The Impact of Monetary and Commodity Fundamentals, Macro News and Central Bank Communication on the Exchange Rate: Evidence from South Africa

BALÁZS ÉGERT

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Abstract

This paper studies drivers of high-frequency (daily) dynamics of the South African rand vis-à-vis the dollar from January 2001 to July 2007. We find strong nonlinear effects of commodity prices, perceived country and emerging market risk premium and changes in the dollar-euro exchange rate on changes in daily returns of the rand-dollar exchange rate. We also identify a one-sided nonlinear mean reversion to the long-term monetary equilibrium. In addition we establish very short-lived effects on the exchange rate of selected macroeconomic surprises and central bank communication aimed at talking up the rand.

JEL Code: E31, F31, O11, P17.

Keywords: exchange rate, nonlinearity, commodity prices, monetary model, macroeconomic news, central bank communication, South Africa.

Balázs Égert
OECD, Economics Department
balazs.egert@oecd.org

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1 Introduction

The observed large fluctuations of the South African rand against the dollar and the euro over the last 10 years or so raise a number of questions. The first series of questions relates to the role of economic fundamentals in explaining the appreciation and depreciation episodes of the past years. In particular, one might wonder whether conventional (monetary) fundamentals play a role in nominal exchange rate determination in South Africa, whether markets' reactions to macroeconomic news have a bearing on the rand's exchange rate, whether the rand is sensitive to fluctuations in the price of South Africa's main export goods (commodities) and whether changes in the risk perception of international investors vis-à-vis the South African economy and more generally towards emerging market economies have an impact on the rand. The second set of questions is concerned with central bank activity. Specifically, we may ask whether interest rate policy, central bank communication relating to the exchange rate and the interest rate influenced the rand.

The existing body of literature answers some of these questions for industrialised countries and to a lesser extent for emerging market economies. For instance, it has been shown recently that the failure of the monetary model to explain nominal exchange rate movements in industrialised countries in the 1980s (Meese and Rogoff, 1983) was largely due to the low power of the tests to reject the null of no cointegration between the nominal exchange rate and the monetary fundamentals (MacDonald and Taylor,1994; Groen, 2000; Rapach and Wohar, 2004), the short time span of the data (Rapach and Wohar, 2002) or structural breaks (Goldberg and Frydman, 2001). There is also increasing empirical evidence that the monetary model helps model the exchange rate of some emerging market economies.[2]

In addition, past empirical research showed that adjustment towards long-term equilibrium may be nonlinear. For instance, Sarno and Taylor (2002) argue that the mean reversion to Purchasing Power Parity is quicker if the exchange rate is far away from it and that no mean reversion occurs if the deviation from equilibrium is small.

Traditional fundamentals are usually measured at monthly frequencies. A way to match economic variables with daily exchange rate data is to look at real-time macroeconomic variables in the form of the surprise component of macroeconomic news releases. For the main currency pairs, the literature seems to agree on a number of issues regarding the effect of the surprise component of macroeconomic news on the exchange rate. First, bad news has a larger impact that goods news (Andersen et al, 2002; Galati and Ho, 2001; and Laakkonen, 2007). Second, the effects are incorporated in the exchange rate very quickly (Chaboud et al, 2004). Third, the effect varies over time (Galati and Ho, 2001) and differs across different types of macroeconomic news (Edison, 1996; Ehrmann and Fratzscher, 2005). Furthermore, Ehrmann and Fratzscher (2005) argue that macroeconomic surprises can explain a large number of directional changes in the euro/dollar exchange rate even if they cannot account for the size of the changes. Evans and Lyon (2003) point out that most of the effects of macronews transit through order flows. Some of these stylised facts are found to also hold for emerging countries (Kopecky, 2004; and Kiss, 2004).

While numerous studies established a link between the real exchange rate and commodity prices using monthly or quarterly data[3], only a few papers investigated the relation between

[2] See e.g. Crespo-Cuaresma et al. (2005) for emerging European markets, Civcir (2003) for Turkey and Chinn (1999a) for East Asian economies and for South Africa and Odedokun (1997) for African economies.

[3] Gruen and Kortian (1996) and Bailliu et al. (2007) show that the real exchange rate of Australia and Canada can be modelled remarkably well using real commodity prices as the only explanatory. For South Africa, Aron, Elbadawi and Kahn (1997), Chinn (1999b) and Mtonga (2006) find a strong link between the real exchange rate and the real gold prices and MacDonald and Ricci (2004) and Frankel (2007) for the real price of the basket of commodities exported by South Africa.

the nominal exchange rate and commodity prices for daily data. For instance, Cowan et al. (2007) detect a strong link between the daily nominal exchange rate and the price of copper for Chile.

Regarding the second set of questions, central bank communication can influence the exchange rate via the coordination channel. Fratzscher (2004, 2005) shows that official statements of the ECB about the euro-dollar exchange rate had both short- and long-run effects on the exchange rate, and that they did not need to be accompanied by actual interventions to be effective. Jansen and de Haan (2003) point out that ECB communication only increased volatility but did not influence the level of the exchange rate during the first 5 years of EMU. Jansen and de Haan (2005) also looked at statements by national central banks in the euro area and concluded that the effect of verbal statements on the exchange rate was small and short-lived in particular if combined with the release of macroeconomic news. For the same period, Siklos and Bohn (2007) find that actual interest rate moves had a larger impact on the exchange rate than verbal interventions and thus conclude that deeds matter more than words. They point out that the estimation techniques used influence the conclusions and that the way how central bank statements are coded in empirical works also matter. Gábriel and Pintér (2006) report a smoothing effect of central bank communication on the Hungarian forint / euro exchange rate.

Our paper has a number of novel features. First, to our knowledge, nobody thus far has undertaken to analyse the determinants of short-run exchange rate movements in South Africa. Second, the literature presented above usually includes only a subset of possible explanatory variables but do not analyse them all at the same time. Against this background, we propose to combine different strands of the literature by including a large number of possible explanatory variables in our empirical model. Third, researchers usually used Purchasing Power Parity equilibrium (proxied by sample averages of the real exchange rate) to model nonlinear mean reversion. Instead of these simple approximations, we estimate the long-run monetary equilibrium of the nominal exchange rate to investigate nonlinearity in the mean reversion of the nominal exchange rate towards its long-term equilibrium.

The remainder of the paper is structured as follows: The following two sections discuss methodological issues and overview the dataset. Section 4 subsequently presents the results and Section 5 draws concluding remarks.

2 Modelling approach

This section sets out our two-stage approach. First, we present how long-run equilibrium is computed. Second, we describe our high frequency exchange rate model.

2.1 Monetary equilibrium

The monetary model of the exchange rate is used to estimate the nominal equilibrium exchange rate.[4],[5] The basic monetary model including relative money supplies, relative real GDP and the interest rate differential is considered:

Note, however, that Cashin, Cespedes and Sahay (2002) could not establish a robust long-run relationship between real exchange rate and commodity prices in South Africa.

[4] An easy way to obtain long-term values of the exchange rate for modelling high frequency exchange rates is to use a moving average or a trend obtained on the basis of a filtering technique. It appears, however, more appropriate to evaluate the long-run nominal exchange rate in a more structural way.

[5] It is current practice to evaluate the long-term real exchange rate (also termed equilibrium real exchange rate) by estimating a reduced form real exchange rate model. The problem with this approach is that it gives the deviations of the real exchange rate from its estimated long-run values, and that deviations can be corrected either via changes in the nominal exchange rate

$$e_t = (m_t - m_t^*) - \beta_1(y_t - y_t^*) + \beta_2(i_t - i_t^*) \quad (1)$$

where e_t is the nominal exchange rate, expressed as units of domestic currency units over one unit of foreign currency (an increase means depreciation of the domestic currency). Equation (1) shows that a relative rise in money supply results in a real currency depreciation. An increase in relative real income causes a real depreciation. Regarding the effects of the interest rate, a rise in the long-term interest rate differential is related to a currency depreciation, in line with the uncovered interest parity condition.

We extend the basic model by including:

a.) commodity prices, eg the price of gold and metals (El Shazy, 1989)

b.) productivity differential to capture the Balassa-Samuelson effect (see Clements and Frankel, 1980, and Crespo-Cuaresma et al 2005)

c.) stock prices (Friedman, 1988)

d.) trade balance to measure the country risk premium (Hooper and Morton, 1982)

We first check the integration of the variables[6]. As they turn out to be I(1) processes, we subsequently use dynamic ordinary least squares (DOLS) to estimate the long-run relationship. Stock and Watson (1993) show that DOLS accounts for the endogeneity of the regressors and serial correlation in the residuals by incorporating lags and leads of the regressors in first differences:

$$Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i X_{i,t} + \sum_{i=1}^{n} \sum_{j=-k_1}^{k_2} \gamma_{i,j} \Delta X_{i,t-j} + \varepsilon_t \quad (2)$$

where k_1 and k_2 denote, respectively, leads and lags. The length of leads and lags is determined on the basis of the Schwarz information criteria. The presence of cointegration is assessed upon stationarity of the residuals obtained from the long-term relationship ($Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i X_{i,t} + \varepsilon_t$). We also make use of the error correction term as a test of cointegration as Kremers, Ericsson and Dolado (1992) argue that it is more powerful than the residual-based Dickey-Fuller test. Furthermore, we cross-check cointegration using Johansen's trace statistics.

In addition, we also analyse structural breaks in the cointegrating vector. For this purpose, we rely on the regime shift model of Gregory and Hansen (1996) that allows for endogenous break in the constant and the slope coefficients.

2.2 High frequency exchange rate modelling

We incorporate the monetary equilibrium in our model of exchange rate returns (Δe_t).[7] Our linear specification is the following:

$$\Delta e_t = \alpha + \sum_{j=1}^{n} \beta_j Z_{j,t} + \sum_{i=1}^{5} \delta_i D_{i,t} + \varepsilon_t \quad (3a)$$

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or changes in domestic or foreign prices. Therefore, it is more convenient to estimate a nominal exchange rate model where adjustments to equilibrium can occur only through changes in the nominal exchange rate.

[6] The augmented Dickey-Fuller (ADF), Philips-Perron (PP) and Elliot-Rothernberg and Stock unit root tests and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) stationarity test.

[7] Returns are calculated as follows throughout the paper: (X(t)/X(t-1)-1)*100

$$\sigma_t^2 = \zeta + \sum_{j=1}^{n} \psi_j Z_{j,t} + \sum_{i=1}^{5} \lambda_i D_{i,t} + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \qquad (3b)$$

where Z contains the explanatory variables. The explanatory variables are taken in the conditional variance equation as they are (the raw data) but also in absolute values ($|Z|$). D_1, D_2, D_3 and D_4 are dummy variables that take the value of 1 on Tuesday, Wednesday, Thursday and Friday, respectively, often identified in the existing literature as an important phenomenon of daily exchange rate movements. D_5 is a dummy variable that captures holidays. ε_{t-1}^2 and σ_{t-1}^2 are the ARCH and GARCH terms that are needed because of the volatility clustering observed in the exchange rate return series.

Next, we allow for nonlinear effects in the explanatory variables as a function of the deviation from the monetary equilibrium (DEV). First, we look whether deviations from the equilibrium are linked in a nonlinear fashion to changes in the exchange rate in the mean equation. Second, we also allow for nonlinearities in other explanatory variables such as commodity prices and the country risk premium. The nonlinear model with one nonlinear variable can be written along the lines of the framework proposed by Hansen (1999):

$$\Delta e_t = \begin{cases} \alpha + \sum_{j=1}^{n-2} \beta_j \cdot Z_{j,t} + \sum_{i=1}^{5} \delta_i D_{i,t} + \varphi_{11} \cdot DEV_t + \varepsilon_t & if \quad \rho \le T \\ \alpha + \sum_{j=1}^{n-2} \beta_j \cdot Z_{j,t} + \sum_{i=1}^{5} \delta_i D_{i,t} + \varphi_{21} \cdot DEV_t + \varepsilon_t & if \quad \rho > T \end{cases} \qquad (4a)$$

$$\sigma_t^2 = \zeta + \sum_{j=1}^{n} \psi_j Z_{j,t} + \sum_{i=1}^{5} \lambda_i D_{i,t} + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \qquad (4b)$$

where ρ is the threshold variable (deviation from monetary equilibrium), T denotes the threshold value of the threshold variable that separates the two regimes. The threshold variable is the deviation from equilibrium. Thus, deviation from the monetary equilibrium is allowed to have a different effect on exchange rate returns depending on the distance of the exchange rate from its equilibrium value. Note that monthly deviations from the monetary equilibrium are linearly interpolated to daily frequencies. The errors are assumed to be white noise. The two-regime model can be easily extended to three regimes:

$$\Delta e_t = \begin{cases} \alpha + \sum_{j=1}^{n-2} \beta_j \cdot Z_{j,t} + \sum_{i=1}^{5} \delta_i D_{i,t} + \varphi_{11} \cdot DEV_t + \varepsilon_t & if \quad \rho \le T_1 \\ \alpha + \sum_{j=1}^{n-2} \beta_j \cdot Z_{j,t} + \sum_{i=1}^{5} \delta_i D_{i,t} + \varphi_{21} \cdot DEV_t + \varepsilon_t & if \quad T_2 \ge \rho > T_1 \\ \alpha + \sum_{j=1}^{n-2} \beta_j \cdot Z_{j,t} + \sum_{i=1}^{5} \delta_i D_{i,t} + \varphi_{31} \cdot DEV_t + \varepsilon_t & if \quad \rho > T_2 \end{cases} \qquad (5a)$$

$$\sigma_t^2 = \zeta + \sum_{j=1}^{n} \psi_j Z_{j,t} + \sum_{i=1}^{5} \lambda_i D_{i,t} + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \qquad (5b)$$

The selection between linear and nonlinear models is done as follows. We first estimate the linear model and the two-regime model. A grid search with steps of 1% of the distribution is carried out to find the value of the threshold variable that minimizes the sum of squared residuals of the estimated two-regime model. Hansen (1999) shows that the null hypothesis of $\varphi_1 = \varphi_2$ can be tested using a likelihood ratio test. Given that the likelihood ratio test statistic

does not follow a standard asymptotic distribution as the threshold value is not identified under the null hypothesis, the distribution of the test statistic is obtained through bootstrapping based on random draws with replacements using 1000 replications (Hansen, 1999).

If the likelihood ratio test statistic rejects the null hypothesis of the linear model against the two-regime model (on the basis of the bootstrapped critical values), we also analyse whether there are three different regimes instead of two-regimes. A three-regime model is estimated using the two threshold values of the threshold variable that minimise the sum of squared residuals across the estimated models.[8] The bootstrap procedure described above is applied to the two-regime and three-regime models.

3 Data description

3.1 Commodity prices, perceived country risk premium and changes in rating

Daily data on returns of the London gold price and platinum prices are employed to study the link between commodity prices on the rand/dollar exchange rate. Furthermore, changes in the perceived country risk is measured by the Emerging Markets Bond Index (EMBI) that is constructed as the spread between the yield of the dollar-denominated long-run South African government debt and the yield of long-run US government debt. Spillovers from other emerging markets are captured by the global EMBI index including all major emerging markets (Asia, Central and Eastern Europe and Latin America).

We also collected news from Factiva regarding announcement of forthcoming and actual rating upgrades by Standard & Poor's ((S&P), Fitch and Moody's).[9]

3.2 Central bank communication on the exchange rate and interest rate

Our dataset on oral communication of the central bank regarding the exchange rate and interest rate policy is compiled from Factiva (a Dow Jones Company) by using the following keywords: (exchange rate (or interest rate) AND rand) AND (reserve bank OR central bank OR governor OR Mboweni). Overall, the central bank sought to talk up the rand against the dollar when the rand depreciated in 2001 and from mid-2004 until 2005. Statements aimed at exchange rate weakening are less frequent and occur mainly between 2005 and 2006.

Regarding communication on the interest rate, the central bank may want to prepare the markets for future interest rate moves. For instance, statements expressing concerns about inflation and thus the need for higher interest rates may cause markets to incorporate these pieces of news in the exchange rate that will appreciate. Central bank communication with regard to the interest rate was rather asymmetric between 2001 and 2007. The central bank talked a lot about the need for higher rates or for rates being kept unchanged, but never hinted at possible interest rate cuts.

Central bank communication, interest rate and macroeconomic news in the foreign benchmark country, the US economy, should also impact on the rand/dollar exchange rate. We employ a simple but powerful indicator for these events: the dollar/euro exchange rate. For instance,

[8] The threshold from the two-regime model is held fixed and a grid search is used to identify the second threshold. We impose the restriction that the two thresholds should be separated at least by 10% of our sample observations and that the 10% of the sample is trimmed on both sides of the distribution. Once the second threshold is identified, a backward grid search is done to identify the first threshold as suggested by Hansen (1999).

[9] Our sample comprises only upgrades and no downgrades.

Ehrmann and Fratzscher (2005) showed that the listed variables have a significant influence on the dollar/euro exchange rate

Table 1 below gives some examples on central bank communication with regard to the exchange rate and the interest rate.

Table 1. Examples of oral interventions by SARB Governor Tito Mboweni

	News quotes from "Factiva"
	EXCHANGE RATE
14 May 2001.	"Inflation is coming down slowly but surely and, of importance to you, by no stretch of the imagination can the **rand** be regarded as overvalued," he added.
24 November 2004	Pressure on the dollar is likely to mean the **exchange rate** of the **rand** will remain firm in the future, but the central bank will not intervene to stem gains, Reserve Bank chief Tito **Mboweni** said on Wednesday.
25 November 2005	Sectors of the economy that were taking financial strain from the **rand** at its current levels should learn to live with reality, Reserve Bank **governor** Tito **Mboweni** said last night.
7 September 2006	**"Mboweni** said given the imbalance on the trade account, with imports continuing to outstrip exports, **an adjustment in the value of the rand was inevitable**. "I don't take any view on the level of the **exchange rate** but clearly when you have an imbalance ... something has to give," he said."
	INTEREST RATE
29 November 2001	"If strong **exchange rate** depreciation, for example, leads to higher 'imported' inflation...the central bank would have to raise short-term interest rates in order to brake the inflation spiral."
12 May 2005	"I think we are quite comfortable that the decisions made so far...will keep us within the inflation target," Reserve Bank **Governor** Tito **Mboweni** told the news conference.
7 September 2006	"The only way to deal with conspicuous consumption is by raising interest rates," **Mboweni** said in a departure from prepared remarks, adding that while rates were high South Africa's "sociology" did not permit for a low rate environment.

Source: Factiva

3.3 Macroeconomic news

Regarding macroeconomic news announcements, the surprise component is calculated by comparing the actual outcome with market expectations. The list of macroeconomic variables for which data on market expectations are available is shorter for South Africa than for developed countries like the US or the euro area countries. Our list contains the following macroeconomic variables:

- CPIX and PPI
- Real GDP growth
- M3
- Trade balance

The shortcoming of the monthly Reuters surveys that are the source of our market expectations is that they reflect market expectations one month (or one quarter) prior to the news releases by Statistics South Africa (CPIX, PPI, GDP), the Reserve Bank (M3) and the South African Revenue Service (trade balance). This means that by the time of the news releases, market expectations might have evolved since the survey was conducted.

3.4 Unbiasedness and efficiency of market expectations

An important question when using data on market expectations is whether market expectations are unbiased and efficient. Unbiasedness means that expectations do not exhibit systematic mistakes with regard to the realisation of the variable considered. Weak form efficiency means that forecast errors cannot be explained by past information. In technical terms, the following equations are estimated (Joyce and Read, 1999):

$$X_t = \alpha + \beta \cdot \mathrm{E}_{t-1}(X_t) + \varepsilon_t \qquad (8)$$

Where the null of unbiasedness ($H_0 : \alpha = 0 \quad and \quad \beta = 1$) is tested against the alternative of biasedness ($H_1 : \alpha \neq 0 \quad and \quad \beta \neq 1$) using the Wald test.

$$X_t - \mathrm{E}_{t-1}(X_t) = \varpi + \sum_{i=1}^{n} \theta_i \cdot X_{t-i} + \varepsilon_t \qquad (9)$$

Where the null of efficiency ($H_0 : \theta_1 = \theta_2 = ... = \theta_n = 0$) is tested against the alternative of inefficiency ($H_1 : \theta_1 \neq \theta_2 \neq ... \neq \theta_n \neq 0$).

The results reported in Table 2a and 2b indicate that expectations regarding CPIX are biased and that expectation with regard to CPIX, PPI and to some extent the trade balance are inefficient. This finding is somewhat in contradiction with the literature concerning developed market economies for which market expectations are usually found to be unbiased and efficient (Joyce and Read, 1999; Gravelle and Moessner, 2001; Ehrmann and Fratzscher, 2002).

Table 2a. Unbiasedness of macroeconomic and interest rate expectations

	α	t-stat	β	t-stat	No. OBS	Wald test (p-value)
CPIX	-0.58	-3.18	1.10	38.93	75	**0.00**
PPI	-0.04	-0.15	1.04	32.91	75	0.15
GDP growth	-0.22	-0.42	1.08	7.12	24	0.81
M3	2.41	0.98	0.91	7.70	25	0.21
Trade balance	-0.70	-1.37	1.18	5.37	52	0.11

Table 2b. Efficiency of macroeconomic and interest rate expectations

	Wald test (p-value)					
	n=1	n=2	n=3	n=4	n=5	n=6
CPIX	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
PPI	**0.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
GDP growth	0.46	0.68	0.78	0.65	0.85	0.87
M3	0.18	0.57	0.76	0.63	0.58	0.22
Trade balance	0.50	0.50	**0.05**	0.10	0.23	0.41

Note: n denote the maximum lag number

4 Results

The estimation results of the monetary model are reported in Table 3. We first estimate our benchmark model including relative output, relative money supply and the interest rate differential. We then extend the benchmark model by adding one additional explanatory variable at a time. While the residual-based cointegration tests never reject the null of no cointegration, Johansen's trace statistics indicate the presence of one cointegrating relationship for 7 out of the 10 models. In these cases, the error correction terms from the DOLS model are always negative and statistically significant. We take this as a weak evidence for cointegration. Looking at the coefficients, they have the correct sign in line with the theoretical priors and are statistically significant. Note also that the tests do not indicate

the presence of structural breaks. Model 8 will be included in the short-run exchange rate model as it is selected by the Akaika, Schwarz and Hannan-Quinn information criteria.

Table 3. Estimation results for the monetary model for the rand-dollar exchange rate, Dynamic OLS, 1980:1-2008:6

	1	2	3	4	5	6	7	8	9	10
Cointegration										
Residual-based cointegration test										
UR (SIC)	-2.47 (1)	-2.759 (1)	-2.468 (1)	-2.423 (1)	-3.278 (1)	-2.085 (0)	-2.469 (1)	-2.461 (1)	-2.272 (1)	-2.236 (4)
Error correction term										
ECT	-0.014	**-0.02****	**-0.016***	**-0.014***	**-0.027****	**-0.016***	**-0.015***	**-0.017****	-0.012	-0.01
Johansen trace statistics										
r=0	48.6**	**45.96***	**65.08*****	**84.73*****	**66.91***	**73****	**90.53*****	**101.65*****	111.94***	64.5
r=1	17.47	15.2	24.65	43.29	30.57	38.6	42.42	37.63	49.45**	28.46
Long-run coefficients										
CONST	0.829***	0.878***	0.872***	0.814***	0.853***	0.781***	0.826***	3.875***	-3.457***	34.358***
LOG_M3	0.835***		0.767***	0.868***	0.904***	0.968***	0.834***	0.754***	0.908***	0.872***
LOG_M2		0.696***								
LOG_GDPR	-1.432***	-1.173***	-1.866***	-1.098***	-0.545***	-1.695***	-1.426***	-1.487***	-1.071***	-0.712***
IR_LR	0.025***	0.022***		0.026***	0.017***	0.029***	0.026***	0.026***	0.029***	0.044***
IR_SR			0.018***							
LOG_GOLD				-0.159***						
LOG_METAL					-0.465***					
LOG_PROD						0.711***				
LOG_SM							0.001			
LOG_TBC								-1.126***		
LOG_TBQ									1.566***	
LOG_TBY										-12.43***
Error correction model										
No OBS	425	425	423	425	425	425	425	424	425	423
R-squared adj	0.076	0.080	0.037	0.102	0.089	0.082	0.077	0.105	0.073	0.070
SIC	-3.957	-3.961	-3.912	-3.973	-3.959	-3.951	-3.946	-3.977	-3.941	-3.937
AIC	-4.005	-4.009	-3.96	-4.031	-4.017	-4.009	-4.003	-4.034	-3.998	-3.994
HQ	-3.986	-3.99	-3.941	-4.008	-3.994	-3.986	-3.98	-4.011	-3.976	-3.972

Notes: ECT denotes the error correction term, while UR is the residual based cointegration test. (ECM) and (DOLS) indicate that the reported statistics refer to the error correction model and the long-run relationship estimated using DOLS, respectively. *, ** and *** mean statistical significance at the 10%, 5% and 1% levels. M2, and M3 are monetary aggregates, GDPR is real GDP interpolated linearly from quarterly to monthly frequency. IR_LR and IR_SR are long-run and short-run interest rates. The aforementioned variables are expressed as the difference between the domestic and foreign (US) variables. GOLD is the UK London gold price, METAL is the "CRB Spot Index Metals" price of gold. PROD is the productivity and relative price differentials. SM is the stock market index, TBC is the cumulated trade balance to GDP, TBQ and TBY are quarterly and annualised trade balances over GDP against the US.

Let us now consider the estimation results of the high-frequency GARCH models obtained for the period from January 4, 2001 to July 4, 2007. We estimate the linear, two-regime and three-regime models for various model specifications where the differences come from:

- allowing nonlinearity only for the variable deviation from monetary equilibrium and allowing nonlinear effects in four additional variables (changes in gold and platinum prices, country and emerging market risk premium, the interest rate differential and changes in the dollar/euro exchange rate)[10]
- using the deviation from equilibrium with and without lag (both as an explanatory and threshold variable). The use of the deviation from equilibrium with a lag tantamount to an error correction model with a partial mismatch between the long-term and short-term determinants of the exchange rate.
- alternative interpolation of the monthly deviation series to the daily frequency (linear last match and cubic last match interpolation)
- using the explanatory variables as they are (Z) and in absolute values ($|Z|$) in the conditional variance equation.
- Two measures of the rand-dollar exchange rate return calculated using quotes at 14:25 and 24:00 (18:00 New York, 24:00 local South African time).

When nonlinearity is allowed only for the deviation from equilibrium, usually the two-regime model is selected with a one-sided nonlinear mean reversion on the stronger side of the rand/dollar exchange rate (Table 4a and Table A1 in the appendix).[11] This one-sided nonlinear mean reversion on the stronger side of the currency is a very robust finding as it holds across alternative model specifications if we allow for nonlinearity in other explanatory variables as well (changes in gold and platinum prices, country and emerging market risk premium, the interest rate differential and changes in the dollar/euro exchange rate) and as the negative autoregressive coefficient estimates in the lower regime remain stable (Table 4b). Overall, the results are robust to alternative interpolation methods for the monthly deviation series, to alternative treatments of the data in the conditional variance equation, to the two measures of the exchange rate[12] and whether or not the deviation from equilibrium is used contemporaneously or with a lag in the equations.[13] It should be noted that allowing for nonlinearity increases the adjusted r-squared of the models by a factor of 2. Nevertheless, our models explain only around 10% of the variations in daily exchange rate returns.

When we allow for nonlinearity in six additional regressors, we are always able to reject the two-regime model in favour of the three-regime model. The choice of the three-regime model reflects strong nonlinearities in the additional variables.

In the linear specification, rises in gold prices and the dollar/euro exchange rate are related to a rand appreciation against the dollar, irrespective of the model specification. By contrast, the effect

[10] For the other variables, the number of available observations is not sufficient to do the grid search.
[11] In two cases, three-regime nonlinearity is chosen (model 4 and 8 in Table 4a). In one of them, there is strong mean reversion to equilibrium is the deviation is large on both sides, but no mean reversion happens if the exchange rate is close to equilibrium. But this finding is clearly a not robust result to alternative model specifications.
[12] Note that we also estimated exponential GARCH(1,1) (EGARCH) and threshold GARCH(1,1) (TGARCH) models. The asymmetric (exponential and threshold) terms are usually statistically insignificant.
[13] Only results based on lagged deviation from equilibrium are reported in the paper. The full set of results for the contemporaneous deviation from equilibrium is available upon request.

of changes in risk perception towards South Africa and more generally towards emerging market economies, the interest rate differential and the rating dummy changes depending on the whether we use mid-day or end-day exchange rate data.

As shown in Table 4b, the effects of the growth rate of gold prices and the dollar-euro exchange rate are highly nonlinear: A rise in gold prices has strong appreciating effects if the rand is considerably weaker than the monetary equilibrium (upper regime) and the results suggest appreciating effects in the middle and lower regimes using end-day exchange rate data. . Furthermore, the size of the impact of increasing gold prices on the exchange rate is about twice as high as the impact of increasing platinum. A depreciation of the dollar against the euro is associated with a rand appreciation vis-à-vis the dollar in the lower regime (if the rand is considerably stronger than the monetary equilibrium).

The sensitivity of the results regarding the effects of increasing country risk and emerging market risk virtually disappears once we allow for nonlinearity: Rising country risk premium is found to be linked with currency depreciation in the middle regime when the currency is close to its monetary equilibrium, while an increase in the general risk perception towards emerging market economies relates to a rand depreciation when the currency is the upper regime, i.e. when it is considerably weaker than the monetary equilibrium. The effect of the interest rate differential evaporates across alternative model specifications, while changes in platinum prices generate a rand appreciation in the upper regime for mid-day exchange rate returns and a depreciation in the lower regime for end-day exchange rate returns.

Regarding central bank communication and macroeconomic news, the estimation results indicate that the impact on the exchange rate depends largely on the use of the type of the exchange rate return. For instance, a trade balance position better and GDP growth rate higher than expected by market participants is associated with a rand appreciation against the dollar at 14.25 but not at the end of the day. By contrast, surprises in the CPI and M3 lead to appreciation only in the exchange rate return series at the end of the day but not earlier.[14] Similarly, central bank communication aimed at talking up the rand against the dollar appears to have the expected appreciating effect only at the end of the day.

We interpret the sensitivity of the results for central bank communication and macroeconomic surprises to the date of exchange rate data collection as a sign that the effect of the aforementioned factors on the exchange rate is very short lived and does not carry over to a period longer than a day.

With regard to the conditional variance equation (see Table A3 in the appendix), only PPI surprises seem to have consistent and statistically significant negative impact on exchange rate volatility across various model specifications. In addition, day-of-the week dummies appear to be linked negatively to exchange rate volatility even though this effect is not significant in half of the cases: volatility is higher on Mondays than during the rest of the week.

[14] It is not clear why CPI and M3 surprises are associated with a rand appreciation instead of a nominal depreciation that could be expected if purchasing power parity would hold.

Table 4a. Coefficient estimates, mean equations, GARCH(1,1), 2001-2007

Model	**(1a)**	**(2a)**	**(3a)**	**(4a)**	**(5a)**	**(6a)**	**(7a)**	**(8a)**
	Exchange rate quoted at 14.25				Exchange rate quoted at 24.00			
	lin raw	cub raw	lin @abs	cub @abs	lin raw	cub raw	lin @abs	cub @abs
C	**-0.13**	**-0.26**	**-0.20**	**-0.21**	-0.09	-0.08	-0.08	-0.08
Δe_{t-1}	-0.02	-0.02	-0.01	-0.01	**-0.08**	**-0.08**	**-0.10**	**-0.10**
DEV (-1)								
Lower regime	**-0.41**	**-2.14**	**-1.88**	**-2.00**	**-1.71**	**-1.60**	**-1.69**	**-1.83**
Middle regime (for 3 regimes)		*0.29*						0.22
Upper regime	0.07	**-3.53**	0.12	0.14	0.24	0.22	0.18	0.05
Country risk, commodity prices and other external factors								
Δ EMBI_SA	**0.02**	**0.02**	0.01	*0.01*	0.00	0.00	0.00	0.00
Δ EMBI_GLOBAL	0.01	0.01	0.01	0.01	**0.07**	**0.07**	**0.07**	**0.07**
Δ GOLD	**-0.07**	**-0.07**	**-0.06**	*-0.05*	**-0.28**	**-0.28**	**-0.26**	**-0.26**
Δ PLATINUM	-0.02	-0.02	-0.03	-0.03	0.02	0.02	0.01	0.01
Δ USD/EUR	**-0.33**	**-0.32**	**-0.34**	**-0.34**	*-0.11*	*-0.11*	**-0.11**	**-0.11**
Δ TB3M_DIFF	-0.01	-0.01	0.00	0.00	**-0.01**	**-0.01**	**-0.01**	**-0.01**
RATING_DUMMY	**0.49**	**0.46**	**0.49**	**0.55**	0.18	0.18	0.18	0.19
Macroeconomic surprises								
Trade balance	*-0.07*	**-0.07**	**-0.08**	**-0.08**	*-0.05*	*-0.05*	-0.04	-0.04
CPIX	0.17	0.18	0.31	0.29	*-0.76*	*-0.76*	**-0.88**	**-0.88**
PPI	-0.38	-0.41	-0.34	-0.35	0.03	0.03	-0.13	-0.12
M3	-0.27	-0.28	-0.23	-0.24	**-0.42**	**-0.41**	**-0.38**	**-0.38**
GDP	**-0.49**	**-0.50**	**-0.42**	**-0.40**	-0.17	-0.17	-0.24	-0.25
Central bank communication								
FX strengthening	-0.32	-0.34	-0.13	-0.15	**-0.63**	**-0.64**	**-0.53**	**-0.53**
FX weakening	-0.05	-0.04	0.11	0.05	0.73	0.72	0.62	0.62
Policy rate rise	0.42	0.42	0.39	0.36	0.55	0.54	0.55	0.54
Policy rate unchanged	-0.58	-0.56	*-0.58*	*-0.58*	0.42	0.42	0.47	0.46
Day of the week and holiday dummies								
TUE	*0.14*	*0.14*	*0.13*	*0.14*	0.02	0.02	0.05	0.05
WEN	**0.26**	**0.26**	**0.27**	**0.28**	0.02	0.02	0.00	0.00
THU	*0.15*	*0.15*	**0.18**	**0.17**	0.03	0.03	0.02	0.02
FRI	**0.17**	**0.17**	*0.15*	*0.15*	0.02	0.02	0.03	0.03
HOLIDAYS	-0.05	-0.06	-0.01	0.01	-0.04	-0.04	-0.04	-0.04

Notes: Bold (underlined italic) figures indicate statistical significance at the 5% (10%) level. "lin" and "cub" indicate that monthly series for the monetary equilibrium are converted to daily frequency using linear match last and cubic match last interpolation. "raw" and "@abs" indicate that the variables are used as they are or in absolute values in the conditional mean equation. DEV(-1) is the deviation from monetary equilibrium with a lag of one day.

Table 4b. Coefficient estimates, mean equations, GARCH(1,1), 2001-2007

Model	**(1b)**	**(2b)**	**(3b)**	**(4b)**	**(5b)**	**(6b)**	**(7b)**	**(8b)**
	Exchange rate quoted at 14.25				Exchange rate quoted at 24.00			
	lin raw	cub raw	lin @abs	cub @abs	lin raw	cub raw	lin @abs	cub @abs
C	**-0.23**	**-0.24**	**-0.24**	**-0.14**	-0.07	-0.07	0.00	-0.06
Δe_{t-1}	-0.03	-0.04	-0.02	*-0.05*	**-0.14**	**-0.14**	**-0.12**	**-0.13**
DEV(-1)								
Lower regime	**-2.20**	**-2.19**	**-2.01**	-1.06	**-1.71**	**-2.04**	**-0.43**	**-1.48**
Middle regime	0.21	0.25	0.20	0.14	0.27	0.30	0.10	0.15
Upper regime	0.28	0.25	0.16	-0.04	0.14	0.17	0.03	0.11
Country risk, commodity prices and other external factors								
Δ EMBI_SA								
Lower regime	-0.01	-0.01	*-0.01*	**-0.02**	**-0.02**	**-0.02**	-0.01	-0.01
Middle regime	**0.17**	**0.18**	**0.16**	**0.19**	**0.20**	**0.20**	**0.19**	**0.18**
Upper regime	**0.02**	**0.02**	**0.03**	0.01	0.00	0.01	0.01	-0.01
Δ EMBI_GLOBAL								
Lower regime	0.01	0.01	-0.01	0.03	**0.11**	**0.11**	**0.09**	**0.10**
Middle regime	-0.07	-0.06	-0.04	-0.05	-0.06	-0.06	-0.05	-0.04
Upper regime	**0.04**	*0.05*	0.04	**0.04**	**0.05**	**0.05**	*0.07*	**0.08**
Δ GOLD								
Lower regime	-0.06	-0.06	-0.04	-0.11	**-0.32**	**-0.31**	**-0.30**	**-0.31**
Middle regime	*-0.20*	-0.18	-0.12	**-0.25**	**-0.30**	**-0.30**	**-0.25**	*-0.20*
Upper regime	**-0.12**	**-0.12**	**-0.10**	**-0.06**	**-0.15**	**-0.16**	-0.02	**-0.26**
Δ PLATINUM								
Lower regime	0.02	0.01	0.01	0.10	**0.07**	**0.06**	**0.07**	**0.17**
Middle regime	0.07	0.06	0.10	0.02	-0.08	-0.09	-0.08	-0.06
Upper regime	**-0.09**	**-0.07**	**-0.09**	-0.04	-0.01	-0.01	-0.05	0.01
Δ USD/EUR								
Lower regime	**-0.20**	**-0.19**	*-0.16*	-0.05	**-0.31**	**-0.30**	**-0.24**	**-0.33**
Middle regime	0.07	0.13	-0.04	0.19	0.44	0.44	0.40	0.35
Upper regime	**-0.49**	**-0.49**	**-0.50**	**-0.42**	-0.07	-0.09	-0.05	**-0.16**
Δ TB3M_DIFF								
Lower regime	-0.03	-0.03	-0.04	0.01	-0.02	-0.01	**-0.02**	**-0.05**
Middle regime	*-0.03*	-0.02	*-0.03*	-0.03	-0.04	-0.04	*-0.04*	-0.03
Upper regime	0.00	0.00	0.01	0.00	-0.01	**-0.02**	-0.01	*-0.01*
RATING_DUMMY	*0.38*	*0.40*	**0.48**	**0.45**	0.22	0.23	0.19	0.20
Macroeconomic surprises								
Trade balance	**-0.07**	**-0.07**	**-0.07**	**-0.07**	-0.04	-0.04	-0.04	-0.04
CPIX	0.13	0.11	0.24	0.17	**-0.80**	**-0.82**	**-0.88**	**-0.90**
PPI	-0.25	-0.31	-0.25	-0.23	0.01	-0.02	0.02	-0.07
M3	-0.27	-0.27	-0.21	*-0.30*	**-0.34**	**-0.34**	**-0.34**	**-0.37**
GDP	**-0.45**	**-0.42**	-0.22	**-0.48**	-0.34	-0.36	-0.26	-0.26
Central bank communication								
FX strengthening	-0.49	-0.38	-0.14	-0.35	**-0.68**	**-0.69**	**-0.50**	*-0.44*
FX weakening	0.14	0.13	0.25	0.04	0.66	0.67	0.58	0.62
Policy rate rise	0.31	0.29	0.23	0.28	0.57	0.56	0.50	0.54
Policy rate unchanged	-0.38	-0.42	-0.57	-0.55	0.45	0.43	*0.58*	0.40
Day of the week and holiday dummies								
TUE	*0.13*	*0.12*	*0.13*	0.12	0.03	0.02	0.02	0.04
WEN	**0.25**	**0.27**	**0.30**	**0.25**	0.02	0.02	0.00	0.02
THU	*0.16*	**0.16**	*0.15*	**0.17**	0.03	0.02	0.04	0.03
FRI	**0.18**	**0.17**	*0.15*	**0.16**	-0.01	-0.01	0.02	0.03
HOLIDAYS	-0.05	-0.06	-0.02	-0.08	-0.06	-0.07	-0.05	-0.05

Notes: See table 4a.

5 Concluding remarks

In this paper, we sought to uncover short-term drivers of the South African rand vis-à-vis the US dollar from January 2001 to July 2007. We identified four major quantitatively important factors influencing daily exchange rate returns in South Africa: i) Nonlinear mean reversion to the long-run monetary equilibrium if the exchange rate is stronger than what the monetary equilibrium would imply; ii.) gold prices the changes of which lead to strong currency appreciation against the dollar in a highly nonlinear fashion, iii.) general risk perception of markets towards emerging-market economies and towards South Africa that causes a currency depreciation and that depends on how far the currency is located from the monetary equilibrium; and iv.) developments in the dollar/euro exchange rate the effect of which is strongest if the exchange rate is considerably more appreciated than the monetary equilibrium. We found some evidence for very short-lived effects on the rand-dollar exchange rate of various macroeconomic surprises and central bank communication aimed at talking up the rand (but not weakening it).

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Appendix

Table A1. Model selection and nonlinearity, 2001-2007

Nonlinearity only in the deviation from monetary equilibrium

Model	**(1a)**	**(2a)**	**(3a)**	**(4a)**	**(5a)**	**(6a)**	**(7a)**	**(8a)**
	Exchange rate quoted at 14.25				Exchange rate quoted at 24.00			
	lin raw	cub raw	lin @abs	cub @abs	lin raw	cub raw	Lin @abs	cub @abs
	Nonlinearity - bootstrapped p-values							
	Test No. 1: H0: linear vs.H1: 2-regime nonlinearity							
	Test No. 1: H0: 2-regime nonlinearity vs. H1: 3-regime nonlinearity							
Test No. 1	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**
Test No. 2	0.11	**0.03**	0.24	0.14	0.17	0.15	0.95	**0.01**
	Thresholds							
	Lower (T1) and upper (T2) thresholds							
	(percentile of the distribution of the threshold variable)							
T1	0.74	0.15	0.27	0.29	0.57	0.58	0.31	0.32
T2		0.42						0.77
R^2adj	0.040	0.040	0.040	0.041	0.068	0.068	0.068	0.064
	ARCH and GARCH effects – coefficient estimates							
ARCH	**0.124**	**0.123**	**0.140**	**0.139**	**0.139**	**0.139**	**0.145**	**0.148**
GARCH	**0.547**	**0.545**	**0.578**	**0.579**	**0.561**	**0.561**	**0.578**	**0.577**
OBS	1692	1692	1692	1692	1692	1692	1692	1692

Notes: "Lin" and "cub" indicate that monthly series for the monetary equilibrium are converted to daily frequency using linear match last and cubic match last interpolation. "raw" and "@abs" indicate that the variables are used as they are or in absolute values in the conditional mean equation. OBS is the number of observations used in the equations. Bold (underlined italic) figures indicate statistical significance at the 5% (10%) level.

Table A2. Model selection and nonlinearity, 2001-2007

Nonlinearity in six variables

Model	**(1b)**	**(2b)**	**(3b)**	**(4b)**	**(5b)**	**(6b)**	**(7b)**	**(8b)**
	Exchange rate quoted at 14:25				Exchange rate quoted at 24:00			
	lin raw	cub raw	lin @abs	cub @abs	Lin Raw	cub raw	lin @abs	cub @abs
	Nonlinearity - bootstrapped p-values							
	Test No. 1: H0: linear vs.H1: 2-regime nonlinearity							
	Test No. 1: H0: 2-regime nonlinearity vs. H1: 3-regime nonlinearity							
Test No. 1	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Test No. 2	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Thresholds							
	Lower (T1) and upper (T2) thresholds							
	(percentile of the distribution of the threshold variable)							
T1	0.49	0.48	0.46	0.15	0.58	0.57	0.73	0.23
T2	0.88	0.88	0.87	0.89	0.89	0.89	0.89	0.88
R^2adj	0.081	0.081	0.078	0.075	0.109	0.109	0.103	0.099
	ARCH and GARCH effects – coefficient estimates							
ARCH	**0.115**	**0.111**	**0.142**	**0.132**	**0.133**	**0.134**	**0.146**	**0.143**
GARCH	**0.546**	**0.539**	**0.573**	**0.577**	**0.550**	**0.554**	**0.571**	**0.576**
OBS	1692	1692	1692	1692	1692	1692	1692	1692

Notes: See Table A1

Conditional variance equations

Table A3. Coefficient estimates, conditional variance equations, GARCH(1,1), 2001-2007

Model	**(1b)**	**(2b)**	**(3b)**	**(4b)**	**(5b)**	**(6b)**	**(7b)**	**(8b)**
	Exchange rate quoted at 14:25				Exchange rate quoted at 24:00			
	lin raw	cub raw	lin @abs	cub @abs	lin raw	cub raw	lin @abs	Cub @abs
C	0.97	0.97	1.05	1.07	1.05	1.06	1.13	1.14
Δe_{t-1}	0.08	0.07	-0.06	-0.06	0.06	0.06	-0.06	-0.05
DEV_{t-1}	-0.14	-0.15	-0.27	-0.10	-0.12	-0.11	-0.17	-0.18
Country risk, commodity prices and other external factors								
Δ EMBI_SA	0.00	0.00	**-0.02**	-0.01	0.01	0.01	-0.02	**-0.02**
Δ EMBI_GLOBAL	0.01	0.00	-0.04	-0.03	0.01	0.00	-0.03	-0.03
Δ GOLD	-0.05	-0.05	*-0.07*	-0.07	-0.05	-0.05	-0.08	-0.08
Δ PLATINUM	0.01	0.01	-0.04	-0.04	0.00	0.00	*-0.05*	*-0.05*
RATING_DUMMY	-0.10	-0.10	-0.13	-0.07	-0.31	-0.31	-0.12	-0.14
Δ USD/EUR	0.03	0.02	-0.10	-0.10	0.01	0.01	-0.14	-0.13
Δ TB3M_DIFF	0.00	0.00	-0.01	-0.01	0.00	0.00	-0.01	-0.01
Macroeconomic surprises								
Trade balance	**0.05**	**0.05**	**-0.07**	**-0.07**	**0.07**	**0.07**	**-0.09**	**-0.10**
CPIX	0.36	0.42	**-0.82**	**-0.91**	0.02	0.03	**-0.87**	**-0.87**
PPI	**-0.53**	**-0.52**	**-0.53**	**-0.53**	**-0.61**	**-0.58**	-0.45	-0.46
M3	-0.18	-0.14	-0.12	-0.17	**-0.20**	**-0.19**	-0.11	**-0.14**
GDP	*-0.45*	-0.38	-0.13	-0.25	-0.25	-0.24	-0.05	-0.12
Central bank communication								
FX strengthening	-0.23	-0.24	-0.13	-0.16	-0.61	**-0.65**	**-0.58**	**-0.71**
FX weakening	0.12	0.11	0.25	0.03	-0.17	-0.16	-0.02	-0.04
Policy rate rise	0.27	0.15	0.62	0.02	-0.15	-0.14	0.03	-0.03
Policy rate unchanged	-0.84	-0.80	**-1.01**	-0.39	**-0.72**	**-0.78**	-0.48	*-0.57*
Day of the week and holiday dummies								
TUE	**-0.69**	**-0.69**	*-0.43*	-0.31	**-0.48**	**-0.45**	-0.28	-0.22
WEN	**-0.49**	**-0.49**	-0.23	-0.23	**-0.50**	**-0.48**	-0.27	-0.25
THU	**-0.41**	**-0.43**	-0.19	-0.18	**-0.42**	**-0.40**	-0.22	-0.22
FRI	*-0.36*	*-0.39*	-0.24	-0.15	**-0.65**	**-0.61**	**-0.51**	**-0.47**
HOLIDAYS	**-0.40**	**-0.41**	**-0.54**	-0.24	**-0.35**	**-0.33**	**-0.40**	-0.29

Notes: Bold (underlined italic) figures indicate statistical significance at the 5% (10%) level. "Lin" and "cub" indicate that monthly series for the monetary equilibrium are converted to daily frequency using linear match last and cubic match last interpolation. "Raw" and "@abs" indicate that the variables are used as they are or in absolute values in the conditional mean equation.

Data appendix

Monetary model (1980:m1-2008:m6)

NOMINAL EXCHANGE RATES

South African rand/USD: IFS/IMF (via Datastream, code: SAI..AF)

MONEY SUPPLY (M2)

South Africa: Main Economic Indicators/OECD (via Datastream, code: SAOMA002B)

US economy: Main Economic Indicators/OECD (via Datastream, code: USOMA002B)

MONEY SUPPLY (M3)

South Africa: Main Economic Indicators/OECD (via Datastream, code: SAOMA013B)

US economy: Main Economic Indicators/OECD (via Datastream, code: USOMA013B)

REAL GDP (interpolated linearly from quarterly to monthly frequency)

South Africa: Main Economic Indicators/OECD (via Datastream, code: SAOSN029C)

US economy: Quarterly National Accounts/OECD (via Datastream, code: USOEXP001D)

SHORT-TERM INTEREST RATE (3-month T-bill)

South Africa: IFS/IMF (via Datastream, code: SAI60C..)

US economy: IFS/IMF (via Datastream, code: USI60C..)

SHORT-TERM INTEREST RATE (long-term government bond yield)

South Africa: IFS/IMF (via Datastream, code: SAI61...)

US economy: IFS/IMF (via Datastream, code: USI61...)

REAL GOLD PRICE (Nominal gold price index expressed in USD, deflated by US PPI manufacturing**)**

Nominal gold price: UK LONDON GOLD, Datastream, code: UKI..C..A

US PPI: Main Economic Indicators/OECD (via Datastream, code: USOPP017F)

REAL METAL PRICE (Nominal metal price index expressed in USD, deflated by US PPI manufacturing**)**

Nominal metal price: CRB Spot Index Metals, Datastream, code: CRBSPMT

US PPI: Main Economic Indicators/OECD (via Datastream, code: USOPP017F)

PRODUCTIVITY DIFFERENTIAL: Industrial production in manufacturing divided by employment in manufacturing. Productivity in the services sector is assumed to equal 0

INDUSTRIAL PRODUCTION IN MANUFACTURING

South Africa: Main Economic Indicators/OECD (via Datastream, code: SAOL1105G)

US economy: Main Economic Indicators/OECD (via Datastream, code: USOPRI38G)

EMPLOYMENT IN MANUFACTURING (data for South Africa are interpolated linearly from quarterly to monthly frequency)

South Africa: Datastream, code: SAEMPTMUG.

US economy: Datastream, code: USEMPMANO

SHARE PRICES

South Africa: Datastream total market stock price, code: SASHRPRCF

US economy: New York Stock Exchange Composite Index (via Datastream, code: USNYSCOM)

TRADE BALANCE

The balance of the trade account related to nominal GDP

The cumulated balance of the trade account related to nominal GDP

TRADE ACCOUNT: Exports from South Africa and imports to South Africa in USD (via Datastream, exports: SAOXT$03A, imports: SAOXT$09A)

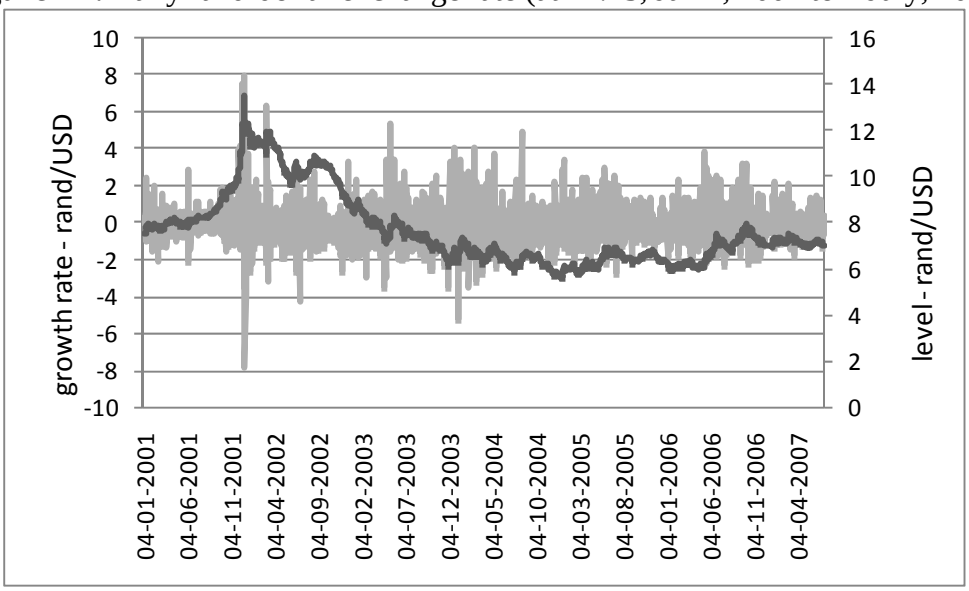
NOMINAL GDP (interpolated linearly from quarterly to monthly), South Africa, Datastream, code: SAGDP...B)

Daily exchange rate model (Jan 4, 2001 to 7 July, 2007)

RAND-DOLLAR EXCHANGE RATE (quoted at 14:25 South African time): calculated using the rand-euro exchange rate and the dollar-euro exchange rate obtained from the ECB (dollar-euro, Datastream code: USECBSP, rand-euro, Datastream code: SAECBSP)
RAND-DOLLAR EXCHANGE RATE (quote at 18:00 New York (24:00 local South African time): Global Treasury Information Services, Datastream code: USSARCM
DOLLAR-EURO EXCHANGE RATE (quote at 14:25 local South African time): ECB, code: USECBSP)
GOLD PRICE: Gold Bullion U$/Troy Ounce, Datastream code: GOLDBLN
PLATINUM PRICE: London Platinum Free Market $/Troy, Datastream code: PLATFRE
RISK PREMIUM: J.P. Morgan Emerging Markets Bond Index for South Africa and big emerging markets (EMBIG)
VERBAL INTERVENTIONS, RATINGS, MACROECONOMIC NEWS: Factiva
INTEREST RATE DIFFERENTIAL:

South Africa: 3-month T-billI, Datastream code: SATBL3M
US economy: US Treasury constant maturities 3-month, Datastream code: FRTCM3M

Figure A1. Daily rand-dollar exchange rate (at 14:25, Jan 4, 2001 to 7 July, 2007)



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