What DCC-GARCH model tell us about the effect of the gold price's volatility on south african exchange rate?

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What DCC-GARCH model tell us about the effect of the gold price's volatility on south african exchange rate?[☆]

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Abstract

The aim of this paper is to study through a model rarely used and little known, the influence of the gold price's volatility on the south african real exchange rate. More precisely, it is to show that through the Dynamic Conditional Correlation GARCH model; model used in our paper, we get results that are consistent with economic works on the relationship between gold price's volatility and the real exchange rate. The period retained in this research paper going from May 1995 to April 2014. After analysis, we find that in the short term, the real exchange rate is more sensitive to its own volatility shocks, compared to the effect of the volatility shock of gold price. The last shock, although high, is less persistent on the real exchange rate.

Keywords: Volatility, exchange rate, gold prices, returns/yields, DCC-GARCH

1. Introduction

The relationship between economic fundamentals and the exchange rate regime is one of the most controversial issues of the international economy and a long-standing puzzle. The existence or not of a possible relationship is what on which economists focus theirs works. The exchange rate is a very important economic variable because it has some influence on the terms of trade, especially for major exporters of raw materials, energy or not. However, for countries whose economies are heavily dependent in exports of commodities, world prices seem to have a strong and systemic influence on their currencies (Chen and Rogoff (2003)). This is the case

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of some countries in America, Africa, Eastern Europe and Asia, with major exporters such as Canada, Australia, New Zealand, South Africa, Angola, the Democratic Republic of Congo, Peru, Russia, China, etc.

One of the largest exporter of strategic raw materials in the world is South Africa. First African economic power long now behind Nigeria, South Africa is a capitalist country favorable to the market economy and above all characterized by good financial integration. The gross income of South Africa before 2013, represented the quarter ($\frac{1}{4}$) of the African Gross domestic product with an annual average rate of 5%. In addition to have the most competitive markets in Africa, the country has a strong endowment of raw materials such as gold, diamonds, titanium, platinum (1^{st} WP), magnesium (1^{st}WP) of chromium, vanadium, manganese, carbon, uranium. Among this resource basket, gold remains the first wealth of the country and a key impulse of the South African economy. South Africa has been recognized as the world leader in the gold market until 2006; resource that the country has around 50% and 70% of planetary reserves.

Since 2007, South Africa has lost his place in favor of China at the time of the financial crisis. In economic and finance spheres, gold has unique qualities that enhance risk management and capital preservation for institutional and private investors. This is what specialists call the *Safe haven* or *Valeur refuge*. In finance, a modest allocation of gold makes a valuable contribution to the performance of a portfolio by protecting against downside risk without reducing the long-term returns. These qualities are especially considered during periods of financial instability. This represents an opportunity for gold exporters and investors. An increasing of the price of gold represents a gain for the country, so a funding source of their economic activity. However, the declining a shortfalls for the country. Thus, all price fluctuations affect the real value of the currency. Recently, In South Africa, policymakers have found that the periods of high volatility have limited investment and its effects were compounded in the periods when the South African Rand was overvalued with Dutch disease effects. Indeed, ”given the high level of volatility in commodity prices, it is important for countries rich in natural resources in general to better understand the relationship between the volatility of commodity prices and fluctuations in the rate of change” (Arezki et al. (2012)).

In this paper, our main objective is to study through a model rarely used and little known, the influence of the volatility in gold price on the South African real exchange rate. More precisely, it is to show that, through the Dynamic Conditional Correlation GARCH model; model used in our paper, we get results that are consistent with economic works on the relationship between gold price's volatility and the real exchange rate. The period retained in this research paper going from May 1995 to April 2014. After analysis, we find that in the short term, the real exchange rate is more sensitive to its own volatility shocks, compared to the effect of volatility shock of gold price. The last shock, although high, is less persistent on the real exchange rate.

The rest of the paper is organized as follows: section 2 is related to the research question, the section 3 presents the methodology, the section 4 the data used, the section 5 the empirical results and finally the section 6 concludes our work.

2. Literature

2.1. Definition and concepts

The volatility in general, measures the amplification of the variation of a price of an asset or a financial variable. In other words, the volatility is the propensity of an asset to deviate from its average price over a given period. It is the intensity of the value of any asset around a trend. In terms of properties, the volatility varies over the time (heteroskedastic) and is self-correlated in majority (non-stationary). Most economic studies have shown that financial assets/variables are mostly heteroskedastic and past volatility influences the present one. In addition, the volatility of an asset is grouped in packets, *i.e* there is a succession of phases of low volatility followed by high volatility ones and vice versa (*Clusters Volatility*). Besides this, it is important to note that in the analysis of volatility, downturns assets tend to generate heavy volatility than those induced by the same magnitude of price increases: that is called *Leverage effect*.

The volatility analysis plays an important role when it helps to take economic and financial decisions. The volatility analysis arouses the interest of investors, policy makers, because it is both a source of risk and opportunity. In short term, high volatility equals to a higher likelihood of losses, so a possibility that the asset price collapses strongly and quickly. For a long-term investor, volatility is the opportunity to buy when prices are low and sell when prices are too high, so an opportunity to gain. This means that the expected return is greater when the asset sees his price climbs over quickly and strongly (*" The risk is high, the expected gain will be"*).

2.2. Volatility transmission models

In our study, we are interested in a specific model to analyze the transmission of volatility. Most time, the models used to analyze the transmission of volatility are the threshold models, GARCH models. These last models are used in our work. But we have two type of GARCH models. The univariate model and the multivariate models. What is the difference between the two models? The univariate GARCH models are more interested in the sensitivity and persistence of a variable volatility shock on itself. Conversely, GARCH multivariate models (MVGARCH) analyze the impact of the volatility of a variable on another variable. The most obvious application of MGARCH models is the study of relationships between co-volatilities and volatility in several markets. In our study we analyze the influence of the volatility of gold prices on the real exchange rate.

However it is important to say why we use in our study MVGARCH model. The MV-GARCH model is rarely used to estimate this kind of relationship, but very effective because it takes full account of price volatility, the nonlinearity in variance, but especially heteroskedasticity. In addition, these models can perform good macroeconomic forecasts, to make good economic decisions that are consistent with the literature. Apergis and Papoulakos (2013) through their study of the Australian dollar and the gold price showed the importance of using the multivariate GARCH models. By using variables such as terms of trade, the differential in interest rates, gold prices and the real exchange rate, they find that the conditional volatility of the exchange rate incorporates some information on the price gold, *i.e*, the conditional volatility of the exchange rate may predict the future price of gold. These empirical results provide support to the literature of Meese and Rogoff (1983), on the ability of the volatility of exchange rate to account for future changes in commodity prices.

3. Methodology

If the univariate case is the subject of numerous studies, the multivariate case is still little studied. In this section we define the model *Dynamic Conditional Correlation* GARCH model introduced by Engle (2002). Note that in practice, the fact of analyzing only one series is not very useful. The interest of a study based on the transmission of volatility is to review and analyze the various relationships that have different series together. Thus, understanding and predicting the time dependence in moments of second order of an asset is important in financial econometrics. It is now widely accepted that financial volatility moves in time through the assets and markets. Recognizing this function through a multivariate modeling framework led to more relevant empirical models than working with separate univariate models. Therefore analyze the transmission of volatility through financial market variables requires the use of multivariate GARCH models.

Before performed any analysis by multivariate GARCH approach, it is important to verify the presence of GARCH effect at least in the explanatory variable. The test performed is the Ljung-Box based on the squares of the series returns. This is a matching test; a non-correlation test on the square of yields. The null hypothesis of no autocorrelation in the square of yields corresponds to the existence of ARCH effects in the series. however, the alternative hypothesis of the presence of autocorrelation corresponding to the existence of GARCH effect. For orders p and q a Box-Jenkins selection procedure is used. The maximum likelihood method is used to estimate the GARCH model. Let define a DCC-GARCH model.

Let X_t a vector $(n \times 1)$ of stationary process, $X_t \sim$ DCC-GARCH if:

$$X_t = \mu_t + \varepsilon_t \tag{1}$$

$$\varepsilon_t = H_t^{\frac{1}{2}} \varepsilon_t \tag{2}$$

$$H_t = D_t R_t D_t \tag{3}$$

with

$$D_t = \begin{pmatrix} \sqrt{H_{1,t}} & \dots & 0 \\ : & \ddots & : \\ 0 & \dots & \sqrt{H_{n,t}} \end{pmatrix}$$

and

$$R_t = \begin{pmatrix} 1 & \rho_{12,t} & \rho_{13,t} & \dots & \rho_{1n,t} \\ \rho_{21,t} & 1 & \rho_{23,t} & \dots & \rho_{2n,t} \\ \rho_{3,t} & \rho_{32,t} & 1 & \dots & \rho_{3n,t} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \rho_{n1,t} & \rho_{n2,t} & \dots & \rho_{n,n-1,t} & 1 \end{pmatrix}$$

where

$$H_{i,t} = \alpha_{0i} + \sum_{q=1}^{Q_i} \alpha_{iq}\varepsilon_{i,t-q}^2 + \sum_{p=1}^{P_i} \beta_{ip} H_{i,t-p}$$

μ_t: Vector $(n \times 1)$ of conditional expectation of X_t at t,

ε_t : Vector $(n \times 1)$ conditionals errors of n actifs at t, with $E(\varepsilon_t) = 0$ and $Cov(\varepsilon_t) = H_t$,

H_t: is the matrix $(n \times n)$ of conditional variances and covariances of ε_t at t,

D_t: diagonal matrix $(n \times n)$ of conditional standard errors of ε_t at t, which is always positive

R_t: Matrix $(n \times n)$ of conditional correlations of ε_t at t.

ε_t: Vector $(n \times 1)$ of errors $i.i.d.$ with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t \varepsilon_t^{'}) = I_n$.

We note that R_t is the dynamic matrix. H_t must be always positive. R_t should be positive and also that its elements are less than or equal to one ($\rho_i \leq 1 \; \forall \; i$). For this we break R_t in two (02) matrix:

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \tag{4}$$

with

$$Q_t^* = \begin{pmatrix} \sqrt{q_{11,t}} & \dots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \dots & \sqrt{q_{nn,t}} \end{pmatrix}$$

and

$$Q_t = \begin{pmatrix} q_{11,t} & \sqrt{q_{11,t}q_{22,t}} & \dots & \sqrt{q_{11,t}q_{nn,t}} \\ \sqrt{q_{11,t}q_{22,t}} & q_{22,t} & \dots & \sqrt{q_{22,t}q_{nn,t}} \\ \vdots & \vdots & \ddots & \vdots \\ \sqrt{q_{11,t}q_{nn,t}} & \sqrt{q_{22,t}q_{nn,t}} & \dots & q_{nn,t} \end{pmatrix}$$

For a DCC(p,q)

$$Q_t = [1 - \sum_{i=1}^{P} \alpha_{DCC,i} - \sum_{j=1}^{Q} \beta_{DCC,j}]\bar{Q} + \sum_{i=1}^{P} \alpha_{DCC,i}(\varepsilon_{t-i}\varepsilon_{t-i}^{'}) + \sum_{j=1}^{Q} \beta_{DCC,j} Q_{t-j} \tag{5}$$

For a DCC$(1,1)$

$$Q_t = (1 - \alpha_{DCC} - \beta_{DCC})\bar{Q} + \alpha_{DCC}\varepsilon_{t-1}\varepsilon_{t-1}^{'} + \beta_{DCC}Q_{t-1}$$

with α_{DCC} and β_{DCC} are scalars. $R_t > 0$ if and only if $Q_t > 0$. So that H_t is positive, it is necessary that the following conditions are satisfied:

$$\alpha_{DCC} \geq 0; \beta_{DCC} \geq 0; \text{avec } (\alpha_{DCC} + \beta_{DCC}) < 1.$$

Consider a DCC-GARCH$(1,1)$ bivariate model used in this study:

$$H_{11,t} = \alpha_{0,1} + \alpha_{11}\varepsilon_{1,t-1}^{2} + \beta_{11}H_{11,t-1}$$

$$H_{22,t} = \alpha_{0,2} + \alpha_{21}\varepsilon_{2,t-1}^{2} + \beta_{21}H_{22,t-1}$$

$$Q_t = (1 - \alpha_{DCC} - \beta_{DCC})Q + \alpha_{DCC}\varepsilon_{t-1}\varepsilon_{t-1}^{'} + \beta_{DCC}Q_{t-1}$$

The parameters to be estimated are α_{01}, α_{02} representing the average conditional volatility of series 1 et 2; α_{11}, α_{21} called ARCH parameters measuring sensitivity and β_{11}, β_{21} GARCH parameters that measure the persistence. Thus α_{ij} $\forall\ i,j = 1,2$ measures the sensitivity of the shock of the asset i on the asset j and $\beta_i j$ $\forall\ i,j = 1,2$ measures the persistence of the shock of asset i on the asset j.

The estimate of the DCC-GARCH model is by the maximum likelihood method and the likelihood function fo $X_t = \sqrt{H_t}\varepsilon_t$ is written:

$$L(\theta) = \prod_{t=1}^{T} \frac{1}{\sqrt{(2\pi)^n/H_t}} \exp(-\frac{1}{2}X_t^T H_t X_t) \tag{6}$$

where $\theta = (\phi, \omega)$ are the parameters to be estimated, with:

$$\phi = (\alpha_0, \alpha_{1,i}, ..., \alpha_{p,i}, \beta_{1,i}, ..., \beta_{Q,i})$$

and

$$\omega = (\alpha_{DCC}, \beta_{DCC})$$

The log-likelihood is written as follows:

$$\ell = -\frac{1}{2}\sum_{t=1}^{T}(n\log(2\pi)) + 2\log|D_t| + \log|R_t| + X_t^{'}D_t^{-1}R_t^{-1}D_t^{-1}X_t \tag{7}$$

The log-likelihood is the sum of a term volatility $\ell_v(\theta)$ and another of correlation $\ell_c(\theta,\phi)$.

$$\ell(\theta,\phi) = \ell_v(\theta) + \ell_c(\theta,\phi) \tag{8}$$

with

$$\ell_v(\theta) = -\frac{1}{2}\sum_{t=1}^{T}(n\log(2\pi)) + 2\log|D_t| + X_t^{'}D_t^{-1}R_t^{-1}D_t^{-1}X_t$$

and

$$\ell_c(\theta,\phi) = -\frac{1}{2}\sum_{t=1}^{T}(\log|R_t| + \varepsilon_t^{'}R_t^{'}\varepsilon_t - \varepsilon_t^{'}\varepsilon_t)$$

The model estimation is done in two steps. The first is to estimate the conditional variance of series with a univariate GARCH ($\ell_v(\theta)$), and the second is to use the standardized residuals obtained to estimate the parameters of the dynamic correlation matrix ($\ell_c(\theta,\phi)$).

First step

In this step we maximize the term of volatility $\ell_v(\theta)$. We replace R_t by an identity matrix I_n. So we have:

$$\begin{aligned}
\ell_v(\theta) &= -\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi) + 2log|D_t| + log|I_n| + X_t^{'}D_t^{-1}R_t^{-1}D_t^{-1}X_t) && (9)\\
&= -\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi) + 2log|D_t| + X_t^{'}D_t^{-1}R_t^{-1}D_t^{-1}X_t) && (10)\\
&= -\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi) + \sum_{i=1}^{n}(log(H_{i,t}) + \frac{X_{i,t}^2}{H_{it}}) && (11)\\
&= -\frac{1}{2}\sum_{t=1}^{T}\sum_{i=1}^{n}(nlog(2\pi) + log(H_{i,t}) + \frac{X_{i,t}^2}{H_{it}}) && (12)
\end{aligned}$$

$log(2\pi)$ is constant, so we maximize:

$$\ell_v(\theta^{)} = -\frac{1}{2}\sum_{t=1}^{T}\sum_{i=1}^{n}(log(H_{i,t}) + \frac{X_{i,t}^2}{H_{it}}) \tag{13}$$

The estimator θ^* of θ is obtained by:

$$\theta^* = arg_\theta max\ell(\theta)$$

Second step

This step is to estimate the correlation term $\ell_c(\theta,\phi)$. Once the first step is completed, this is performed using the likelihood function now well specified:

$$\ell_c(\theta,\phi) = -\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi)+2log|D_t|+log|R_t|+X_t^{'}D_t^{-1}R_t^{-1}D_t^{-1}X_t) \quad (14)$$

$$= -\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi)+2log|D_t|+log|R_t|+\varepsilon_t^{'}R_t^{-1}\varepsilon_t) \quad (15)$$

$$\ell_c(\theta,\phi) = -\frac{1}{2}\sum_{t=1}^{T}(log(|R_t|)+\varepsilon_t^{'}R_t^{-1}\varepsilon_t) \quad (16)$$

and we obtain the estimator:

$$\phi^* = arg_\phi max \ell_c(\theta,\phi)$$

Under general conditions, the likelihood estimator will converge and asymptotically normal:

$$\sqrt{T}(\hat{\theta}-\theta_0) \longrightarrow \aleph(0,V(\theta_0))$$

In terms of benefits, the DCC-GARCH models are modeling directly the variance and the co-variance but also its flexibility. They allow to take into account the change in the relationship between volatility of variables over the time, so to measure the real impact of the volatility of a variable on another.

4. Data

After defining the model, we present the variables that we use in our study (see Table 1): The data considered in our study are monthly and the period going from May 1995 to March 2014. Before any statistical operation, we remove the seasonal effect of series of gold prices ”GP” with the x12-arima process. Once done, we define two variables — the real exchange rate and the gold price — we use in our analysis.

4.1. Real exchange rate

Figure 1 shows the evolution of the real exchange rate calculated as follows:

$$rer_t = s_t + p_t^{us} - p_t^{sa} \quad (17)$$

Name	Label	Source	Seasonality
Gold price	GP	Federal Reserve	Yes
Nominal exchange rate	S	OECD stats	No
South Africa CPI	P_{sa}	OECD stats	No
United States CPI	P_{us}	OECD stats	No

CPI = Consumer Price Index

Table 1: Series

with s the nominal exchange rate (price quotation system), p_t^{us} the Consumer Price Index of United States, and p_t^{sa} the Consumer Price Index of United States of South Africa. All variables are expressed in logarithms. The analysis of the graph presents enormous transitory shocks to the real value of the Rand. The most salient points are the gradual depreciation of the Rand which lasted from 1999 to 2002 (the sharp depreciation of the rand), and also that from 2007 to 2008 during financial crisis. Careful analysis of the graph shows a cyclical evolution of the exchange rate, cycles that tend to decline over the years.

4.2. Price of gold

For the evolution of world gold price shown in figure 2, apart the slight decrease in the price of gold between 1995 and 2002, the value of the ounce of gold has increased steadily by attending an historic price of $1,896.5$ dollars per troy ounce on Sept 5, 2011. Since the value of an ounce of gold has steadily declined. But it is important to note the slight fall of the value of gold $(692,50)$ dollars during the 2008 recession before increasing thereafter.

4.3. Joint analysis

When we jointly analyze the evolution of the two series, we note that the declines in gold prices is followed by a depreciation of the exchange rate. Thus, after the recession of 2001, we note that the rise in world gold price until 2008 is followed by a phase of appreciation of the

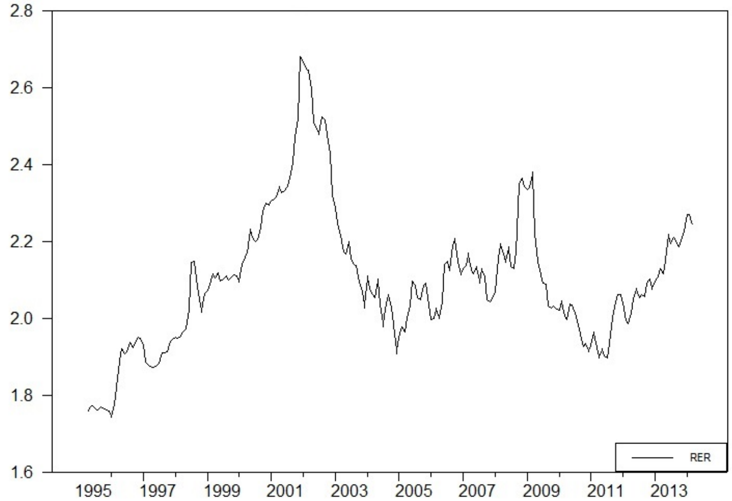

Figure 1: Evolution of real exchange ZAR/USD

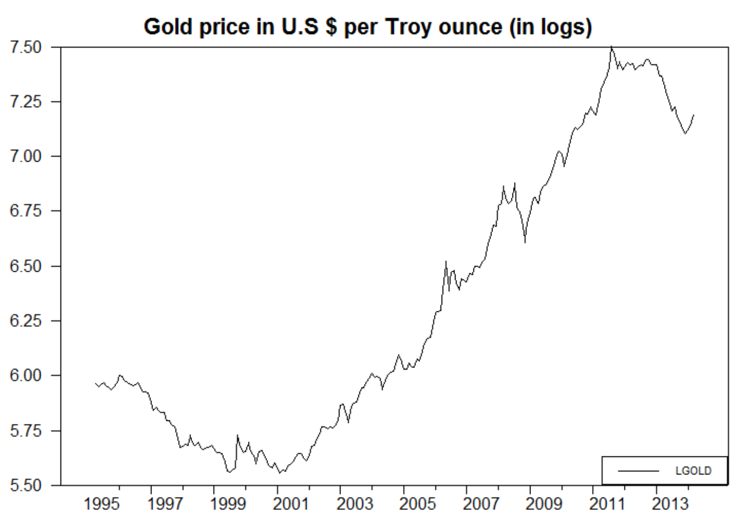

Figure 2: Evolution of price of gold

South African currency. The slight drop in the price of gold in November 2008 corresponds to a real depreciation of the Rand. Thus, there is therefore a correspondence ”lower world price of gold - real depreciation of the exchange rate” on one side, and ”rising global gold prices - real appreciation of the exchange rate” on the other hand. What seems normal for a coherent and exporter of raw materials.

4.4. Unit root test

We do a unit root test to verify the order of integration of the two series. The Augmented

	ADF	
	Level	Difference
rer	I(1)	I(0)
gp	I(1)	I(0)

Table 2: Unit root test

Dickey-Fuller test tells us that the two variables are integrated of order 1 because our two variables vary over time and do not seem stationary. To make them stationary and usable for our study, we differentiate the two series[1].
Once the unit root test performed, we can now focus our empirical results.

5. Empirical Results

5.0.1. Stability test

Before analyzing the volatility, it is necessary to verify the stability of the relationship between the real exchange rate and the price of gold being over the period. July 2007, date of the beginning of the global financial crisis — marked by a liquidity crisis and sometimes solvency — represents the breaking point of our analysis. The stability test performed indicates that the link between the real exchange rate and the price of gold is stable around the period. The probability associated with the test(Fisher) 0.9172 is above the threshold $\alpha = 5\%$, which does not

[1] $\Delta X_t = \frac{X_t - X_{t-1}}{X_{t-1}}$

STABILITY TEST

F-statistic	0.086420	**Prob. F(2,223)**	0.9172

Chow Breakpoint Test: 2007M07

Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 1995M05 2014M03

Table 3: Stability test of Chow

allow us to reject the hypothesis of relationship stability.

We can not performed our analysis with MVGARCH whether residues between the real exchange rate and the gold price are not heteroskedastics. The White test performed and presented in Table ref white shows that the variance of the residuals between the two variables vary over time. The volatility varies over time.

Chi-sq	df	Prob.
31.71035	12	0.0015

Sample: 1995M04 2014M03

Table 4: VAR Residual Heteroskedasticity Tests: No Cross Terms

5.1. DCC-GARCH(1,1) model

We study the sensitivity and persistence through a DCC-GARCH model. This allows us to measure the real impact of gold price's volatility on the real exchange rate. This model allows to take into account the dynamics of the volatility and the correlation between the two variables. We start from a VAR (1) model [2] to define our GARCH model:

$$\begin{cases} \Delta rer_t = a_1 + b_{11}\Delta rer_{t-1} + b_{12}\Delta gp_{t-1} + \varepsilon_{1,t} \\ \Delta gp_t = a_1 + b_{21}\Delta rer_{t-1} + b_{22}\Delta gp_{t-1} + \varepsilon_{1,t} \end{cases} \tag{18}$$

[2] $p = 1$ is the number of Lag that whitens the series of residuals, ie to have non-autocorrelated residuals

$$\varepsilon_t = H_t^{\frac{1}{2}} \varepsilon_t \tag{19}$$

$$H_t = D_t R_t D_t \tag{20}$$

$$\begin{cases} H_{11,t} = \alpha_{0,1} + \alpha_{11}\varepsilon^2_{1,t-1} + \beta_{11}H_{11,t-1} \\ H_{22,t} = \alpha_{0,2} + \alpha_{21}\varepsilon^2_{2,t-1} + \beta_{21}H_{22,t-1} \end{cases} \tag{21}$$

with $D_t = \begin{pmatrix} \sqrt{H_{1,t}} & 0 \\ 0 & \sqrt{H_{2,t}} \end{pmatrix}$, $R_t = \begin{pmatrix} 1 & \rho_{12,t} \\ \rho_{21,t} & 1 \end{pmatrix}$. $\varepsilon_t = (\varepsilon_{1,t}, \varepsilon_{2,t})$, with $E(\varepsilon_t) = 0$ et $Cov(\varepsilon_t) = H_t$. ε_t is the error vector $i.i.d.$ H_t is the conditional variance-covariance matrix.

The parameters of interest are: $\theta = (\alpha_{0,1}, \alpha_{11}, \beta_{11}, \alpha_{0,2}, \alpha_{21}, \beta_{21}, \alpha_{DCC}, \beta_{DCC})$. The assets 1 and 2 represent the real exchange rate and the gold price.

The estimation of the model by the maximum likelihood method gives the results shown in the table 5.

Variable	Coefficient	Std Error	T-Stat
$\alpha_{0,1}$	0.000126***	0.000023	5.58100
$\alpha_{0,2}$	0.000296***	0.000023	12.64768
α_{11}	0.268775***	0.023349	11.51121
β_{11}	0.688840***	0.016523	41.69050
α_{21}	0.174110***	0.037532	4.63893
β_{21}	0.585653***	0.022692	25.80881
α_{DCC}	0.000000	-	-
β_{DCC}	0.543939	-	-

Table 5: Results of the Dcc-Garch(1,1) estimation

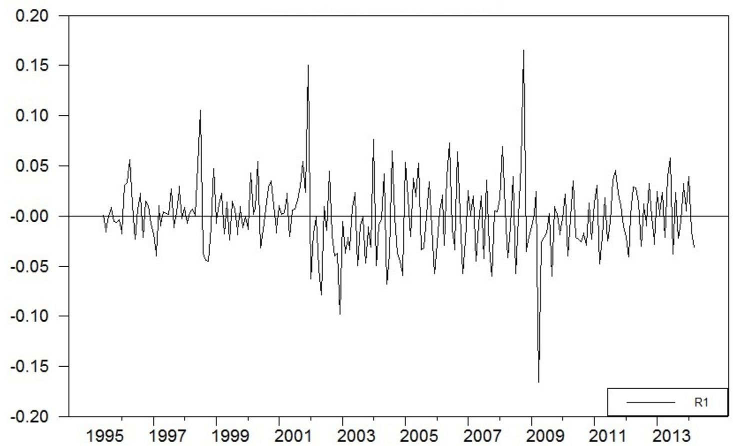

Figure 3: Dcc-Garch(1,1) residuals

Our results are consistent with those of theory. The coefficient $\alpha_{Dcc} \approx 0$ is approximatively equal to zero, the coefficient β_{Dcc} greater than zero, and the sum of two which is less than 1 ($\alpha_{Dcc} + \beta_{Dcc} < 1$). However, before the interpretation of our results, it is necessary to validate the results of our model. This need the stationarity of our residuals. The figure 3 show us that the mean of residual series seem constant along the time and seem stationary. Results which allows us to validate our model.

5.2. Interpretation of results

Remember that α_{ij} indicates the sensitivity of the Asset j following a volatility shock of the asset i. β_{ij} indicates the persistence of the Asset j following a volatility shock of the asset i. We interpret the results presented in Table 5. The volatility of the real exchange rate and gold prices are on average close to zero, 0.000126 for the real exchange rate and 0.000296 for gold price. The phases of real appreciation of the real exchange rate and rising in gold price are more recurrent in the evolution of both series. In addition the South African Rand is more sensitive to its own volatility shocks (0.268775) compared to the volatility shocks of the price of gold (0.174110). As Frankel (2007), the 2002 depreciations phases are not explained by decreases in the price of gold. Regarding the persistence of shocks, we find that the impact of volatility in the real exchange rate on itself are more persistent and amounts to 68.88%, compared to the persistence of volatility shocks of the price of gold on the actual value of the

Rand which amounts to $58,565\%$. We perform the short-term analysis. Our results show that the real exchange rate is influenced by its own volatility. Gold price volatility's shocks have a persistent effect on the real value of the rand, however this effect is less than that of short-term real exchange rate. The price of gold is volatile but its effects on the exchange rate are less than the effects of the exchange rate. However, it is important to clarify that the persistence of the gold price volatility shocks on the exchange rate is high.

6. Conclusion

We set ourselves the aim of studying through a model rarely used and little known effect of the volatility of gold prices on the South African real exchange rate over the period from May 1995 to April 2014. More precisely, it is to show on one hand that the price of gold to influence the real exchange rate of the South African Rand, but on the other hand to show that through the dynamic conditional correlations Garch model, results are consistent with those of economic work which are obtained on the said relationship. After analysis we find that in the short term, the real exchange rate of the South african Rand is more sensitive to its own shocks relative to impact of the volatility shock in the price of gold. Besides the volatility shock of the price of gold, even high, but are less persistent on the real exchange rate volatility shocks that the real exchange rate to itself. However it would be better to analyze the nonlinear effects of volatility by threshold models to have a clearer idea of the impact of persistence.

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