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Agricultural commodity price shocks and their effect on growth in sub-Saharan Africa

Tony Addison¹ and Atanu Ghoshray²

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Abstract

Commodity price shocks are an important type of external shock and are often cited as a problem for economic growth in sub-Saharan Africa. This paper quantifies the impact of agricultural commodity price shocks using a near vector autoregressive model. The novel aspect of this model is that we define an auxiliary variable that can potentially capture the definition of a price shock that allows us to determine whether the response of per capita Gross domestic product (GDP) growth in sub-Saharan Africa to these price shocks is asymmetric. We find that there is evidence of such asymmetric responses to commodity price shocks.

Keywords: commodity prices, external shocks, price shocks, economic growth, aid flows
JEL classification: E30, F40, O11

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1 Introduction

External shocks, such as fluctuations in commodity prices and natural disasters, are often cited as reasons for low and unstable growth in low-income countries (LICs), especially in sub-Saharan African (SSA) countries (Raddatz 2007). The World Bank (WB), International Monetary Fund (IMF), and the United Nations Conference on Trade and Development (UNCTAD) have emphasized that the level and volatility of commodity prices in particular, has been an important influence on economic growth and the incidence of poverty in LICs. SSA countries are mostly heavily dependent on the export of a single or few commodities. For many countries at least half of their income depends on the exports of a few commodities. As a result, large fluctuations or shocks to commodity prices can have a large impact on individual incomes, which in turn affects the well-being of a country's population.

Many SSA countries have experienced a general increase in economic growth since the turn of the century and this is often attributed, at least in part, to the sustained increase in commodity prices (*The Economist* 2013). Increasing demand from emerging economies has largely driven the rise in prices. This demand surge and increasing trend in commodity prices comes after a long period of decreasing or stagnant prices. Recent research has shown that the historical trends in commodity prices can be characterized as a combination of increasing, constant, and decreasing trends (see Ghoshray et al. 2014; Ghoshray 2011; Harvey et al. 2010; and Kellard and Wohar 2006). The increasing and changing variability of real commodity prices (Ghoshray 2013) makes it difficult for SSA countries to manage them to their advantage.

Moreover, since many SSA countries are still recipients of aid (sometimes substantially), commodity price shocks also complicate the management and timing of aid flows, as unexpected shocks affect government revenues, the budgetary position, and the balance of payments, all of which have implications for level and timing of official development assistance (ODA). Commodity price shocks thereby add further complexity to the donor–recipient relationship in managing aid.

The literature is replete with references to commodity price movements, such as trends, cycles, volatility, and variability.¹ However, there is less agreement about which particular manifestations of commodity price movements matter to developing countries. This paper focuses specifically on two manifestations of commodity price movements, namely price shocks. The emphasis on these two particular manifestations of commodity price movements has been driven by studies due to Mork (1989), Hamilton (1996, 2003), and Killian and Vigfusson (2011), which have tested for the effect of oil price shocks on the macroeconomy.

Commodity price shocks can take the form of oil price shocks, shocks in the prices of key inputs, shocks in the prices of key exports, and food price shocks (to give several examples). Though in recent years SSA countries have experienced a general increase in economic growth, on the whole, for at least the past half a century, economic growth in SSA countries has been slow (Easterly and Levine 1997; Ndulu and O'Connell 2007). Using data from the World Development Indicators (WDI), Anderson and Bruckner (2012) calculate that the average share of GDP from agriculture in SSA countries during the past half a century has

¹ See, for example, Ghoshray et al. (2014); Byrne et al. (2013); Erten and Ocampo (2013); Ghoshray (2013, 2011); Harvey et al. (2010), and references within.

been more than a third. Even with the recent increase in economic growth, agricultural production in SSA has accounted for approximately a quarter of total GDP (Sandri et al. 2007).

Given the importance of agriculture to SSA economies, shocks concerning that sector are of special importance for policy. Accordingly, this paper studies the effect of agricultural commodity price shocks on the per capita incomes of SSA countries.² In particular, we determine whether a positive commodity price shock has a larger effect than a negative commodity price shock. This is an interesting issue as one can determine whether commodity price increases (obtained by censoring changes in prices) have more predictive power for SSA incomes than do uncensored changes in commodity prices. This study also traces out the effects of unanticipated commodity price shocks on per capita incomes.

We adopt an appropriate definition of an agricultural commodity price shock following the specification put forward by Mork (1989), obtained by censoring oil price changes. In his study, Mork pointed out that positive oil price shocks had a greater impact on the United States (US) economy than negative shocks. Hamilton (1996, 2003) refined the definition of an oil price shock by introducing the concept of the net oil price increase. This measure distinguishes between commodity price increases that establish new highs relative to recent experience and increases that simply reverse recent decreases.

Deaton and Laroque (1992) and Deaton (1999) note that primary commodity prices tend to be characterized by short-lived booms typically triggered by low stock holdings and long periods of flat prices. Reliable estimates of the duration of commodity price shocks are essential when considering counter-cyclical stabilization policies in primary-commodity exporting countries. Whether commodity booms benefit developing countries or not, has been studied extensively in the literature. Deaton and Miller (1996) point out that the difficulty in predicting the likely duration of a commodity price shock is a constraint on the ability of developing country policy makers to manage commodity booms and slumps. Deaton and Miller (1996) recommend countries to adopt policies that make fundamental adjustments to all price shocks, unless they can be identified as temporary without any ambiguity. However, even if the effect of price shocks can be safely concluded as transitory, there are difficulties involved in assessing the nature and duration of these shocks.

This study adds to the literature a crucial dimension by being more specific about whether these specific attributes of agricultural commodity price movements, such as price shocks, matter for growth, and if so, measuring their impact and documenting their robustness. To our knowledge, such studies of agricultural price shocks have not been analysed in terms of their potential effect on economic growth. By modelling positive shocks and sustained increases (that is, high prices relative to recent experience) separately, it is possible to determine which of these manifestations of price movements are most relevant to economic growth. We make a unique perspective in coverage by carefully selecting commodities that constitute a large or significant share of exports for selected SSA countries and study the effects for each country individually. Riddell (2007) argues that country based approach of analysis provides reliable evidence and this view has been corroborated by Juselius et al. (2013).

² Whether per capita GDP is an appropriate measure of inclusive growth remains a debatable issue. However, Garcia-Verdu et al. (2012) find that high per capita economic growth is closely linked to inclusive growth when considering a selection of SSA countries.

This paper is structured as follows: Section 2 describes the literature review, followed by a description of the econometric methods. Section 4 describes the data and the empirical results. Finally, the last section concludes, with a particular focus on the policy implications.

2 Literature review

Bleaney and Greenaway (2001) estimate a panel data model for a sample of 14 SSA countries over 1980–95, and show that growth is negatively affected by terms of trade volatility and investment by real exchange rate instability. Blattman et al. (2007) investigate the impact of terms of trade volatility, arising from excessive commodity price fluctuations, on the growth performance of a panel of 35 commodity-dependent countries between 1870 and 1939. Using a panel database, they provide evidence of the adverse effects of volatility on foreign investment and, through that, on economic growth in what they call ‘periphery’ nations. Using historical data, Blattman et al. find that countries experiencing more volatile commodity prices tend to grow more slowly than countries experiencing relatively stable price movements. In addition, when commodity prices show a favourable trend, the core countries tend to perform better than their peripheral counterparts. Aghion et al. (2009), using a system GMM dynamic panel data method for 83 countries over the period 1960–2000, show that higher levels of exchange rate volatility can stunt growth, especially in countries where capital markets are thin and where financial shocks are the main source of macroeconomic volatility.

Commodity prices are known to be volatile and it has been suggested that natural resource prices in particular, have been largely detrimental to growth (Hausmann and Rigobon 2003; Blattman et al. 2007). Auty (1993) describes the phenomenon of ‘natural resource curse’ where countries endowed with natural resources experience low economic growth in comparison to countries who achieve high economic growth with little or no natural resources. However, the empirical evidence regarding the impact of natural resource prices on economic growth is mixed, with some confirming Sachs and Warner’s (1995) results of a negative effect on growth (see Rodriguez and Sachs 1999; Gylfason et al. 1999; and Bulte et al. 2005, among others). A growing number of papers provide evidence against the resource curse hypothesis. Brunnschweiler and Bulte (2008) argue that the so-called resource curse does not exist when one uses the correct measure of resource abundance (rather than dependence) in regressions. Furthermore, Alexeev and Conrad (2009) show that there is little or no evidence that large endowments of oil or minerals slow long-term economic growth; rather, natural resource endowments enhance long-term growth. Another related branch of the literature investigates the channels through which natural resource abundance affects economic growth. Gylfason (2001) and Gylfason and Zoega (2006) highlight that resource abundance leads to lower investment in physical capital which then dampens growth. However, most of these studies focus on the effect of the level of resource abundance on economic growth and no attempt is made to study the effects of commodity price volatility on per capita economic growth. Besides, the literature has focussed on the effect of natural resources on economic growth. We believe there are persuasive arguments to model the effects of agricultural prices on economic growth. Unlike natural resources, which are non-perishable and are fixed in supply underneath the earth’s crust, agricultural commodities are perishable and the supply can be greatly affected by natural disasters. For example, a bad harvest which reduces the supply of agricultural products would lead to a corresponding price rise which may be quite high and persistent to clear the market.

This paper contributes to several strands of the literature that have explored the link between external shocks and real economic activity in low-income countries. For example, Easterly et al. (1993) show, using growth regressions, that variation in the growth of terms of trade can explain a large part of the variation in the economic growth of a selection of countries. Mendoza (1995) and Kose and Riezman (2001) adopt calibrated general equilibrium models and find that almost half of output fluctuations in LICs can be accounted for by terms of trade shocks. However, using a different methodological approach, Vector Autoregressive (VAR) models, Deaton and Miller (1996) and Hoffmaister et al. (1998) show that terms of trade shocks account for a small fraction of output volatility. Broda (2004) employs a panel VAR approach and finds that terms of trade shocks have a larger output impact in countries with fixed exchange rates. Raddatz (2007) also employs a panel VAR model to find that external shocks play a small but significant role in explaining output volatility. Collier and Goderis (2012) adopt a panel error correction model to study the effect of commodity prices on output per capita, separating the long-term and short-term effects. Their results show that commodity price increases have an impact on per capita GDP in the short term. However, for countries that have poor governance, the long-term effects of commodity price booms are negative (reflecting mismanagement of the resource revenues when governance is weak).

Recent studies on external shocks and their impact on economic activity (such as, Ahmed 2003; Broda 2004; Raddatz 2007; and Collier and Goderis 2012) have employed a panel VAR or panel error correction model approach. A major drawback of these studies is that the dynamics is common across cross sectional units. This assumption is driven by the fact that with the limited time series data available, the country specific dynamics cannot be estimated. However, Pesaran and Smith (1995) state that this assumption will likely result in obtaining estimates that underestimate (overestimate) short-run (long-run) impact of the shocks if the dynamics differ across countries. Juselius et al. (2013) lend support to the argument that panel models require fairly strict assumptions. While Raddatz (2007) argues that this criticism can be mitigated by choosing countries that are relatively homogenous, we find our results from individual country evidence, which confirms the heterogeneity of experience. Besides, the explanatory variables are likely to be heterogeneous. As a case in point, the dynamics of individual commodity prices which may be closely related (such as cocoa and coffee), have been found by recent studies (see Kellard and Wohar 2006; Ghoshray 2011; Ghoshray et al. 2014) to exhibit dynamics that are widely different. These studies recommend against using aggregate indices that constitute a group of commodities (such as metals, beverages, etc.), and conclude that individual commodities should be modelled separately.

The previous studies employ econometric models that imply the log of real GDP be linearly related to the log of real commodity prices. This functional relationship would mean that if the price of a commodity falls, the real GDP should fall; if the price of the commodity rises, then that should induce economic growth by the same mechanism operating in the reverse direction. Commodity price swings matter for the short-run macroeconomy precisely because of the ability to disrupt government expenditure on infrastructure and development. A price shock makes governments of countries that are heavily reliant on commodities uncertain about the future. Given this uncertainty as to how governments should respond to price increases or decreases, especially if such increase or decrease tends to be persistent, there is room to argue that the relation between commodity price shocks and real GDP per capita is non-linear.

This paper therefore departs from previous studies by examining a parsimonious bi-variate near-VAR taking into account the limited number of time series observations. The novel

approach of this bi-variate VAR model is to study the effects of both positive and negative commodity price shocks on economic growth. This is carried out by defining an auxiliary variable that captures a more appropriate definition of a price shock. This paper tests for asymmetric effects of large positive price shocks and sustained price changes on economic growth. These are especially important for the design of policy.

3 Econometric methodology

We follow the model suggested by Kilian and Vigfusson (2011), and test for its validity for accounting the responses of economic growth in SSA to both positive and negative commodity price shocks. The focus on a VAR model instead of a static model is of importance in that researchers are more interested in treating variables as endogenous to the system and also allow for dynamic behaviour to be analysed. To illustrate this point of view, we start with the VAR with symmetric data generating process and then turn to the case of asymmetric data generating process.

Consider a bi-variate VAR(p) model. The two variables denoted y_t and x_t , are the variables of interest, being per capita GDP and commodity prices respectively.

In the following VAR(p) model we have a symmetric data generating process in which the responses of y_t to positive and negative values of x_t are the same:

$$\begin{aligned} x_t &= b_{10} + \sum_{i=1}^p b_{11,i} x_{t-i} + \sum_{i=1}^p b_{12,i} y_{t-i} + \varepsilon_{1,t} \\ y_t &= b_{20} + \sum_{i=1}^p b_{21,i} x_{t-i} + \sum_{i=1}^p b_{22,i} y_{t-i} + \varepsilon_{2,t} \end{aligned} \quad (1)$$

where $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are white noise error terms.

However, if we wish to estimate a censored VAR(p) model, so that we allow for only positive values of x_t (denoted by x_t^+) in the second equation of (1); then as the data generating process may be symmetric, neglecting the negative values of x_t would make the regression invalid and the effects of positive values of x_t (denoted by x_t^+) on y_t will be overestimated (see Kilian and Vigfusson 2011).

The VAR model proposed by Kilian and Vigfusson can produce consistent and valid estimators of co-efficients regardless of whether the data generating process is symmetric or asymmetric. This does not suffer from the problem of the censored VAR model, and it allows both positive and negative oil price shocks to affect the economy (but to different magnitudes). We make use both Mork's (1989) measure of oil price, in which oil price increases and decreases are treated separately in the regression, and Hamilton's (1996, 2003) net oil price increase transformation applied to agricultural commodity prices in this study.

The asymmetric VAR model using Mork's transformation of commodity price is given by the near VAR model below:

$$\begin{aligned} x_t &= b_{10} + \sum_{i=1}^p b_{11,i} x_{t-i} + \sum_{i=1}^p b_{12,i} y_{t-i} + \varepsilon_{1,t} \\ y_t &= b_{20} + \sum_{i=1}^p b_{21,i} x_{t-i} + \sum_{i=1}^p b_{22,i} y_{t-i} + \sum_{i=0}^p g_{21,i} x_{t-i}^+ + \varepsilon_{2,t} \end{aligned} \quad (2)$$

Following the line of reasoning proposed by Mork (1989), we adopt a non-linear model of commodity prices where the following auxiliary variable describes a price shock:

$$x_t^{+} = \max[0, [\Delta x]_t]$$

In this case, the model allows us to treat commodity price increases in a different way to commodity price decreases, therefore allowing a test for asymmetry of impact. The first equation of (2) is identical to the first equation of a standard linear VAR as in (1), but the second equation in (2) includes x_t and x_t^{+} and as such, both commodity price increases and decreases affect per capita GDP. Given the estimates of these co-efficients, one can calculate the dynamic responses to unanticipated positive and negative commodity price shocks.

The alternative asymmetric VAR model using Hamilton's (1996, 2003) transformation of commodity prices is given by the following near VAR model:

$$\begin{aligned} x_t &= b_{10} + \sum_{i=1}^p b_{11,i} x_{t-i} + \sum_{i=1}^p b_{12,i} y_{t-i} + \varepsilon_{1,t} \\ y_t &= b_{20} + \sum_{i=1}^p b_{21,i} x_{t-i} + \sum_{i=1}^p b_{22,i} y_{t-i} + \sum_{i=0}^p g_{21,i} x_{t-i}^{(+,net)} + \varepsilon_{2,t} \end{aligned} \quad (3)$$

It may be argued that many of the changes in commodity prices are corrective movements to the long-term inter-temporal equilibrium level, such that increases or decreases essentially illustrate mean-reverting characteristics. Following Hamilton (2003) we propose an alternative model where commodity prices remain persistently high over a period of time. The auxiliary variable is constructed as:

$$x_t^{(+,net)} = \max[0, [x_{t-\max\{x\}}(t-1), x_{t-2}, \dots, x_{t-n}]]$$

where n is the exogenously chosen period of high-persistent prices. If one wants a measure of how unsettling an increase/decrease in commodity prices is likely to be for economic growth, this model would seem appropriate, as it compares the current commodity price with where it has been over the previous years.

The 'net increase' measure separates only persistent and exceptional commodity price shocks from other observations in the price data. In contrast, the modified measure due to Mork (1989) attributes to every price increase the possibility to trigger a stronger than the average reaction of the per capita GDP in the system of equations. The key advantage of equation (2) or (3) is that the dynamic responses are consistently estimated being completely agnostic to the nature of the data generating process (Kilian and Vigfusson 2009). If commodity price increases and decreases received exactly the same weight in regressions of per capita economic growth, it would imply that the dynamic responses of per capita income growth to such commodity price shocks are symmetric. Following the traditional approach of testing for asymmetry to positive and negative shocks due to Mork, we can test for symmetry in the framework of (2) and (3) by the following hypothesis:

$$H_0: (g_{21,1} = g_{21,2} = \dots = g_{21,p}) = 0 \quad (4)$$

The hypothesis test given by (4) can be conducted by means of a Wald test with an asymptotic chi-squared distribution. Kilian and Vigfusson (2011) note that the test due to Mork (1989) excludes the contemporaneous regressor, and put forward a modified version of the model by Mork, which involves testing the following null hypothesis:

$$H_0: (g_{21,0} = g_{21,1} = g_{21,2} = \dots = g_{21,p} = 0) \quad (5)$$

Kilian and Vigfusson (2011) note that the modified version of Mork's model may have higher power, and hence, we choose to employ this test in our subsequent analysis. The same slope based test given by (5) will also be employed for assessing the asymmetry test of the net increase model due to Hamilton (1996, 2003).

To understand why all these factors matter, consider feeding equation (3) with a very large positive shock. For a given commodity price variable x_t , it is very likely that $[\Delta x]_t$ will be positive and that x_{T^+} will be different from zero, affecting economic growth through the co-efficient $g_{21,0}$. Alternatively, the smaller the size of the shock, the higher the probability that the term x_{T^+} will be zero, resulting in a more muted response of y_t .

The method of computing impulse response functions (IRF) for symmetric VARs can be problematic when applied to a VAR where one of the endogenous variables is censored (Kilian and Vigfusson 2011). The problem arises because of the fact that the effect of the shock which depends on the recent history of the censored variable x_{T^+} , is ignored. The sign of future shocks will also affect the likelihood that the censored terms x_{T^+} may reach the zero bound, therefore switching on and off their effect on the future values of y_t . In this setup, the IRF needs to be estimated through simulation methods. An algorithm is employed to perform such a simulation using equations (3) or (4) to simulate two paths of the endogenous variables (see Kilian and Vigfusson 2011). The IRF are computed for a given horizon h , conditional on the history that take into account the size of the shock denoted by δ . The averaging over all the histories gives us the unconditional IRF denoted $I_y^h(\delta)$. After computing the IRFs to positive and negative shocks, a formal asymmetry test using a Wald test on the cumulated responses up to a specific horizon h can be conducted as follows:

$$I_y^h(\delta) - I_y^h(-\delta) = 0$$

To carry out this test an estimate of the variance of $I_y^h(\delta) - I_y^h(-\delta) = 0$ is required. This is obtained using a bootstrap simulation. This is done by generating a number (say N) of artificial samples using equations (3) or (4) and for each artificial sample the IRF to a positive and negative shock is estimated. The variance of $I_y^h(\delta) - I_y^h(-\delta)$ is then computed as the sample analogue from the N IRFs obtained on the artificial samples.

4 Data and empirical results

The two variables of interest in this study are international agricultural commodity prices and the real per capita GDP of 17 SSA countries. The real per capita GDP is measured in constant 2000 US\$ and is obtained from the WDI compiled by the WB. For real commodity prices we choose an extended data set of the original Grilli-Yang Commodity Price Index (GYCPI). The data is updated according to the method documented in the paper by Pfaffenzeller et al. (2007). For this study, we choose the period 1960–2010 to allow a match with the per capita

GDP data sample. We choose nine out of the 24 commodities as they account for a significant proportion of the total exports for the countries in this study.

Commodity prices are known to be very volatile (Deaton and Laroque 1992). Parametric models can be used to identify shocks to commodity prices that differentiate between positive and negative shocks. A strong view has been built that commodity prices do not have symmetric shocks. Deaton and Laroque note that downward movements in prices are typically longer in duration (and slower to occur) than upward movements in prices, which tend to be sharp.

What causes these different shocks? Shocks to demand affect industrial commodities, whereas shocks to supply affect agricultural commodities. Demand for commodities is fairly inelastic and can be classified as a derived demand, since commodity production often forms a small component of the final product (cocoa in chocolate, for example). This is in line with the theory of derived demand. Low demand elasticities imply that a moderate shock in production can have a substantial price impact. Consider the case of a positive supply shock. This will cause prices to fall substantially. However, the fall in commodity prices can be cushioned by storage. The reasoning is as follows: When prices are low as a result of negative demand shock or positive supply shock or both, stockholding is likely to increase. Consumption demand is augmented by stock demand until the expected return from holding stocks is equal to the rate of interest on comparable risky investments. As a result stockholding induces positive correlation to commodity prices.

Also consider a price increase resulting from a negative supply shock or positive demand shock or both. This would lead to destocking provided an inventory exists. If and when a stock-out occurs, the price is determined simply by the equality of supply and demand. The non-negativity constraint on stocks implies that storage would be more effective in moderating downward price movements than upward price movements. This leads to the observation that prices typically exhibit long flat troughs interspersed with occasional sharp peaks. As a result, commodity price distributions are generally skewed to the right. Table 1 illustrates some basic statistics that describe the degree of persistence to exogenous shocks, the variability and the nature of spikes in prices that are caused due to stock-outs.

Table 1: Basic statistics of commodity prices 1960–2010

Country	AR (1)	AR (2)	C.V.	Skewness	Kurtosis
Beef	0.63	0.29	0.22	0.74 [^]	1.22 [^]
Cocoa	0.83	0.61	0.51	1.77 [^]	4.01 [^]
Coffee	0.73	0.49	0.45	1.64 [^]	5.56 [^]
Cotton	0.93	0.86	0.43	0.60 [^]	-0.71
Rubber	0.79	0.66	0.37	0.87 [^]	0.95
Sugar	0.60	0.28	0.74	2.93 [^]	10.63 [^]
Tobacco	0.79	0.49	0.14	0.09	-0.07
Tea	0.88	0.79	0.38	1.01 [^]	-0.23
Wool	0.85	0.73	0.48	0.83 [^]	-0.24

Source: Authors' calculations.

Note: [^]denotes significance at the 10% level.

For all the commodities considered in this study, we find that they are characterized with first order auto-correlation co-efficients of at least 0.6, with more than half of the commodities

being roughly around 0.8 or greater. The second order correlation co-efficients are lower but are still substantial. The co-efficient of variation shows that sugar is most volatile. For the rest of the commodities though the volatility is lower, there is a considerable amount of variability in prices. All the commodities (except for tobacco) show a significant positive skewness, which implies that the upwards spikes in these commodities are more pronounced than downward spikes. None of the commodity prices show negative skewness. Substantial kurtosis is found for sugar, coffee, cocoa, and beef, which means that when considering the distribution of these prices, the tails are thicker than those of a normal distribution.

A sample of 17 SSA countries is selected for this study, being Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic (CAR), Chad, Democratic Republic of Congo (DRC), Gabon, Ghana, Kenya, Lesotho, Malawi, Rwanda, Togo, and Zambia. These countries have been chosen as they are dependent on primary commodities for their income and broadly cover a wide range of commodities (such as beef, cotton, cocoa, coffee, rubber, sugar, tobacco, tea, and wool). Many of these SSA countries have open economies with the exports of a single commodity corresponding to a high percentage of their GDP. Table 2 shows the share of the export earnings of a single commodity as a percentage of GDP in recent years.

Table 2: Export earnings of a single commodity as a percentage of GDP

Country	Commodity	1998	2001	2005	2010
Benin	Cotton	5.9	5.87	9.02	1.50
Botswana	Beef	n.a.	2.64	n.a.	1.03
Burkina F.	Cotton	4.9	5.14	n.a.	2.53
Burundi	Coffee	7.2	3.80	4.24	3.45
Cameroon	Cocoa	5.1	2.43	1.27	2.71
CAR	Cotton	1.4	1.50	n.a.	0.49
Chad	Cotton	5.7	n.a.	n.a.	0.21
Côte d'Ivoire	Cocoa	14.4	15.9	9.12	10.82
DRC	Coffee	1.4	n.a.	n.a.	0.10
Gabon	Rubber	n.a.	0.09	0.14	0.34
Ghana	Cocoa	5.5	6.92	7.77	2.63
Kenya	Tea	6.5	4.34	3.03	3.62
Lesotho	Wool	1.9	n.a.	n.a.	0.04
Malawi	Tobacco	23.8	9.84	n.a.	17.31
Rwanda	Coffee	1.3	0.93	1.43	0.99
Togo	Cotton	n.a.	0.54	1.92	1.75
Zambia	Sugar	0.4	1.16	1.01	0.87

Source: Authors' calculations from FAOSTAT and the WDI.

Note: n.a. denotes data not available.

The unstable dynamics of commodity price behaviour compounds the problems of commodity dependent countries. The volatile nature of prices is widely believed to have caused the fluctuations in export earnings in many of the SSA countries. The instability of export earnings is likely to have adverse effects on incomes, investment, and employment with consequently detrimental effects for inclusive growth.

Based on the three empirical models highlighted in the Section 3, we conduct the symmetry (slope based) tests on the two non-linear models (that is, modified Mork and Hamilton) and the causality test on the symmetric model. The results are reported in the Table 3.

Table 3: Symmetry tests: Baseline model

Country	Modified Mork's Model	Marginal Signif. Level	Hamilton's 3 Year Net Increase	Marginal Signif. Level	Linear Symmetric Model	Marginal Signif. Level
Burundi	0.171	0.843	0.596	0.555	0.084	0.772
Benin	1.517	0.230	0.052	0.949	5.728	0.021**
Botswana	0.618	0.543	0.056	0.945	0.229	0.634
Burkina F.	1.992	0.148	2.428	0.101	0.536	0.467
Cameroon	0.747	0.479	0.249	0.095*	6.353	0.015**
CAR	0.010	0.989	0.655	0.524	1.069	0.306
Chad	7.367	0.001***	1.194	0.313	6.617	0.013**
Côte d'Ivoire	0.184	0.832	3.370	0.044**	2.071	0.156
DRC	4.406	0.018**	1.112	0.339	2.000	0.163
Gabon	2.057	0.140	0.101	0.903	0.329	0.568
Ghana	0.683	0.510	0.050	0.950	7.018	0.011**
Kenya	0.036	0.964	0.327	0.722	0.002	0.957
Lesotho	2.064	0.120	1.090	0.346	12.919	0.036**
Malawi	2.676	0.080*	0.184	0.832	2.620	0.112
Rwanda	2.809	0.071*	0.789	0.461	0.024	0.876
Togo	0.944	0.396	0.225	0.789	3.048	0.057*
Zambia	1.962	0.152	1.301	0.283	3.732	0.032**

Source: Authors' calculations.

Note: ***denote significance at the 1%, 5%, and 10%, respectively.

In the case of coffee, price shocks are found to affect the per capita GDP of Malawi and Rwanda. The nature of the price shock in this case is akin to that of the modified model of Mork (1989), where price increases (positive changes in prices) are censored to allow for a non-linear asymmetric VAR model. Coffee prices have shown considerable variation over the sample period (see Table 1) and Rwanda's dependence on coffee as a major source of income has fluctuated over the last decade (see Table 2). In comparison, the DRC has decreased its dependence on coffee. However, in the DRC, coffee output has fallen steadily since the 1980s, owing to disease, lack of maintenance and planting, and smuggling to neighbouring countries—all associated with the country's ongoing conflicts. In recent years, the region has suffered insecurity and civil wars, which have displaced coffee farmers forcing them to abandon their coffee plantations. The upshot is that apart from internal shocks, such as conflict, external shocks, such as commodity price volatility, may have affected per capita GDP in the DRC.

Interestingly, coffee price shocks have shown no impact on the per capita income of Burundi. For cocoa, we find that price shocks have a significant effect in all the countries that depend on cocoa exports. For all these countries there is a significant contribution of export earnings to GDP. In particular, we find that a substantial portion of income in the Côte d'Ivoire is derived through the export of cocoa. The effect of a price shock is symmetric in the case of Cameroon and Ghana. However, for Côte d'Ivoire we find that the asymmetric price shock (that is, the Hamilton three year net increase) has a significant effect on real per capita GDP.

Malawi draws a substantial income from the export of a single commodity being tobacco. We find that the censored price shock increase has an impact on economic growth in Malawi. Cotton price shocks are found to have an impact on Benin, Chad, and Togo. In the case of Benin and Togo, the effect of the shock is symmetric. Both increases and decreases in cotton prices have an impact on the countries' real per capita GDP. There has been a small but significant increase in the dependency of these countries on cotton as a major contributor to GDP over the last decade. In the case of Chad, however, the effect of shocks is asymmetric. There is no effect of price shocks on per capita GDP for the CAR and Burkina Faso. For these two countries the export earnings from cotton as a percentage of GDP has been declining over the recent years. Zambia and Lesotho are affected by symmetric price shocks. Wool and sugar prices are found to cause economic growth in Zambia and Lesotho respectively. Beef has no impact on economic growth in Botswana and the same can be said for tea in Kenya.

In summary, out of the 17 countries chosen in this study, five countries reject the null hypothesis of symmetry, concluding that commodity price increases and decreases have an effect on per capita incomes, but to different extents. We also find evidence, that for the remaining 12 countries, there are six countries where changes in commodity prices affect per capita incomes in a linear fashion. That is, price increases and decreases have approximately the same effect on per capita incomes. Our results from individual country evidence confirm the heterogeneity of experience.

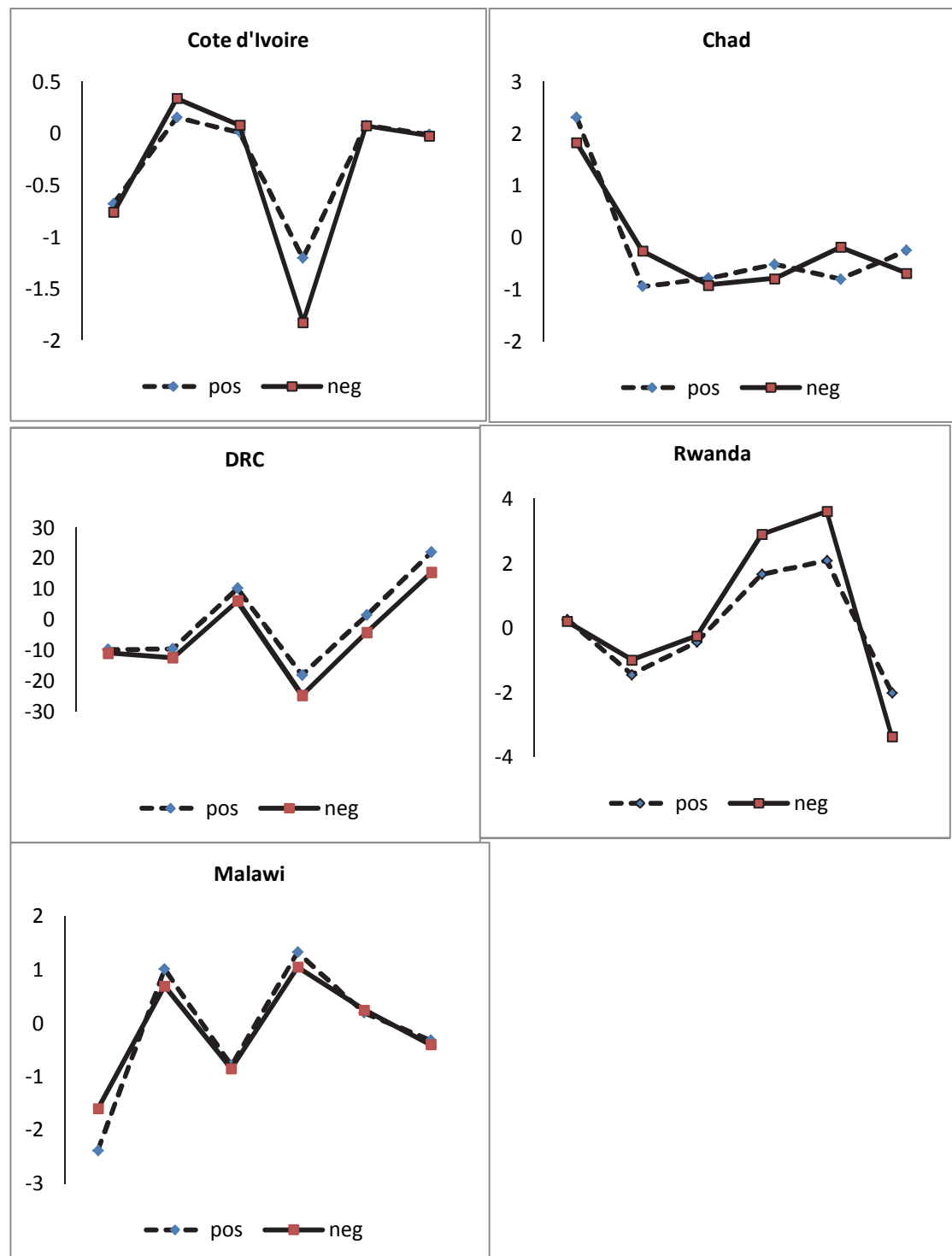
Given that we find evidence of non-linearity in five out of the 17 SSA countries, we conduct an impulse response analysis to study the effects of how a 1 standard deviation shock to commodity prices affects per capita GDP growth in these countries. Figure 1 traces out the response of per capita GDP to a positive and negative commodity price shock.

Using the net cocoa price increase over a three year maximum, we find that after the impact of the shock in the current period there is initially a marginal rise in GDP and then a sharp drop followed by a gradual recovery to the initial level. This drop occurs around the third year and there appears to be a significant difference at this particular time horizon. The negative shock seems to have a greater impact on real GDP per capita than a positive effect. For Rwanda, Malawi, and the DRC, we find that there is a cyclical response of per capita GDP to a commodity price shock. At various horizons there appears to be a significant difference. In the case of Chad, real output per capita is found to fall sharply in the first period after the shock which thereafter stabilises with a mild cyclical fluctuation. Again in this case significant differences between the two responses (positive and negative shocks) appear at different horizons. As discussed before, we carry out a formal test to determine whether these differences are significant.

We start the impulse response function based test of symmetry by allowing the system of equations given by (3) or (4) to be hit by a commodity price shock of standard size, that is, one standard deviation. The results of the test for symmetry are given in Table 4, where for different horizons we record the probability values of the Wald asymmetry test discussed in Section 3. Values below 0.10 indicate that the null hypothesis of symmetry can be rejected at the 10 per cent significance level and are highlighted in bold. The horizon is set to five years so that we can trace the effect of a price shock for up to five years in the future. In the case of Côte d'Ivoire, we find that only after a couple of years after the price shock, the p values are no longer significant at the 10 per cent level, indicating that at longer horizons, as the effect of the initial impulse vanishes, the responses to shocks of different signs converge to each

other. In the case of Cameroon, the results are clearly in favour of the null hypothesis of symmetry since the tests do not detect any significant difference in the IRF to shocks of different signs. Systematic non-linearities are, however, found in the case of the DRC and Chad at different horizons. In the case of Malawi, Côte d'Ivoire, and Rwanda we detect non-linearities in certain specific horizons, though there is no systematic nature of the presence of non-linearities.

Figure 1: Impulse response analysis subject to asymmetric shocks



Source: Authors' illustrations.

Table 4: Impulse response function based test of symmetry for 1 standard deviation shock

	Horizon					
	0	1	2	3	4	5
Cameroon	0.859	0.119	0.196	0.211	0.198	0.253
Chad	0.018	0.010	0.005	0.004	0.005	0.007
Côte d'Ivoire	0.024	0.067	0.143	0.009	0.258	0.052
DRC	0.098	0.067	0.015	0.016	0.033	0.056
Malawi	0.009	0.034	0.167	0.021	0.186	0.270
Rwanda	0.867	0.556	0.369	0.030	0.054	0.088

Source: Authors' calculations.

Note: Number of replications to construct the covariance matrix set equal to 100.

Our test results suggest there is evidence of non-linearity in the response of economic growth when we use the auxiliary variables to define a commodity price shock. That is, we find evidence against the null of symmetry; for almost a third of the countries chosen in our sample. These results suggest that inferring the effect of unanticipated commodity price shocks on economic activity from the usual linear impulse response analysis is likely to be flawed.

5 Conclusion

Many countries in SSA remain heavily dependent on primary commodities as their major source of income. All of these commodities have been subject to high price volatility, and as a result, export earnings have been volatile. This has hindered investment, especially investment in human and physical capital to diversify economies away from their dependence on primary commodities. This paper illustrates the importance of price shocks to economic growth in selected SSA countries. In this respect, the main objective of the paper has been to test whether positive shocks as opposed to negative shocks, and net (sustained) three year shocks in agricultural commodity prices, have any causal effects on per capita GDP growth in SSA countries. The general picture that emerges from this study is that such shocks are expected to have an economically meaningful impact on economic growth, and the evidence exists. We find that approximately a little less than a third, that is, five out of the 17 countries chosen in this study, exhibit an asymmetric response to the sort of price shocks that we employ in this study. Out of these five countries, the dependence on a single commodity has declined over time, although for two countries, Côte d'Ivoire and Malawi, the share of export earnings from a single commodity remains worryingly high. We also find that when employing a linear model, there is further evidence of another six countries whose per capita GDP is influenced by commodity price movements. In this case, however, the response to commodity price movements is symmetric. These six countries have shown that the dependency on a single commodity has fluctuated over time. However, two countries (Benin and Ghana) have a modest share of export earnings from a single commodity export.

The upshot from our analysis is that if we allow for a different (non-linear) nature of commodity price shocks, then our conclusions can be quite different. While using a linear model we find only limited evidence, that is, in only five of the seventeen SSA countries, per capita incomes are affected by price movements. However, when allowing for the non-linear definitions of price shocks, we find that a further six countries' per capita income responds asymmetrically to such price shocks. From a policy perspective our results suggest that the emphasis of commodity price shocks as a source of economic instability in SSA countries

should not be understated. While our results are in line with those of Collier and Goderis (2012) and Raddatz (2007), we specifically show that the link between commodity prices and economic growth, allowing for both linear and non-linear models, is quite profound as opposed to previous studies. Of course, there are other external and internal shocks that should not be disregarded, however, we find that commodity prices alone have an important impact on economic growth, and have non-trivial quantitative effects which merit attention.

What are the policy implications for the issue of inclusive growth? Pilot programmes of cash transfers have been launched in various countries chosen in this study, such as Burkina Faso, Ghana, Kenya, Malawi, and Zambia. However, it has been argued that these transfers are ad hoc social support schemes that are not aimed at smoothing income, but to protect low-income households by improving education and health outcomes for children. Given that the cash transfer programme is based on using household characteristics rather than current income, these programmes are unlikely to insure against income volatility resulting from international commodity price shocks (Bourguignon 2012). While Gupta et al. (2007) and Coady et al. (2010) have emphasised the importance of not being rushed to take ad hoc measures after a price shock so that transfers can be channelled properly to low-income households, an additional problem remains to address the impact of positive and negative shocks, which can have an asymmetric effect on GDP. Another policy instrument is a public employment programme that offers jobs which are below the market wage rate, directed to individuals who are unable to earn a living (Bredenkamp and Bersch 2012). These are temporary programmes which are implemented during a period of crisis. However, the problem with these programmes is the cost and the delay in starting the programme on time. Furthermore, there is no clear mechanism for increasing the intensity of these programmes (possibly financed through foreign aid) in response to a commodity price shock. A further policy instrument would be to expand microfinance. This would allow individuals to smooth their consumption when hit by positive or negative shocks. However, in SSA countries where the large majority of the people do not have access to any finance institution, it is unlikely that microfinance can play a role in coping with income shocks (Bourguignon 2012).

These policy instruments are important for addressing how vulnerable households in SSA countries can cope with idiosyncratic shocks to incomes. Implementing these policies requires governments to have the capacity for funding these transfers and programmes through fiscal policy in the face of commodity price fluctuations. Of course, accumulating reserves during good times and spending these reserves during bad times would be a straightforward mechanism to deal with the welfare impact of fluctuations in GDP. However, as we have observed in the past, this is difficult to implement given the political pressures that governments face during boom times. Obviously, setting a rule to implement these policies becomes more difficult given the evidence we find with respect to the mix of linear and non-linear asymmetric shocks that are found to have an impact on per capita real GDP. It is likely that countries which experience depressed commodity prices over a protracted period of time would require much more ODA than is presently available.

Given the volatility of aid flows, the implication is that for some vulnerable SSA countries, some of the aid may need to be saved in the short term, especially when faced with a negative commodity price shock. Studies by Aiyar et al. (2005) as well as Foster and Killick (2006) indicate that many SSA countries saved a part of the increased aid inflows. However, donors are reluctant to continually provide aid that is saved, and there are pressures in the recipient country to spend the increased inflows of aid especially if the aid is linked to specific projects (Gupta et al. 2007). Ultimately, for SSA countries the capacity of governments and policy

makers to use aid effectively needs to be understood by both donors and recipients given the possible asymmetric nature of commodity price shocks that can be commodity specific and applicable to specific countries.

As far as donors are concerned, directing aid to the development of infrastructure that facilitates trade will help them support countries to diversify their economies (Bourguignon 2012). Granting SSA countries more trade preferences may help them diversify into the export of other primary commodities and possibly manufactured goods (Collier and Venables 2007). A horizontal diversification programme should include higher value added products as well as temperate products that are unrelated to traditional exports, so that a balance can be achieved between commodities that are subject to persistent and short-lived shocks. The strategy of horizontal diversification would be successful depending on farmer access to improved credit, good quality seeds, improved rural infrastructure, and efficient cultivating techniques. Vertical diversification would require state supported institutions in order to facilitate quality and technological upgrading. Overall, any diversification programme has to be developed in line with current trends in international commodity trade.

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