MASTER OF MANAGEMENT IN FINANCE AND INVESTMENTS

A RESEARCH REPORT ON

Commodity Prices and Exchange Rates in Southern African Countries

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ABSTRACT

This study empirically assesses the relationship between exchange rates movements with non-fuel commodity prices indices of five Southern African countries, namely; Botswana, Malawi, Mozambique, South Africa, and Zambia. Monthly International Monetary Fund (IMF) non-fuel commodity price indices (NFCI) and monthly exchange rates (expressed USD per unit of the local currencies) that span January 1996 to September 2018 were used for this study.

The econometric techniques employed were EG two-stage and Johansen Trace cointegration tests, VAR(1) models, and Granger causality tests. The cointegration tests reveal no long-run relationship between commodity price index and exchange rates for all of the selected countries, which implies that in the long term there is equilibrium link between these two variables of interest for neither Botswana, Malawi, Mozambique, South Africa, nor Zambia.

The study fails to reject that there is no Granger causality between the commodity price index and exchange rates in both directions for Botswana, Malawi, and Mozambique. At the 10% significance level commodity price index Granger cause exchange rates and exchange rates Granger cause commodity price index for South Africa; Zambia has only a uni-directional Granger causality from exchange rates to commodity price index. Thus, the interdependence between these two variables is not complete but partial.

It is recommended that, for further studies, an endeavor be made to find the possible exogenous variables that serve as the determinants of commodity prices and exchange rates.

DECLARATION

I, Edward Theka, Student Number: 718376, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in Finance and Investment at the University of the Witwatersrand, Johannesburg.

It has not been submitted before for any degree or examination in this or any other university.

Signature ----------

Edward Theka

Signed at ..... On the ..... day of 2019

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1. Chapter 1: Introduction

1.1 Background to the study

Commodities are an important component of the global economy for many different but obvious reasons. They support the livelihoods of the masses in all classes of economies; developed, emerging, and frontier. Commodities are also particularly essential for the industrial revolutions the world continues to witness. This applies to a broad range of them; including, but not limited to precious metals (gold, silver, and platinum, etc.), base metals (aluminium, copper, lead, tin, zinc, etc.), and soft agricultural commodities (coffee, cocoa, corn, cotton, etc.).

It is quite obvious that commodities have been a source of national income for countries where they are mined or grown. This applies to different countries across different continents. The revenues generated from commodities are mainly from their exportation, rather than internal use. This implies a corresponding import expenditure for countries that are not endowed with some of these natural resources. The interaction of imports and exports of commodities between countries is facilitated by the foreign currency (exchange rate) as the medium of exchange. Given the size of the global market on commodities and the complexities in currency differences across countries, the relationship between commodities prices and exchange rates (for exporting) economies has been a constant puzzle. This relationship has received widespread attention because of the ramifications it has on the macroeconomic wellbeing of commodity-exporting countries (Aslam et al., 2016). On the other hand, for countries whose wealth largely depends on commodity exports, prices are affected by macroeconomic variables such as the net foreign asset position, productivity differentials, trade openness, public expenditure, and especially terms-of-trade (defined as the ratio of the prices of a country's exports to the prices of its imports) which in turn determine their real exchange rates (Dauvin, 2014). For many African (and developing) countries that depend on national revenue from commodities exports on the one hand but with weak (as compared to developed economies) macroeconomic fundamentals, on the other hand, commodity prices and exchange rate relationships are important aspects of their national terms-of-trade dynamics under floating exchange rate regimes.

Since the early 2000s, the pronounced increases in the prices of fuel and non-fuel commodities around the world has renewed interest in their relationship with exchange rates of exporting countries culminating in the term "*commodity currencies*". This term has been applied to both developed countries (Chaban, 2009; Coudert, Couharde, & Mignon, 2008, 2011; Kearns, 2007; Cashin, Céspedes, & Sahay, 2004; etc.) and developing countries (Bodart, Candelon, & Carpantier, 2012; Groen & Pesenti, 2011; Kohlscheen, 2010; Maveé, Perrelli, & Schimmelpfennig, 2016; Schaling, Ndlovu, & Alagidede, 2014; etc.). Amongst others, the term stems from the Chen (2002) who find that for three major Organisation for Economic Co-operation and Development (OECD) primary commodity producers, nominal exchange rates show a strong response to changes in the world market prices of their exports (see, also Chen & Rogoff, 2003; Chen, Rogoff, & Rossi, 2010).

On the other hand, Clements & Fry (2008) propose "currency commodities" premised on the argument that because of pricing power, the value of currencies of certain commodity-producing countries affects commodity prices, such as metals, energy, and agricultural-based products. One spin-off from these two theories is "oil currencies" with specific reference to Organisation of Petroleum Exporting Countries (OPEC) (Korhonen & Juurikkala, 2009). This study is based on the former two arguments to examine commodity prices and exchange rates relationship for selected Southern African countries which depend on commodity exports. This study is important since the impact of trade fluctuations in commodity exporting economy results in high volatility in their real exchange rates, with the detrimental effect on their economies as enterprise players, particularly small firms, struggle to hedge against this volatility (Arezki et al, 2014).

1.2 Problem Definition

Studies bordering on commodity prices and exchange rates for commodity exporting countries in Africa have been on the rise in recent years. These studies have risen in the light of many countries (including African countries) adopting exchange rate liberalisations since the early 1990s because it allows for a fair analysis of this interaction. However, given the dependence of many African countries on commodity exports (see Appendix 1 for a summary – Southern Africa is the most dependent on exports of non-fuel commodities than all the rest), the extent of research does not match this magnitude.

One the one hand, many of these studies have been limited to one country and one export commodity only. For instance, Adubi and Okunmadewa (1999) indicate agricultural exports and exchange rates in Nigeria are inversely related after the devaluation of the Naira in 1986. Similarly, Arezki et al. (2014) found that, South Africa, gold price volatility played a key role in explaining excessive exchange rate volatility with reverse direction of causality pre- and post- capital account liberalisation. Further, following the global financial crisis (GFC), Maveé et al. (2016) find that the instability in the South Africa Rand (ZAR) is mainly driven by commodity price volatility, besides global market volatility and domestic political uncertainty. They considered the four main exported commodities (gold, coal, platinum, iron ore), and the main imported commodity (Brent crude oil).

To exclude the effects of the weight of petroleum products in establishing commodities prices and exchange rates nexus Schaling et al. (2014), with inspiration from Chen & Rogoff (2003) and Simpson (2002) use non-fuel commodity price index against the ZAR in reverse directions between 1996 and 2010. They find a unidirectional causal link from commodity prices to the ZAR. This study takes this as a point of departure and addresses the important gaps in the literature.

First, the extant literature is focused on South Africa and Nigeria while other countries such as Botswana is a world dominant exporter high-quality gem diamonds. In this study, a number of Southern African countries are examined together. Second, this study employs current data from 1999 to 2018 review the findings from the above studies. Third, the study scales up Schaling et al. (2014) by including a cross-section of Southern African countries (i.e. Botswana, Malawi, Mozambique, and Zambia) which are very dependent upon Diamond, Tobacco and Sugar, Aluminium, and Copper, respectively. Further, with different countries studied, differing findings can lead to a retrospective analysis of the country-specific features such as foreign aid that moderate exchange rates. The findings from this study can help governments and policymakers in formulating monetary mechanisms that improve their terms-of-trade given the importance of both commodities and exchange rates for the health of their respective economies.

1.3 Research Objectives

The main purpose of this study is to examine the relationship between commodity prices and exchange rates in 5 selected commodity-dependent countries in Southern Africa. In doing so, the following specific objectives are investigated:

- To examine the trend in non-fuel commodity index and exchange rates for the selected Southern African countries (Botswana, Malawi, Mozambique, South Africa, and Zambia)
- To examine the direction of causality between non-fuel commodity index and exchange rates for the selected Southern African countries
- To investigate the concepts of "commodity currencies" and "currency commodities" for each of the selected Southern African countries
- To compare and contrast non-fuel commodity price-exchange rates link for the selected Southern African countries.

1.4 Research Questions

The study poses the following questions based on the research of objectives:

- What is the historical pattern of non-fuel commodity index and exchange rates in the selected Southern African countries?
- What is the direction of causality between non-fuel commodity index and exchange rates for the selected Southern African countries?
- Does the concept of "commodity currencies" or "currency commodities" apply to each of the selected Southern African countries?
- Is the relationship between relationship between non-fuel commodity index and exchange rates for the selected Southern African countries time-variant (changing at different time horizons)?

1.5 Delimitations and limitations of the study

This study spans across selected Southern African countries with distinct major commodity exports from 1996 to 2018 and thus excludes other regions of Africa as well as countries that have significant commodity export earnings but not to the levels of those selected. This potentially limits the generalisation of inferences for all African countries and also for the world.

Another limitation stems from the use of non-fuel commodity index as a proxy for commodity exports. Though this moderates the huge impact of petroleum products from the analysis, it also leaves an incomplete picture of for the study. Further, by using this index the specific commodity's price relationships with exchange rates are silenced given that each of the countries has at least one dominant commodity.

Furthermore, prices and revenues associated with a commodity of a country maybe dependent on pre-negotiated trade agreement rather than by the prevailing forces of demand and supply. This constrains the true reflection of the relationship with exchange rates given that exchange rates are typically floating. Lastly, the exclusion of other macroeconomic variables such as inflation and balance of payments which tend to impact exchange rates temper the robustness of inferences from the study.

1.6 Significance of the study

This study is important for commodity-dependent Southern African countries to manage, to the extent of their abilities, the link between commodity export earnings (and prices) and exchange rates. Noting the inevitable dependence of some developing countries on income from their commodity exports Cashin, Céspedes, & Sahay (2004) emphasise the ability of these countries to determine their monetary policy in order to attract their forex inflows from their commodity exports. An understanding of whether their countries are characterised by commodity currencies or currency commodities will inform their actions in order to improve the health of their national accounts in terms of growth and stability.

In the group of countries chosen for this study (South Africa, Malawi, Mozambique, Botswana and Zambia) robust literature only exists for South Africa and some for Zambia, yet this basket of countries is an area of focus in the definition of sub-Saharan African countries fitting the definition of where a great portion of commodities are exported from. With the knowledge of the differences of how these countries are under the commodity price-exchange rate link, it can engender a comparative policy analysis between the countries to improve their respective standings. Furthermore, by nature of the interdependence of these countries' economies through import and exports between them, it is important to understand the dynamics of each of these economies in relation to their exports revenue and economic stability, to understand their levers of growth.

1.7 Organization of the study

The study is structured into five chapters. Chapter one is an introduction to the study. It focuses on the background of the study, statement of the problem, study objectives, research questions, the significance of the study, and the scope and limitations of the study. The second chapter throws light on the theoretical review of the literature on the subject matter and further analyses the empirical studies that have been undertaken with a focus on African countries and their commodity exports vis-à-vis exchange rates.

Chapter three presents the research methodology employed for this study, details of selected the study area and the variables. Further, it details out the specific econometric techniques that are employed to help answer the research question to address the research objectives. Chapter four provides the analysis, interpretation and discussion of the findings of the study. The final chapter concludes the study and makes inferences from the analysis. Recommendations are also made to stakeholders of this study.

2. Chapter 2 : Literature Review

2.1 Commodity prices and exchange rates

It is widely understood that commodity prices can have an impact on real exchange rates of the exporting countries, and particularly so in the case of small open economies. Bodart, Candelon and Carpantier (2011) pay particular attention to this, in the light of commodity boom and bust cycles of periods recent to their study, a phenomenon that has recurred even in the periods after this publication. What is unique of this study, is that it is one of few that focuses on small developing countries, but also specifically incorporates the non-mineral exports of African countries. They argue, that, unlike the studies of Chen and Rogoff (2003) and Cashin et al. (2004), which use export indices, their study on specific dominant exports (single dominant commodity) of each of their countries selected, provides more insight into the relationship between that commodity price fluctuation and the corresponding exchange rate.

Their study is particularly founding for the purposes of this study in that the overall relationship between exchange rate movements and commodity prices is substantially established for further analysis in other studies. In their findings, they concluded that the real exchange rate appreciated in tandem with the price of the leading commodity exported by the country increasing, where dominant commodity accounted for at least 20 percent of the total exports of the country. A further observation was also that "the larger the share of the main exported commodity, the stronger is the impact on the real exchange rate" as one would infer from the assumed relationship. One key inference from these results is that small developing countries heavily specialized in the export of one commodity can be deemed to be vulnerable to "Dutch disease" effects. They recommend in their conclusion that such countries would fare well to consider the ease of monetary (or exchange rate) policy in periods of long or lasting increase in commodity prices.

Coudert, Couharde and Mignon (2008) embarked on a study to review the impact of terms of trade and their influence on real exchange rates, in a comparison of oil and commodity currencies. They specifically sought to investigate whether the effect of terms of trade on the real exchange rate was different in oil-exporting countries compared to other commodity producers, and secondly to quantify the extent to which exchange rate misalignments are linked to exchange rate regimes and to the anchor currency. Of the 52 commodity-exporting countries observed in the study, the mix included African countries, specifically Malawi and Zambia,

and for this reason, the observations of this literature are deemed to be significant for the guidance of the direction of this study.

Significant findings of this study were that real exchange rates co-move with commodity prices in the long run, as they are cointegrated. Similar relationships were observed for oil-exporting countries, although the response of their real exchange rates to oil price was found to be smaller.

They also observed common patterns in real exchange rates of commodity and oil exporters; most commodity prices were on a downward trend in the 1980s and the 1990s, commodity currencies tended to depreciate. A similar observation applied for oil- currencies.

For pegged currencies, their anchor was the determinants of their behaviour. "USD-pegged currencies were dragged down by the dollar fall and appear undervalued at the end of the period, whereas EUR-pegged currencies were being pushed upwards by the euro appreciation". They also found that there was high volatility in anchor currencies, such that they may have overshadowed the impact of economic fundamentals on pegged exchange rates. The comparison of misalignments of pegged commodity and oil currencies across different periods confirmed that during periods of dollar (euro) overvaluation, currencies pegged to the dollar (euro) showed overvaluation, whereas the reverse applied when the dollar (euro) is undervalued. This confirms that, even for the African commodity-exporting countries, the same dynamics apply with respect to terms of trade and the real exchange rates.

A study by Cashin et al. (2004) sought to determine how many commodity-exporting countries have 'commodity currencies'; meaning that movements in real commodity prices can explain fluctuations in their real exchange rates. In their examination of real commodity-price explanation of movements in the real exchange rates of 58 commodity-dependent countries, over a long period (1980 – 2002), they observed that a third of the commodity-exporting countries exhibited robust evidence in support of the long-run co-movement of national real exchange rate and real commodity-export price series. A key revelation of this study was also the dispelling of the previous theories of Power Purchasing Parity as a model basis of exchange rate movements, as it was found that the long-run real exchange rate of commodity currencies is not constant (as would be implied by parity-based models) but is time-varying, being dependent on movements in real commodity prices. Their weak exogeneity tests also indicated that, for the majority of commodity currencies, it is the real exchange rate which adjusts to

restore the long-run equilibrium with real commodity prices, an extrapolation of the direction of causality.

Drawing inference from this, Dauvin (2014) also investigated the relationship between energy prices and the real effective exchange rate of commodity-exporting countries. In this study, two sets of countries: 10 energy-exporting and 23 commodity-exporting countries over the period 1980– 2011, were analysed. In a bid to we show that a certain threshold exists beyond which the real effective exchange rate of both energy and commodity exporters reacts to oil prices, they concluded that the link was through the terms-of-trade. The study's selection of commodity-exporting countries again here includes Malawi and Zambia, lending significance of the study's results to the context of this research.

Specifically, it was found in this study that a positive long-term relationship existed between energy terms-of-trade and the real effective exchange rate of energy-exporting countries; such that 10% increase in energy price quantifiably led to a 2.5% appreciation of their currency, coining these "energy currencies".

"Commodity currencies" are defined as currencies that move in tandem with global prices of primary commodity products, as a result of those countries' dominant dependency on the export of the specific commodity export as a source of their income. By deduction then, these commodities whose prices are substantially affected by currency fluctuations can be referred to as ***"currency commodities".*** The impact of both commodity currencies and currency commodities operating simultaneously in global markets is explored comprehensively in a study by Clements and Fry (2008). Previous studies to this had only focused on specifically the causal link from commodity prices to currency values, deemed as "commodity currency" models, or the impact of exchange rate changes on commodity prices, which is determined by pricing power in global markets, deemed as "currency commodities", without assessing the simultaneous interaction.

The revelations from this approach were significant in quantifying that there was less compelling evidence that currencies are affected by commodities, as opposed to commodities being affected by the commodity currencies. Their evidence from the analysis showed that "spillovers from commodities to currencies contributed less than 1 percent to the volatility of the currency returns, whilst spillovers from currencies to commodities generally contributed

between 2 and 5.2 percent to the commodities", and this is an inference into the direction of causality, one of the key questions in the construct of the research proposed here.

Chen and Rogoff (2003) cite correctly that there is an elusive connection between economic fundamentals and exchange rates, which is considered to be one of the most controversial issues in international finance. Their study explored the shocks in commodity prices and exchange rates by studying commodity exporting countries of relatively well-developed open countries (Australia, Canada, and New Zealand). This research was driven by the observations of difficulties in empirically relating exchange rate behaviour to shocks in macroeconomic fundamentals of earlier studies by other earlier researchers, such as Meese-Rogoff (1983), Frankel and Rose (1995) and Froot and Rogoff (1995). Using OLS regressions, they found that, with the exception of Canada, the terms of trade, measured as the export to import price ratio appeared strongly correlated with the real exchange rates.

Arezki et al. (2014) then inferred on these findings by Chen and Rogoff (2003), to explore, specifically for South Africa, the relationship between gold price and the South African Rand to US dollar exchange rate volatility in a pre- and post-capital account liberalization period. Traditional unit test roots (Phillips-Perron and Dickey-Fuller) confirmed that the two time series of gold price and exchange rate were co-integrated, and then using a Vector Error Correction Model (VECM), and find that, in the long run, gold price volatility is driven by real effective exchange rate (REER). This study's findings are important because they refer to an emerging economy, South Africa.

A similar study by Jain and Biswal (2016) explores the dynamic linkages amongst oil price, gold price, exchange rate and stock market in India. This study is also deemed relevant because India is an emerging economy, and its exchange rate relationship with gold price becomes of interest when compared to the findings of Arezki et al (2014), described above. A DCC-GARCH model was used to examine the time-varying correlations between the series, and observation of the signs of the coefficients of the model drew inference that a fall in gold prices would cause a depreciation of the Indian Rupee exchange rate and that in turn caused a fall in the Sensex, the index of the stock market, of that country. Further still, in this study, using Non-Linear Causality tests to explore the lead-lag relations of these variables, the direction of causality was observed such that gold price causes the exchange rate in India, and subsequently, the exchange rate causes stock market behaviour. This is in line with the findings of Arezki et

al (2014), whose observation was also that the gold price volatility was the influencer of the South African Rand volatility.

The significance of oil in the energy market and its impact on world economy provides an interesting basket case for the study of these oil-exporting countries, with a particular focus on their exchange rates. The volatility of oil prices also then creates the right environment of analysis of the relationship, as most oil exporting countries would have this as their dominant export. Korhonen and Juurikkala (2007), in their study, interestingly apply a BEER (Behavioural Equilibrium Exchange Rate) approach, where a number of plausible variables are introduced as determinants of real exchange rate, to eliminate the bias of any particular theory of exchange rate determination.

Their study revealed, from the coefficient estimates, that a 10% increase in the real price of oil led to an appreciation of approximately 5% in the equilibrium exchange rate of a typical oil-producing country, for all of their chosen OPEC countries. Another interesting revelation from the study is that Real per capita GDP, did not appear to have a clear effect on real exchange rate, dispelling a notion otherwise assumed that higher per capita GDP relative to the US can be associated with a stronger currency, and proving that the sole determinant of th exchange rate fluctuations was due to the oil price variability. This finding is significant in leading the study, from its inference that there is an arguable case of independence in studying the direct relationship of commodity price to real exchange rates of any exporting country, as is done in this study.

2.2 Causality and Cointegration in Commodity prices and exchange rates

The second concept in this study follows from the first, on the assumption that there is indeed a directional relationship between commodity prices and exchange rates, as indicated by the several studies outlined in the section above. This is the question on the direction of causality, and the study by Zhang et al. (2016) explores both theories. In the first instance changes in a commodity price lead to changes in the exchange rate of the corresponding commodity currency, but also explores the second instance, where through financial and speculative features of foreign exchange markets, exchange rates can help predict economic fundamentals including commodity prices.

The first theory proposal relies on macroeconomic and trade-theory arguments, where an increase in the price of a commodity should naturally produce upward pressure on the demand for its currency, which leads to an appreciation of that currency against other major currencies. This then suggests that exchange-rate movements can be predicted by economic variables. The second theory, however, is that exchange rates are determined, similar to asset prices, by the net present value of fundamentals, implying that exchange rates should lead and cause commodity prices.

The importance of understanding which of the two are verifiable, is important, particularly to inform monetary and macroeconomic policymakers who may attempt to correct for systemic shocks through strategies of fixing or floating exchange rates, for example, during such periods. Zang et al. (2016) found, interestingly, that there was evidence of Granger causality between commodity prices and exchange rates in both directions, but "the evidence and measured strength are much stronger in the direction of commodity price to exchange rate (the macroeconomic/trade mechanism), especially at short horizons". As a result of these findings, they concluded that the debate on which of the theories is dominant remains open, and further research like this one can add to the body of studies attempting to create a robust conclusion on the explanation.

Alagidede, Ndlovu and Schalin (2014) undertook a very similar study, looking at causality and cointegration between the South African Rand and commodity prices. Using a commodity price index, they looked at the relationship between the natural logs of exchange rates (ZAR: USD) and the natural log of the commodity price index. This study has the closest correlation with the research proposed here, with the exception that this study looks at another four countries in the SADC region in conjunction, and heavy inference is drawn from the methodology and outcomes of Alagidede, Ndlovu and Schalin (2014). Their study found, in conclusion, that there was a direct relationship between commodity prices and exchange rates in South Africa, although, comparative to OECD countries, the relationship was relatively weaker. With regards to causality, they found that changes in commodity prices led to changes in exchange rates.

A deeper look at causality is found in literature in the study Zhang, Dufour and Galbraith (2016), where a look at three commodities (crude oil, gold and copper) in four countries (Canada, Australia, Norway and Chile) was examined. This study is deemed to be relevant because of its observations with regards to gold and copper, which are being examined in this

study with respect to South Africa and Zambia. They explore the first assumption that changes in a *commodity price* lead changes in the exchange rate of the corresponding commodity currency and a second one that suggests that the financial and speculative features of foreign exchange markets imply that *exchange rate fluctuations* lead to changes in commodity prices. An additional insight from this study is its exploration of these dynamics across multiple horizons, as it is known that observations can vary in terms of short and long-run relationships between variables.

In conclusion, they identified the following causal patterns which are relevant to the research questions of this study: that there is evidence of a Granger-causality between commodity prices and exchange rates although statistical evidence and measured intensity of the effects are much stronger in the direction of commodity prices to exchange rates, especially at a short horizon.

A further relevant study shows the existence of a very short-term relationship, using daily frequency data between changes in the price of a country's major commodity export, and changes in its nominal exchange rate Ferraro, by Rogoff and Rossi (2015). The results indicate that there is little systematic relation between commodity price changes and exchange rate changes when the observations are assessed at monthly and quarterly frequencies. However, in the very short-term, an "out-of-sample fit" relationship between commodity prices and exchange rates was found to be significantly robust. This finding is significant to guide what frequency of data to be used in this study, being daily price information.

The thrust of this assessment was to determine if the price of a country's major commodity export can predict movements in its nominal exchange rate in a pseudo-out-of-sample forecasting exercise. The results are in support of an existent direct relationship between exchange rates and commodity prices, similar to those of Zhang, Dufour and Galbraith (2016) and Arezki et al. (2014).

In summary, there is strong literature to support that there exists a direct relationship of cointegration between exchange rates and commodity prices, and while methodology of analysis varies, as well as potential questions of the direction of causality, there is a strong case for the specific assessment of, in particular, developing exporting countries of Africa, for which there is limited specific focus, and the case for this study is substantially justifiable.

3. Chapter 3: Methodology

3.1 Introduction

This chapter describes the methodological approaches employed to answer the research questions in Chapter 1. Both theoretical and empirical groundings are established here. This study empirically assesses the relationship between exchange rates movements with non-fuel commodity prices indices of five Southern African countries, namely; Botswana, Malawi, Mozambique, South Africa, and Zambia. This is undertaken to uncover currency commodities and/or commodities currencies depending on the direction of causality and their time-varying equilibrium relationships. These countries are selected based on their strength in commodity exports as established by UNCTAD (2016). For a balanced analysis, the study uses monthly International Monetary Fund (IMF) non-fuel commodity price indices (NFCI) and monthly exchange rates (expressed USD per unit of the local currencies) that span January 1996 to September 2018.

The starting date of 1996 ensures availability of data for all four countries as well as indicating a stage where floating exchange rate regimes have been fully operationalized in these countries. To match NFCI exchange rates were converted to monthly indices with 2016 as the base year (i.e. 2016M6=100) beginning 2019. The NFCI is calculated based on the global import share over a 3-year period (2014-2016), and is normalised to 100 at year 2016 prices; denominated in US dollars. It represents three broad commodity asset classes: (1) precious metal, (2) food and beverages, and (3) industrial inputs[1]. The NFCI is chosen to sidestep the impact of petroleum commodity prices on the analysis since, on their own, they are significant in the world market place and hence affect different macroeconomic variables in diverse ways. Fuel and energy takes 40.9% of the total weight of the global commodity index. This approach has been employed by Schaling et al. (2014), Chen & Rogoff (2003), Simpson (2002), Cashin et al. (2004), Ndlovu (2011), etc. All data are gleaned from the Bloomberg Terminal.

[1] https://www.imf.org/en/Research/commodity-prices

Exchange rate index is calculated as $EX_t = {EX_t}/{EX_{tB}} * 100$ where EX_t is the current exchange rate and EX_{tB} is the base exchange rate. Both exchange rates and commodity price indices are used in their natural logarithm form in the analysis.

3.2 Theoretical framework

The theoretical framework of this study is partially based on Simpson (2002), also employed by Schaling et al. (2014) for only South Africa. Thus, fitting to the selected countries in Southern Africa they are relatively large or small, open, commodity-exporting economies. Schaling et al. (2014) establish South Africa as a relatively large economy. The commodity exporting feature has been established already in Chapter 1. As regards openness it can be inferred from the export dependence. It also established in Angwenyi (2013) and Warner (2000). Following De Gregorio & Wolf (1994) and Obstfeld, Rogoff, & Wren-Lewis (1996), additional assumptions can be made: 1) the countries' exports are primary goods (agriculture and minerals) 2) terms of trade for the exported goods play an essential role in the determination of real exchange rates. The accompanying feature of these countries is that "a boom in commodity prices would exert upward pressure on the real exchange rate through its effect on wages and demand for non-traded goods through a channel similar to the standard Balassa-Samuelson effect[2]" Schaling et al. (2014, p.678). This causes an imbalance in the nominal exchange rate which requires a correction for efficient allocation of resources. In short, the framework indicates that an improvement in the terms of trade (as defined by the difference is prices of imports and exports) results in an appreciation of the domestic currency (Habib & Kalamova, 2007).

3.3 Econometric Models

Given that both short- and long-run relationship are investigated a supported model in the literature to start with is the Vector Autoregressive (VAR) equation (Luetkepohl, 2011; Sims, 1980). Bivariate VAR(p) for currency commodities and commodity currencies are given in equation (3.1) and equation (3.2), respectively.

$$EX_t = \alpha_0 + \sum_{i=0}^{p} \alpha_i \, EX_{t-i} + \sum_{i=0}^{p} \theta_i \, C_{t-i} + \epsilon_t \qquad (3.1)$$

[2] It describes the long-run behaviour of real exchange rate in terms of the productivity performance of trade vis-à-vis non-traded goods (Choudhri & Khan, 2005).

$$C_t = \beta_0 + \sum_{i=0}^{p} \beta_i C_{t-i} + \sum_{i=0}^{p} \phi_i EX_{t-i} + \mu_t \quad (3.2)$$

where $EX_t, C_t, p, \epsilon_t, \mu_t$ denote natural log of exchange rate at time t, natural log of commodity price at time t, the optimal lag length, and error terms, respectively. The bivariate VAR has one equation for each variable and each equation contains only the lagged values of that variable and the lagged values of the variable in the model which connotes endogeneity. The VAR(p) model allows for tests of stationarity, cointegration, and bi-directional Granger causality which are in line with the objectives of this study. In the case of cointegration found to be non-existent between the variables, a differenced VAR (p) model is estimated to realise the impact of exchange rates on commodity index prices and vice versa. Further, commodity prices and exchange rates are in VAR(p) are non-stationary but cointegrated, the VAR can be estimated by taking into account the error correction term in Eq. (3.3) - which can be seen as the short-run relationship. The model then becomes a vector error-correction model (VECM) which is a restricted form of VAR(p) (Brooks, 2019; Gujarati, 2011).

Cointegration between EX_t and C_t is said to be true if both integrated at order (I(1) – stationary at first difference) but the linear combination of them (in terms of residuals) is I(0) as per unit root testing. That is to say the cointegrating relationship may be referred to as a long-term or equilibrium phenomenon. Hence it is possible that variables can deviate from their equilibrium relationship in the short-run, would return in the long run.

$$\Delta EX_t = A_1 + A_2 \Delta C_t + A_3 \mu_{t-1} + \nu_t \quad (3.3a)$$

$$\Delta C_t = B_1 + B_2 \Delta EX_t + B_3 \gamma_{t-1} + \pi_t \quad (3.3b)$$

The error correction mechanism (ECM) combines the first differenced and lagged levels of cointegrating variables (Hendry, Pagan, & Sargan, 1984). The error correction mechanism popularised was by Engle and Granger in the Granger Representation Theorem that if two variables are cointegrated, the relationship between the two can be expressed as an error correction mechanism (ECM) (Engsted & Johansen, 1997).

Take equation (3.3a) for instance, if it turns out to be zero implies no disequilibrium between the commodity prices and exchange rates and the long-run relationship will be given by the

cointegrating relationship. The reverse is true. If $\Delta C_t = 0$ and $\mu_{t-1} > 0$ it means ΔEX_t is too high to be in equilibrium by a quantity equivalent to $A_1 + A_2 EX_{t-1}$. Since A_3 is expected to be negative, it renders $A_3 \mu_{t-1}$ negative and hence EX_t will be negative to restore the equilibrium in the next period. Similarly, if C_t is below its equilibrium value if $\mu_{t-1} > 0$ $A_3 \mu_{t-1}$will be positive, which will cause it to be positive, leading EX_t to rise in period t. This mean the absolute value of A_3 decides rate at which the equilibrium is restored.

3.4 Granger-causality tests

The final stage to determine whether a country has currency commodities of commodity currencies is to perform Granger-causality tests between exchange rates and commodity prices (Engle & Granger, 1987). In simple terms a variable X is said to Granger-cause another variable Y if Y can be better predicted from the past values of X and Y together than the past of Y alone, other relevant information being used in the prediction (Pierce & Haugh, 1977). It is worth noting that Granger causality is not equivalent to the usual meaning the word "causality". For instance, even if y_1 does not cause y_2, it may still help to predict y_2 and thus Granger-causes y_2 if changes in y_1 precede those of y for some reason. It follows that Granger-causality is primarily based on the historical values of the variables, exogeneity occurs, as noted by Sims (2002) if in a two-variable pair one fails to cause the other, and hence they are independent.

3.5 Unit root and Stationarity tests

As a preliminary test, a statistical equilibrium of the exchange rates and commodity prices are examined. This can be achieved by formal unit root or stationarity tests (i.e. autoregressive unit root tests) via Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS). Visual observation (graphical methods) to look out for the absence of trend and seasonality or otherwise are only suggestive. The test is based on a random walk with drift (intercept) model – an autoregressive model of order 1 AR(1) in Eq. (3.4).

$$\begin{aligned} C_t &= \alpha + bC_{t-1} + \varepsilon_t, \qquad \varepsilon_t \sim (0, \sigma^2) \\ C_t - C_{t-1} &= \alpha + bC_{t-1} + \varepsilon_t - C_{t-1} \\ \Delta C_t &= \alpha + (b-1)C_{t-1} + \varepsilon_t \end{aligned} \tag{3.4}$$

Let $b = \omega$ in Eq. (3.4) then $\omega = 0$ when $b = 1$, which is a unit root. Thus, the random walk is unit root process; a non-stationary process in which the variance increases linearly with time t

in ε_t and a constant. For the ADF the following hypothesis can be stated (Said & Dickey, 1984):

$$H_0: \omega = 0, (has\ a\ unit\ root; non - stationary)$$
$$H_1: \omega < 0, (does\ not\ have\ unit\ root;\ stationary) \quad (3.5)$$

To reject the null hypothesis the test statistic must be bigger in absolute terms (more negative) than the critical ADF values at the corresponding significance level (1%, 5%, and 10%). The

ADF test is noted for its low power when the process is stationary but with a root close to the non-stationary boundary. This problem is solved by treating serial correlation in the test regressions in a different way. Kwiatkowski, Phillips, Schmidt, & Shin (1992) (KPSS) formulate a Lagrangian Multiplier (LM) test for stationarity by decomposing the series into the sum of a deterministic trend, a random walk, and a stationary error similar to the ADF. The null hypothesis is stated as follows:

$$H_0: C_t \sim \mathrm{I}(0), (stationarity)$$
$$H_0: C_t \sim \mathrm{I}(1), (non - stationarity) \quad (3.5)$$

To reject the null hypothesis of stationarity at a given significance level the LM test statistics must be greater than its corresponding critical values at the corresponding significance level (1%, 5%, and 10%).

Following the theoretical framework and the econometric techniques the following hypotheses can be tested in line with the objectives for the study:

Ho1: There is no relationship in trend between non-fuel commodity prices and exchange rate.
Ho2: The exchange rates and commodity price indices or their first differences for the selected Southern African countries are not statistically associated.
Ho3: There is no statistically long-run relationship between exchange rates and commodity price indices or their first differences for the selected Southern African countries.
Ho4: There is no statistically significant uni-directional and/or bi-directional causality between exchange rates and commodity prices indices or their first differences for the selected Southern African countries.

3.5 Cointegration Tests

The test for the existence follows the Engel-Granger (EG) two-step procedure (Engle & Granger, 1987). In the simplified version of EG two-step test of cointegration, it determines whether or not a linear combination (r_t) of two time series EX_t and C_t follows an autoregressive model of order 1 (AR(1)). It follow that the procedure searches for α, β, and ρ in Eq. (3.4) and (3.5) to satisfy the condition that if $|\rho| < 1$ then EX_t and C_t are cointegrated (i.e. they have a long-run equilibrium relationship) (Clegg, 2014).

$$EX_t = \alpha + \beta C_t + r_t \tag{3.6}$$

$$r_t = \rho * r_{t-1} + \psi_t \tag{3.7}$$

For the sake of robustness, both the ADF and Johansen's Trace tests (JOT) are performed on Eq. (3.7) for unit root and stationarity. The null hypothesis is the same as stated in equation (3.4). That is to say to cointegration to be established Eq. (3.7) should be stationary at level.

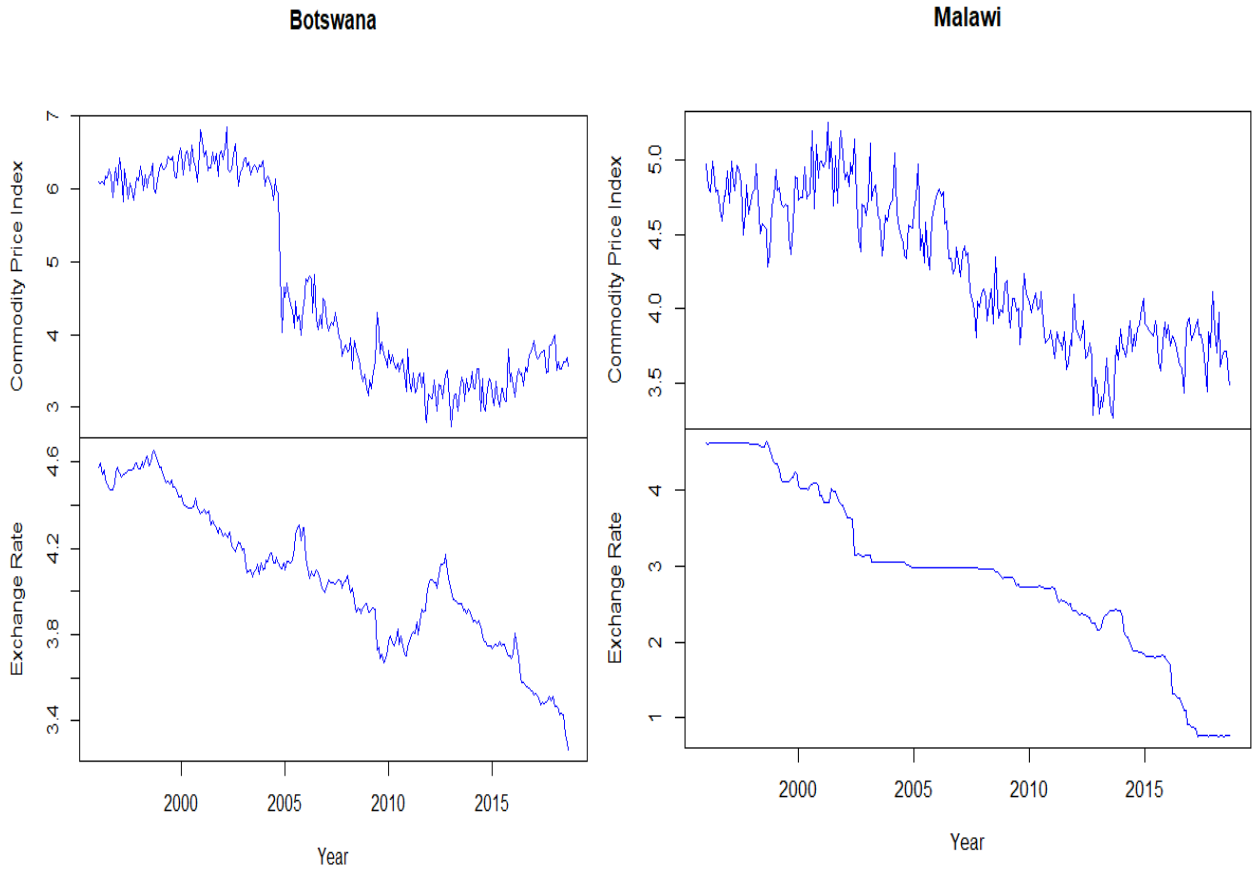
4. Chapter 4: Presentation of results

4.1 Trend Analysis of Commodities Price Indices and Exchange Rates

The overall pattern in the commodity price indices and exchange rates for all the selected Southern African countries is a compositely decreasing one from January 1996 through to September 2018. These are displayed in Figures 1, 2, and 3. This is suggestive of causality and cointegration and hence they are tested in subsequent parts of this Chapter.

For Botswana, commodity prices seem to have a more volatile experience than exchange rates and opposing patterns about 2013 and 2014. A sharp long decline is also observed for commodity in 2015 which may suggest a structural break. It helps that Johansen's trace test of cointegration was applied which is able to handle structural breaks in the data. Unlike Botswana, Malawi's do not seem to suggest any structural breaks as well as there is a closer pattern for commodities and exchange rates.

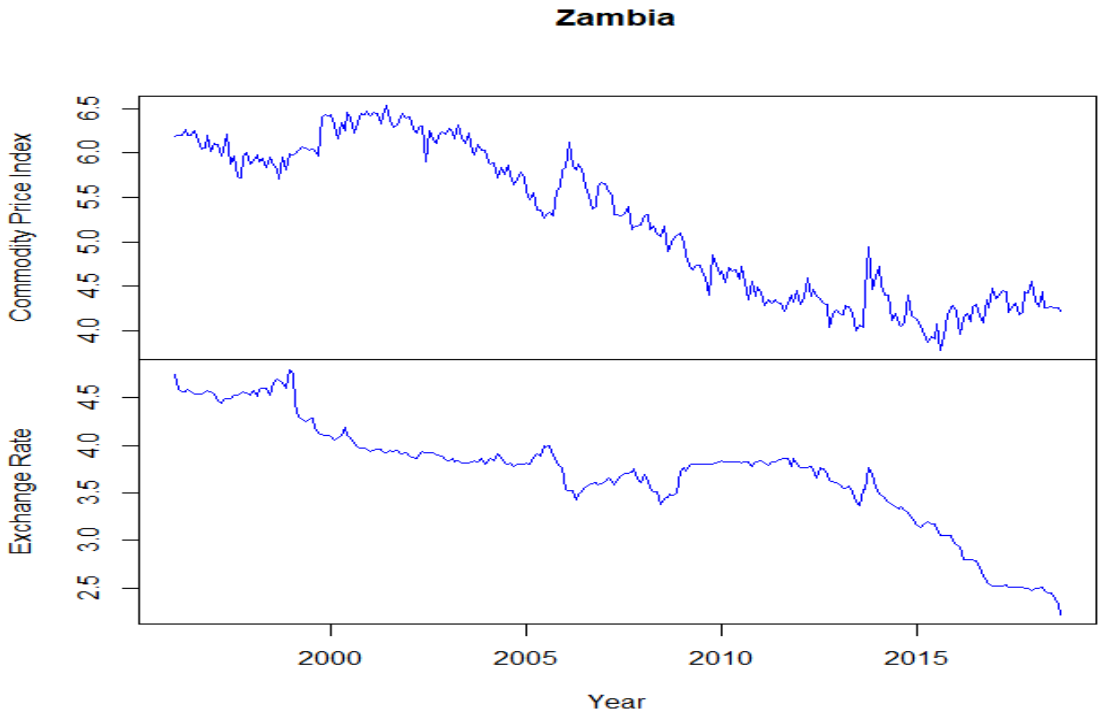
Figure 1: Commodity Price Index and Exchange Rate trends for Botswana and Malawi



In Figure 2 (Mozambique and South Africa) the dynamics are similar to those in Figure 1. Commodity price indices are more gyrating than exchange rates with a particularly wide spike in 2015 for Mozambique which slightly alters the pattern. Zambia (Figure 3) on the other hand, follow the downward trend with intermittent instability but no sign of a significant change to indicate structural breaks. In all post-1996 seems to indicate a stable floating exchange rate regime for all these countries; a property that allows for an objective assessment of the commodity-currency link.

Figure 2: Commodity Price Index and Exchange Rate trends for Mozambique and South Africa

Figure 3: Commodity Price Index and Exchange Rate trends for Zambia



4.2 Stationarity Tests

To proceed to investigate cointegration stationarity or otherwise of the time series has to be established. In Table 1 both the ADF and KPSS test are performed on levels and differences series.

Table 1: Unit root and stationarity tests

Country	**Variable**	**ADF**		**KPSS**	
		Levels	**First Difference**	**Levels**	**First Difference**
Botswana	*Commodity*	-1.1793[a]	-6.9542[b]	4.0497[b]	0.11222[a]
	Exchange Rate	-2.0502[a]	-6.3311[b]	4.0997[b]	0.11555[a]
Malawi	*Commodity*	-3.0549[a]	-9.4675[b]	4.1387[b]	0.020173[a]
	Exchange Rate	-1.7493[a]	-6.0773[b]	4.2203[b]	0.13492[a]
Mozambique	*Commodity*	-2.8602[a]	-9.1593[b]	4.527[b]	0.028705[a]
	Exchange Rate	-2.742[a]	-5.3541[b]	3.9085[b]	0.066366[a]
South Africa	*Commodity*	-2.2468[a]	-7.8722[b]	4.2674[b]	0.12237[a]
	Exchange Rate	-1.5172[a]	-6.3667[b]	3.0256[b]	0.10314[a]
Zambia	*Commodity*	-2.0783[a]	-7.5971[b]	4.3054[b]	0.067212[a]
	Exchange Rate	-0.97008[a]	-6.0904[b]	3.5587[b]	0.19429[a]

[[a]] [[b]] indicate test decision taken at 1% and 5% significance levels respectively.

For ADF and for all countries both commodity price indices and exchange rates are non-stationary at levels. At the 1% significance level the null hypothesis of non-stationarity cannot be rejected. However, with KPSS the null hypothesis of stationarity cannot be accepted at the 5% significance level. The reverse is the case of first difference; the series is stationary at 5% for ADF and 1% for KPSS.

These imply that both exchange rates and commodity price indices from January 1996 to September 2018 are integrated of order 1 (i.e. I(1)). As a prerequisite, this justifies a test of cointegration between the two variables over the time horizon.

4.3 Cointegration Tests

Following the EG two-step process of cointegration test a unit root stationarity test is performed on the coefficient of the linear combination (residual regression) of commodity price and exchange rates as presented in Table 2. Given the null hypothesis of no cointegration both the ADF and JOT fail to reject this at all conventional levels of significance. This is in line with the findings of Schaling et al. (2014) and (Ndlovu, 2011) for South Africa in particular. However, Ndlovu & Schaling (2018) evidence a support for long-run relationship in the commodity-price link using augmented purchasing paper parity (PPP) and monetary-based models.

A graphical rendition of these are presented in Panel A. The non-stationarity of the residuals is clearly seen in the plots (lower portion). A confirmation of no cointegration is also displayed in the upper portions for all countries. In addition, the residual equations are also provided for each case. This means that there is no long-run equilibrium relationship between commodity price and exchange rates for all the selected South African countries. This offers good grounds to model VAR for all the countries' commodity price indices and exchange rates in the sub-section.

Table 2: EG two-step cointegration tests

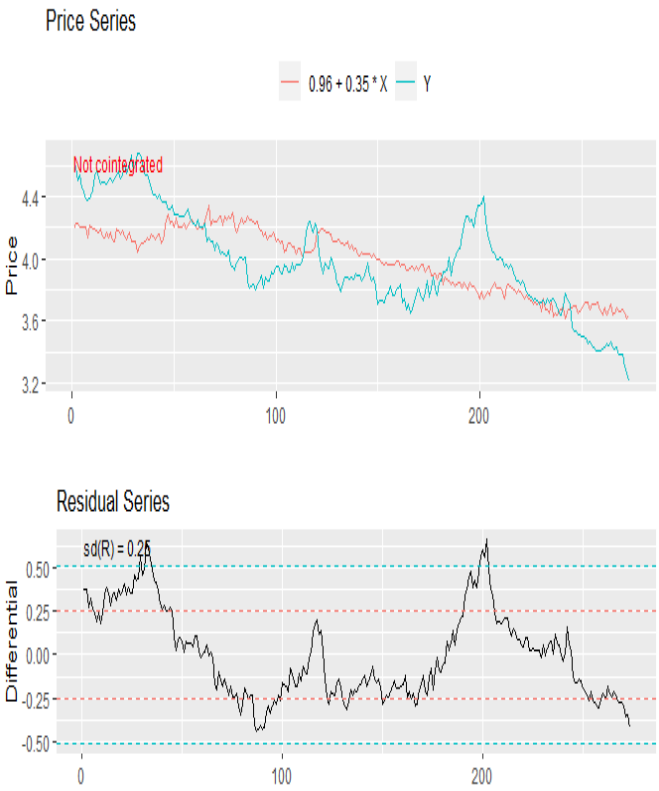
	Botswana	**Malawi**	**Mozambique**	**South Africa**	**Zambia**
ADF	-0.859	-1.697	-2.090	-1.570	-0.862
p-value	0.91381	0.63974	0.45755	0.69899	0.91335
JOT	-12.928	-28.110	-14.373	-13.163	-9.901
p-value	0.40098	0.00770	0.29620	0.38396	0.65619

Panel A: EG two-stage cointegration test plots

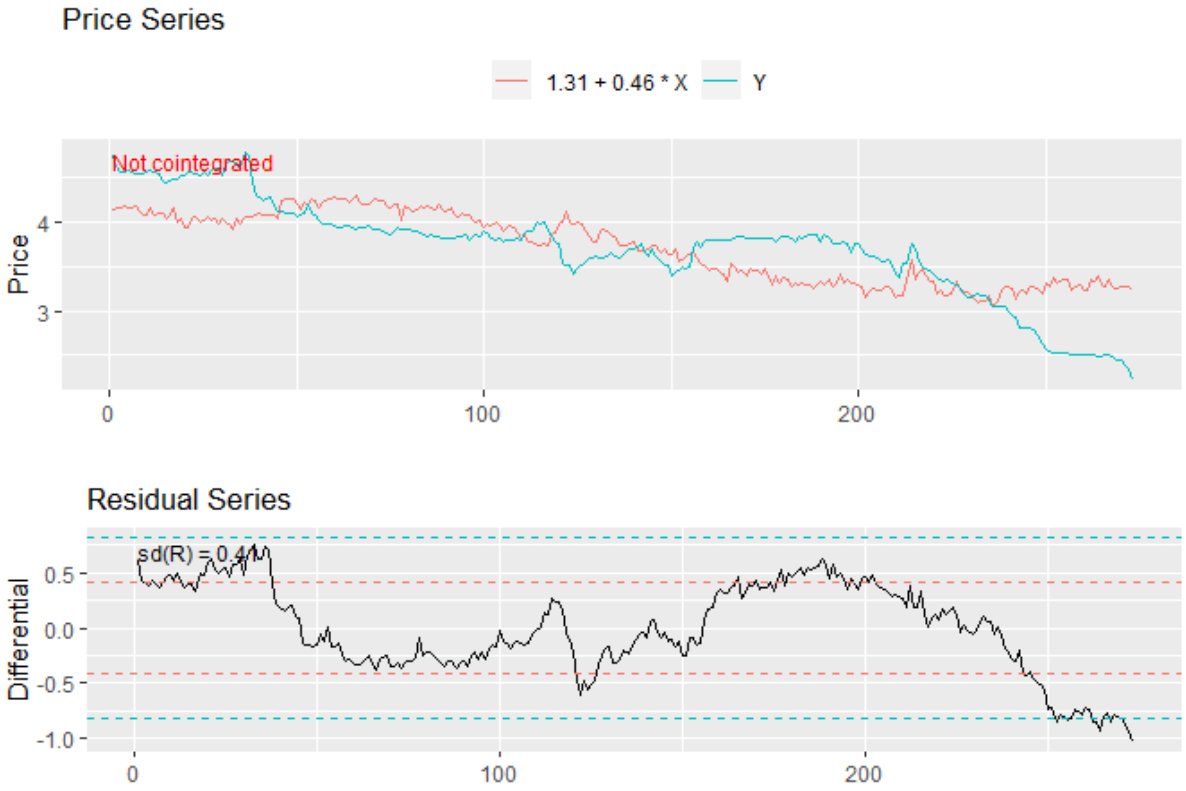
(a) Botswana

(b) Malawi

I Mozambique



(d) South Africa



(e) Zambia

4.5 VAR Models

As mentioned earlier, with the establishment of no long-run equilibrium for all countries between commodity index and exchange rates VAR models can be estimated for investigating the impact they have on each other. In Table 3 VAR(1) models are presented for all economies. To achieve parsimonious models optimal lag length selection was conducted using the Schwarz information criterion (SIC) to obtain lag of order 1, hence VAR(1). Since the variable are I(1) across the board VAR(1) is estimated at first difference. These are estimated with both commodity price indices and exchange rates alternating as regressors and regressands.

For Botswana exchange rates inversely belong in the commodity model but commodity does not belong in the exchange rate model. Exchange rates are determined by a constant term indicating no relationship with commodity price index. But 1 percent increase in exchange rates results in a 27% fall in commodity price index, and vice versa, ceteris paribus. Given that the exchange rate is in the form USDBWP a depreciation in the local currency raises the price of commodity exports for Botswana and the reverse is true. That is to say, Botswana is "currency commodity" economy contrary to Schaling et al. (2014) for South Africa. The "currency commodity" model is given in Eq. (3.8).

$$\Delta C_t = -0.26860 \Delta EX_{t-1} \tag{3.8}$$

Table 3: VAR(1) models for commodity price indices and exchange rates

Botswana (Commodity)			**Botswana (Exchange Rate)**		
Regressor	**Coefficient**	**p-value**	**Regressor**	**Coefficient**	**p-value**
Constant	-0.01191 (0.01402)	0.396	*Constant*	-0.004858 (0.002005)	0.016**
ΔC_{t-1}	-0.05187 (-0.121)	0.904	ΔEX_{t-1}	-0.009224 (-1.093)	0.276
ΔEX_{t-1}	-0.26860 (-4.548)	0.000***	ΔC_{t-1}	0.027102 (0.443)	0.658
Malawi (Commodity)			**Malawi (Exchange Rate)**		
Constant	-0.005632 (-0.543)	0.587	*Constant*	-0.012198 (-3.808)	0.000***
ΔC_{t-1}	-0.340004 (-5.928)	0.000***	ΔEX_{t-1}	0.146520 (2.426)	0.0159**
ΔEX_{t-1}	0.072412 (0.370)	0.711	ΔC_{t-1}	-0.009470 (-0.534)	0.594
Mozambique (Commodity)			**Mozambique (Exchange Rate)**		
Constant	-0.01151 (-0.931)	0.353	*Constant*	-0.005507 (-2.646)	0.009***
ΔC_{t-1}	-0.48117 (-8.971)	0.000***	ΔEX_{t-1}	0.126446 (2.087)	0.037**

ΔEX_{t-1}	0.05686 (0.158)	0.875	ΔC_{t-1}	0.003348 (0.371)	0.711
South Africa (Commodity)			**South Africa (Exchange Rate)**		
Constant	-0.009581 (-1.730)	0.085*	*Constant*	-0.005452 (-1.946)	0.053*
ΔC_{t-1}	-0.365206 (-6.447)	0.000***	ΔEX_{t-1}	0.006045 (0.099)	0.921
ΔEX_{t-1}	-0.211512 (-1.760)	0.079*	ΔC_{t-1}	-0.056277 (-1.964)	0.051*
Zambia (Commodity)			**Zambia (Exchange Rate)**		
Constant	-0.011631 (-1.434)	0.1527	*Constant*	-0.007742 (-2.385)	0.018**
ΔC_{t-1}	-0.276705 (-4.744)	0.000***	ΔEX_{t-1}	0.095789 (1.590)	0.113
ΔEX_{t-1}	-0.265666 (-1.765)	0.079 *	ΔC_{t-1}	0.018247 (0.781)	0.435

, **, ** indicate significance at 10%, 5%, and 1% levels, respectively.

In terms of Malawi, the study cannot establish neither a "commodity currency" nor a "currency commodity" since neither exchange rate nor commodity belong in the model of each other. Both current commodity process and exchange rates are significantly determined by their lagged values (and a constant for the latter). These models are exhibited in Eq. (3.9).

$$\Delta C_t = -0.340004\ \Delta C_{t-1} \tag{3.9a}$$

$$\Delta EX_t = -0.012198\ - 0.146520 \Delta EX_{t-1} \tag{3.9b}$$

The situation with Mozambique is almost the same as that of Malawi; commodities (negatively) and exchange rates (positively) both significantly determined by their lagged values. Hence the commodity prices and exchange rates are independent of each other in Mozambique as well as Malawi. These models are given in equation (3.10).

$$\Delta C_t = -0.48117 \Delta C_{t-1} \tag{3.10a}$$

$$\Delta EX_t = -0.005507 + 0.126446 \Delta EX_{t-1} \tag{3.10b}$$

When it comes to South Africa, there is a dilemma for both "currency commodity" and "commodity currency" given that they both belong in the model for the other with negative relations, however, at different magnitudes of elasticity. At the 10% significance level, the exchange rate has an elasticity of 21% in the commodity model, and commodity model has an elasticity of 5.6% in the exchange rate model, all other things being equal. See Eq. (3.11). Thus,

South African has more of a "currency commodity" economy than the other way round. This both a partial contradict and confirmation the "commodity currency" of the Rand as found by Schaling et al. (2014). This indicates that the "commodity currency" or "currency commodity" for an economy may not be static but time-varying due to changes in global market dynamics.

$$\Delta C_t = -0.009581 \ - 0.365206\ \Delta C_{t-1} - 0.211512 \Delta EX_{t-1} \quad (3.11a)$$

$$\Delta EX_t = -0.005452 - 0.056277\ \Delta C_{t-1} \quad (3.11b)$$

Lastly, Zambia is "currency commodity" economy. There is a negative elasticity of 27% at the 10% significance level. Commodity does not belong in the exchange rate model, neither does the lag on the exchange rate itself. Zambia's "commodity currency" model is presented in Eq. (3.12).

$$\Delta C_t = -0.276705 \Delta C_{t-1} - 0.265666 \Delta EX_{t-1} \quad (3.12)$$

4.6 Granger-causality Tests

The last objective of this study pertains to examining Granger causality between commodity price indices and exchange rates per selected Southern African economy. The bi-directional test results are provided in Table 4 together with the respective null hypothesis.

At all conventional levels of significance, the study fails to reject that there is no Granger causality between commodity price index and exchange rates in both directions for Botswana, Malawi, and Mozambique. These conform to the VAR(1) Malawi and Mozambique but not for Botswana. It is worth noting "currency commodity" and "commodity currency" do not necessarily imply Granger causality. The implication is that commodity prices and exchange rates are independent of each other that policymakers should take this into account in decision making since exogenous factors are involved in the price determination process.

However, the case is not so for South Africa and Zambia. At the 10% significance level commodity price index **Granger cause** exchange rates and exchange rates **Granger cause** commodity price index for South Africa. This conforms to the partial "commodity currency" and "currency commodity" from the VAR(1) model. It means that, to a large extent, in South Africa the prices of these two variables are endogenously determined. Further, Arezki et al.

(2014) find that causality runs from the Rand to the gold price volatility but the causality runs the other way around for the post-liberalization period with monthly data from 1979 to 2010. This confirms the important role of commodity price volatility in explaining exchange rate.

But Zambia has only a uni-directional Granger causality from exchange rates to commodity price index. Thus, the interdependence between these two variables is not complete but partial, hence other exogenous factors may influence the price determination.

These differences in causality and "commodity currency" and/or "currency commodity" for the Southern African countries are in consonance with the findings of Cashin et al. (2004) where terms of trade varies for about half of all Sub-Sahara African countries.

Table 4: Pairwise Bi-directional Granger Causality Tests

Botswana	Obs	F-Statistic	Prob.
EXCHANGE RATE does not Granger Cause COMMODITY PRICE INDEX	270	0.0147	0.903
COMMODITY PRICE INDEX does not Granger Cause EXCHANGE RATE		1.1936	0.275
Malawi			
EXCHANGE RATE does not Granger Cause COMMODITYPRICE INDEX	270	0.1373	0.711
COMMODITY PRICE INDEX does not Granger Cause EXCHANGE RATE		0.28553	0.593
Mozambique			
EXCHANGE RATE does not Granger Cause COMMODITYPRICE INDEX	270	0.02494	0.875
COMMODITY PRICE INDEX does not Granger Cause EXCHANGE RATE		0.1376	0.711
South Africa			
EXCHANGE RATE does not Granger Cause COMMODITY PRICE INDEX	270	3.0966	0.079[c]
COMMODITY PRICE INDEX does not Granger Cause EXCHANGE RATE		3.8562	0.0501[c]
Zambia			
EXCHANGE RATE does not Granger Cause COMMODITYPRICE INDEX	270	3.1148	0.078 [c]
COMMODITY PRICE INDEX does not Granger Cause EXCHANGE RATE		0.61068	0.435

[[c]] indicate test decision taken at 10% significance level

4.7 Summary

In this chapter the study has implemented the specific econometric models that speak to the objectives of the study. These model are unit root stationarity tests, two- way Granger tests, EG two-step and Johansen Trace tests of cointegration, and VAR(1) models to ascertain "commodity currency" or its reverse for each of the selected Southern African countries.

The analysis reveal a mixture of both similarities and disparities across the countries with respect causality and VAR(1) models. However, all countries exhibit no long-run equilibrium (i.e. no cointegration) between commodity price index and exchange rates which permits the use of VAR(1) models across the board to investigate their short-run dynamics of commodity-exchange rate links.

It becomes clear that neither "commodity currency" nor "currency commodity" exists for Malawi and Mozambique but the "currency commodity" does apply for Botswana while the "commodity currency" is shown for Zambia. It is interesting to find that both scenarios pertain to South Africa but it is stronger for "currency commodity" than it is for its counterparty.

5. Chapter 5: Summary, conclusions and recommendations

5.1 Summary

This study sought to empirically examine the relationship between commodity prices and exchange rates in five Southern African countries. Both short- and long-run relations were examined using monthly data from January 1996 to September 2018. This span was chosen to offer an objective assessment because exchange rates liberalisation in these countries were established in the early 1990s to ensure a floating rate regime. Further, Botswana, Malawi, Mozambique, South Africa, and Zambia were chosen because they represent the countries the Southern part of Africa with at least one dominant commodity export earner to their national income the price which have a potential impact on their local currency against the US dollar.

In addition, the choice of Southern African is informed by their substantial component in the global commodities export and the fact that research on commodity price – exchange rate link covering this geographical area is largely lacking except for South Africa. This is also in an effort to scale the works on South Africa to its neighbouring countries in the spirit of Schaling et al. (2014), Ndlovu (2011), Cashin et al. (2004), etc. To dissociate the influence of oil/petroleum products in the study, the IMF non-fuel commodity price index was used. It has been noted that fuel and/or energy takes 40.9% of the total weight of the global commodity index. This choice is also strongly supported in the literature.

In addition to establishing short- and long-run link between commodities and exchange rates in these countries via cointegration tests, the study aimed at investigating the notion of "currency commodity" and/or "commodity currency" for each country using the available data. These provide answers to the question as to whether exchange rates drive commodity prices and at what magnitude and vice versa. Finally, Granger causality was conducted to understand the historical lead-lag nexus between exchange rates and commodity price index of each economy.

The econometric techniques employed in this study are EG two-stage and Johansen Trace cointegration tests, VAR(1) models, and Granger causality tests as they serve the respective research objective.

5.2 Findings and Conclusions

To start with cointegration tests reveal no long-run relationship between commodity price index and exchange rates for all of the selected countries. It implies that in the long term there is equilibrium link between these two variables of interest neither Botswana, Malawi, Mozambique, South Africa, nor Zambia. Thus, any monetary and/or trade policies with the aim of reaping long term benefits may not be appropriate or beneficial to any country. Actions may have to target short to medium term gains rather than some far distant future.

With this outcome VAR(1) model, on the other hand, reveal varying results for different countries. First, neither "currency commodity" nor "commodity currency" was found to be the dynamics in Malawi and Mozambique. That is to say, as much as exchange rates do not belong to commodity price index models, commodity price indices do not belong to exchange rate models for these two countries. This further implies, to a large extent that the drivers of the exchange rates on the one hand and commodity prices, on the other hand, are influenced by forces other than these two variables. Hence, a wider policy analysis must be conducted to maintain sustainable levels of these two variables.

However, the case is different for Botswana, South Africa, and Zambia. There is enough evidence to suggest a "currency commodity" for Botswana which means to some statistically significant extent exchange rates determine the prices of commodities. Specifically, an appreciation in exchange rates hurt commodity price and vice versa. But for Zambia, like Botswana, a definite "currency commodity" link is established. Similar arguments and analogies may be drawn for these two economies. Since these findings are new, the study is unable to corroborate or contrast with other studies, other than the data used.

This also applies to South Africa and strongly so. But there is a puzzle because South Africa also show weak evidence of "commodity currency" which is the opposite of "currency commodity". It means exchange rates determine commodity prices (strongly) and commodity prices also determine exchange rates (weakly). The latter has not been the case in the literature involving South Africa but the former has been in studies such as Schaling et al. (2014) and Ndlovu (2011). This can be explained by the fact that the two opposing phenomena may not be fixed in time but changing as the world currency and commodity market dynamics keep

changing. It goes without mention that South African trade and monetary policies may have to be dynamic and time-variant as its exchange rates and commodity price relationship and may have to be strongly endogenously centred.

Finally, Granger causality in either direction was not found for Botswana, Malawi, and Mozambique. This is regardless of the "currency commodity" found for Botswana; this has a telling feature of moderating this phenomenon. For these three economies, exogenous factors are strongly involved in how exchange rates and commodity prices are determined. Policy implications may be strongly exogenous and biased as well.

For Zambia there is a Granger causality running from exchange rates to commodity price index. It means historically, the latter lags the former. This fact may corroborate the "currency commodity" found earlier for Zambia but does not fully explain endogenous determination of prices dynamics; only partially.

Similar to Arezki et al. (2014), we find there is causality from exchange rates to commodity prices at one period in time and the reverse at another period for South Africa. This further supports the "commodity currency" and "currency commodity" puzzle revealed by the VAR(1) model.
Policy implications are thus analogous.

The findings in this study is also similar to those found by Cashin et al. (2004) where terms of trade varies for about half of all Sub-Sahara African countries. It stands to reason that there should be country-specific trade and monetary policies in order to benefit from their natural resources endowments rather than drowned by the exchange rate volatilities.

5.3 Recommendation for future studies

For further studies, an endeavour can be to find the possible exogenous variables that serve as the determinants of commodity prices and/or exchange rates. Also, other sub-regional blocks can be considered in regardless of the proportion of their national incomes derived from commodity exports.

Further, other advanced econometric models can be used to investigate whether differing results may be found using the same data and variables in addition to more data and variables. Again, as seen with South Africa in terms of the time-varying relationship, a continued study should be underway to track the results found in this study so as to see if they apply other Southern African countries.

6. References

Adubi, A. A., & Okunmadewa, F. (1999). Price, exchange rate volatility and Nigeria's agricultural trade flows: A dynamic analysis.

Alagidede, P., Ndlovu, X., Schaling, E., (2014). Modelling the rand and commodity prices: A Granger causality and cointegration analysis. *South African Journal of Economic and Management Sciences*, *17*(5), 673–690.

Angwenyi, V. (2013). *Competition Law and Regional Integration: The Common Market for Eastern and Southern Africa (COMESA)* (SSRN Scholarly Paper No. ID 2406825). Rochester, NY: Social Science Research Network. Retrieved from https://papers.ssrn.com/abstract=2406825

Arezki, R., Dumitrescu, E., Freytag, A., & Quintyn, M. (2014). Commodity prices and exchange rate volatility: Lessons from South Africa's capital account liberalization. *Emerging Markets Review*, *19*, 96–105.

Aslam, A., Beidas-Strom,S., Bems, R., Celasun, O., Çelik,S.K., and Kóczán,Z., (2016). Trading on Their Terms? Commodity Exporters in the Aftermath of the Commodity Boom. IMF Working Paper, WP/16/27

Bodart, V., Candelon, B., & Carpantier, J.-F. (2012). Real exchanges rates in commodity producing countries: A reappraisal. *Journal of International Money and Finance*, *31*(6), 1482–1502. https://doi.org/10.1016/j.jimonfin.2012.02.012

Brooks, C. (2019). *Introductory econometrics for finance*. Cambridge university press.

Cashin, P., Céspedes, L. F., & Sahay, R. (2004). Commodity currencies and the real exchange rate. *Journal of Development Economics*, *75*(1), 239–268.

Chaban, M. (2009). Commodity currencies and equity flows. *Journal of International Money and Finance*, *28*(5), 836–852.

Chen, Y. (2002). Exchange rates and fundamentals: evidence from commodity economies. *Mimeograph, Harvard University*.

Chen, Y., & Rogoff, K. (2003). Commodity currencies. *Journal of International Economics*, *60*(1), 133–160.

Chen, Y.-C., Rogoff, K. S., & Rossi, B. (2010). Can Exchange Rates Forecast Commodity Prices? *The Quarterly Journal of Economics*, *125*(3), 1145–1194. https://doi.org/10.1162/qjec.2010.125.3.1145

Choudhri, E. U., & Khan, M. S. (2005). Real Exchange Rates in Developing Countries: Are Balassa-Samuelson Effects Present? *IMF Staff Papers*, *52*(3), 387–409.

Clegg, M. (2014). *On the Persistence of Cointegration in Pairs Trading* (SSRN Scholarly Paper No. ID 2491201). Rochester, NY: Social Science Research Network. Retrieved from https://papers.ssrn.com/abstract=2491201

Clements, K. W., & Fry, R. (2008). Commodity currencies and currency commodities. *Resources Policy*, *33*(2), 55–73.

Coudert, V., Couharde, C., & Mignon, V. (2008). Do terms of trade drive real exchange rates? Comparing oil and commodity currencies. *Centre d'Etudes Prospectives et d'Informations Internationales (CEPII), Paris*, *32*.

Coudert, V., Couharde, C., & Mignon, V. (2011). Does Euro or Dollar Pegging Impact the Real Exchange Rate? The Case of Oil and Commodity Currencies. *The World Economy*, *34*(9), 1557–1592. https://doi.org/10.1111/j.1467-9701.2011.01400.x

Dauvin, M. (2014). Energy prices and the real exchange rate of commodity-exporting countries *International Economics 137* (2014) 52–72

De Gregorio, J., & Wolf, H. C. (1994). *Terms of trade, productivity, and the real exchange rate*. National Bureau of Economic Research.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, 251–276.

Engsted, T., & Johansen, S. (1997). Granger's representation theorem and multicointegration.

Ferraro,D., Rogoff, K., & Rossi, B.,(2015) Can oil prices forecast exchange rates? An empirical analysis of the relationship between commodity prices and exchange rates. *Journal of International Money and Finance*, 2015, vol. 54, issue C, 116-141

Frankel, J., & Rose,A.,(1995). *A Survey of Empirical Research on Nominal Exchange Rates*, Center for International and Development Economics Research (CIDER) Working Papers 233409

Froot, K., & Rogoff, K., (1995) Perspectives on PPP and Long-Run Real Exchange Rates. *Handbook of International Economics, 3*: 1647-88.

Groen, J. J., & Pesenti, P. A. (2011). Commodity prices, commodity currencies, and global economic developments. In *Commodity Prices and Markets, East Asia Seminar on Economics, Volume 20* (pp. 15–42). University of Chicago Press.

Gujarati, D. N. (2011). *Econometrics by example/Damodar Gujarati.*

Habib, M. M., & Kalamova, M. M. (2007). *Are There Oil Currencies? The Real Exchange Rate of Oil Exporting Countries* (SSRN Scholarly Paper No. ID 1032834). Rochester, NY: Social Science Research Network. Retrieved from https://papers.ssrn.com/abstract=1032834

Hendry, D. F., Pagan, A. R., & Sargan, J. D. (1984). Chapter 18 Dynamic specification. In *Handbook of Econometrics* (Vol. 2, pp. 1023–1100). Elsevier. https://doi.org/10.1016/S1573-4412(84)02010-9

Jain, A.,& Biswal, P.,(2016). Dynamic linkages among oil price, gold price, exchange rate, and stock market in India . *Resources Policy*, vol. 49, issue C, 179-185

Kearns, J. (2007). Commodity currencies: why are exchange rate futures biased if commodity futures are not? *Economic Record*, *83*(260), 60–73.

Kohlscheen, E. (2010). Emerging floaters: pass-throughs and (some) new commodity currencies. *Journal of International Money and Finance*, *29*(8), 1580–1595.

Korhonen, I., & Juurikkala, T. (2009). Equilibrium exchange rates in oil-exporting countries. *Journal of Economics and Finance*, *33*(1), 71–79. https://doi.org/10.1007/s12197-008-9067-x

Kwiatkowski, D., Phillips, P. C., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of Econometrics*, *54*(1–3), 159–178.

Luetkepohl, H. (2011). *Vector Autoregressive Models* (Working Paper). Retrieved from http://cadmus.eui.eu//handle/1814/19354

Maveé, N., Perrelli, M. R., & Schimmelpfennig, M. A. (2016). *Surprise, surprise: What drives the rand/US dollar exchange rate volatility?* International Monetary Fund.

Meese, R., Rogoff,K., (1983). Empirical Exchange Rate Models of the Seventies: Do they fit out of sample? *Journal of International Economics 14* , 3 - 24

Ndlovu, X. (2011). *The relationship between the South African Rand and commodity prices: examining cointegration and causality between the nominal classes* (Master Thesis). Wits Business School. Retrieved from http://wiredspace.wits.ac.za/handle/10539/10860

Ndlovu, X., & Schaling, E. (2018). The South African rand, fundamentals and commodity prices. *African Review of Economics and Finance*, *10*(1), 23–31.

Obstfeld, M., Rogoff, K. S., & Wren-Lewis, S. (1996). *Foundations of international macroeconomics* (Vol. 30). MIT press Cambridge, MA.

Pierce, D. A., & Haugh, L. D. (1977). Causality in temporal systems: Characterization and a survey. *Journal of Econometrics*, *5*(3), 265–293.

Said, S. E., & Dickey, D. A. (1984). Testing for unit roots in autoregressive-moving average models of unknown order. *Biometrika*, *71*(3), 599–607.

Shane,M., Roe,T., & Somwaru,A., Exchange Rates, Foreign Income, and U.S. Agricultural Exports. *Agricultural and Resource Economics Review* 37/2 (October 2008) 160–175

Simpson, J. L. (2002). *The Relationship between Commodity Prices and the Australian Dollar* (SSRN Scholarly Paper No. ID 314872). Rochester, NY: Social Science Research Network. Retrieved from https://papers.ssrn.com/abstract=314872

Sims, C. A. (1980). Macroeconomics and reality. *Econometrica: Journal of the Econometric Society*, 1–48.

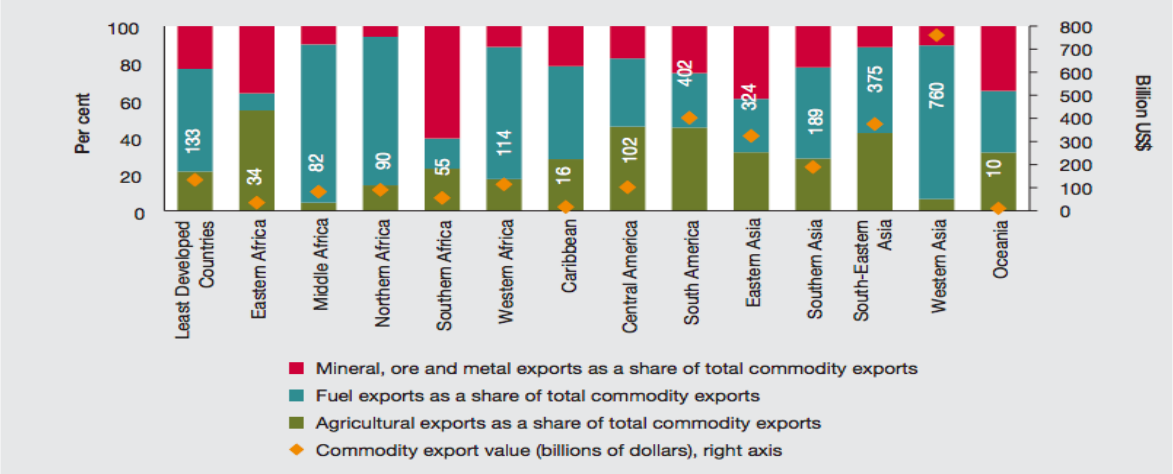
UNCTAD. (2017). The State of Commodity Dependence 2016. UNCTAD. Retrieved from https://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=1883

Warner, M. (2000). Competition policy and small open economies: Investment, trade and competition policy in developing countries and some implications for COMESA. *Competition Policy, Trade and Development in the Common Market for Eastern and Southern Africa, UNCTAD, Geneva*.

Zhang,H., Dufour,J., Galbraith, J. (2016) Exchange rates and commodity prices: Measuring causality at multiple horizons. *Journal of Empirical Finance 36*, 100–120

7. Appendices

Appendix 1: United Nations report on commodity dependence



Source: (UNCTAD, 2017)