

# FUEL PRICE AND EXCHANGE RATE DYNAMICS IN SOUTH AFRICA: A TIME SERIES ANALYSIS

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## Abstract

This paper empirically examined the relationship between fuel price and exchange rate in South Africa. Monthly data spanning over the period of January 2001 to December 2013 was used while adopting the cointegration method. The Augmented Dickey Fuller (ADF) test showed that all variables (Fuel Price, Exchange rate and New Vehicle sales) became stationary after the first difference. The results from Johansen cointegration test indicated no cointegrating equation, indicating that series were not cointegrated. The findings show that fuel price is affected by at least its two previous month prices. Both explanatory variable coefficients (0.541228 and -0.368649), show that fuel price will be increased by 20 cents Rand due to its previous two month prices. The results from impulsive test confirmed VAR test results. This paper provided evidence that there was a causal link from the exchange rates to petrol price during last one sub-period. The implication therefore is that in South Africa an increase of the fuel price is a response to the Rand value fluctuations ceteris paribus. Based on the findings of the study, policy implications and suggestion for future research are made.

**Keywords:** Fuel Price, Exchange Rate, Cointegration, Vector Autoregressive (VAR), South Africa

**JEL Classification:** F30, F31, C22, Q43

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## 1 Introduction

There is a growing consensus that global crude oil price fluctuations are mainly driven by changes in the demand for oil and fuel price being above US\$100/bbl has become regular news (KPMG, 2008). Exchange rates have been thought to have a significant impact on the export and import of goods and services. Consequently, influencing the price of those products that are traded (Harri, Nalley & Hudson, 2009). Since petrol price and exchange rates both have been experiencing fluctuations, their relationship has attracted considerable interest from many economists globally. The impact of exchange rates in local economies is often not widely publicised. Nevertheless, Gill Marcus, the former South African Reserve Bank Governor, observed that the weak Rand (South African currency) exchange rate affected the petrol price. In December 2013 and January 2014 the Rand depreciation cumulatively led to an increase of 55 cents per litre. A further increase in petrol price of 30 cents per litre prevailed in February 2014 due to weak exchange rate (Enca, 2014). Therefore, there is a link between fuel price and exchange rates. Unfortunately this link is hardly articulated by academics, especially in South Africa.

Globally, the changes in the price of crude oil between 1997 and 2011 have been difficult to explain

with only fundamentals related to the supply/demand balance. But the change in the global-US dollar exchange rate over the last decade has had significant implications for local, as well as global companies and the South Africa economy. Being an oil importing country, South Africa needs to examine the existence of a link between fuel price and exchange rate. Though this link is generally recognised through media, not enough research has been empirically conducted to explicitly bring this relationship to the fore in South Africa.

The present study aims at investigating the relationship between fuel price and exchange rate in South Africa. The study is organised as follows: section one gives the introduction. This is followed by a review of some empirical studies in section two. Data sources and the econometric model are discussed in section 3. Whilst section 4 focuses on the methodology used, section 5 discusses the results and findings. Lastly the sixth section concludes the whole research.

## 2 Review of some empirical studies

Several studies designed to determine the relationship between fuel price and exchange rate have been conducted by many macroeconomists nationally and internationally. These studies have been discerned by

the different sample sizes, time when conducted, variables used and the different settings and contexts in which they were conducted. This section explores a few of these studies.

The spillover effect of the USA dollar exchange rate on oil prices was studied by Zhang, Fan, Tsai and Wei (2008) using econometrics models that included cointegration, VAR, ARCH type. The newly proposed approach then to test Granger causality in risk exploring mean spillover, volatility spillover and risk spillover was also used. A significant long-term equilibrium cointegrating relationship between the two markets was identified. In addition they found that apparent volatility and clustering for the two market prices existed, though their volatility spillover effect was not significant. It was also established that the instant fluctuation in US dollar exchange rate did not cause significant change in the fuel market.

Like any other countries, China is not different: the issue of linkage between oil shocks and the real exchange rates has become a perennial source for concern of investigation. This is because the country's recent advent of its more flexible exchange rate system. Huang and Guo (2006) investigated the extent to which the oil price shock and three other types of underlying macroeconomic shocks impacted the trend movements of China's real exchange rate. Using the VAR model, the study established that real fuel price shocks led to a minor appreciation of the long-term real exchange rate since China depended less on imported fuel than its trading partners.

Trying to fill the existing gap in the literature, Yousefi and Wirjanto (2004) brought together the insights on exchange rate pass through and oil market structure models. The study adopted a novel empirical approach to the crude-oil price formation for the purpose of highlighting the price reactions of OPEC member countries to changes in the exchange rate of the USA dollar against other major currencies and prices of other members.

Using Vector Autoregressive (VAR) modelling and cointegration techniques, Rautava (2004) analysed the impact of international oil prices and the real exchange rate on the Russian economy and its fiscal policy. The results indicated that the "Russian economy is influenced significantly by fluctuations in oil prices and the real exchange rate through both long-run equilibrium conditions and short-run direct impacts" (Rautava, 2004:315).

With usage of Engle-Granger and causality tests, Chaudhuri and Daniel (1998) demonstrated that the nonstationary behaviour of US dollar real exchange rates, over the post-Bretton Woods era, was caused by the nonstationary behaviour of real oil prices. They used data set of real exchange rates for 16 OECD countries and for real oil prices. Monthly data were from 1973:01-1996:02 for all countries except Italy and Switzerland where samples ended in 1993:11, and Belgium where the sample was from 1980:01-1996:03.

Amano and Norden (1998) examined the issue of the relative importance of real versus monetary shocks in explaining exchange rate movements. In other words, they investigated oil prices and the rise and fall of the US real exchange rate. They found that a stable link exists between oil price shocks and the US real effective exchange rate over the post-Bretton Woods period. They suggested that oil prices may have been the dominant source of persistent real exchange rate shocks and that energy prices may have important implications for future work on exchange rate behaviour (Amano & Norden, 1998:299).

Using monthly panel data from G7 countries with a sample size of 394, Chen and Chen (2006) investigated the long-run relationship between real oil prices and real exchange rates. The results show that real oil prices may have the dominant source of real exchange rate movements. This implies the existence of a link between the two variables. In addition, the findings of the paper from panel predictive regression suggested that real oil prices had significant forecasting power.

### 3 Data source and econometric model

The current study focuses on the relationship between fuel price and exchange rate in South Africa. Also includes new vehicle sale index in the model. Therefore, the following are the mathematical (1) and econometric (2) models used in this paper:

$$FP = f(EXR, NVS) \quad (1)$$

$$FP_t = \alpha + \beta_1 EXR_t + \beta_2 NVS_t + \mu_t \quad (2)$$

#### 3.1 Dependant variable

FP = fuel price per litre in Rand (South African currency)

#### 3.2 Explanatory variables

EXR = Real exchange rate

NVS = New vehicle sale Index

$\alpha$  = Intercept

$\beta$ 's = Slope coefficients

$\mu$  = Error term

The contemporary examination uses secondary monthly time series data for the period from January 2001 to December 2013. The fuel price data were obtained from Statistics South Africa, exchange rate data was obtained from South African Reserve Bank while new vehicle sale index was gathered from easydata.com website.

### 4 Methodological discussion

The vector autoregressive (VAR) model is one of the most successful, flexible, and easy to use for the analysis of multivariate time series. It is a natural

extension of the univariate autoregressive model to dynamic multivariate time series. The VAR model has proven to be especially useful for describing the dynamic behaviour of economic and financial time series and for forecasting. It often provides superior forecasts to those from univariate time series models

and elaborate theory-based simultaneous equations models. Forecasts from VAR models are quite flexible because they can be made conditional on the potential future paths of specified variables in the model. Below, is the VAR model used in this paper:

$$FP_t = \alpha_1 + \sum_{j=1}^K \beta_{1j} FP_{t-j} + \sum_{j=1}^k \lambda_{1j} EXR_{t-j} + \sum_{j=1}^k \gamma_{1j} NVS_{t-j} + \varepsilon_{1t} \quad (3)$$

$$EXR_t = \alpha_2 + \sum_{j=1}^K \beta_{2j} FP_{t-j} + \sum_{j=1}^k \lambda_{2j} EXR_{t-j} + \sum_{j=1}^k \gamma_{2j} NVS_{t-j} + \varepsilon_{2t} \quad (4)$$

$$NVS_t = \alpha_3 + \sum_{j=1}^K \beta_{3j} FP_{t-j} + \sum_{j=1}^k \lambda_{3j} EXR_{t-j} + \sum_{j=1}^k \gamma_{3j} NVS_{t-j} + \varepsilon_{3t} \quad (5)$$

Where  $\alpha$  is the intercept;  $\beta$ ,  $\lambda$  and  $\gamma$ , are the coefficients;  $k$  is number of lags and  $\varepsilon$ 's are the stochastic error terms (known as shocks in a VAR model). Before estimating the above equations, the Augmented Dickey Fuller (ADF) test was used to test for the unit root in the variables. If the variables have a unit root, a cointegration test is generally undertaken to establish whether nonstationary variables move together over time and have a linear combination (Brooks, 2008). When are  $I(1)$ , such variables are said to be cointegrated if a linear combination of them can be stationary (Brooks, 2002:388). This implies that two nonstationary series may be bound by some relationship in long run (Niyimbanira, 2013). The cointegrating relationship is, therefore, considered as a long run or equilibrium phenomenon of variables that might deviate from short run relationship (or may have no tendency to move together) but return their association in the long run (Patterson, 2000:15). This research uses the Johansen's cointegration test to identify whether trends in fuel price and real exchange rate that contain a unit root have a long run relationship in South Africa. The Johansen's (1988 and 1991) multivariate cointegrating Vector Autoregressive (VAR) approach is discussed by Brooks (2002); Charemza and Deadman (1993 & 1997) and Enders (2004) as follows:

Considering unrestricted VAR model:

$$Z_t = \sum_{i=1}^k A_i Z_{t-i} + \varepsilon_t \quad (6)$$

$$\begin{bmatrix} FP_t \\ EXR_t \\ NVS_t \end{bmatrix} = A_1 \begin{bmatrix} FP_{t-1} \\ EXR_{t-1} \\ NVS_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} FP_{t-2} \\ EXR_{t-2} \\ NVS_{t-2} \end{bmatrix} + \dots + A_k \begin{bmatrix} FP_{t-k} \\ EXR_{t-k} \\ NVS_{t-k} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \quad (8)$$

Using the transformation shown in Equation (7), this can be presented as:

$$\text{Where: } Z_t = \begin{bmatrix} FP_t \\ EXR_t \\ NVS_t \end{bmatrix} \text{ is column vector of}$$

observations on fuel price, real exchange rate and new vehicle sale index; and,  $\varepsilon_t$  = a column vector of Random errors which are usually assumed to be contemporaneously correlated but not autocorrelated. Assuming that all variables are cointegrated in the same order, the VAR model (6) can be presented as follows:

$$\Delta Z_t = \Pi Z_{t-k} + \sum_{i=1}^{k-1} \Gamma_i \Delta Z_{t-i} + \varepsilon_t, \text{ for } k \geq 2 \quad (7)$$

Where:  $\Pi = -(I - A_1 - A_2 - \dots - A_k)$ ; and,  $\Gamma_i = -(A_{i+1} + A_{i+2} + \dots + A_k)$ ,  $i = 1, \dots, k-1$

That is:

$$\Gamma_1 = -(A_2 + A_3 + \dots + A_k);$$

$$\Gamma_2 = -(A_3 + \dots + A_k);$$

$$\Gamma_{k-1} = -A_k.$$

According to Charemza and Deadman (1997:172), the matrix  $\Pi$  represents constant dynamic adjustments of first difference of variables respectively to the levels, regardless of time difference. Thus, using the three variables (fuel price, exchange rate and new vehicle sale index) of the VAR model of this paper, the decomposition of matrices  $\Pi Z_{t-1}$  (or  $\Pi Z_{t-k}$ ) is as follows:

$$\begin{bmatrix} \Delta FP_t \\ \Delta EXR_t \\ \Delta NVS_t \end{bmatrix} = \Pi \begin{bmatrix} FP_{t-1} \\ EXR_{t-1} \\ NVS_{t-1} \end{bmatrix} + \Gamma_1 \begin{bmatrix} \Delta FP_{t-1} \\ \Delta EXR_{t-1} \\ \Delta NVS_{t-1} \end{bmatrix} + \dots + \Gamma_{k-1} \begin{bmatrix} \Delta FP_{t-k+1} \\ \Delta EXR_{t-k+1} \\ \Delta NVS_{t-k+1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \quad (9)$$

According to Johansen and Juselius (1990), the matrix  $\Pi$  (whose dimension is a 3 by 3 in this case), can be expressed as a product of two matrices:

$$\Pi = \alpha\beta' \text{ (where } \alpha \text{ and } \beta' \text{ are both the same since } \Pi \text{ is a square matrix).} \quad (10)$$

The matrix  $\beta'$  gives the cointegrating vectors (a matrix of long run coefficients), while  $\alpha$  stand for the adjustment of parameters that shows the level of speed with which the system responds to last period's deviations from the equilibrium (Brooks, 2002:406). Therefore, Johansen test is based on the examination of the  $\Pi$  matrix which can be interpreted as long-run coefficient matrix, since in equilibrium, all the  $\Delta Y_{t-i}$  will be zero and setting the error terms ( $u_t$ ) to their expected value of zero will leave  $\Pi Y_{t-k} = 0$ . Hence, the test for cointegration between FP, EXR and NVS is calculated by looking at the rank (r) of the  $\Pi$  matrix

with the use of its eigenvalues. Since the matrix has two columns, its maximum rank is 2 and its minimum rank is zero. But, for the matrix  $\Pi$  to have a rank of 1, the largest eigenvalue must be significantly non-zero, while others will not be significantly different from zero. It should be noted that in case there is no cointegrating equation found the Vector Error correction model wouldn't be estimated. However, if the cointegration test indicates that variables are not co-integrated, then the VAR model will be the one to be used. Thus, the following equations would be used but without error correction term:

$$\Delta FP_t = \alpha_1 + \sum_{j=1}^K \beta_{1j} \Delta FP_{t-j} + \sum_{j=1}^K \lambda_{1j} \Delta EXR_{t-j} + \sum_{j=1}^K \gamma_{1j} \Delta NVS_{t-j} + \Psi_1 u_{2t-1} + \varepsilon_{1t} \quad (11)$$

$$\Delta EXR_t = \alpha_2 + \sum_{j=1}^K \beta_{2j} \Delta FP_{t-j} + \sum_{j=1}^K \lambda_{2j} \Delta EXR_{t-j} + \sum_{j=1}^K \gamma_{2j} \Delta NVS_{t-j} + \Psi_2 u_{2t-1} + \varepsilon_{2t} \quad (12)$$

$$\Delta NVS_t = \alpha_3 + \sum_{j=1}^K \beta_{3j} \Delta FP_{t-j} + \sum_{j=1}^K \lambda_{3j} \Delta EXR_{t-j} + \sum_{j=1}^K \gamma_{3j} \Delta NVS_{t-j} + \Psi_3 u_{3t-1} + \varepsilon_{3t} \quad (13)$$

Where  $\Delta$  is the first difference operator,  $u_{1t-1} \dots u_{3t-1}$  are error correction terms and  $\Psi_{1, \dots, 7}$  are error correction coefficients. These error correction coefficients are expected to capture the adjustments of change in the variables towards long-run equilibrium, while the coefficients,  $\beta$ ,  $\lambda$  and  $\gamma$ , are expected to capture the short-run dynamics of the model (Muzindutsi and Sekhampu, 2013).

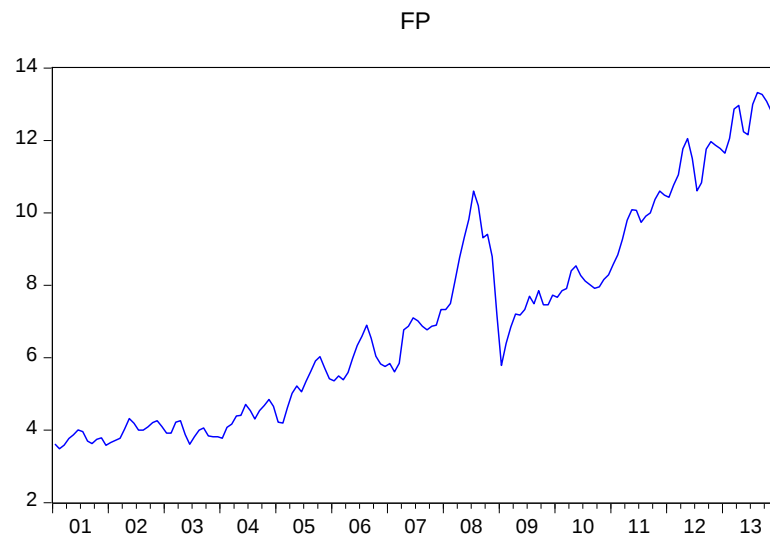
## 5 Discussion of results and findings

According to Niyimbanira (2013) as in any time series analysis, it is a good idea to plot the observed values of the data series over time in order to have an idea whether the given data is a stationary or not. This is also confirmed by Gujarati and Porter (2009) who posit that before one pursues formal tests, it is always advisable to plot the time series under investigation graphically. Such plots provide an initial clue about the likely nature of the time series. The advantage is

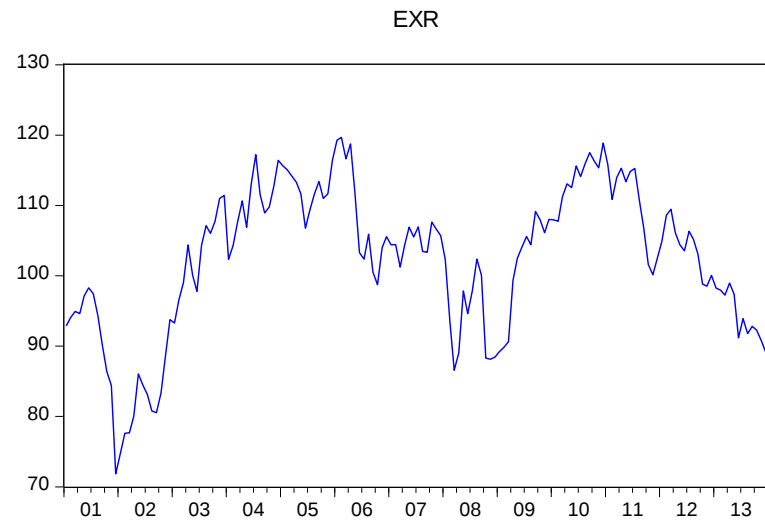
that a visual display helps to present information of a dataset in a summarised and informative way. The following are the individual plots of the data this paper uses.

FP is trending upwards. This suggests that its mean is changing. It may show that FP is not stationary. Figure 2 and 3 (average real exchange rate and new vehicle sales index) might represent a Random walk series which shows a definite trend. Gujarati (2003:807) suggests that the above realisations are the starting point of any analysis when one uses time series. But between 2006 and 2009 all the three variables commonly indicate trending downwards which may be due to global economic crisis faced. This has effects because the currencies of African countries got weaken in a generalized fashion vis-à-vis the U.S. dollar at the onset of the global economic crisis (Ltaifa *et al*, 2009).

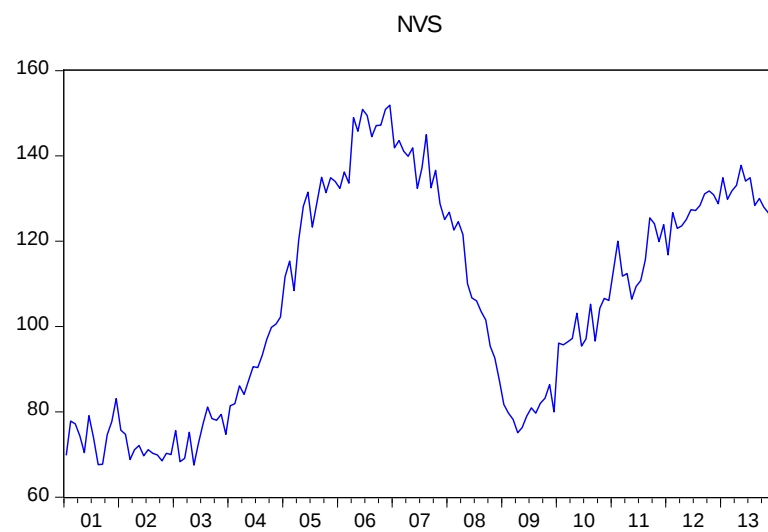
**Figure 1. Fuel price**



**Figure 2. Average real exchange rate**



**Figure 3. New vehicle sales**



Secondary, all variables were tested for stationarity using ADF and the results showed that all variables become stationary after the first difference. This means that FP, EXR and NVS were integrated of order one, I(1). It should be noted that the shocks to these I(1) series have permanent effects; the reason why it is important to have a formal test for a unit root. As general rule, nonstationary time variables must not be used in a regression model, in order to avoid the problem of spurious regression (Niyimbanira, 2012 & 2013). However it should be indicated that in a case where two or more variables

share similar stochastic trends, they are said to be cointegrated if a linear combination of them is stationary. In addition, the lag length was determined, using the lag length selection criteria of Akaike, Schwarz and Hannan-Quinn information criteria. A lag of 2 was selected based on the criterion with the lowest value which is the Hannan-Quinn information criteria; this is shown in table 1. Although lag of 2 was chosen, we run the data using lag of 8 given by LR, FPE and AIC and results were different from the theory, the reason why lag of 2 was chosen.

**Table 1.** VAR lag order selection criteria

| Lag | LogL     | LR       | FPE      | AIC      | SC       | HQ              |
|-----|----------|----------|----------|----------|----------|-----------------|
| 0   | -871.572 | NA       | 41.1878  | 12.2318  | 12.2949* | 12.2570         |
| 1   | -851.447 | 39.1245  | 35.2543  | 12.0762  | 12.3248  | 12.1772         |
| 2   | -832.275 | 36.4662  | 30.5853  | 11.9339  | 12.3690  | <b>12.1107*</b> |
| 3   | -823.544 | 16.2410  | 30.7144  | 11.9377  | 12.5593  | 12.1903         |
| 4   | -818.359 | 9.42663  | 32.4246  | 11.9911  | 12.7991  | 12.3194         |
| 5   | -806.526 | 21.0183  | 31.2059  | 11.9514  | 12.9459  | 12.3555         |
| 6   | -796.682 | 17.0720  | 30.8989  | 11.9396  | 13.1206  | 12.4195         |
| 7   | -790.978 | 9.65259  | 32.4425  | 11.9857  | 13.3532  | 12.5414         |
| 8   | -763.424 | 45.4742* | 25.1151* | 11.7262* | 13.2802  | 12.3577         |
| 9   | -760.289 | 5.04328  | 27.3843  | 11.8082  | 13.5486  | 12.5155         |
| 10  | -754.266 | 9.43327  | 28.7092  | 11.8499  | 13.7768  | 12.6329         |
| 11  | -751.181 | 4.70334  | 31.3999  | 11.9326  | 14.0459  | 12.7914         |
| 12  | -741.920 | 13.7294  | 31.5455  | 11.9289  | 14.2288  | 12.8635         |

Note: \*indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Given that all variables are I(1), the next step in the analysis is to test for cointegration by forming a potentially cointegrating regression and testing its residuals for non-stationarity (Brooks, 2002). In this case the Johansen system procedure was used for cointegration which tests the existence of long-run relationship between the series. The results from Johansen test are presented in table 2.a (Unrestricted Cointegration Rank Test (Trace)) and 2.b. (Unrestricted Cointegration Rank Test (Maximum Eigenvalue)). The results reveal that trace statistics (in 2.a) and max-Eigen Statistics (in 2.b) are all smaller than the critical value; meaning that, based on study by Mills and Mills (1991), the series are not cointegrated. Consequently, the null hypothesis of no cointegrating vectors (none) cannot be rejected. This also means that all other null hypotheses cannot be rejected. Given that there are no linear combinations of the variables are stationary, this means that there is no error correction representation (Brook, 2002).

Although there is no direct interpretation for the coefficients in the VAR estimates, the relationship

depicted as well as the levels of significance are still important. As indicated in the section of methodology, if variables are I(1) equations 11, 12 and 13 were used for VAR. The results from the VAR are shown in table 3. Findings show that fuel price is affected by at least its two previous month prices. This is explained by (D(FP(-1)) and D(FP(-2)) coefficients which are statistically significant were their t values are 7.11150 and 4.85831. In other words looking at both coefficients (0.541228 and -0.368649), one may conclude that fuel price will be increased by 20 cents due its previous two month prices. In term of how exchange rate influence FP, both D(EXR(-1)) and D(EXR(-2)) coefficients are statistically significant where their t values are -2.20919 and 2.44657 respectively. This implies that the previous month exchange rate have a negative effect on this month fuel price while the second previous month have a positive one. Furthermore, the negative signs of exchange rates coefficients show that the depreciation of Rand increases fuel price; meaning there is a negative relationship between exchange rates and

petrol price in South Africa. This is in line with Yousefi and Wirjanto (2004) who provided evidence that a depreciation of the dollar triggers an increase in the price of oil. In addition, the results indicate that

new vehicle sales of a both two previous months do not have any effect on fuel price. This is confirmed by the statistical insignificance of their t values: 0.40823 and 0.98340.

**Table 2.** Johansen test results

**2.a. Unrestricted Cointegration Rank Test (Trace)**

| Hypothesized<br>No. of CE(s) | Eigenvalue | Trace<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|--------------------|------------------------|---------|
| None                         | 0.107623   | 23.26012           | 29.79707               | 0.2335  |
| At most 1                    | 0.037171   | 6.066350           | 15.49471               | 0.6877  |
| At most 2                    | 0.002293   | 0.346610           | 3.841466               | 0.5560  |

Note: Trace test indicates no cointegration at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

**2.b. Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**

| Hypothesized<br>No. of CE(s) | Eigenvalue | Max-Eigen<br>Statistic | 0.05<br>Critical Value | Prob.** |
|------------------------------|------------|------------------------|------------------------|---------|
| None                         | 0.107623   | 17.19377               | 21.13162               | 0.1630  |
| At most 1                    | 0.037171   | 5.719739               | 14.26460               | 0.6494  |
| At most 2                    | 0.002293   | 0.346610               | 3.841466               | 0.5560  |

Note: Max-eigenvalue test indicates no cointegration at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

From table 3, looking on the results in first column, this study provides evidence that there is a causal link from the exchange rates to petrol price during last one sub-period. Understandably, South Africa as a petrol importing country this means that an

increase of the fuel price is a response from Rand depreciation. This is in line with other studies which also concluded that the causality mainly runs from exchange rates to oil prices (Cheng, 2008) and (Yousefi & Wirjanto, 2004).

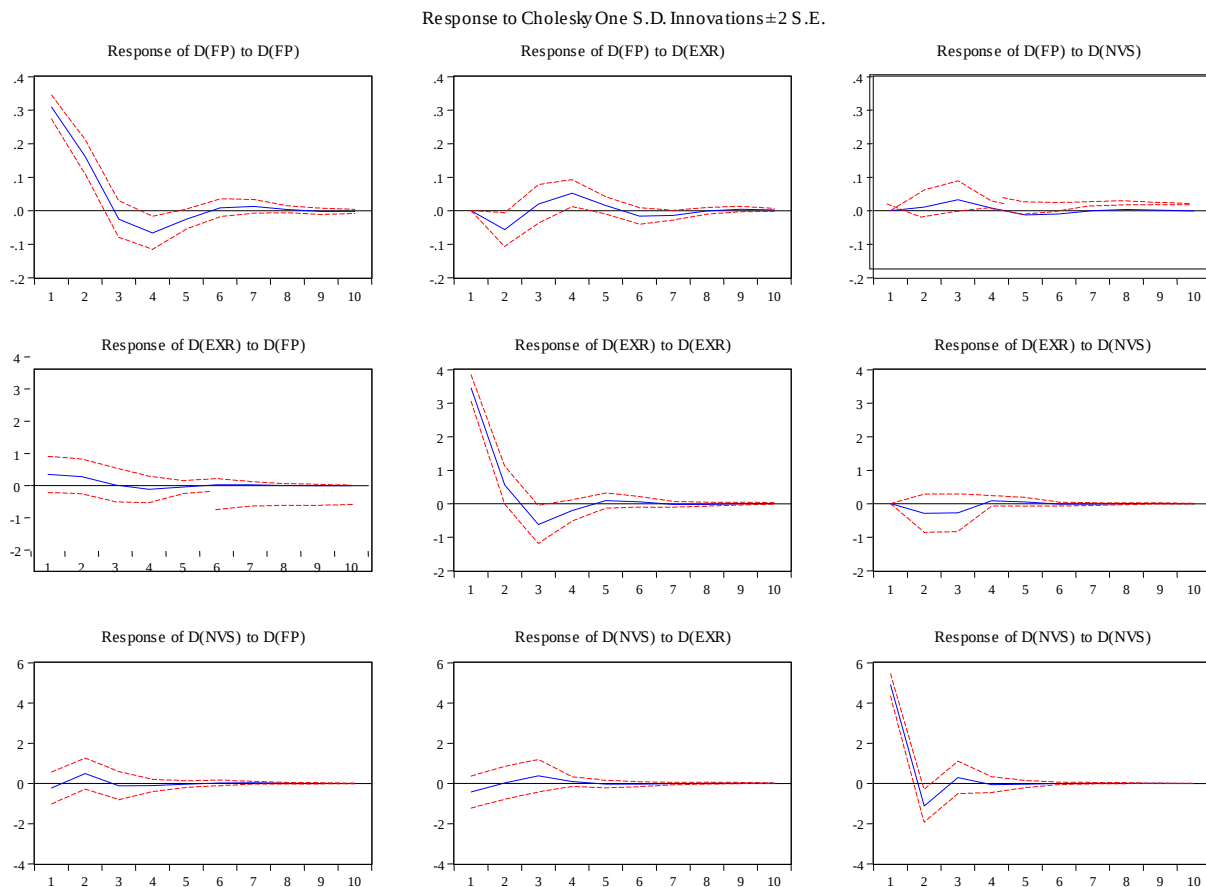
**Table 3.** Result of the VAR estimates: FP, EXR, and NVS (2001-2013)

|                | D(FP)                                | D(EXR)                               | D(NVS)                               |
|----------------|--------------------------------------|--------------------------------------|--------------------------------------|
| D(FP(-1))      | 0.541228<br>(0.07611)<br>[ 7.11150]  | 0.687775<br>(0.85335)<br>[ 0.80597]  | 1.418895<br>(1.21155)<br>[ 1.17114]  |
| D(FP(-2))      | -0.368649<br>(0.07588)<br>[-4.85831] | -0.174124<br>(0.85081)<br>[-0.20466] | -0.904333<br>(1.20796)<br>[-0.74865] |
| D(EXR(-1))     | -0.016049<br>(0.00726)<br>[-2.20919] | 0.154869<br>(0.08146)<br>[ 1.90122]  | -0.022188<br>(0.11565)<br>[-0.19185] |
| D(EXR(-2))     | 0.017892<br>(0.00731)<br>(0.00731)   | -0.199643<br>(0.08200)<br>(0.08200)  | 0.136620<br>(0.11642)<br>(0.11642)   |
| D(NVS(-1))     | 0.002121<br>(0.00520)<br>[ 0.40823]  | -0.058335<br>(0.05827)<br>[-1.00117] | -0.228269<br>(0.08272)<br>[-2.75939] |
| D(NVS(-2))     | 0.005071<br>(0.00516)<br>[ 0.98340]  | -0.061106<br>(0.05782)<br>[-1.05690] | 0.003191<br>(0.08209)<br>[ 0.03887]  |
| C              | 0.048291                             | -0.024636                            | 0.361495                             |
| R-squared      | 0.297142                             | 0.077461                             | 0.067656                             |
| Adj. R-squared | 0.268257                             | 0.039549                             | 0.029340                             |
| Sum sq. resids | 13.99766                             | 1759.829                             | 3547.335                             |
| S.E. equation  | 0.309636                             | 3.471833                             | 4.929180                             |
| F-statistic    | 10.28721                             | 2.043155                             | 1.765747                             |
| Log likelihood | -34.14419                            | -403.9514                            | -457.5764                            |

It is commonly known in econometrics that a shock of one variable does not only directly affects itself but is also transmitted to all of the other endogenous variables through the dynamic (lag) structure of the VAR. Therefore, an impulsive response function traces the effects of a one-time shock to one of explanatory variables on current and future values of the endogenous variables. In this case, the results from impulsive test confirm what was said above from VAR test results. In other words, figure 4 is about the impulse responses of the fuel

price which are consistent with economic reasoning. Regarding response to D(FP) results on figure 4, especially the first on second row, a shock in exchange rate largely depicts a positive effect on fuel price. Given a one standard deviation shock in exchange rate, fuel price will increase from the first period all the way to the sixth period and it will be stable between period five and period ten. This means that even if we could use 3 or 4 lags it was going to show that fuel prices are affected mostly by exchange rate of previous month.

**Figure 4.** Impulse Response Functions: FP, EXR and NVS (2001-2013)



## 6 Conclusion

As an open and middle income country, South Africa considers exchange rate as a key macroeconomic policy instrument that ensures export promotion and economic growth. Using the cointegration method, this paper empirically investigated the relationship between fuel prices and exchange rates in South Africa. All variables were tested for stationarity using ADF and the results showed that all variables become stationary after the first difference. This means that FP, EXR and NVS were integrated of order one,  $I(1)$  meaning that the shocks to these  $I(1)$  series have permanent effects, the reason why it is important to have a formal test for a unit root. The link between oil

prices and US dollar exchange rates has been frequently analysed and popular findings are that the real exchange rates and real oil prices are cointegrated. The results in this study indicate that exchange rates and petrol prices are not cointegrated. However, the results from VAR indicate that the previous month exchange rate have a negative effect on the current month's fuel price while the second previous month have a positive one. Furthermore, the negative signs of exchange rates coefficients show that the depreciation of Rand increases fuel price; meaning there is a negative relationship between exchange rates and petrol price in South Africa. Policy makers should keep in mind that whenever attempting to control exchange rate they should look

on how it may affect petrol price. Though, many of the policies that can address the impact of rising petrol prices on consumers are long-term in nature, this study suggests that short-term exchange rate policy would be more effective than long-term with regard to petrol price in South Africa. For future research, this paper suggests the usage of nominal exchange rate and other macroeconomic variables to investigate how they affect petrol price in South Africa.

## References

1. Amano, R.A. & Van Norden, S. (1998), Oil Prices and the Rise and Fall of the US Real Exchange Rate. *Journal of International Money and Finance*, Vol. 17, pp. 299–316.
2. Brook, C. (2002), *Introductory Econometrics for Finance*. Cambridge University Press, Cambridge.
3. Brook, C. (2008), *Introductory Econometrics for Finance*. 2nd ed. Cambridge University Press, Cambridge.
4. Charemza, W. W. & Deadman, D. F. (1993), *New Direction in Econometric Practice: General to Specific Modelling, Cointegration and Vector Autoregression*. Brookfield, Edward Elgar Publishing Limited.
5. Charemza, W. W. & Deadman, D. F. (1997), *New Directions in Econometric Practice*. Cheltenham: Edward Elgar Publishing Limited.
6. Chaudhuri, K. & Daniel, B. C. (1998), Long-run equilibrium real exchanges and oil prices. *Economic Letters*, Vol. 58, pp. 231–238.
7. Chen, S.S. & Chen, H.C. (2006), Oil prices and real exchange rates. *Energy Economics*, Vol. 29, pp. 390–404.
8. Cheng, K.C. (2008). Dollar Depreciation and Commodity Prices. IMF, *World Economic Outlook*, pp. 48–50.
9. Dickey, D. & Fuller, W. A. (1979), Distribution of the Estimates for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association*, Vol. No.366, pp. 427–431.
10. ENCA. (2014), Depreciation could see petrol price of R16 per litre. Retrieved from <http://www.enca.com/money/depreciation-could-see-petrol-price-r16-litre>. Date 20.04. 2014.
11. Enders, W. (2004), *Applied Econometric Time Series*, Wiley Series in Probability and Statistics, 2nd edition.
12. Gujarati, D.N. (2003), *Basic Econometrics*. 4<sup>th</sup> Ed., McGrawHall, New York.
13. Harri, A. Nalley, L. & Hudson, D. (2009), The Relationship between Oil, Exchange Rates, and Commodity Prices. *Journal of Agricultural and Applied Economics*, Vol. 42, No.2, pp. 501–510.
14. Huang, Y. & Guo, F. (2007), The role of oil price shocks on China's real exchange rate. *China Economic Review*. Vol. 18, 403–416.
15. Johansen, S. (1991), Estimation and Hypothesis Testing of Cointegrated Vectors in Gaussian Vector Autoregressive Models. *Econometrica*, Vol. 59, No. 6, 1551–1580.
16. KPMG. (2008), Oil and Basic Fuel Prices: The Exchange Rate Impact. Retrieved from <http://www.kpmg.com/ZA/en/IssuesAndInsights/ArticlesPublications>. Date 20.04.2014.
17. Ltaifa, N.B., Kaendera, N. and Dixit, S. (2009), Impact of the Global Financial Crisis on Exchange Rates and Policies in Sub-Saharan Africa. International Monetary Fund, Publication Services, Washington, DC.
18. Maddala, G. (2001), *Introduction to Econometrics* (3rd ed.). John Wiley & Sons, Ltd, West Sussex.
19. Maddala, G. (2001), *Introduction to Econometrics*. 3rd ed. John Wiley & Sons, Ltd, West Sussex.
20. Mills, T.C. & Mills, A.G. (1991), The International transmission of bond market movements. *Bulletin of economic research*, Vol. 43, pp. 273–282.
21. Muzindutsi, P.F & Sekhampu, J.T (2013), Socially Responsible Investment and Macroeconomic Stability in South Africa: An Application Of Vector Error Correction Model. *Journal of Applied Business Research*, Vol. 29, No. 6, pp. 1623–1630.
22. Niyimbanira, F. (2012), Real demand for money demand in South Africa: an econometric analysis. Lambert Academic Publishing, Saarbrücken.
23. Niyimbanira, F. (2013), An Overview of Methods for Testing Short- and Long-Run Equilibrium with Time Series Data: Cointegration and Error Correction Mechanism. *Mediterranean Journal of Social Sciences*, Vol.4, No.4, pp. 151–156.
24. Patterson, K. (2000), *An introduction to applied econometrics. A time series approach*. Palgrave (St. Martin's Press), New York.
25. Rautava J. (2004), The role of oil prices and the real exchange rate in Russia's economy: a cointegration approach". *Journal of Comparative Economics*, Vol. 32, pp. 315–327.
26. Yousefi, A. & T. S. Wirjanto (2004), The Empirical Role of the Exchange Rate on the Crude-Oil Price Formation. *Energy Economics*, Vol. 26, No.5, pp. 783–799.
27. Zhang, Y.J., Fan, Y., Tsai, H.T., & Wei, Y.M. (2008), Spillover Effect of US Dollar Exchange Rate on Oil Prices. *Journal of Policy Modeling*, Vol. 30, No. 6, pp.973–991.