.Y	**0.968 (***)**	**0.036 (***)**	0.001	-0.004
L.C	**0.068 (**)**	**0.584 (***)**	0.041	**0.042 (**)**
L.I	0.049	-0.013	**0.712 (***)**	**0.045 (**)**
L.G	-0.047	0.11	0.085	**0.562 (***)**
Psn	-0.03	0.02	0.002	0.032
L.Psn	-0.025	0.04	-0.01	-0.026
Psp	-0.013	-0.014	-0.04	-0.024
L.Psp	-0.014	-0.017	-0.005	-0.006
RLpsn	-0.007	-0.10	0.005	**-0.129 (***)**
L.RLpsn	**-0.16 (**)**	**-0.20 (**)**	-0.076	0.085
RMpsn	0.055	**0.19 (**)**	0.036	**0.085 (**)**
L.RMpsn	0.035	0.13	-0.013	-0.053
Aidsn	0.005	-0.01	0.012	-0.002
L.Aidsn	0.015	0.016	-0.004	**-0.013 (**)**
RLaidsn	0.01	-0.01	-0.003	0.01
L.RLaidsn	-0.023	0.00	**-0.043 (***)**	-0.002
RMaidsn	-0.00	0.016	-0.018	-0.015
L.RMaidsn	-0.003	-0.013	0.017	0.006
Aidsp	-0.009	-0.002	0.002	0.001
L.Aidsp	**0.017 (***)**	-0.002	-0.00	-0.004

Table 3

Different Price Shock Sizes

	Size of Price Shock vs Impact Low-Reserve Countries			
Shock Size	Y	C	I	G
5%	-0.16	-0.19	0.00	-0.12
10%	-0.25	-0.20	0.00	-0.14
15%	-0.24	-0.27	0.00	-0.17
20%	-0.18	-0.23	-0.22	-0.19

	Size of Price Shock vs Impact Medium-Reserve Countries			
Shock Size	Y	C	I	G
5%	0.00	0.19	0.00	0.085
10%	0.00	0.20	0.00	0.10
15%	0.00	0.26	0.00	0.14
20%	0.00	0.29	0.00	0.16

	Size of Price Shock vs Impact High-Reserve Countries			
Shock Size	Y	C	I	G
5%	0.00	0.00	0.00	0.00
10%	0.00	0.00	0.00	0.00
15%	0.00	0.00	0.00	0.00
20%	0.00	0.00	0.00	0.00

Table 4

Different Aid Shock Sizes

	Size of Aid Shock vs Impact Low-Reserve Countries			
Shock Size	Y	C	I	G
2%	0.00	0.00	-0.04	-0.013
4%	0.00	0.00	-0.04	-0.013
10%	0.00	0.00	-0.04	-0.0125
15%	0.00	0.00	-0.04	-0.012

	Size of Aid Shock vs Impact Medium-Reserve Countries			
Shock Size	Y	C	I	G
2%	0.00	0.00	0.00	-0.029
4%	0.00	0.00	0.00	-0.029
10%	0.00	0.00	0.00	-0.028
15%	0.00	0.00	0.00	-0.027

	Size of Aid Shock vs Impact High-Reserve Countries			
Shock Size	Y	C	I	G
2%	0.00	0.00	0.00	-0.013
4%	0.00	0.00	0.00	-0.013
10%	0.00	0.00	0.00	-0.0125
15%	0.00	0.00	0.00	-0.012

Table 5

Persistent Shocks

	Y	C	I	G
L.Y	**0.977 (***)**	-0.007	0.014	0.021
L.C	0.15	**0.953 (***)**	**0.11 (**)**	-0.02
L.I	0.13	0.043	**0.594 (***)**	0.07
L.G	0.26	0.006	0.18	**0.483 (**)**
Psn	0.068	**0.214 (***)**	-0.028	-0.039
L.Psn	**-0.265 (***)**	0.079	0.028	**0.082 (**)**
Psp	0.026	0.044	-0.028	-0.013
L.Psp	-0.037	-0.019	0.012	0.002
RLpsn	-0.185	-0.14	-0.088	0.012
L.RLpsn	0.024	0.12	-0.033	-0.044
RMpsn	-0.022	-0.05	0.042	0.043
L.RMpsn	0.072	-0.13	-0.072	-0.042
Aidsn	-0.026	0.005	**-0.037 (***)**	-0.013
L.Aidsn	0.005	-0.027	-0.009	-0.013
RLaidsn	-0.005	-0.037	0.028	**-0.012 (**)**
L.RLaidsn	0.031	0.032	0.012	0.013
RMaidsn	0.015	-0.003	-0.002	0.014
L.RMaidsn	-0.048	0.043	-0.013	-0.013
Aidsp	-0.019	0.012	-0.014	0.011
L.Aidsp	-0.005	0.002	0.004	0.004

Table 6

Oil Exporting Countries

	Y	C	I	G
L.Y	**0.84 (***)**	**-0.054 (***)**	0.005	-0.02
L.C	0.1	0.12	-0.08 (***)	0.296
L.I	0.10	-0.48	**0.56 (***)**	0.046
L.G	**-0.31 (***)**	0.44	-0.003	0.27
Psn	-0.007	**0.11 (***)**	-0.012	**0.176 (***)**
L.Psn	-0.12	0.16	-0.004	-0.093
Psp	-0.038	**0.07 (***)**	-0.007	0.122
L.Psp	-0.12	**0.05 (***)**	-0.014	0.063
RLpsn	-0.085	0.12	0.11	**-0.20 (***)**
L.RLpsn	**-0.26 (**)**	-0.056	-0.15	0.24
RMpsn	-0.15	0.00	0.14	**0.125 (**)**
L.RMpsn	0.15	0.15	-0.07	-0.13
Aidsn	0.02	**-0.06 (***)**	0.009	**-0.02 (**)**
L.Aidsn	0.04	-0.047	-0.004	-0.05
RLaidsn	-0.021	-0.008	-0.01	**0.008 (**)**
L.RLaidsn	-0.023	0.023	**-0.037 (***)**	-0.002
RMaidsn	0.007	0.029	-0.008	**-0.018 (***)**
L.RMaidsn	-0.03	-0.03	**0.019 (***)**	0.026
Aidsp	-0.004	-0.02	-0.003	**-0.019 (***)**
L.Aidsp	0.005	-0.025	-0.004	-0.02

Table 7

Non-Oil Exporting Countries

	Y	C	I	G
L.Y	**0.973 (***)**	**-0.038 (***)**	0.008	**0.017 (**)**
L.C	0.038	**0.63 (***)**	**0.127 (***)**	**0.056 (**)**
L.I	0.067	0.04	**0.87 (***)**	0.03
L.G	0.128	-0.029	0.07	**0.72 (***)**
Psn	**-0.04 (***)**	0.018	-0.001	0.026
L.Psn	-0.005	0.047	-0.036	-0.012
Psp	-0.018	0.006	**-0.033 (**)**	-0.022
L.Psp	0.005	-0.012	0.015	0.01
RLpsn	-0.048	**-0.21 (***)**	-0.057	**-0.09 (***)**
L.RLpsn	-0.041	-0.11	0.024	0.043
RMpsn	0.11	**0.25 (***)**	-0.015	0.014
L.RMpsn	-0.06	0.077	-0.019	-0.028
Aidsn	0.006	0.005	0.01	0.000
L.Aidsn	0.012	0.01	-0.013	-0.007
RLaidsn	0.033	-0.013	0.004	0.001
L.RLaidsn	**-0.029 (**)**	0.014	-0.011	0.01
RMaidsn	-0.007	-0.007	-0.032	-0.006
L.RMaidsn	0.011	-0.022	0.017	-0.001
Aidsp	-0.009	0.004	0.008	0.007
L.Aidsp	**0.021 (***)**	0.00	0.007	-0.001

Table 8

CFA Franc Zone Countries

	Y	C	I	G
L.Y	**0.965 (***)**	**-0.054 (***)**	-0.01	-0.001
L.C	-0.14	**0.57 (***)**	-0.096	**-0.038 (**)**
L.I	**-0.11 (**)**	-0.11	**0.64 (***)**	-0.014
L.G	-0.079	-0.17	0.018	**0.53 (***)**
Psn	-0.047	-0.15	0.15	0.011
L.Psn	0.077	0.17	-0.09	-0.012
Psp	-0.059	-0.09	0.022	0.005
L.Psp	-0.024	0.001	0.028	-0.01
RLpsn	-0.075	**-0.23 (**)**	-0.004	**-0.10 (**)**
L.RLpsn	**-0.14 (**)**	-0.003	-0.16	0.013
RMpsn	0.08	**0.41 (***)**	0.065	**0.14 (**)**
L.RMpsn	-0.072	-0.08	0.15	-0.025
Aidsn	-0.016	-0.008	0.002	-0.002
L.Aidsn	-0.015	-0.001	0.01	-0.004
RLaidsn	0.018	-0.013	0.001	0.004
L.RLaidsn	0.008	-0.019	**-0.031 (**)**	-0.004
RMaidsn	0.016	-0.001	0.001	**-0.016 (**)**
L.RMaidsn	0.018	-0.003	0.001	0.006
Aidsp	-0.006	**-0.018 (**)**	-0.002	-0.01
L.Aidsp	0.016	**-0.023 (**)**	-0.004	0.00

Table 9

Non-CFA Franc Zone Countries

	Y	C	I	G
L.Y	**1.01 (***)**	**-0.045 (***)**	**0.009 (**)**	0.022
L.C	0.064	**0.50 (***)**	**0.10 (***)**	0.062
L.I	0.038	**0.17 (***)**	**0.86 (***)**	0.043
L.G	-0.019	-0.145	**0.09 (**)**	**0.74 (***)**
Psn	-0.015	**0.06 (**)**	-0.012	0.037
L.Psn	-0.017	**0.08 (**)**	-0.015	-0.021
Psp	0.02	0.002	-0.029	-0.013
L.Psp	0.002	-0.013	0.015	0.019
RLpsn	-0.021	0.003	-0.07	**-0.20 (***)**
L.RLpsn	-0.035	**-0.40 (***)**	-0.016	0.24
RMpsn	0.093	-0.04	0.015	0.13
L.RMpsn	-0.015	0.15	0.017	-0.10
Aidsn	0.011	-0.01	0.016	-0.003
L.Aidsn	0.016	0.00	-0.016	-0.011
RLaidsn	0.024	0.028	0.004	0.007
L.RLaidsn	**-0.037 (***)**	0.023	-0.019	0.009
RMaidsn	-0.01	-0.007	**-0.044 (***)**	-0.002
L.RMaidsn	0.006	-0.026	0.02	-0.001
Aidsp	-0.01	0.009	0.007	0.008
L.Aidsp	0.021	0.00	0.004	-0.005

References

1) Aizenman ,Joshua and Marion,Nancy , 2004, "International Reserve Holdings with Sovereign Risks and Costly tax Collection", *The Economic Journal*, Vol. 114, No. 497 (Jul., 2004), pp. 569-591, Blackwell Publishing for the Royal Economic Society

2) Aizenman ,Joshua , 2007, "Large Hoarding of International Reserves and the Emerging Global Economic Architecture", *NBER* Working Paper, WP13277

3) Alfaro, Laura and Kanczuk, Fabio, June 2007, "Optimal Reserve Management and Sovereign Debt", *Journal of International Economics*, Vol. 77, Issue 1, February 2009, Pages 23-36

4) Archibald, G. C. And Richmond, J., 1971, "On the Theory of Foreign Exchange Reserve Requirements", *The Review of Economic Studies*, Vol. 38, No. 2 (Apr., 1971), pp. 245-263

5) Avraham Ben-Bassat and Daniel Gottlieb, 1992, "On the Effect of Opportunity Cost on International Reserve Holdings", *The Review of Economics and Statistics*, Vol. 74, No. 2 (May, 1992), pp. 329-332, The MIT Press

6) Cashina ,Paul, McDermott, C. John, & Pattillo, Catherine, 2004, "Terms of trade shocks in Africa: are they short-lived or long-lived?",J*ournal of Development Economics,* Vol. 73 (2004), pp. 727– 744

7) Cashin ,Paul and Mcdermott ,C. John, 2002 , "The Long-Run Behavior of Commodity Prices: Small Trends and Big Variability", *IMF Staff Papers* Vol. 49, No.2, International Monetary Fund

8) Cashin, Paul, Liang ,Hong, and Mcdermott ,C. John, 2000 , "How Persistent Are Shocks to World Commodity Prices?",*IMF Staff Papers* Vol. 47, No. 2, International Monetary Fund

9) Cuddington ,John T. and Urzúa ,Carlos M., 1989 , "Trends and Cycles in the Net Barter Terms of Trade: A New Approach", *The Economic Journal*, Vol. 99, No. 396 (Jun., 1989), pp. 426-442

10) Deaton ,Angus and Miller ,Ron, 1995, "International commodity Prices, Macroeconomic Performance and Politics in Sub-Saharan Africa", *International Finance Section*, Department of Economics, Princeton University

11) Frenkel, Jacob A. and Jovanovic ,Boyan, 1981, “Optimal International Reserves: A Stochastic Framework”, *Economic Journal*, Vol. 91, No. 362 (Jun., 1981), pp. 507-514, Blackwell Publishing for the Royal Economic Society

12) Frenkel ,Jacob A., 1974, “The Demand for International Reserves by Developed and Less-Developed Countries”, *Economica*, New Series, Vol. 41, No. 161 (Feb., 1974), pp. 14-24, Blackwell Publishing

13) Grilli, Enzo and Maw Cheng Yang, 1988, “Primary Commodity Prices, Manufactured Goods Prices and the Terms of Trade in Developing Countries”, *World Bank Economic Review*, Vol. 2, No. 1, pp 1-47

14) Pesaran ,M. Hashem, 2004, “General Diagnostic tests for Cross Section Dependence in panels”, CESifo Working Paper Series No. 1229; IZA Discussion Paper No. 1240. Available at SSRN: http://ssrn.com/abstract=572504

Appendix I

List of Commodities

Aluminum	Cotton	Lead	Pepper	Superphosphate
Alumina	Fish meal	Linseed Oil	Phosphate Rock	Tea
Banana	Gasoline	Maize	Rice	Timber
Beef	Gold	Manganese	Rubber	Tin
Cocoa	Groundnut	Natural Gas	Shrimp	Tobacco
Coal	Hides	News Print	Silver	Vanilla
Coconut	Iron Ore	Nickel	Sisal	Wheat
Coffee	Industrial Diamonds	Oranges	Sorghum	Wool
Copper	Jute	Palm Oil	Soybean	Zinc
Copra	Lamb	Petroleum	Sugar	

Appendix II

Data Sources

- GDP, Private Consumption, Investment, Government Expenditure, GDP Deflator data: UNSTATS
- Commodity Price data: International Financial Statistics, Food and Agricultural
- Organization and United States Geological Survey.
- Commodity Export Shares: UN Comtrade.
- AID data: Source OECD

Appendix III

List of Countries

Angola	Congo, Republic of	Kenya	Sao Tome and Principe	Zambia
Benin	Cote d'Ivoire	Madagascar	Senegal	Zimbabwe
Burkina Faso	Ethiopia	Malawi	Sierra Leone	
Burundi	Gabon	Mali	South Africa	
Cameroon	Gambia	Mozambique	Swaziland	
Cape Verde	Ghana	Namibia	Tanzania	
Central African Republic	Guinea	Nigeria	Togo	
Comoros	Guinea Bissau	Rwanda	Uganda	