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Agricultural Commodity Price Shocks and their Effect on Growth in Sub-Saharan Africa

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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 and allows us to determine whether the response of per capita 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

JEL code E30, F40, O11

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, IMF and UNCTAD have emphasised 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.

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 just several examples). Though in recent years SSA countries have experienced a general increase in economic growth, on the whole, for at least the last half 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 the average share of GDP from agriculture in SSA countries during the past half century has 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, Valenzuela and Anderson, 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 (1989) pointed out that positive oil price shocks had a greater impact on the U.S. 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

[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.

[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 clsely linked to inclusive growth when considering a selection of SSA countries.

between commodity price increases that establish new highs relative to recent experience and increases that simply reverse recent decreases.

This study adds to the literature in a crucial dimension by aiming to be more specific about whether this specific attribute of agricultural commodity price movement, such as price shocks, matters for growth, and if so, to measure their impact, and to document 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).

This paper is structured as follows: The following section describes the literature review, followed by a description of the econometric methods. The next section 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 1980–1995 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. Blattman et. al. (2007) using historical data 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) described 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 (1999) results of a negative effect on growth [see Rodriguez and Sachs (1999), Gylfason et al. (1999), and Bulte et al. (2005) among others]. On the other hand, 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 due to 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) has shown, 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 or VAR models) Deaton and Miller (1996) and Hoffmaister et. al. (1998) 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 ECM 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, 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 have recommended against

using aggregate indices that constitute a group of commodities (such as metals, beverages, etc.,) and have concluded that individual commodities should be modelled separately.

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 nonlinear.

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

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

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 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 (2011) can produce consistent and valid estimators of coefficients regardless of whether the data generating process is symmetric or asymmetric. The 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 (1989) transformation of commodity price is given by the near VAR model below:

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

Following the line of reasoning proposed by Mork (1989), we adopt a nonlinear 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 coefficients, 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:

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

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:

$$x_t^{+,net} = max[0, x_t - \max\{x_{t-1}, x_{t-2}, \ldots., x_{t-n}\}]$$

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 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 (1989), we can test for symmetry in the framework of (2) and (3) by the following hypothesis:

$$H_0: \left(g_{21,1} = g_{21,2} = \cdots g_{21,p} = 0\right) \tag{4}$$

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 (1989) which involves testing the following null hypothesis:

$$H_0: \left(g_{21,0} = g_{21,1} = g_{21,2} = \cdots g_{21,p} = 0\right) \tag{5}$$

Kilian and Vigfusson (2011) note that the modified version of Mork's model may have higher power, and 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).

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 U.S. dollars and was obtained from the World Development Indicators compiled by the World Bank. For real commodity prices we choose an extended data set of the original Grilli-Yang Commodity Price Index (GYCPI). For this study we choose the period 1960-2010 to allow a match with the per capita GDP data sample.

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 up that commodity prices do not have symmetric shocks. Deaton and Laroque (1992) 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.

Table 1 below describes 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 about here]

For all the commodities considered in this study, we find that they are characterised with first order autocorrelation coefficients of at least 0.6, with more than half of the commodities being roughly around 0.8 or greater. The second order correlation coefficients are lower but are still substantial. The coefficient 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 was 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 below shows the share of the export earnings of a single commodity as a percentage of GDP in recent years.

[Table 2 about here]

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 nonlinear models (that is, modified Mork and Hamilton) and the causality test on the symmetric model. The results are reported in the Table 3 below.

[Table 3 about here]

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 nonlinear 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 D.R.C. 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 Cote 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 Cote d'Ivoire we find that the asymmetric price shock (that is, the Hamilton 3 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 country's 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 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, 5 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 6 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, confirms the heterogeneity of experience.

5. Conclusion

This paper illustrates the importance of price shocks to economic growth in selected SSA countries. The result 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, 5 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 six countries, the dependence on a single commodity has declined over time, although for two countries, Cote 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 6 countries whose per capita GDP is influenced by commodity price movements. In this case however, the response to commodity price movements is symmetric. These 6 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 (nonlinear) 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 nonlinear 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 nonlinear 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.

TABLES

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

^denotes significance at the 10% level

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
C.A.R.	Cotton	1.4	1.50	n.a	0.49
Chad	Cotton	5.7	n.a	n.a	0.21
Cote d'Ivoire	Cocoa	14.4	15.9	9.12	10.82
D.R.C.	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 World Development Indicators. N.a. denotes data not available.

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****
C.A.R.	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**
Cote d'Ivoire	0.184	0.832	3.370	**0.044****	2.071	0.156
D.R.C.	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****

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

References

Aghion, P., P. Bacchetta, R. Rancière, and K. Rogoff. 2009. Exchange Rate Volatility and Productivity Growth: The Role of Financial Development. *Journal of Monetary Economics*. 56, 494–513

Ahmed, S. 2003. Sources of Macroeconomic Fluctuations in Latin America and Implications for choice of Exchange Rate Regime. *Journal of Development Economics* 72, 181 – 202.

Aiyar, S., A. Berg, and M. Hussain. 2005. The Macroeconomic Challenge of More Aid, in Finance and Development. 42, No. 3. Washington DC: IMF.

Alexeev, M. and R. Conrad. 2009. The Elusive Curse of Oil. *Review of Economics and Statistics*. 91, 586–598

Anderson, K. and M. Bruckner. 2012. Distortions to Agriculture and Economic Growth in Sub-Saharan Africa. Policy Research Working Paper 6206. World Bank. Washington DC.

Auty, R. 1993. *Sustaining Development in Mineral Economies: The Resource Curse Thesis*. New York. OUP.

Blattman, C., J. Hwang, and J.G. Williamson. 2007. Winners and losers in the commodity lottery: The impact of terms of trade growth and volatility in the periphery 1870 – 1939. *Journal of Development Economics*. 82, 156 – 179.

Bleaney, M. and D. Greenaway. 2001. The Impact of Terms of Trade and Real Exchange Rate Volatility on Investment and Growth in Sub-Saharan Africa. *Journal of Development Economics*. 65, 491–500.

Broda, C. 2004. Terms of Trade and Exchange Rate Regimes in Developing Countries. *Journal of International Economics* 63, 31 – 58.

Brunnschweiler, C.N., and E. Bulte. 2008. The Natural Resource Curse Revisited and Revised: A Tale of Paradoxes and Red Herrings. *Journal of Environmental Economics and Management* 55, 248 – 264.

Bulte. E., R. Damania, and R. Deacon. 2005. Resource intensity, Institutions and Development. *World Development*. 33, 1029 – 1044.

Byrne, J.P., G. Fazio, and N. Fiess. 2013. Primary commodity prices: Co-movements, common factors and fundamentals. *Journal of Development Economics*. 101, 16 – 26.

Collier, P. and B. Golderis. 2012. Commodity prices and growth: An empirical investigation. *European Economic Review*. 56, 1241 – 1260.

Collier, P. and A. Venables. 2007. Rethinking Trade Preferences: How Africa can Diversify its Exports. *World Economy* 30, 1326 – 1345.

Deaton, A. 1999. Commodity prices and growth in Africa. *Journal of Economic Perspectives*. 13, 23–40

Deaton, A. and R. Miller. 1996. International Commodity Prices, Macroeconomic Performance and Politics in Sub-Saharan Africa. *Journal of African Economies* 5, 99 – 191.

Deaton, A., Laroque, G., 1992. On the Behaviour of Commodity Prices. *Review of Economic Studies* 59, 1-23.

Easterly, W., M. Kremer, M. Pritchett and L. Summers. 1993. Good Policy or Good Luck? Country Growth Performance and Temporary Shocks. *Journal of Monetary Economics*. 32, 459 – 483.

Easterly, W. and R. Levine 1997. Africa's Growth Tragedy: Policies and Ethnic Divisions. *Quarterly Journal of Economics*. 112, 1203-1250.

Erten, B. and J.A. Ocampo. 2013. Super Cycles of Commodity Prices since the Mid-Nineteenth Century. *World Development* 44, 14 – 30.

Foster, M., and T. Killick. 2006. What Would Doubling Aid Do for Macroeconomic Management in Africa? ODI Working Paper No. 06/264 London: Overseas Development Institute.

Garcia-Verdu, R., A. Selassie and A. Thomas. . 2012. Inclusive Growth in Sub-Saharan Africa: Evidence from Six Countries during Recent High Growth Period. in R. Aretzki, C. Patillo, M. Quintyn, and M. Zhu (ed) Commodity Price Volatility and Inclusive Growth in Low Income Countries. IMF, Washington DC, USA. p. 205 – 224.

Ghoshray, A., Kejriwal, M. and Wohar, M., 2014. Forthcoming. Breaks, Trends and Unit Roots in Commodity Prices: A robust examination. *Studies in Nonlinear Dynamics and Econometrics*

Ghoshray, A., 2013. Dynamic persistence of primary commodity prices. *American Journal of Agricultural Economics*, 95 (1), pp. 153-164.

Ghoshray, A., 2011. A reexamination of trends in primary commodity prices. *Journal of Development Economics*, 95 (2), pp. 242-251.

Gylfason, T. and G. Zoega. 2006. Natural Resources and Economic Growth: The Role of Investment. *World Economy*. 29, 1091–1115.

Gylfason, T. 2001. Natural Resources, Education, and Economic Development. *European Economic Review*. 45, 847–859.

Gylfason, T., T. Herbertsson, and G. Zoega. 1999. A Mixed Blessing: Natural Resources and Economic Growth. *Macroeconomic Dynamics* 3, 204 – 225.

Hamilton, J.D., 1996. This is what happened to the oil price-macroeconomy relationship. *Journal of Monetary Economics* 38, 215-220.

Hamilton, J.D., 2003. What is an oil shock? *Journal of Econometrics* 113, 363-398.

Harvey, D.I., Kellard, N.M., Madsen, J.B., Wohar, M.E. 2010. The Prebisch Singer Hypothesis: Four Centuries of Evidence. *Review of Economics and Statistics* 92, 367-377.

Hausmann, R. and R. Rigobon. 2003. An Alternative Interpretation of the Resource Curse: Theory and Policy Implications. in *Fiscal Formulation and Implementation in Oil Producing Countries*. ed J. Davis. Washington DC; IMF, 12 – 44.

Hoffmaister, A., J. Roldos and P. Wickham. 1998. Macroeconomic Fluctuations in Sub-Saharan Africa. *IMF Staff Papers* 45.

Kellard, N., Wohar, M. 2006. On the prevalence of ternds in primary commodity prices. *Journal of Development Economics*, 79, 146 – 167.

Kilian, L. and Vigfusson, R.J., 2011. Are the responses of the U.S. economy asymmetric in energy price increases and decreases? *Quantitative Economics* 2, 419-453.

Kilian, L. and R. Vigfusson. 2009. Pitfalls in Estimating Asymmetric Effects of Energy Price Shocks. International Finance Discussion Papers 970. Board of Governors of the Federal Reserve System. U.S.A.

Kose, M.A. and R. Riezman. 2001. Trade Shocks and Macroeconomic Fluctuations in Africa. *Journal of Development Economics*. 65, 55 – 80.

Lee, K., Ni, S., and Ratti, R.A., 1995. Oil shocks and the macroeconomy: the role of price variability. *Energy Journal* 16, 39-56.

Mendoza, E. 1995. The terms of trade, the real exchange rate, and economic fluctuations. *International Economic Review*. 36, 101 – 137.

Mork, K.A., 1989. Oil and the macroeconomy when prices go up and down: an extension of Hamilton's results. *Journal of Political Economy* 97, 740-744.

Ndulu, B.J. and S.A. O'Connell 2007. Policy Plus: African Growth Performance 1960-2000, Ch. 1 in B.J. Ndulu, P. Collier, R.H. Bates and S. O'Connell (eds.), *The Political Economy of Economic Growth in Africa, 1960-2000*, Cambridge: Cambridge University Press. 3 – 75.

Pesaran, H. and R. Smith. 1995. Estimating Long Run Relations from Dynamic Heterogeneous Panels. *Journal of Econometrics* 68, 79 – 113.

Pfaffenzeller, S., Newbold, P., Rayner, A. 2007. A short note on updating the Grilli and Yang commodity price index. *World Bank Economic Review* 21, 151-163.

Raddatz, C. 2007. Are external shocks responsible for the instability in low income countries? *Journal of Development Economics*. 155 – 187.

Rodriguez, F. and J. D. Sachs. 1999. Why Do Resource-Abundant Economies Grow More Slowly? *Journal of Economic Growth*. 4, 277–303

Sachs, J. and A. Warner. 1999. Natural Resource Abundance and Economic Growth. NBER Working Paper.

Sandri, D., E. Valenzuela and K. Anderson. 2007. Economic and Trade Indicators, 1960 to 2004. Agricultural Distortions Working Paper 02, World Bank, Washington DC.