South Africa and United States stock prices and the rand/dollar exchange rate

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Abstract

This paper seeks to examine the dynamic causal relations between the two major financial assets, stock prices of the US and South Africa and the rand/US$ exchange rate. The study uses a mixed bag of time series approaches such as cointegration, Granger causality, impulse response functions and forecasting error variance decompositions. The paper identifies a bi-directional causality from the Standard & Poor's 500 stock price index to the rand/US$ exchange rate in the Granger sense. It was also found that the Standard & Poor's stock price index accounts for a significant portion of the variations in the Johannesburg Stock Exchange's All Share index. Thus, while causality in the Granger sense could not be established for the relationship between the price indices of the two stock exchanges it can argued that there is some relationship between them. The results of the study have implications for both business and Government.

Keywords: Exchange rate, cointegration, stock price, impulse response, variance decomposition and Granger causality.

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1 Introduction

Even though the size of the South African equity market is quite small compared to that of the US there appear to be some interactions among participants of the two markets. For example, a number of South African firms are also listed on US stock exchanges, such as the New York Stock Exchange (NYSE). Unlike South Africa the US has several stock exchanges with the biggest being the NYSE[1], followed by the NASDAQ[2]. Domestic market capitalisation of the NYSE and NASDAQ were 15.4 trillion and 3.9 trillion US dollars respectively at the end of 2006 (WFE, 2007). The Johannesburg Stock Exchange (JSE) on the other hand is ranked 18th in the world with a market capitalisation[3] of US$711bn. However, the JSE is characterised by a considerable level of volatility just like most emerging market exchanges. Despite the relatively high market volatilities in emerging markets, investors from the less volatile markets of the developed world continue to diversify their investments by including equities from emerging markets such as South Africa in their portfolios.

On the issue of trade, the relationship between South Africa and the US is an important one given the dominant role of the US in world trade and the global economic and financial system. On the other hand South Africa's economy is very much open to international trade and investment especially since the dawn of democracy in 1994. In recent time the US has become one of South Africa's major trading partners; the total value of South African trade with the US has more than doubled from US$5.2 billion in 1999 to US$10.8 in 2004 (IMF, 2006). One of the many implications of the openness of the South African economy to trade and to the US in particular is that changes in the rand/US$ exchange rate may impact local firms that export most of their output or those that import inputs in different ways. For example, in a situation where the exchange rate depreciates competitiveness of local firms is increased as their output becomes cheaper on the international market, and vice versa if the exchange rate appreciates. If firms lose their competitive edge profits will fall due to drop in sales, thus leading to a subsequent drop in stock prices.

Until the Asian financial crisis in 1997, the question of a possible relationship between stock prices and exchange rate in developing countries did not engage the attention of researchers. Most of the studies in the literature that covers the period prior to the crisis, focused on developed economies (Franck & Young, 1972; Solnik, 1987; Aggarwal, 1981; Bahmani-Oskooee & Sohrabian, 1992). Since 1997 a large number of papers have focused on the Asian economies regarding the issue of stock prices and exchange rate, nonetheless sub-Saharan Africa, including South Africa, a leading emerging market economy, has once again been overlooked (Abdalla & Murinde, 1997; Granger et al., 1998; Amare & Mohsin, 2000; Yau & Nieh, 2006). The question that comes to the fore following the discussions above is as follows: is there an empirical relationship among the SA stock, US stock and the rand/US$ exchange rate? The purpose of this paper, therefore, is to examine the dynamic short-term causal relations and the long-term equilibrium relations among stock prices of the US and SA and the rand/US$ exchange rate using time-series analyses. The outcome of the paper regarding the short and long term co-movements among the three financial assets may offer local businesses and international investment portfolio managers additional empirical support for allocation of their assets across the two markets.

The rest of the paper is structured as follows: section 2 presents an overview of the empirical literature on stock market and exchange relationships. In section 3 the theoretical basis is briefly discussed, and the estimation procedure is also presented. The results of the estimations are given in section 4 while the conclusions of the work are the subject of section 5.

2 Literature review

There are two main theories underlying empirical studies concerning the relationship between stock price and exchange rate. These are the goods market approach (Dornbusch & Fisher, 1980) and the portfolio balance approach proposed by Frankel (1993). The two theories establish the theoretical basis for the relationship between stock price and the exchange rate. This part of the paper, however, dwells on a review of empirical studies that investigates the relationship between stock prices and exchange rate.

One of the earlier studies that investigated the relationship between stock prices and exchange rates was the work of Frank and Young (1972). The paper assessed the relationship between six exchange rates and stock prices and found none. Later on Aggarwal (1981), with the aid of monthly stock prices and effective exchange rate data covering the period 1974 and 1978, examined the relationship between the two financial assets. The estimations, which were based on simple regressions, concluded that there was a positive relationship between stock prices and the US dollar in both the short run and the long run, but the relationship was stronger in the short run than in the long run. Solnik (1987) studied the effect of a number of variables including exchange rate, interest rate and changes in inflation expectations and stock prices. The paper dwelt on data from nine developed economies, namely, the US, Japan, Germany, France, the UK, Switzerland, Belgium, Canada and the Netherlands. Among the findings of the study was that a fall in the exchange rate impacted positively on the US stock market as against changes in inflation expectations. Soenen and Hennigar (1988) observed a strong negative relationship between the value of the US dollar and changes in the stock price for the period 1980–1986.

In another study Bahmani-Oskooee and Sohrabian (1992) estimated the relationship between stock prices and the exchange rate using cointegration analysis and the Granger causality test. The paper used the Standard and Poor’s 500 Index and the effective exchange rate for 1973–1988; the frequency of the data was monthly. The authors concluded that there existed a bi-directional relationship between stock prices and the real exchange rate in the short-run, however the paper found no long-run relationship among the variables. Smith (1992), using a portfolio balance approach, concluded that the equities had significant impact on the exchange rate but money supply and bonds had little impact on the exchange rate. The inference that can be drawn from the work is that equities play an important role in determining the level of the exchange rate and hence should feature in exchange rate portfolio balance models.

Barton and Bodnar (1994) found little evidence to support the hypothesis that change in the value of the US dollar explains abnormal stock returns. The work indicated that changes in past values of the dollar were negatively associated with abnormal stock returns. In the study by Ajayi and Mougoue (1996) domestic stock price was found to impact domestic value of the currency negatively in the short run but in the long-run stock price increases tended to impact the exchange rate positively. Abdalla and Murinde (1997), with the aid of monthly data covering the period 1985 and 1994, examined the relation between stock prices and exchange rates in four Asian countries including India, Pakistan, Korea and the Philippines. The study, which used the cointegration approach, found no long-run relations between the two financial assets for Pakistan and Korea but found a long-run relationship for Korea and India. On the question of causality regarding the two variables it was concluded that the there was a uni-directional causality from exchange rate to stock prices in Pakistan and Korea. Because of the existence of long-run relations for India and the Philippines the study used an error correction model to examine the causality for the two countries. The causal relation for India was from exchange rate to stock prices but the reverse was true for the Philippines; in each case the relation was uni-directional.

Granger et al. (1998), in a multi-country study of the ten Asian economies, excluding China and India, with data spanning the period 1986 to 1997 found that exchange rate led stock prices in Japan and Thailand with a positive correlation. In Taiwan, stock prices led exchange rates with negative correlation but no correlation was found for Singapore. For the other countries, Hong Kong, Malaysia, Indonesia and the Philippines, bi-directional causality was observed. Amare and Mohsin (2000) also investigated the relationships between stock prices and exchange rates for nine countries in Asia including Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Thailand and Taiwan. Unlike Granger et al. (1998), who used daily data, Amare and Moshin (2000) used monthly series. The authors found a long-run relationship for Singapore and the Philippines. The reasons assigned for the seeming absence of long-run relationship for the other countries was a possible omission of important variables in the estimated model.

3 Methodology

Though the structural approach to econometric modelling draws on economic theory to estimate the economic relationship between variables, in some instances economic theory does not have the richness that provides dynamic specifications, which incorporates all possible relationships. For example, estimations may be compromised if endogenous variables feature on both sides of an estimated equation. This phenomenon informs the choice of vector autoregression models (Harris & Sollis, 2003) as a tool in estimating the relationship in this paper. Consequently the paper uses time-series techniques in studying the relationship between the stock prices and the exchange rate variable. Be that as it may, there are theoretical bases in the literature for a possible relationship between the variables under consideration.

The empirical analysis begins with an examination of the statistical properties of the variables selected for the analysis, with the aid of unit root tests. The Johansen co-integration technique is then applied to ascertain the presence or otherwise of a long-run relationship among SA stock price, US stock price and the rand/$ exchange rate. Impulse response functions and variance decompositions are then used to overcome the difficulty in explaining the coefficients of the VAR.

3.1 Unit root tests

The unit root tests are meant to help avoid the problem of spurious regressions; this has become standard in econometric practice. However, testing for unit roots in time-series data may not be straightforward as certain assumptions usually associated with the traditional tests may not hold (Harris & Solis, 2003). In the present study three issues are considered. We work on the assumption that the underlying data-generating processes (dgp) may include, among other things, a trend which may be deterministic or stochastic. Second, it is noted that the dgp may be more complicated than a simple autoregressive process (AR) and could possibly involve moving average terms. Third, the power of the test may be compromised when dealing with finite sample size hence the possibility of accepting the null hypothesis of non-stationarity when the actual dgp is in fact stationary. To ensure that the above concerns are addressed in testing for non-stationarity, we use three different unit root test approaches.

The unit root tests used in the study are as follows: the augmented Dickey–Fuller test, ADF (Dickey & Fuller, 1981), Philips and Perron test, PP (Phillips & Perron, 1988) and the Perron and Ng test, NG (Ng & Perron, 2001). For each of the test models three possibilities are considered, that is, a model with pure random walk with lag terms (1); a model that has a drift (2); and a model (3) with drift and a time trend. Presented below in equations (1) to (3) are the differenced autoregressive models (AR) for the three variants:

$$\Delta y_t = \varphi y_{t-1} + \sum_{i=1}^{p-1} y \Delta y_{t-i} + \varepsilon_t \qquad (1)$$

$$\Delta y_t = \lambda + \varphi y_{t-1} + \sum_{i=1}^{p-1} y \Delta y_{t-i} + \varepsilon_t \qquad (2)$$

$$\Delta y_t = \lambda + \varphi y_{t-1} + Kt + \sum_{i=1}^{p-1} y \Delta y_{t-i} + \varepsilon_t \qquad (3)$$

The null hypothesis considered in the ADF test is: $H_0\!: \varphi = 0$, with the alternative, $H_A\!: \varphi \prec 0$. As to which of the three models should be employed in conducting the unit root test, we adopt the rule of thumb developed by Dolado et al. (1990). This approach suggests the application of the test models in the order in which they appear from equations (1) to (3); the first model is selected only if the two outcomes in the models represented by equations (2) and (3) are insignificant.

The Philip and Perron (PP) test deals with the possibility that the underlying dpg may be more complicated than a simple AR process, by introducing a non-parametric adjustment of the t-test statistic undertaken to account for autocorrelation when the dgp is not AR (1). The PP test for unit root adopts the basic Dickey–Fuller type equations for the unit root test. On the other hand, Perron and Ng (1996) improve the size (performance) of the Phillips-type test when there are negative moving average (MA) terms through the addition of appropriate adjustment factors to the original PP test statistics, Z-tests.

3.2 Granger causality test (GC)

The standard Johansen cointegration test begins with the estimation of a vector autoregression model (VAR) after which the Trace and Maximum-Eigen statistics based on the maximum likelihood ratio test is used to decide on whether the null hypothesis of no cointegration is accepted or rejected. The VAR involves the natural logarithms of the three variables, SA and US stock prices as well as the rand/US exchange rates in levels. The GC test (Granger, 1969) helps in investigating the presence of feedback (bi-directional) or one-way causality between variables. Assuming we have two series for variables X_t and Y_t the GC test can be represented in the form:

$$\Delta x_t = \alpha_1 + \sum_{i=1}^{n1} \alpha_{11}(i)\, \Delta x_{t-i} + \sum_{j=1}^{m1} \alpha_{11}(j)\, \Delta y_{t-j} + \varepsilon_{xt} \qquad (4)$$

$$\Delta y_t = \alpha_2 + \sum_{i=1}^{n2} \alpha_{21}(i)\, \Delta x_{t-i} + \sum_{j=1}^{m2} \alpha_{22}(j)\, \Delta y_{t-j} + \varepsilon_{yt} \qquad (5)$$

where ε_{xt} and ε_{yt} are stationary random processes intended to capture other pertinent information not accounted for in the lagged values of the variables, x_t and y_t. The optimal lag length is decided with the aid of Akaike information criteria, AIC in the present study. The series y_t fails to Granger cause x_t if $\alpha_{11}(j) = 0$ (1,2,3, m_1); and the series x_t fails to Granger cause y_t if $\alpha_{21}(i) = 0$ (1,2,3, n_1).

3.3 Generalised impulse response functions and variance decompositions

The generalised impulse response function (G-IRF) and variance decomposition (G-VDC) have been found very useful in overcoming the challenges of interpreting the coefficients of estimated VAR models (Yau & Nieh, 2006). The assumption here is that a shock to the i^{th} variable does not only affect the i^{th} variable but is also transmitted through the dynamic lag structure of the VAR. Thus an impulse response traces the effect of a one-time shock to one of the innovations of current and future values of the endogenous variables. The G-IRF is formally written as follows:

$$x_t = \mu + \sum_{i=0}^{\infty} \phi_{jk}(i)\, \varepsilon_{t-i} \tag{6}$$

where μ is a 3×1 vector of constants, ε_{t-i} is an error vector, $\phi_{jk}(i)$ is a 3×3 matrix such that $\phi_{jk}(0) = I_3$ and the elements of $\phi_{jk}(i)$ represent the "multipliers", which evaluates the interaction between the rand/US$ exchange rates, US Stock and SA Stock over the entire path[4].

Whereas an IRF traces the effect of a shock on one endogenous variable on the other variables in the VAR, variance decomposition seeks to separate the variation in an endogenous variable into the separate shocks to the VAR. Consequently, the VDC provides information about the relative importance of each random innovation that affects the variables in the VAR. The associated variance-covariance matrix representing k-step ahead forecast error and its decomposition can be given as:

$$E\left(X_t - \hat{E}_{t-k}X_t\right)\left(X_t - \hat{E}_{t-k} - X_t\right)'$$
$$= D_0 E\,(\mu_t \mu_t^{'})\, D_0^{'} + D_1 E\,(\mu_t \mu_t^{'})\, D_1^{'} + ... + D_{k-1} E\,(\mu_t \mu_t^{'})\, D_{k-1}^{'} \tag{7}$$

where $\hat{E}_{t-k}x_T = D\left[x_t[x_{t-k}, x_{t-k-a}, x_{t-k-2}, ...\right], X_t$ is vector moving average (VMA) representation of $X_t = \alpha' + \sum_{i=0}^{\infty} C_i\, \varepsilon_{t-i}, D_i = C_i V, \upsilon_{t-1} = V' \varepsilon_{t-i}$, C_i is a 3×3 matrix with $C_0 = I_3$ and V is a 3×3 lower triangular matrix representing the Choleski decomposition.

The recently developed generalised VAR (and its associated G-IRF and G-VDC) by Pesaran and Shin (1998), which are by design invariant to the ordering of its constituent variables, are a marked improvement on the traditional orthogonalised IRF and VDC, which are rather robust to ordering of the variables in the VAR. In a study that compares the two approaches, Dekker et al. (2001) observed the superiority of the generalised VAR against the traditional VAR in studying the linkages among Asia Pacific stock markets. Studies that apply the G-VAR include Yau and Nieh (2006), Peel and Venetis (2003), Hacker and Hatemi-J (2003) among many others.

3.4 Data issues

The frequencies of the data series used in the study are monthly, and they cover the period, 1986 to 2006. The study period 1986–2006 was chosen to capture the pre- and post-democracy periods in South Africa, thus we have 240 data points. Even though there are many stock market indices[5] in the US we chose the Standard and Poor's 500 Index (S&P 500) to represent stocks in the US market. The S&P 500 is widely acknowledged as the best single indicator of the US equity market: the index includes 500 companies in the large cap segment of the US economy with approximately 75 per cent coverage of US equities. It has therefore been touted as the ideal proxy for the total market. With regard to the South African market, we chose the Johannesburg Stock Exchange's All Share Index to characterise the equity market.

The S&P 500 Index with a ticker of FSPI was obtained from I-Net Bridge, South Africa. I-Net also provided the JSE All Share index series. The JSE all share series with the ticker AJ301 was chosen because this was the adjusted share price index that allowed one to go further back in history. The stock market indices represented monthly closing figures. The rand/US dollar exchange rates were obtained from International Financial Statistics, IFS CD

Rom published by the International Monetary Fund. All the analyses consider the variables in natural logarithms. Presented in the table below are three variables in logarithms. It appears the US and SA stock prices as well as the rand/US$ exchange rates have moved fairly together over the study period, for example the blip towards the end of 1987 in US stock is mirrored in SA stock as well.

4 Results

The first stage of the empirical analyses involved examination of the statistical properties of the natural logarithms of all the variables under consideration, US stock, SA stock and the rand/US$ exchange rate. The results of the three unit root tests, ADF, PP and NP are summarised in Table 1 below. The results suggest that the null hypothesis of the presence of unit root in the variables in levels could not be rejected, indicating that all the variables are non-stationary in levels. However, after first-differencing the variables, the null hypothesis of the unit root in each of the series was rejected at the 1 per cent level of significance. Therefore it can be inferred that all the variables are integrated of order 1, I (1).

Table 1
The results of various unit root tests

	US stock			SA stock			EX rate		
ADF									
Level	–2.283	[3]	(0)	–2.214	[3]	(0)	–1.342	[1]	(0)
First difference	–5.402***	[1]	(0)	–14.558***	[1]	(0)	–14.955***	[1]	(0)
PP									
Level	–2.134	[2]	(1)	–2.214	[3]	(0)	–1.312	[3]	(0)
First difference	–15.127***	[1]	(7)	–14.928***	[1]	(4)	–15.184***	[3]	(3)
NP									
Level	–1.974	[3]	(0)	–1.900	[3]	(0)	–1.358	[3]	(0)
First difference	–4.228***	[1]	(0)	–7.682***	[1]	(0)	–3.041***	[2]	(0)

Notes: (1) US Stock, SA Stock and EXR Rate denote the Standard & Poor's 500 Index, the Johannesburg Stock Exchange's All Share Index and the Rand/US $ exchange rate respectively.

(2) ***, ** and * represent significance levels at 1 per cent, 5 per cent and 10 per cent respectively.

(3) The critical values for the ADF and PP tests are obtained from MacKinnon (1996) one-sided p-values. These varied from model to model because of differences in the unit root model specifications. On the other hand the critical values for the PP tests are taken from Ng-Perron (2001, Table 1).

(4) The test statistic for the NP test is the MZt.

(5) The numbers in the bracket indicate the number of exogenous variables in the unit root test model: 3 constant, linear trend; 2 – only a constant; 1- no exogenous variable. The numbers in parenthesis for ADF and NP indicate appropriate lag lengths selected by Schwartz Information Criteria but the numbers in parenthesis for the PP indicate the optimal bandwidth decided by the Bartlett kernel of Newey and West (1994). The Eviews programme automatically selected the appropriate lag length.

After ascertaining the stationarity or otherwise of the variables we began the empirical analysis by estimating an unrestricted VAR involving the three variables under consideration. We also performed the lag order test to find out the optimal lag length for the estimations. The tests identified lag one as the optimal lag length for the estimations. The results of the tests are presented in the Table 2 overleaf.

Table 2
VAR lag order number selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	–117.472	NA	0.00058	1.061427	1.106691	1.079692
1	1165.855	2521.426*	7.72e-09*	–10.16612*	–9.985068*	–10.09306*
2	1171.211	10.38276	7.97E-09	–10.134	–9.81718	–10.0062
3	1175.253	7.726592	8.33E-09	–10.0903	–9.6377	–9.90769
4	1180.586	10.05612	8.60E-09	–10.058	–9.4696	–9.82059
5	1186.729	11.41873	8.82E-09	–10.0329	–9.30863	–9.74062
6	1191.188	8.17163	9.19E-09	–9.99284	–9.13283	–9.64582
7	1194.425	5.84712	9.67E-09	–9.94207	–8.94627	–9.54025
8	1202.035	13.54363	9.80E-09	–9.92982	–8.79823	–9.47321
9	1204.823	4.888961	1.04E-08	–9.8751	–8.60771	–9.36369
10	1208.317	6.032871	1.09E-08	–9.82658	–8.42341	–9.26038
11	1215.23	11.75611	1.11E-08	–9.8082	–8.26923	–9.1872
12	1222.979	12.97191	1.13E-08	–9.79718	–8.12242	–9.12139

Note: *Indicates lag order selected by the criterion.
LR: Sequential modified LR test statistic (each at 5 per cent level of significance
FPE: Final Prediction Error; AIC: Akaike information criterion; SC: Schwarz information criterion
HQ: Hannan-Quin information criterion

The next stage of the investigation was concerned with an examination of the presence or otherwise of cointegration between the variables. The Johansen cointegration maximum likelihood test was performed. Five different specifications of the model linking the variables; S&P 500 stock price index, the Johannesburg Stock Exchange's All Share index and the rand/dollar exchange rate were tested. The variation in the models was based on the assumption regarding the trend; restriction of the constant or otherwise and the linearity (see Table below). Both the trace test and the maximum Eigenvalue test indicate the absence of cointegration between the variables. The individual results showing the test statistics are presented in Appendix tables 1 to 5. Table 3 shows a summary of the cointegration test for 5 models.

Table 3
Selected number of cointegrating relations by model at 5 per cent level of significance

Model	Linear deterministic [unrestricted]	Linear deterministic [restricted]	Quadratic deterministic [unrestricted]	No deterministic [restricted]	No deterministic [unrestricted]
No. of C.E[1]					
Trace test	0	0	0	0	0
Max. Eigenvalue	0	0	0	0	0

Notes: *Critical values based on Mackinnon-Haugh-Michelis (1999).
[1] Number of cointegrating equations.

4.1 Granger causality test

Following the absence of a long-run relationship between the price indices of the two exchanges and the rand/US$ exchange rate, instead of going on to estimate the VECM to ascertain the short run dynamics, we rather use the Granger causality test to find out the direction of causality and then evaluate the short-run dynamics using impulse response functions and forecast error variance decomposition estimates. Table 4 shows the outcomes of the Granger causality test. The results indicate a uni-directional causality from US stock to the rand/US$ exchange rate. No causality in the Granger sense could be established between, for instance, SA stock and the US stock. This was surprising and counter-intuitive because anecdotal evidence such as the secondary listing of South African firms on the NYSE suggests a possibility of a relationship. However, causality and a relationship of some sort cannot necessarily be equated.

Table 4

Pair-wise Granger causality tests

Null hypothesis	F-statistics	Probability
EX rate does not Granger cause SA stock	0.89599	0.48454
SA stock does not Granger cause EX rate	0.45672	0.80815
US stock does not Granger cause SA stock	1.49079	0.19380
SA stock does not Granger cause US stock	1.44056	0.21070
US stock does not Granger cause EX rate	3.53817**	0.00425
EX rate does not Granger cause US stock	0.88109	0.49450

Notes: (1) US stock, SA stock and EX rate denote the S&P 500, the JSE all share index and the rand/US$ exchange rate.
(2) ** denote significance level at 5 per cent.
(3) The null hypothesis, H_0 is for 'no causal relation'.
(4) Optimal lag length is 2; this was selected based on the Akaike information criteria (AIC).

The next step of the empirical assessment was to investigate the effect of a shock to one endogenous variable on the other variables in the VAR; this was done using impulse response functions. We also used variance decomposition to help isolate the variation in an endogenous variable into its constituent shocks to the VAR. The variance decomposition shows the relative importance of each random innovation in affecting the variables in the VAR. In order to ensure that the order at which the variables entered the VAR did not affect the outcomes we used the generalised impulse response functions and generalised variance decomposition frameworks respectively.

4.2 Generalised impulse response functions [G-IRF]

The results of the G-IRF show that there is considerable response to own shock (self response) for all the variables. While this was relatively stronger for SA stocks, the effect wears off considerably by the 12th month after the shock. In the case of the rand/US$ exchange rate the effect of the shock reduces by half at the end of 12 months (see Figure 1). On the other hand, own shock to US stock appears to be permanent.

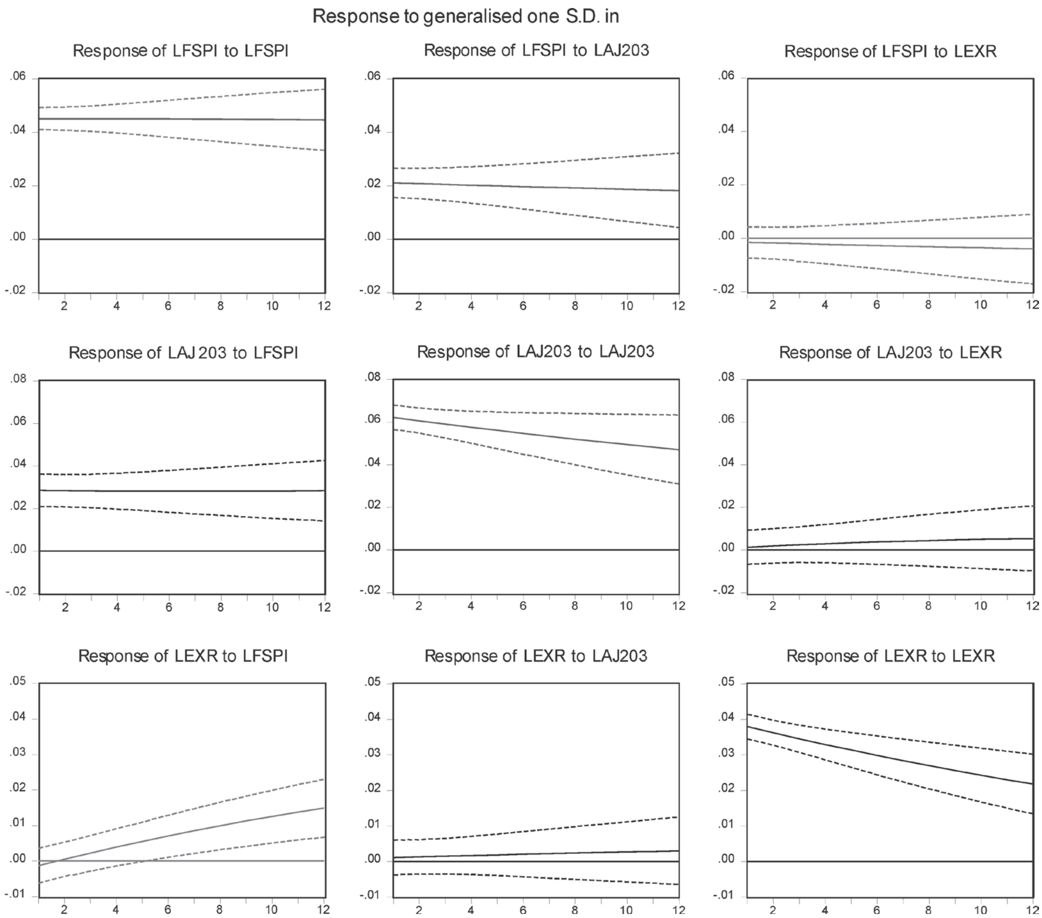
Shocks from the S&P 500 index solicit reasonably high response from the JSE All Share index. This suggests a relationship of some sort between the two exchanges, an assertion that is supported by anecdotal evidence. However, it was found that the S&P 500 does not cause the JSE All Share index in the Granger sense. When the S&P 500 index's response to shocks from the JSE All Share index is assessed, it is noticed that when the ±2 standard error of the response is considered it is close to nought. Nonetheless, given the size of the US Stock exchange relative to the SA stock market, it surprising to see such an outcome suggesting an impact at all, but of course the standard error of the response suggests that the impact is indeed inconsequential.

The exchange rate shocks have little or no effect on either the South African stock exchange or the US stock exchange. On the other hand, the exchange rate has a considerable response to shocks from the S&P 500 stock exchange index. This particular outcome is consistent with the finding that the S&P 500 Granger cause the rand/US$ exchange rate.

Consequently, it can be argued that the effect of shocks from South Africa, either through rand/US$ exchange rate or the stock exchange, has no significant effect on the S & P 500 stock index. This makes intuitive sense given the size of the S&P 500 exchange and listings captured by the index.

Figure 1

Generalised-impulse response functions [LFSP = S&P 500 stock price index; LEXR = rand/US$ exchange rate; LAJ203 = JSE all share index]



4.3 Generalised variance decomposition

The results of the forecast error variance decomposition (FEV) underscore the findings from the generalised impulse response analyses. The FEV outcomes are presented both graphically and in a tabular form (See Table 5 and Figure 2). The results show that each of the variables commands the greatest proportion of the explanatory power in describing the FEV of its own shocks. One important observation is that the S&P 500 stock exchange index explains a considerable proportion of the variance or volatility of the JSE's All Share index. For instance, from 24 per cent in the first month the proportion of variance that is explained by the S&P 500 index increases to 25 per cent by the 10th month (see Table 5 below). Again, the S&P 500 index also explains to an extent the variations in the exchange rate (see Table). This has an intuitive appeal because there is considerable foreign participation on the JSE, particularly from investors from the developed world including the US, and their actions can have considerable impact on the performance of the exchange rate.

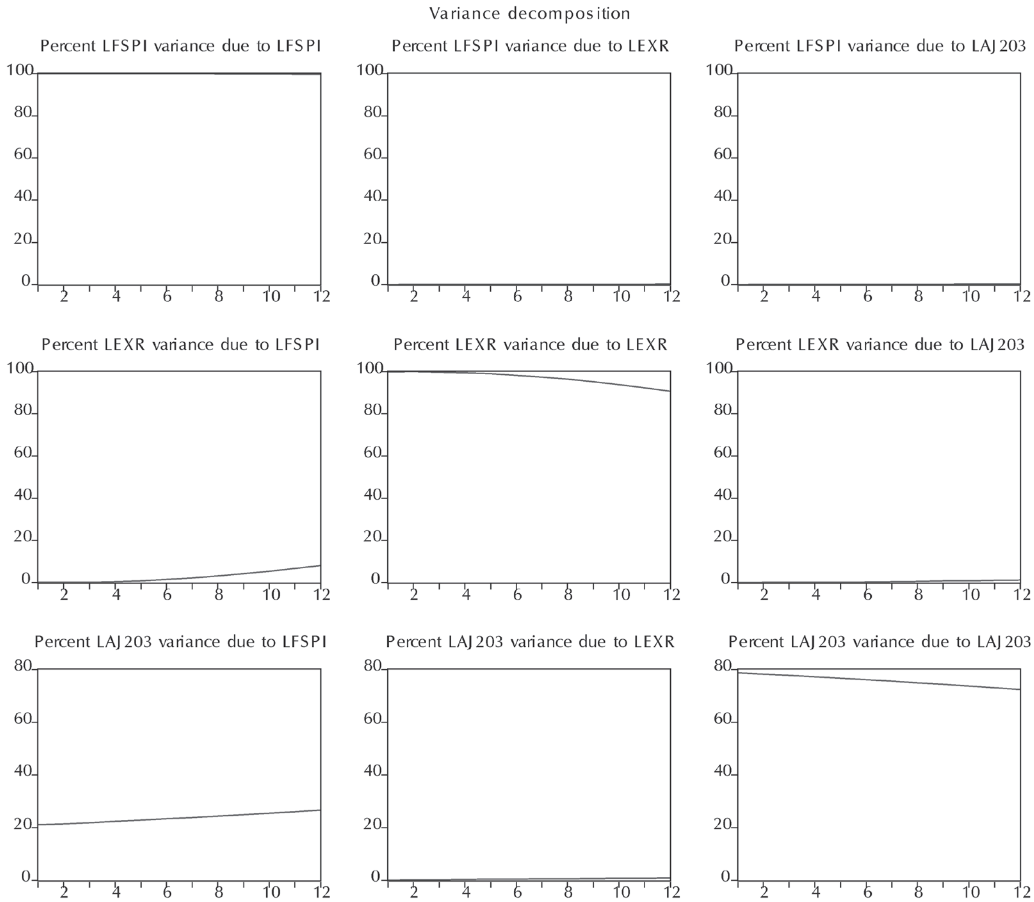
Table 5

The results the forecast error variance decomposition

Variable	Std. error	Period (month)	S&P 500 Index	Exchange rate	JSE All Share Index
S&P 500 Index	0.045	1	100.000	0.000	0.00
	0.090	4	99.973	0.012	0.016
	0.119	7	99.909	0.0361	0.054
	0.142	10	99.816	0.074	0.109
Rand/dollar exchange rate	0.038	1	0.131	99.869	0.000
	0.017	4	0.436	99.456	0.108
	0.089	7	2.185	97.419	0.396
	0.102	10	5.326	93.836	0.841
JSE All Share Index	0.063	1	**21.074**	0.209	78.716
	0.119	4	**22.391**	0.391	77.218
	0.154	7	**23.861**	0.606	75.532
	0.177	10	**25.478**	0.834	73.688

Notes: (1) Each number is a percentage value.
(2) The values of variance decomposition separate
Forecast variance (FEV) in an endogenous variable into percentage shocks to its own and other endogenous variables in the VAR.

Figure 2
Generalised variance decomposition – graphs



5 Conclusions and recommendation

This paper seeks to examine the empirical relationship between the rand/US$ exchange rate and the stock prices of South Africa and the US. The study was undertaken with the aid of the Johansen cointegration technique, the Granger causality test, generalised impulse response function and forecasting error variance decompositions. Monthly data of the three variables from 1986:1 to 2005:11 were used in the estimations.

The Johansen cointegration test could not identify a long-run relationship between the variables of interest; while the result is consistent with a section of the literature such as Yau and Nieh (2006), the outcome contradicts Abdalla and Murinde (1997). The results of the Granger causality test indicate the existence of a uni-directional relationship from the S&P 500 index to the rand/US$ exchange rate. However, there was no significant linkage between the stock prices of SA and Stock prices of the US in the Granger sense. Given the vast differences in the character and performance between US stock markets and South Africa's stock market, it's possible that the linkage between the two markets is probably through the exchange rate and not a direct one. For instance, the JSE attracts a large measure of foreign participation from institutional investors in the developed world, including the US. As a result, whenever funds have been withdrawn as a result of poor investor sentiments these have always had a serious impact on the exchange rate. It is therefore not surprising that the S&P 500 index Granger causes the rand/US$ exchange rate.

Considering the generalised variance decomposition outcomes, it was found that the S&P 500 stock price index explained a considerable part of the variance in the JSE All Share index. This finding lends credence to the argument that the probable link between the S&P 500 index and the JSE All Share index is rather through the rand/US$ exchange rate. The results of the study have implications for both business and Government. For Government, the study shows that the performance of the exchange rate depends on significant external influence via US stocks, hence the S&P 500 index needs to be considered in modelling the rand/US$ exchange rate. Investment fund managers with foreign exchange exposures may have to consider the role of the S&P 500 index in their models for forecasting the path of the rand/US$ exchange rate.

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Endnotes

1 The NYSE is also the biggest exchange in the world while the NASDAQ is in 3rd position in terms of market capitalisation.

2 NASDAQ stands for National Association of Securities Dealers Automated Quotations system; founded in 1971 it is the world's first electronic screen-based stock market; the NASDAQ exchange is uniquely dominated by technology stocks (NASDAQ, 2007).

3 This is defined as the total number of issued shares of domestic companies, including their several classes, multiplied by their respective prices at a given time. This figure reflects the comprehensive value of the market at that time (WFE, 2007).

4 The number three represents the number of variables in the present study.

5 The other major stock indices in the US are:

6 (1) Dow Jones Industrial Average (stocks of 30 large firms in the US – popular indicator;
(2) NYSE Composite Index (all companies listed on the NYSE);
(3) Nasdaq Composite Index (all companies quoted on the NASDAQ; technology-heavy);
(4) NASDAQ-100 Index (100 large NASDAQ stocks from the non-financial sector);
(5) S & Poor (500 large companies often used for general market analysis); Russell 2000 (small-cap stocks) and the Wilshire 5000 Index (represents US market).

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Appendix

Table A1
Model 1: Trends assumption – Quadratic deterministic

Hypothesised no. of cointegrating equation(s) [Rank Test]	Maximum Eigenvalue statistic	Trace statistic
r=0 (None)	13.816	28.057
r≤1 (At most 1)	10.852	14.240
r≤2 (At most 2)	3.3879	3.387

Table A2
Model 2: Trends assumption – Linear deterministic (Restricted constant)

Hypothesised no. of cointegrating equation(s) [Rank Test]	Maximum Eigenvalue statistic	Trace statistic
r=0 (None)	14.130	29.247
r≤1 (At most 1)	11.6227	15.356
r≤2 (At most 2)	3.7338	3.734

Table A3
Model 3: Trends assumption – Linear deterministic

Hypothesised no. of cointegrating equation(s) [Rank Test]	Maximum Eigenvalue statistic	Trace statistic
r=0 (None)	12.042	17.683
r≤1 (At most 1)	4.432	5.640
r≤2 (At most 2)	1.208	1.208

Table A4
Model 4: Trends assumption – No deterministic trend (Restricted)

Hypothesised no. of cointegrating equation(s) [Rank Test]	Maximum Eigenvalue statistic	Trace statistic
r=0 (None)	19.519	29.274
r≤1 (At most 1)	6.423	9.754
r≤2 (At most 2)	3.332	3.332

Table A5
Model 5: Trend assumption – No deterministic trend

Hypothesised no. of cointegrating equation(s) [Rank Test]	Maximum Eigenvalue statistic	Trace statistic
r=0 (None)	19.201	24.461
r≤1 (At most 1)	3.409	6.259
r≤2 (At most 2)	1.851	1.851

Notes: (1) Results of 5 out of the 6 selection criteria provided in Eviews, indicated lag one as the optimal lag order.
(2) ** denote 5 per cent level of significance. The critical values for the hypotheses test are from Osterwald-Lenum (1992).