UNIVERSITY OF THE WITWATERSRAND

Determination of the Real Exchange Rate in Commodity Exporting Countries: Do Commodity Prices Matter?

Master of Management in Finance and Investments

Research Report

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

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ACKNOWLEDGEMENTS

I would like to acknowledge my family, specifically my wife Tintswalo Hlulani Ringana for waiting for me impatiently whist I was away for the year 2016 due to academic commitments relating to the work presented in this paper. 2016 must have been a tough year for you owing to my continued absence in pursuit of education. Hard as it may be I promise not to pursue any program as tough, challenging and emotionally draining though exciting program as the MMFI degree.

I also want thank my two daughters Ntsakisi and Voninga Sitole for being there for me and understanding that daddy will one day come back home with an MMFI degree. I would also like to thank my parents for all their support throughout up to this day. I am also very thankful to my friend Toots Makamu for all the support during the 2016 academic year, appreciated. Last but not least I would like to end by saying thank you to my supervisor Prof Malikane for his guidance and knowledge sharing throughout this journey.

Abstract

This study examines the relationship between major commodity exports and the real exchange rate of commodity exporting countries. We make use of monthly commodity price time series data to determine the causality relationship between exchange rates and the top three commodity exports from 5 commodity exporting countries (Brazil, Chile, Mexico, Norway and South Africa). Due to the phenomenon called “Dutch Disease” commodity exporting countries’ economies are found not to experience large economic success during periods of booming export commodity prices. Using data from the IMF IFS database, only one country out of the five included in this study shows evidence of conitegration relationship between commodity prices and exchange rates, although there is some evidence of commodity prices explaining the movement of exchange rates in all five countries. We find that commodity prices do play a role in the exchange rates movement in commodity exporting countries.

1. Introduction

Given the current slowdown in the global commodity prices most commodity exporting economies are likely to remain under sustained pressure. Exchange rate policies play a fundamental role in bringing an economy back into equilibrium following fundamental shocks. Central banks are continuously faced with major policy decisions such as whether to allow the currency to fluctuate or intervene to bring the currency under control Hegerty (2014). Most studies on exchange rate movements have predominantly based their analysis on the concept of the purchasing power and/ or the uncovered interest parity Cashin et al. (2004). The purchasing power parity (PPP) theory has been subject to criticism from economists following the failure of many empirical studies to relate exchange rate behavior to shocks in economic fundamentals Chen and Rogoff (2003).

The proposed study uses monthly time series data for 5 commodity exporting countries to investigate the relationship between the three major export commodities and the exchange rate. The study seeks to establish where commodities in commodity exporting countries do play a role in explaining fluctuations of exchange rate.

The role of commodity prices in the determination of exchange rate has been a subject of many empirical studies in the past decades. Studies such as Bashir and Kabir (2013), Sjaastad (2008) and Bodart et al (2015) have made various contributions in establishing the linkage between the export commodity prices fluctuation and exchange rate volatility. Commodity currencies have traditionally been associated with exchange rate appreciation during periods of boom in commodity prices Bodart et al (2012). Frankel (2010) refers to this phenomenon as the Natural Resources Curse. They investigate the various channels through which natural resources wealth could result in substandard economic performance. A phenomenon called the Dutch Disease[1] was found to be one

[1] **Frankel (2007)** define Dutch Disease as a phenomenon where the currently slumps when there is a slump in mineral commodity exports and appreciates in mineral resources boom

of the fundamental channels through which commodity exporting countries could fail to outperform countries whose exports are less dominated by primary commodities.

Some empirical studies have suggested that the direction of causality between commodity prices and the real exchange rate can also take the form where fluctuations in exchange rates are able to explain the fluctuations in commodity prices. Zhang et al. (2016) identify two main explanations to the relationship between exchange rate and commodity prices. The first one suggesting that exchange rate volatility can be explained by fluctuations in commodity prices. The second explanation stresses the explanatory power of the exchange rate in explaining key economic fundamentals such as commodity prices.

These two alternative explanations of the relationship between the exchange rate and commodity prices are set apart by the direction causality from one variable to the other. Hegerty (2016) point out the existing relationship between export commodity prices and the entire macroeconomy.

2. Background

The relationship between the real exchange rate and its fundamentals has been regarded as a major source of controversy in international finance Chen and Rogoff (2003). In their literature survey Chen (2004) identified three research areas which characterize the various empirical exchange rate puzzles: “The first area aims to understand the long-run relationship between the nominal exchange rates and various fundamentals. The second area concerns whether fundamentals-based models can produce out-of-sample forecasts that outperform a naïve random walk. The third attempts to explain the high volatility and persistence observed in real exchange rate data.” The proposed study focusses on answering the empirical question of whether prices each of the top three exported commodities can individually explain the long-run variability in the real exchange rate.

Studies focusing on exchange rate volatility in relation to shocks to its fundamental determinants have increased substantially in the past decades mainly due to the macroeconomic implication of exchange rates de Nicola et al. (2016). Farrant and

Peersman (2006) found that exchange rate plays an important role of acting as a shock absorber in bringing a country's economy back into equilibrium. Attempts to model the dependency of exchange rates on commodity prices have generally yielded mixed results Koranchelian (2005). Habib and Kalamova (2007) studied the existence of a long run relationship between real oil prices and the real exchange rate of three oil producing countries; Russia, Norway and Saudi Arabia. They find that the real exchange rate volatility of Russia can be explained by the movement of international oil prices. However their finding with regards to Norway and Saudi Arabia is different. Their empirical findings suggest that there is no evidence of a long run relationship between the real oil prices and the real exchange rate of these two countries.

Chen and Roggoff (2003) pointed out that the "the connection between the economic fundamentals and exchange rates has been one of the most controversial issues in international finance, manifesting itself in numerous empirical puzzles such as the purchasing power parity puzzle." According to Sissoko and Dibooglu (2006) in their study of the exchange rate systems and macroeconomic fluctuations in Sub-Saharan Africa, the available theoretical work on the subject of the effect of the exchange rate system has largely been inconclusive.

3. Problem Statement

Countries that export primary commodities have traditionally been associated with substandard economic performance during periods of economic boom as demonstrated by Frankel (2010). The real exchange rate has been identified by economists and scholars as one of the main channels through which the economic slowdown of commodity exporting countries can be realized. Bodart et al. (2012) point out that this phenomenon happens through the altering of the competitiveness of the non-commodity exportable sectors. The ongoing failure to resolve the PPP puzzle made it difficult for economic researchers to relate the behavior of the real exchange rate to its fundamental shocks Chen and Rogoff (2003). Studies such as Cashin et al. (2004) and Koranchelian (2005) have demonstrated that the bulk of the work conducted by researchers in the

subject of exchange rate modelling has constantly produced structural exchange rate models which almost entirely fail to outperform the naïve random walk model.

The importance of understanding the effects of commodity price shocks on exchange rates of commodity exporting countries was emphasized by Chen and Rogoff (2003) in their study on commodity currencies. They argue that “if one can show that commodity prices are reliable and consistent factors in empirical exchange rate equations it would have important implications across a variety of policy issues.” According to Chen and Rogoff (2003) questions such as how to implement inflation targeting policies would also be answered with such exchange rate equations. A recent study linking the movement of exchange rates and commodity prices by Zhang et al. (2016) alludes to the fact that studies in the area have largely produced opposing implications. Cashin et al (2004) further criticizes the validity of the PPP theory which is the underlying theory in exchange rate determination.

In their studies Arezki et al (2014), Bodart et al. (2015) and Cashin et al. (2004) use an index of commodity prices for their studies. The proposed study uses the real price of each of the top three export commodities. With this study we aim to identify the cointegrating relationship that may exist between the real exchange rates and commodity prices. The second objective of this study is to identify the direction of causality between commodity prices and exchange rates. Furthermore this study aims to measure the relative explanatory power of each of the explanatory variables over time by using time varying coefficients. This approach is to the best of our knowledge unique to this study.

4. Literature Review

Empirical exchange determination has attracted many economics scholars to the subject and the general consensus has been that exchange rate puzzles are yet to be resolved. Exchange rate is considered to be a key economic variable for policy makers in largely open economies especially in developing economies Bodart et al. (2012). Chinn (2006) sites the importance of exchange rate as an economic variable in view of the rapid rate of internationalization in goods and asset markets. Chen (2004) reviewed several classic exchange rate models that have been used for economic and policy context. They found

the canonical monetary approach to exchange rate determination to rely on one or more of the following conditions: long-run purchasing power parity, money market equilibrium, uncovered interest parity, and some variants of the monetary model exchange rate and nominal rigidity.

In modeling the long-run behavior of nominal exchange rates using fundamental determinants such as relative prices, the validity of the strong-form purchasing power parity has been found to be non-existent MacDonald (1997). According to MacDonald (1997) the key to resolving the failure of the strong-form purchasing power parity (PPP) lies in understanding the forces that keep the nominal exchange rate out of its long term equilibrium level. Through the PPP assumption the flexible exchange rate is expected to move towards that equilibrium Kargbo (2003). There have been enormous criticisms levelled against the doctrine of PPP in the past decades concerning its usefulness as an exchange rate determination model Kargbo (2003). The findings of Taylor (1988) were unfavorable to the theory of the PPP, where they found that the exchange rate and relative price level were not cointegrated for any of the five countries studied. These findings meant that exchange rate followed a random walk. However, by correcting for serial correlation in the errors Fleissig and Strauss (2000) found supporting evidence for the PPP doctrine.

In their attempt to resolve the exchange rate puzzle, Chen and Rogoff (2003) studied the relationship between commodity prices and the real exchange rate in OECD economies where the potential dominant shock may be identified. They focused on three OECD economies (Australia, Canada and New Zealand) for their study. They found that the world price of commodity exports appear to have a strong and stable effect on the real exchange rate for New Zealand and Australia. In support of their finding, they pointed out that an exogenous source of terms of trade fluctuation can be identified for these commodity exporting countries because commodity products are transacted in highly centralized global markets.

In a similar study Cashin et al. (2004) examine whether the real exchange rate of commodity exporting countries and their commodity exports move together over time. They extend their study to include exchange rates of developing countries where such

studies have been scarce. In addition, their scope of commodities is wider than that considered in previous studies such as Chen and Rogoff (2003). Through their empirical analysis, they found the average half-life of adjustment of the real exchange rate to its equilibrium with commodity prices to be 10 months which is shorter than the estimate of 3 to 5 years for deviations from PPP. Furthermore, their study found robust evidence in support of the long-run comovement between the real exchange rate and real commodity-export price series for one third of the commodity exporting countries in their sample. According to their finding the long-run real exchange rate of commodity currencies is time varying (not constant) being dependent on the movements in real commodity price. This last finding is not in support of PPP based models.

Coudert et al. (2008) use yearly time series data to assess if the terms trade of different oil producing countries as well as countries producing other non-oil commodities have an effect on exchange rate. Using two samples of 16 oil producing countries and 52 commodity-exporting countries, their study confirmed findings from previous studies that commodity prices and real exchange rates are cointegrated and they move together in the long run. In addition, they found that commodity currencies tend to depreciate as commodity prices followed a downward trend. Pegged currencies were also found to depend largely on the behavior of their anchor currencies.

A recent study by Zhang et al. (2016) uses causal mechanisms which are different from previous studies to examine the relationship between commodity prices and exchange rates for four countries (Canada, Australia, Norway and Chile). The direction of causality was found to exist in both ways although it is much stronger from commodity prices to exchange rate. Bodart et al. (2015) use panel conitegration techniques in their studies to determine the magnitude of the real exchange rates in commodity currencies. This approach is contrary to most studies which merely focus on estimating the response of commodity price shocks without regard for the magnitude of the exchange rate. Arezki et al. (2014) study the volatility of the South African Rand in response to gold price fluctuations. Evidence of conitegration was found to exist between the Rand the price of gold although direction of causality was found to have changed following the liberalization of the South African capital account in 1995.

Contrary to the findings of most recent studies, Bahmani-Oskooee et al. (2013) found that the trade flows of many industries have no long-run relationship to their macroeconomic determinants. They further found that Brazilian agricultural exports were found to be hurt by exchange rate volatility where the direction of causality runs from exchange rate to agricultural exports. The study by Sjaastad (2008) investigated the empirical relationship between the price of gold and the major exchange rates and one of its key findings is that gold no longer seems to be the store of value against world inflation. In an Indian setting Nair (2015) examine the relationship between gold prices and the value of US Dollar. This study concluded that the exchange rate is an essential determinant of the fluctuation of gold prices in India.

All the reviewed literature found evidence of an existing long-run relationship between commodity prices and exchange rates in commodity currencies although with varying direction of causality. The proposed study's contribution to literature is in three ways: firstly it intends to identify the cointegrating relationship between the top three commodity exports and the real exchange rate. Secondly the study will determine the direction of causality between each individual commodity export price. Lastly the study intends to make use of time varying coefficients to measure explanatory power for each of the three commodities in explaining the fluctuation of the real exchange rate over time.

Studies by Zhang (2001) have emphasized the existence of an equilibrium real exchange rate although the real exchange rate from time to time tends to deviate from this equilibrium level. This phenomenon is known as the equilibrium real exchange rate misalignment and they define it as the difference between actual exchange rate and equilibrium exchange rate. This phenomenon play a key role in most countries economic policy decisions. Pfefermann (1985) the phenomenon of exchange rate misalignment where they pin point the negative impact of exchange rate misalignment on export sector of s small open economy. In their study on co-movement of major energy, agriculture and food commodity price returns de Nicola et al. (2016) highlight the potentially large policy and welfare implications that commodity price movement have on an economy. They find that neither variation in interest rate nor exchange rate have much effect on the comovement of commodity prices. This finding therefore implies that causality never flows

from exchange rates to commodity prices. Causality in the opposite direction is the subject of our study.

5. Theoretical Background

The commodity augmented econometric model specified for the purpose of this analysis follows from the model used by Cashin et al. (2004) in their study of exchange rates and fundamentals. Cashin et al. (2004) in their specification make use of the combined Chicago and Keynesian theoretical model augmented with commodity prices. This model was used by Frankel (1979) on his study of the theory of floating exchange rates based on interest rates differential. According to Frankel (1979) the theory of exchange floating exchange rates revolves around monetary or asset approach. Their theoretical review reveals that under the asset approach exchange rates are perceived to move in order to bring back into equilibrium the international demand for stocks of assets. This is opposed to the traditional view that exchange rate move to equilibrate the international demand for goods. Frankel (1979) points out the conflicting views of these economic theories.

Frankel (1979) interprets the two theories to imply the following: in terms of the first view "when domestic interest rates rise, relative to foreign interest rates it is because the domestic currency is expected to lose value through inflation and depreciation. Demand for domestic currency falls relative to foreign currency which causes it to depreciate instantly. This is a rise in the exchange rate, defined as the price of foreign currency." This view then hypothesizes a positive relationship between exchange rate and the nominal interest rate differential Franke (1979). The second theory described by Frankel (1979) proposes that the observed changes in nominal interest rates reflect changes in the tightness of the monetary policy. The channel trough which this occurs is such that "when domestic interest rates increase relative to foreign interest rates it is result of contraction domestic money supply relative to domestic money demand without a matching price reduction." This higher domestic interest rates relative to foreign interest rates tends to attract foreign capital inflow, which causes appreciation of the domestic currency.

This theory there hypothesizes a negative relationship between the exchange rate and nominal interest differential Franke (1979). The model that Frankel (1979) use is a combination of the two theories described above. The combined theoretical suggest that exchange rate differs from its equilibrium value by an amount proportional to the interest differential between domestic and foreign interest rates Frankel (1979). The theory produces an exchange rate determination equation in which spot rate is expressed as a function of the money supply differential between domestic and foreign economy, Relative income level, nominal interest rate differential and inflation differential. The model used by Cashin et al. (2004) is based on this model at it hypothesizes nominal interest differential as negative and inflation differential as positive.

6. Econometric Methodology and Model Specification

There are various methodologies generally in use for statistical data analysis applied by researchers when analyzing economic time series data. Ordinary Least Square methodology is amongst the most common methodology used studies relating time series data. The OLS regression methodology shall be applied for the analysis of the data In order to arrive at a conclusion regarding the determination of exchange rates using commodity prices. Economic researchers have proposed various channels through which commodity prices fluctuations can impact on the real exchange rate. Following their proposal many structural model specifications have been proposed in various attempts to solve PPP puzzle in commodity currencies. The proposed study shall follow the model used by MacDonald and Taylor (1994) where it is assumed that agents would switch from domestic currency to bonds when facing inflation at home, which then results depreciation. The basis for the derivation of this specification is that it's the PPP theory with an additional money market equilibrium, which states that money demand depends linearly on the log of real income and nominal interest rate.

The model to be used for this study is the one derived by Frankel (1979) which assumes interest rate parity where bonds of different countries are perfect substitutes and markets

are efficient. Frankel (1979) has derived a testable real interest differential based model which he specifies as follows:

$$e = m - m* - \emptyset(y - y*) + \alpha(r - r*) + \beta(\pi - \pi*) + \mu$$

Where the coefficients α and β are hypothesized as negative and positive respectively and $\alpha < \beta$ in absolute value.

And $m - m*$ represents the money supply differential between domestic and foreign countries, where m represents domestic and $m*$ represents foreign money supply

B is hypothesized as = 0

$\pi - \pi*$ represents the inflation differential between domestic and foreign countries.

$y - y*$ represents output differential between domestic and foreign countries.

$r - r*$ represents the interest rate differential between the two countries.

The model described above is then augmented with commodity prices by considering the model used by Chen (2004). We consider four commodity price-augmented equations listed below:

Augmented Relative PPP Model is derived as follows:

$s_t = \alpha + \beta_{cp} pcom_t + \beta_p(p_t - p_t*) + \varepsilon_t$ where ε_t is an error term

(1)

where s_t is the exchange rate in foreign currency price of a unit of domestic currency and P_t and P_t* represent domestic and foreign price level respectively.

Augmented Asset Approach Flexible Price Monetary Model:

$$s_t = \alpha + \beta_{cp} pcom_t + \beta_m(m_t - m_{t*}) - \beta y(y_t - y_{t*}) + \varepsilon_t \quad (2)$$

Augmented Flexible Price Monetary Model:

$$s_t = \alpha + \beta_{cp} pcom_t + \beta m(m_t - m_{t*}) - \beta_y(y_t - y_{t*}) + \beta_i(i_t - i_{t*}) + \varepsilon_t \quad (3)$$

Where pcomt represents the major export commodity in a country

Augmented Sticky Price Monetary Model: Specified for 3 commodities

$$s_t = \alpha + \sum_{i=1}^{3} \beta \text{itcppcomt} + \beta_m(m_t - m_{t*}) - \beta_y(y_t - y_{t*}) - \beta_i(i_t - i_{t*}) + \beta_\pi(\pi_t - \pi_{t*}) + \varepsilon_t \quad (4)$$

$(m_t - m_{t*})$ represents money demand differential which can be replaced by a country's Industrial production.

Where pcomt represents the world price in US dollar of a country's major commodity exports.

The model is specified to include differenced time series data in order to remove non stationarity in the data which could result in spurious regressions. Inflation and interest rate data were found to be stationary.

$$s_t = \alpha + \Delta\sum_{i=1}^{3} \beta \text{itcppcomt} + \Delta\beta_m(m_t - m_{t*}) - \Delta\beta_y(y_t - y_{t*}) - \beta_i(i_t - i_{t*}) + \beta_\pi(\pi_t - \pi_{t*}) + \varepsilon_t \quad (5)$$

7. Data

In order to determine the relationship between exchange rates and commodity prices, data from 5 countries will be used. The sample will comprise of monthly time series data of nominal exchange rates and commodity prices which will cover the period from January 1997 to December 2013. The choice of the sample period is informed by the period when the majority of developing and emerging market countries are likely to have started to float their exchange rates. For the purpose of this study real commodity prices will refer to the nominal commodity price of the three individual commodities deflated by the US inflation. A total of three commodity prices will be studied on the basis of their contribution by value of each commodity to the country's total commodity exports following the approach of Bodart et al. (2007). Mexico data will only feature two main commodity export commodities due to the availability of data on the third commodity.

The selection of commodity exporting countries to be included in the study was made following the list of potential commodity currency countries considered by Cashin et al. (2004). Their selection of potential commodity countries followed the International Monetary Fund's classification of developing countries guided by the composition of their exports. In their sample Cashin et al. (2004) also included commodity exporting developed countries in order to contrast their findings in commodity dependent developing countries against those in commodity exporting developed countries. This study shall follow a similar approach by including emerging market countries that rely on primary commodities as a source of export revenue, as well as advanced economies whose export basket is significantly constituted by primary commodities. The selection of commodity exporting countries was as follows: Brazil, Chile, Mexico, Norway and Republic of South Africa. The commodity-countries pairs have been ranked to include the top three primary commodities that each country exports. Following studies such as Cashin et al. (2004) and Chen (2004) it is hypothesized that the primary commodity that dominates a country's commodities export explains the fluctuations to the country nominal exchange rate. The selection of the top three commodities instead of merely selecting the dominant export commodity is so that the periodic shift dominance of the various commodities that countries export may be captured. A commodity that increases from a

lower ranking in terms export revenues amongst the top three export commodities is also expected to begin to explain more of the exchange rate fluctuations.

The data was sourced from the International Monetary Fund (IMF)'s Information Notice System and various world Federal Reserve banks' databases. This includes commodity prices data. The interest used are each country's 3 month Treasury bill Rate relative to the US Treasury Bill rate. Industrial production was used as a proxy for monthly output. CPI differential relative the US CPI was used for inflation differential. M1 monthly data was used as a proxy for money supply. Monthly time series data for nominal exchange rate was used. Table 12 in the appendix shows the contribution to the value of export of each commodity per country.

8. Analysis of Results

Table 1(a) below presents Brazil's results. Although the dominant commodity is significant in explaining the movements in exchange rates as expected, none of the other commodity exports are significant in explaining movements of the exchange rate. The sign of the output differential variable is consistent with theory although not significant. Interest rate differential and inflation differential are neither significant nor consistent with the exchange rate theory. Two lags of the exchange rate were also included and they are significant in explaining the exchange rate movement. This was done for the purpose of removing serial correlation in the model. The model is therefore has no serial correlation since the P-value of the Breusch-Godfrey Serial Correlation LM test is more than 5% as seen in table 1(b). These results are also in line with the mirror image relationship between the Brazilian exchange rate and the top 3 commodity prices as seen in Figure 1(a) to 1(c).

Table 1(a)

Dependent Variable: Δexchange_Rate_Brazil

Variables	Coefficients	P-Value
Constant	0.28997	0.7262
ΔSoyaBeans_Price	-0.12604	0.0083
ΔIronOre_Price	-0.03885	0.3229
ΔSugar_Price	-0.16688	0.2418
r-r*	0.05643	0.3539
Δ (y-y*)	-0.99748	0.8625
π-π*	-18.45214	0.1019
Δ (M1-M1*)	0.05009	0.3474
Δexchange_Rate_Brazil(-1)	0.42840	0.0000
Δexchange_Rate_Brazil(-2)	-0.18155	0.0117

Table 1 (b)

Breusch-Godfrey Serial Correlation LM Test:	P-Value
F-statistic	0.3852
Obs*R-squared	0.3633

The regression results for Chile are presented in Table 2(a) below. Copper is the largest contributor of Chile's primary commodity export basket. Estimation results for the Chilean model suggest that copper prices do drive the fluctuation of the Chilean exchange rate against the US dollar. The other two commodity exports are insignificant in the Chilean exchange rate determination. The negative relationship between the dominant commodity export product and exchange rate is as concluded by studies such as Cashin et al. (2004). All the exchange rate fundamentals are insignificant in explaining the movements in exchange rates of Chile except for the money supply differential variable, the sign of which is consistent with Frankel (1979)'s findings. The Breusch-Godfrey Serial Correlation LM test for the Chile model also shows the P-Value to be more than 5% meaning that there is no serial correlation in the model. Figures 2(a) to 2(c) also show that there is a negative relationship between the Chilean exchange rate and the 3 major

commodity exports. When commodity prices drop, the exchange rate depreciate and vice versa.

Table 2(a)

Dependent Variable: Δexchange_Rate_Chile

Variables	Coefficients	P-Value
Constant	-0.20447	0.5574
ΔCopper_Price	-0.17336	0.000
ΔFNuts_Price	0.02685	0.5627
ΔFish_Price	-0.01287	0.789
r-r*	0.08837	0.3362
Δ (y-y*)	-0.72304	0.8731
π-π*	3.71028	0.7749
Δ (M1-M1*)	0.36316	0.002

Table 2(b)

Breusch-Godfrey Serial Correlation LM Test:	P-Value
F-statistic	0.3804
Obs*R-squared	0.3625

Norway's results are presented in Table 3(a) below. In the Norwegian model the top two commodity exports are significant only at 10% level although the third commodity is significant at 5% level. All three commodity export prices included in the model are consistent with the theoretical framework. The serial correlation test conducted on the Norwegian model reveals that the model has no serial correlation since the P-Value is more that 5%. The relationship between the 3 major commodity exports and exchange rate is also validated by the trend graphs in figure 3(a) to 3(c) in the appendix.

Table 3(a)

Dependent Variable: Δexchange_Rate_Norway

Variables	Coefficients	P-Value
Constant	0.23611	0.3202
ΔNaturalGas_Price	-0.02000	0.0976
ΔFish_Price	-0.06353	0.0841
ΔAluminium_Price	-0.18828	0.0000
r-r*	-0.17014	0.0622
Δ (y-y*)	9.05840	0.4358
π-π*	-0.80478	0.7638
Δ (M1-M1*)	-0.07662	0.3944
Δexchange_Rate_Norway(-1)	0.29943	0.0000
Δexchange_Rate_Norway(-2)	-0.14893	0.0261

Table 3(b)

Breusch-Godfrey Serial Correlation LM Test:	P-Value
F-statistic	0.2894
Obs*R-squared	0.2707

Petroleum and gold are the top two largest commodity exports from Mexico with petroleum topping the charts. The Mexican model predicted in Table 4(a) below shows an appreciation of the exchange rate whenever the price of the prices of both petroleum and gold increase. Although their explanatory power is weak, these two variables are significant in explaining the fluctuations of exchange rates in Mexico. Gold however is significant only at 5% level. The exchange rate determination fundamentals in the model are all insignificant in explaining the movement of the Mexican exchange rate with their P-Values above 5%. Two lag of the exchange rate series were included in the specification of the Mexican model in order remove serial correlation of the residuals. Both these variables are significant and can help explain fluctuations in the exchange rate of Mexico. This conclusion is also validated by the trend graphs of Mexico in Figure 4(a) to (c) in the appendix.

Table 4(a)

Dependent Variable: Δexchange_Rate_Mexico

Variables	Coefficients	P-Value
Constant	0.10661	0.6972
ΔPetroleum_Price	-0.06507	0.0026
ΔGold_Price	-0.06113	0.0739
r-r*	0.06427	0.2802
Δ (y-y*)	2.15348	0.7678
π-π*	-5.40213	0.48
Δ (M1-M1*)	-0.00185	0.9673
Δexchange_Rate_Mexico(-1)	0.26563	0.0003
Δexchange_Rate_Mexico(-2)	-0.1526	0.0352

Table 4(b)

Breusch-Godfrey Serial Correlation LM Test:	P-Value
F-statistic	0.2894
Obs*R-squared	0.2707

South Africa's results are presented in Table 5(a) below. The sign of the interest rate differential in the regression results agrees with the negative sign hypothesized by theory. The P-Value is however more than 5% for the interest differential term which means that it is insignificant in explaining exchange rate fluctuations. The regression results depicted in table 5(a) provide evidence of a commodity currency for South Africa. An increase in either coal or gold prices tends to appreciate the South African Exchange rate relative to the US dollar. Theory also states that the coefficient of inflation differential is larger in absolute value than the interest differential coefficient. This is evident in this model. Coal, PGMs and Gold are currently the three largest commodity export products from South Africa. Both Coal and gold are significant in explaining the fluctuation in exchange rate and the negative signs are consistent with finding of several other studies on commodity exchange rates.

The lag of exchange rate is also related to exchange rate. This term was added to the originally specified model so as to remove serial correlation of the residuals in the model. Contrary to the theory, inflation differential has a negative sign as well as insignificant in explaining the rand movement against the US dollar. Gold price movement has a higher explanatory power of exchange rate compared to coal. The sign of output different as hypothesized by Frankel (1979) is inconsistent with the estimation results. The output differential variable is insignificant at 5% level but only significant at 10% level. Money supply differential is not significant in explaining movements in exchange rates which is in contrast with the theory proposed by Frank (1979). The trend graphs of all the top 3 South African export commodity prices do validate the results of the regression model. These are shown in Figure 5(a) to (c) in the appendix. The Rand appreciates when the price of either coal, gold or PGMs increase and vice versa. The model also contains no serial correlation of the residual as seen in Table 5(b) below where the P-Value is more than 5%.

Table 5(a)

Dependent Variable: Δexchange_Rate_RSA

Variables	Coefficients	P-Value
Constant	0.92690	0.2104
Δcoal_Price	-0.11945	0.0055
ΔPGMs_Price	0.06043	0.2125
ΔGold_Price	-0.21972	0.0006
r-r*	-0.01408	0.9153
Δ (y-y*)	11.70453	0.0766
π-π*	-11.26131	0.2878
Δ (M1-M1*)	0.08879	0.4482
Δexchange_Rate_RSA(-1)	0.20611	0.0033

Table 5(a)

Breusch-Godfrey Serial Correlation LM Test:	P-Value
F-statistic	0.2279
Obs*R-squared	0.2109

9. Cointegration Testing and Direction of Causality

According to theory, if the linear combination of non-stationary variables integrated of order 1 becomes integrated of order o, then these variables are said to be cointegrated. There various methods used by researchers to test for Cointegration and Johansen Cointegration test is one of them. This method was used to test the Cointegration of linear commodity price variables for the 5 countries in this study. The results of the tests are depicted in tables 6 to 10 in the appendix. The null hypotheses being tested tables 6 to 10 is that no Cointegration exists for the variables under consideration on each of the results tables. The rule is that if the P-Value is more than 5% then the null hypotheses of no Cointegration cannot be rejected. Meaning that for Cointegration to exist the P-Value needs to be less than 5%. The results show that only the South African combination of variables are cointegrated since the P-Value is less than 5%. The other 5 countries do not have any evidence of Cointegration.

The next step is to determine the direction of causality between the variable in the South African model. These variables are the South African exchange rate, the Gold prices series, PGMs price series and the coal price series. The results of the direction of causality are shown in table 11. The hypothesis that Coal and PGMs each does not cause exchange rate are rejected because the P-Value is less than 5% for both cases. Gold however has a P-Value of more than 5% therefore the null hypothesis that gold does not cause exchange rate cannot be rejected. This phenomenon can be attributed to the fact that coal has since surpassed gold by value of exports for South Africa. Gold now rank third in terms of contributing to the export value of the South African commodity export basket.

10. Conclusions

The study found that the Dutch Disease phenomenon as described by Frankel (2007) does exist in the five countries that considered in this study. There is evidence to support that the increase in commodity export prices tends to appreciate the currency of the commodity exporting country whole exports are largely dominated by commodities.

Commodity currencies tend to appreciate during periods of economic boom when commodity prices rise. Various studies on the subject have found the phenomenon of This study has therefore found that commodity prices are an integral part of the exchange rate equation in commodity countries. There is evidence for a long run relationship between the South African Rand and the prices of coal and PGMs. The direction of causality runs from coal and PGMs prices to the exchange rate. The study found that there is no evidence of Cointegration in the other 4 countries considered. The findings confirm the many findings of exchange rate research such as Cashin et al. (2004). The implications of these findings are that monetary policies in commodity exporting countries need to be aligned to strategies that react to commodity prices fluctuations in order to successfully manage the effect of exchange rate fluctuations on the overall economy.

11. Appendix

Figure 1(a)

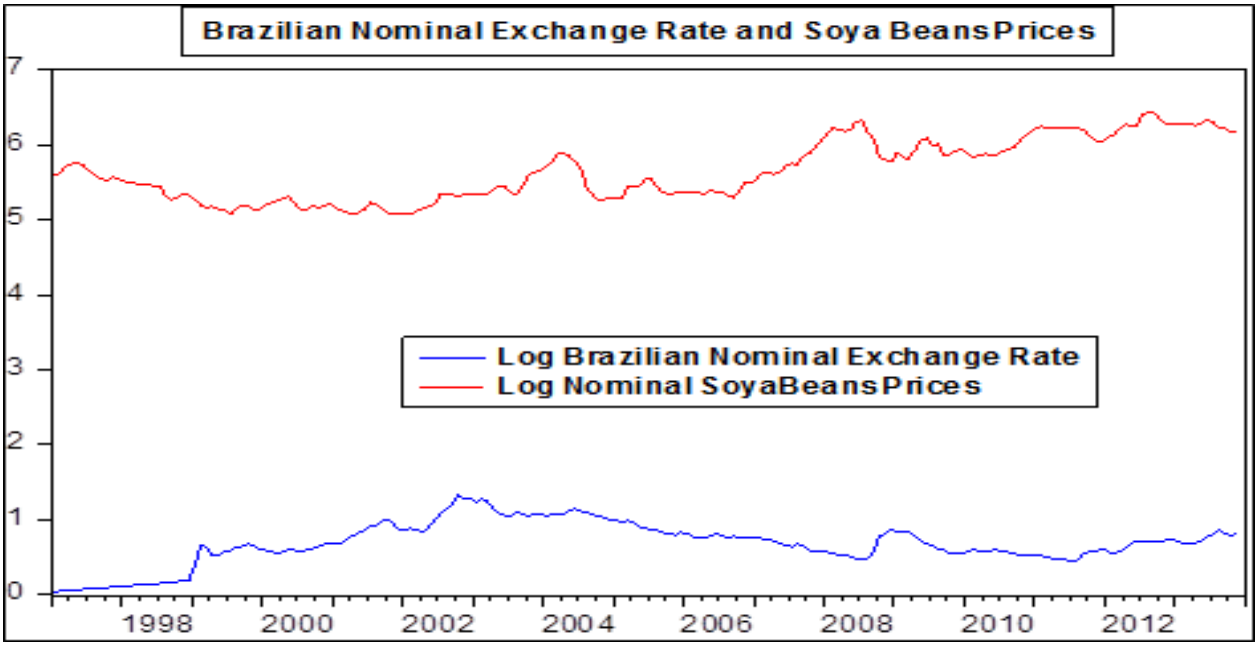

Figure 1(b)

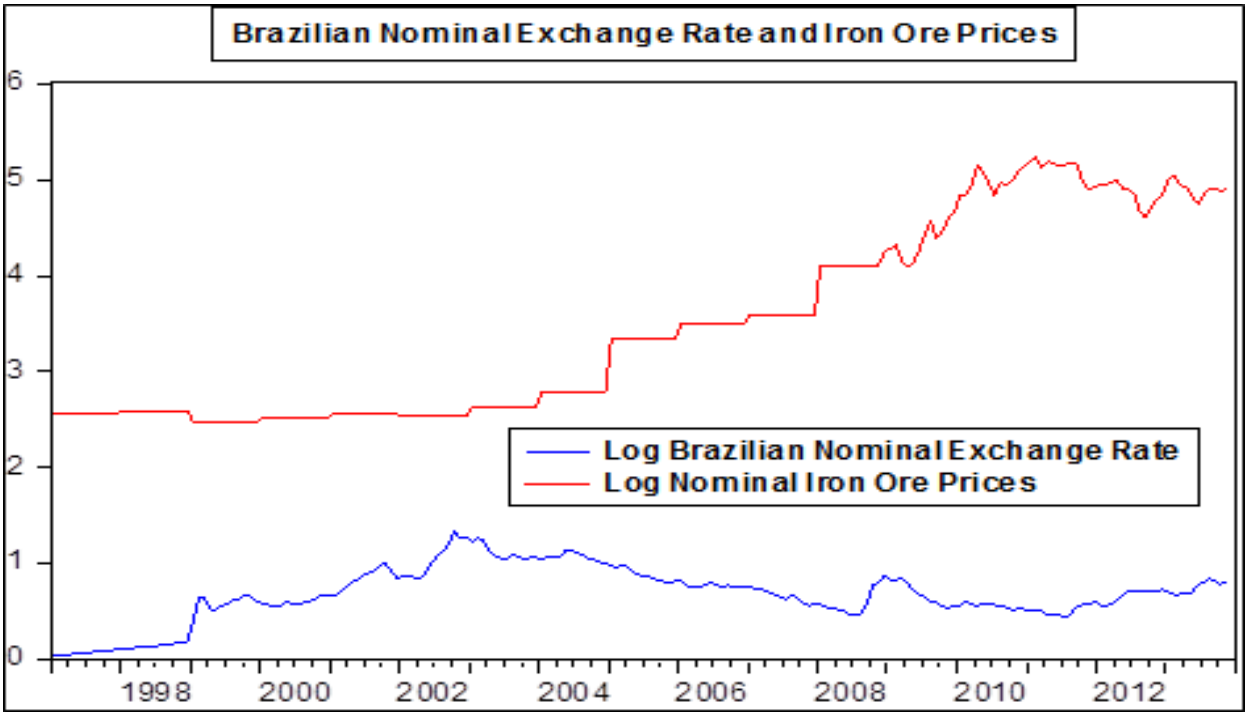

Figure 1(c)

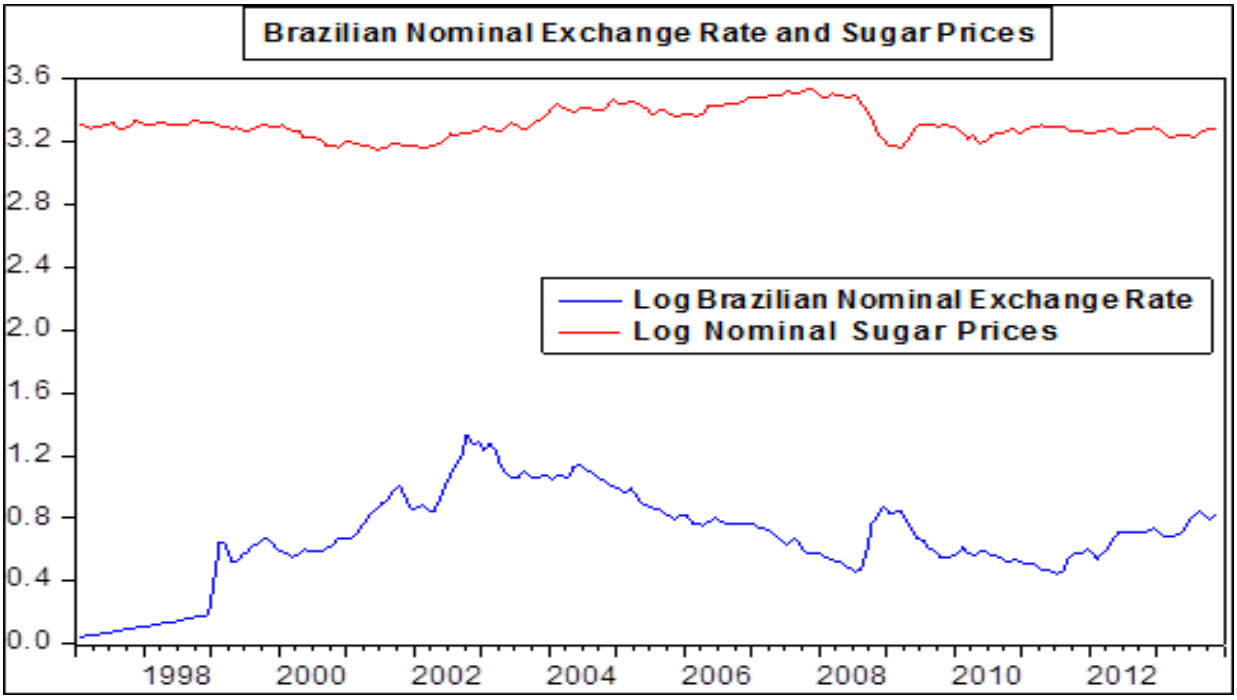

Figure 2(a)

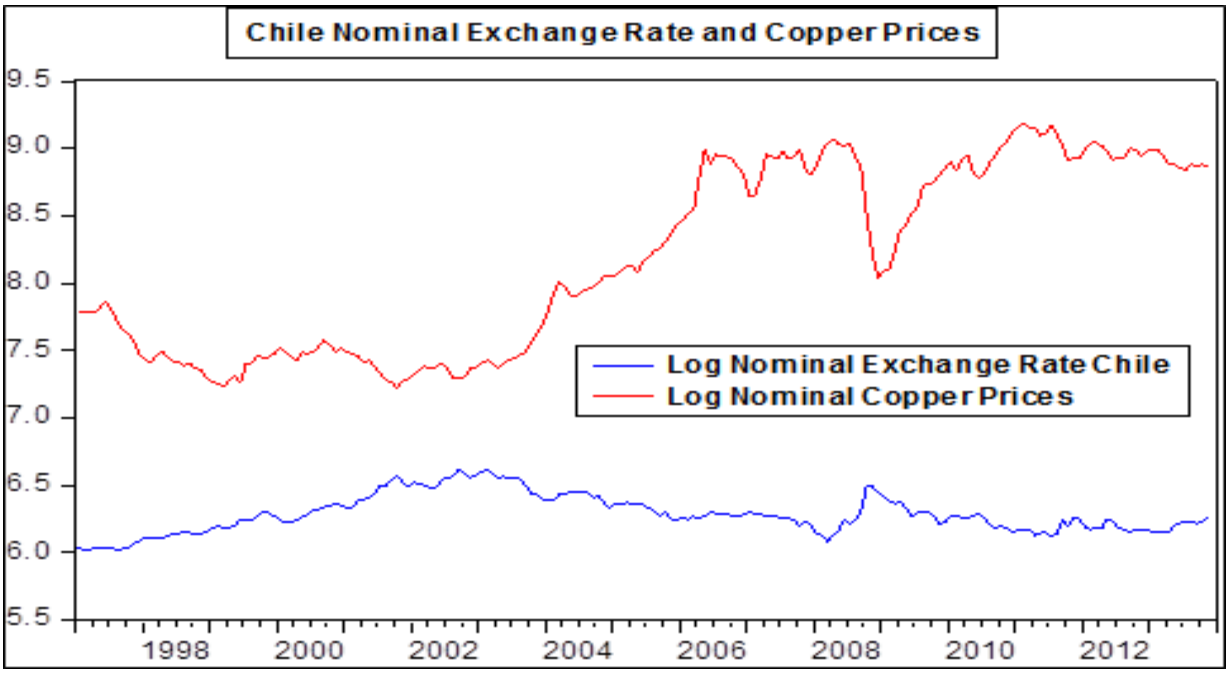

Figure 2(b)

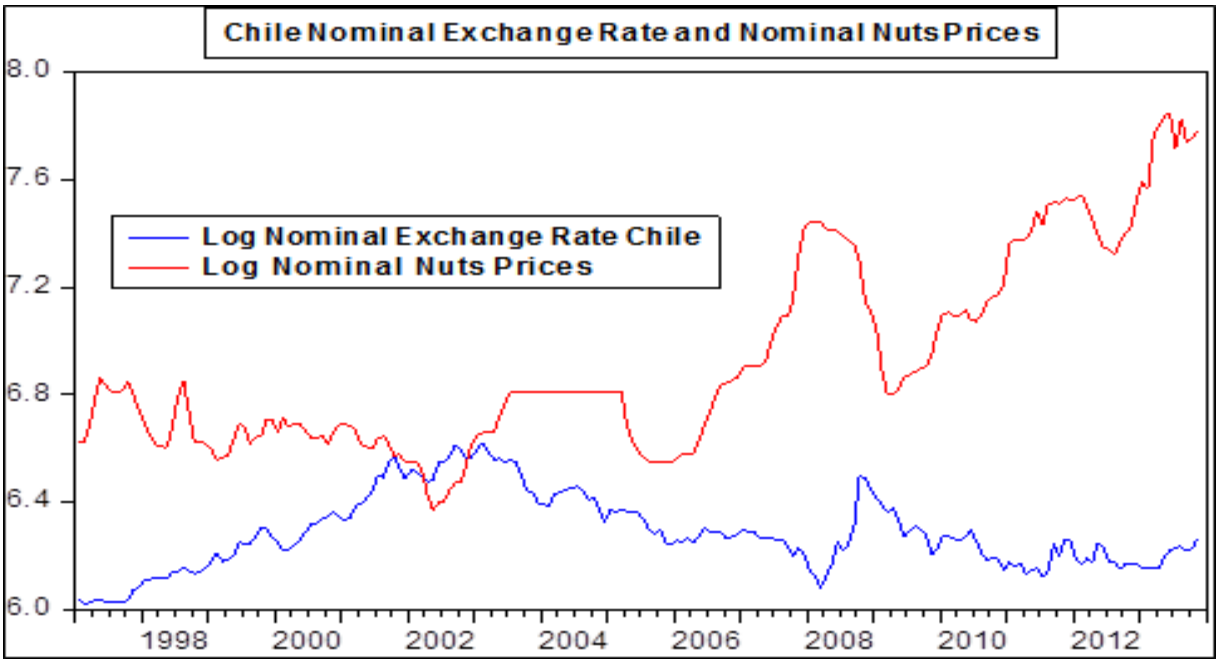
Chile Nominal Exchange Rate and Nominal Nuts Prices
Log Nominal Exchange Rate Chile
Log Nominal Nuts Prices
8.0
7.6
7.2
6.8
6.4
6.0
1998
2000
2002
2004
2006
2008
2010
2012

Figure 2(c)

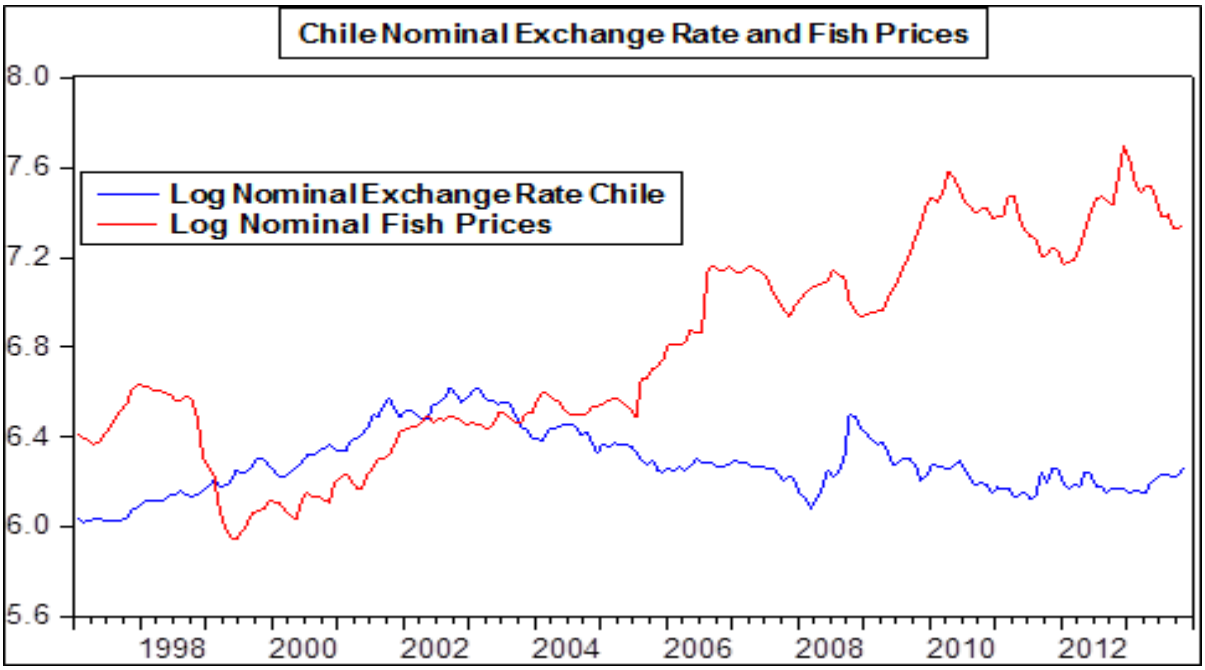
Chile Nominal Exchange Rate and Fish Prices
Log Nominal Exchange Rate Chile
Log Nominal Fish Prices
8.0
7.6
7.2
6.8
6.4
6.0
5.6
1998
2000
2002
2004
2006
2008
2010
2012

Figure 3(a)

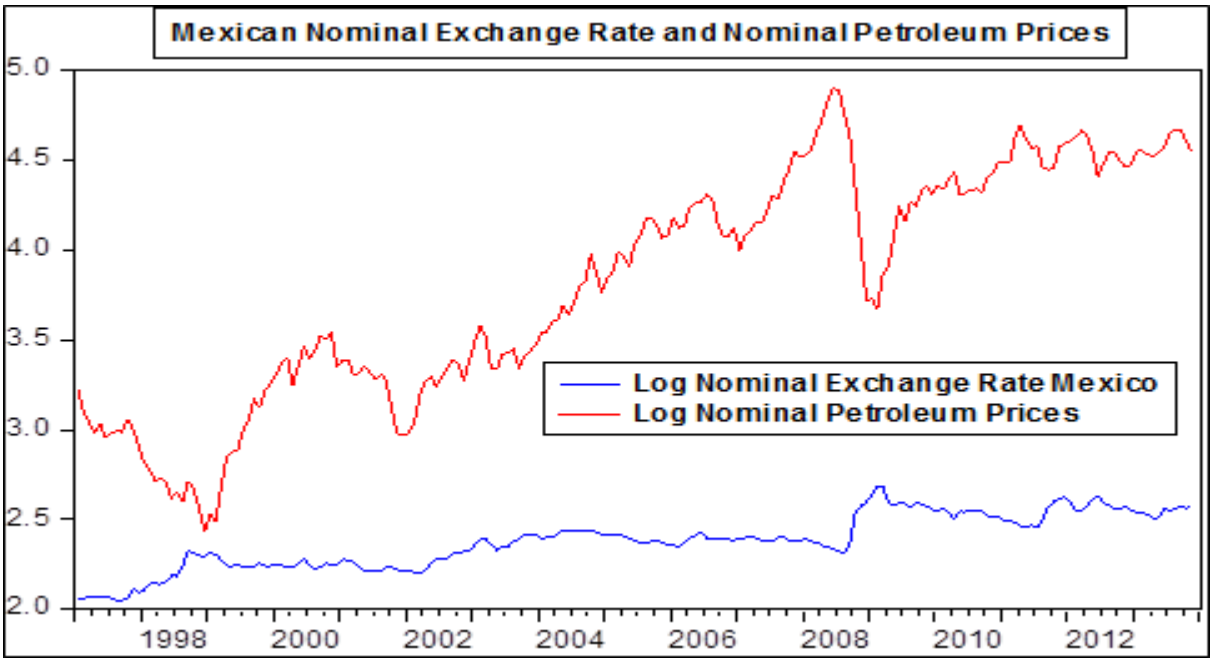

Figure 3(b)

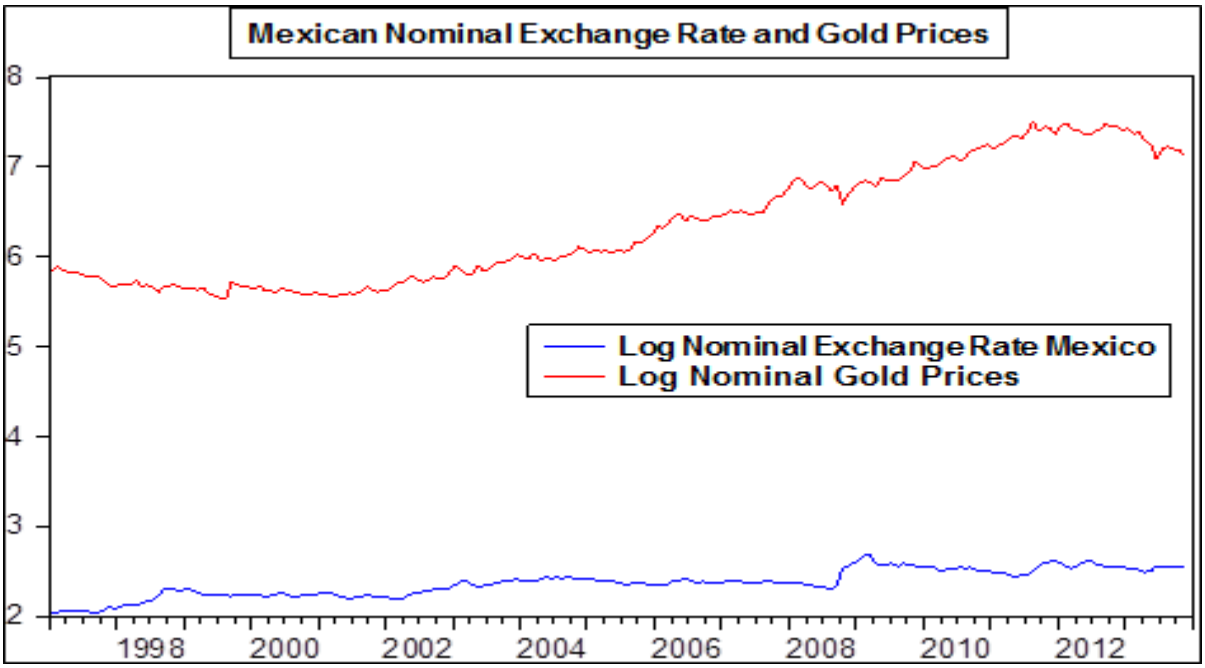

Figure 4(a)

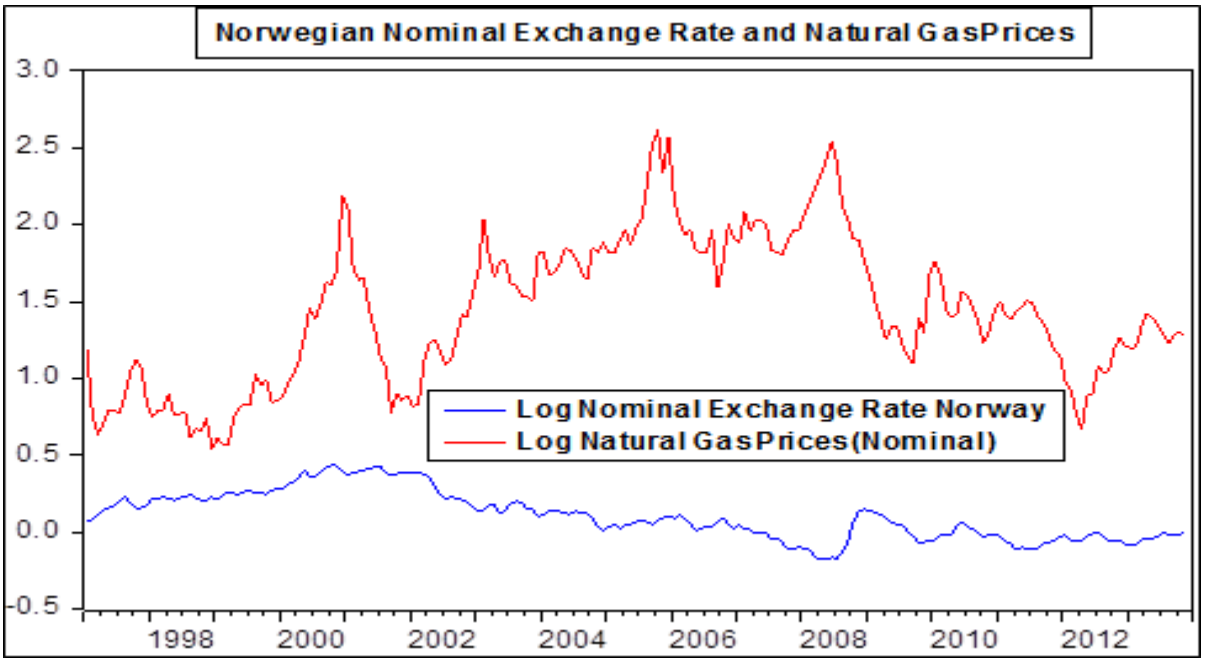

Figure 4(b)

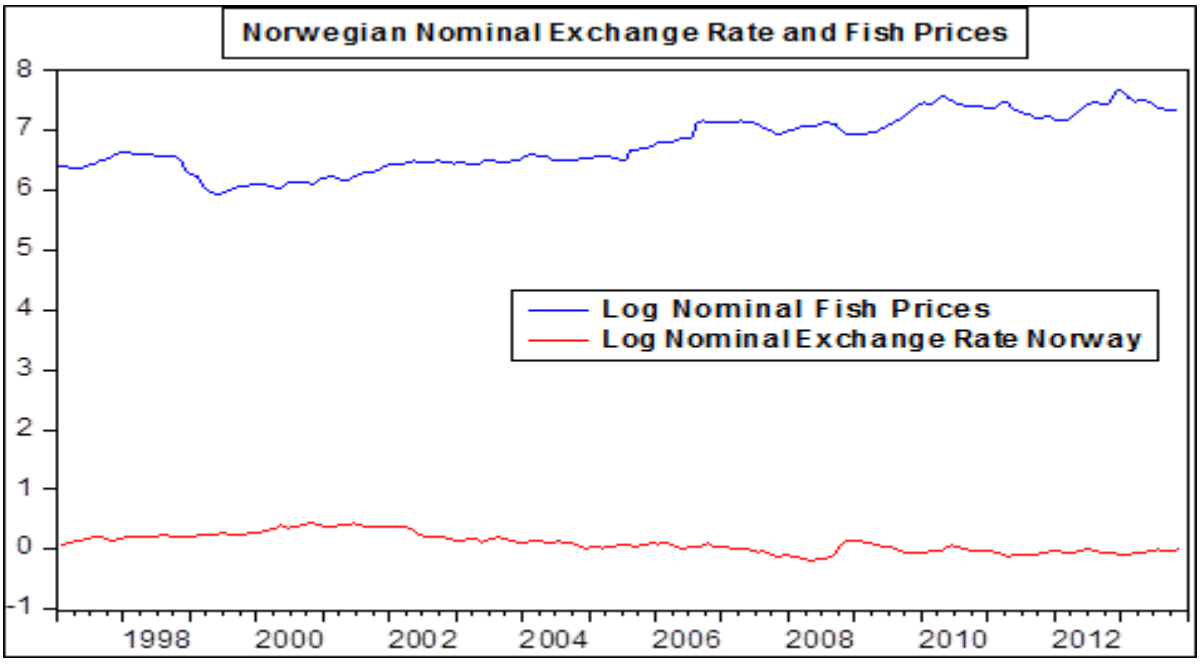

Figure 4(c)

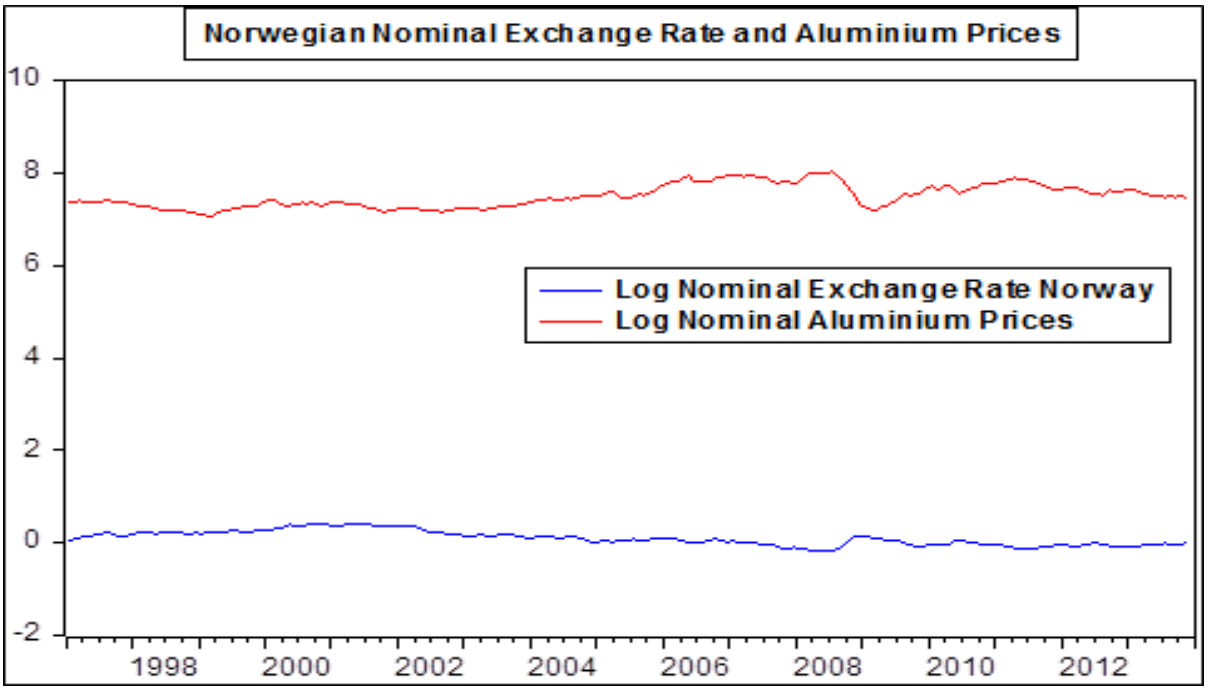

Figure 5(a)

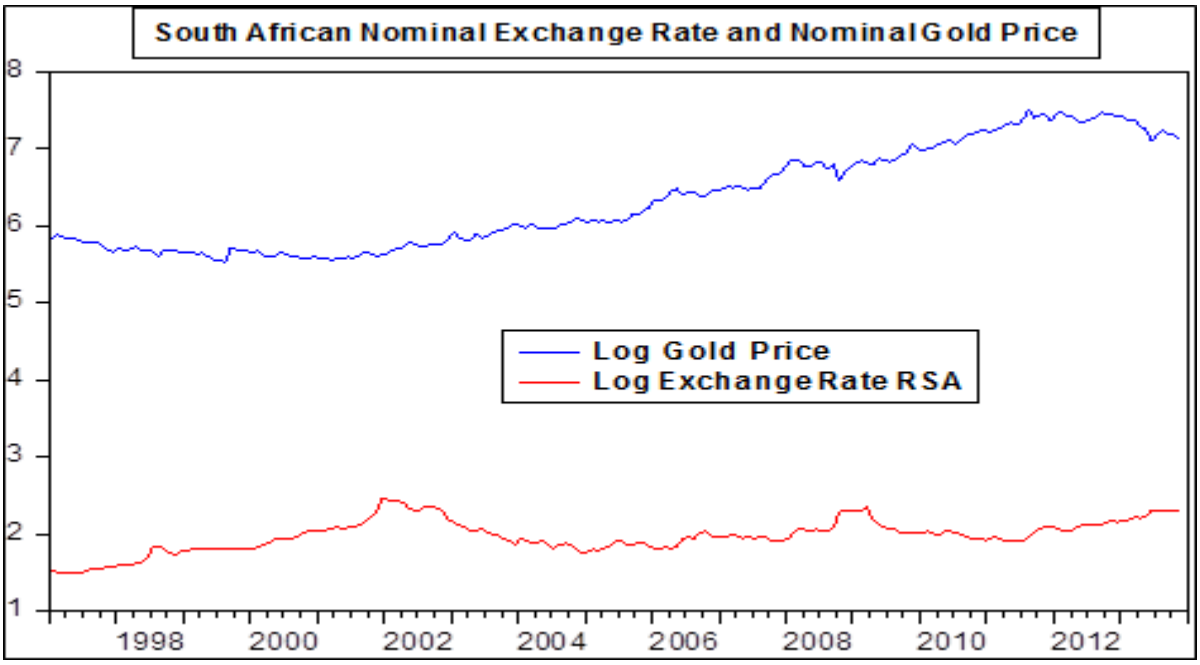

Figure 5(b)

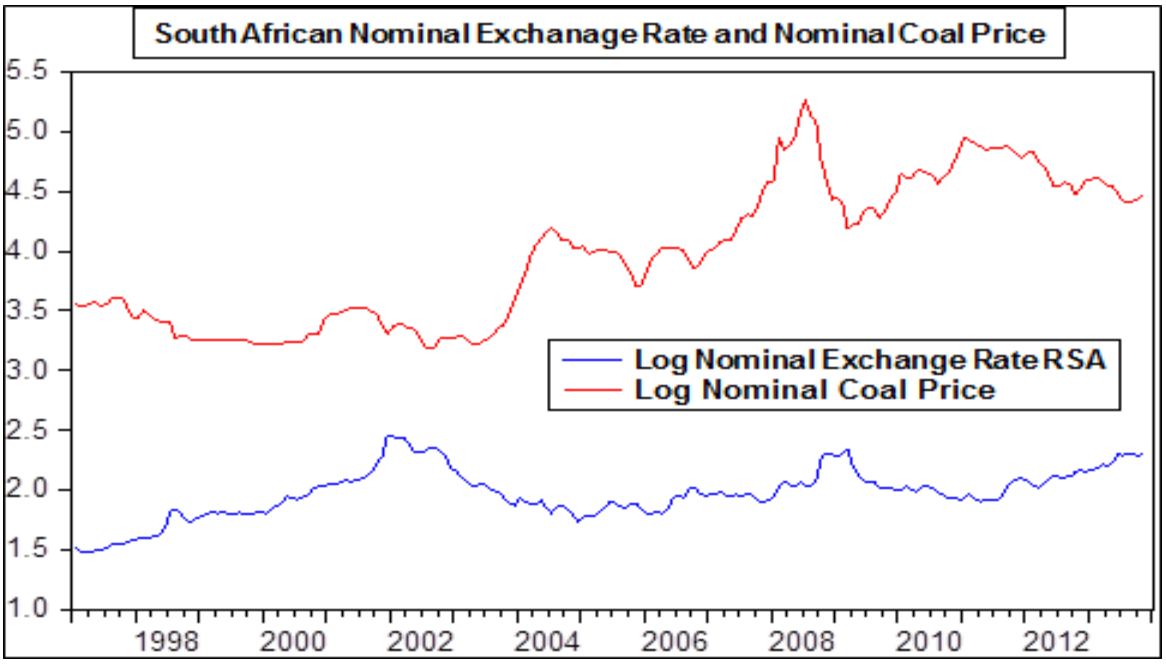

Figure 5(c)

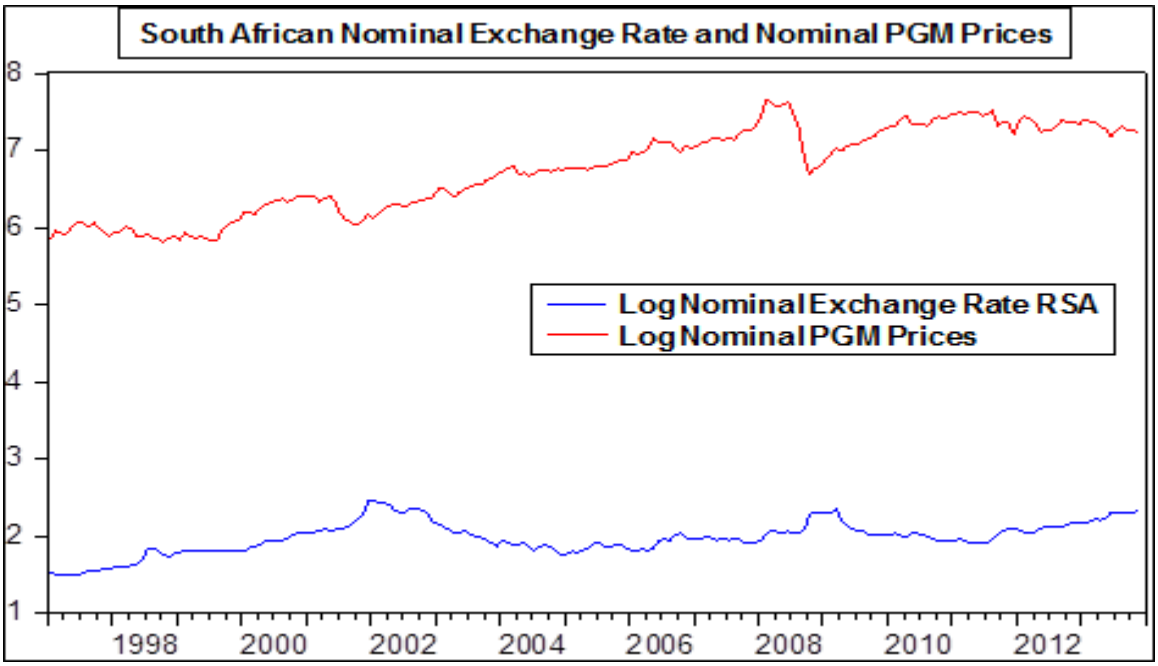

Table 6

RSA Cointegration Test Results

Trend assumption: Linear deterministic trend
Series: EXCHRSA COAL GOLD
PGMS
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.114099	51.09807	47.85613	0.0240
At most 1	0.098522	27.11040	29.79707	0.0990
At most 2	0.029559	6.573885	15.49471	0.6276
At most 3	0.003192	0.633004	3.841466	0.4263

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Table 7

Brazil Cointegration Test Results

Trend assumption: Linear deterministic trend
Series: EXCHBRAZIL SOYABEANS SUGAR
IRONORE
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.071955	31.14821	47.85613	0.6585
At most 1	0.049703	16.13851	29.79707	0.7025
At most 2	0.027575	5.891285	15.49471	0.7083
At most 3	0.001347	0.270951	3.841466	0.6027

Trace test indicates no Cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Table 8

Chile Cointegration Test Results

Trend assumption: Linear deterministic trend
Series: EXCHCHILE COPPER NUTS
FISH
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.085074	30.35846	47.85613	0.7005
At most 1	0.034465	12.75381	29.79707	0.9025
At most 2	0.024868	5.809466	15.49471	0.7179
At most 3	0.004150	0.823391	3.841466	0.3642

Trace test indicates no Cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Table 9

Norway Cointegration Test Results

Trend assumption: Linear deterministic trend
Series: EXCHNORW NATURAL_GAS FISH
ALUMINIUM
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.096746	37.11747	47.85613	0.3420
At most 1	0.053765	16.97079	29.79707	0.6422
At most 2	0.026789	6.028462	15.49471	0.6922
At most 3	0.003287	0.651894	3.841466	0.4194

Trace test indicates no Cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

Table 10

Mexico Cointegration Test Results

Trend assumption: Linear deterministic trend
Series: EXCHMEXIC PETROLEUM
GOLD
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.092180	27.66926	29.79707	0.0863
At most 1	0.039046	8.230808	15.49471	0.4410
At most 2	0.001120	0.225162	3.841466	0.6351

Trace test indicates no Cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Table 11

Granger Causality Test for South Africa

Null Hypothesis:	Obs	F-Statistic	Prob.
COAL does not Granger Cause EXCHRSA	195	2.33448	0.0208
EXCHRSA does not Granger Cause COAL		1.54833	0.1436
GOLD does not Granger Cause EXCHRSA	195	0.84926	0.5606
EXCHRSA does not Granger Cause GOLD		1.12867	0.3461
PGMS does not Granger Cause EXCHRSA	195	2.63823	0.0093
EXCHRSA does not Granger Cause PGMS		2.15261	0.0333

GOLD does not Granger Cause COAL	195	3.88992	0.0003
COAL does not Granger Cause GOLD		3.61170	0.0006
PGMS does not Granger Cause COAL	195	9.86524	3.E-11
COAL does not Granger Cause PGMS		2.89173	0.0047
PGMS does not Granger Cause GOLD	195	3.05898	0.0030
GOLD does not Granger Cause PGMS		1.83360	0.0735

Table 12

Contribution to Export Value for Commodities by Country

Years (2010 – 2013)

Ranking Order	**Brazil**	**Chile**	**Mexico**	**Norway**	**South Africa(RSA)**
1	Copper	Copper	Petroleum	Natural Gas	Coal
2	Nuts	Nuts	Gold	Fish	PGMs
3	Fish	Fish		Aluminium	Gold

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