The unbiased forward rate hypothesis before and after the inflation targeting regime in South Africa: A cointegration Analysis

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The Unbiased Forward Rate Hypothesis Before and After the Inflation Targeting Regime in South Africa: A Cointegration Analysis

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Abstract

This paper investigates the relationship between the future spot and forward rates in the South African foreign exchange market to infer whether the unbiased forward rate hypothesis (UFRH) holds in South Africa. More specifically we examine whether the hypothesis holds in the face of the different monetary policy regimes taken by the South African reserve bank. We distinguish between two periods; (1) the period before inflation targeting and (2) the period after inflation targeting from February 2000 to the present. The study applies the autoregressive dynamic lag (ARDL) cointegration technique to test the existence of the long-run relationship between the two variables. The results of this investigation indicate that existence of a long-run relationship between the two variables for all forward rates horizons, especially for the period after inflation targeting. This indicates that an improvement of market efficiency in South Africa during the inflation targeting period.

Keywords: UFRH, cointegration, monetary policy

JEL classification: C5, G15

I. INTRODUCTION

During the early 1960s, Eugene Fama introduced the concept of efficient markets; where he argued that asset prices fully reflected all relevant and available information (Fama, 1991) by adjusting rapidly to the arrival of new information. In essence the efficient market hypothesis implies that the market processes information rationally in the sense that all relevant information is not ignored and systematic errors are not made (Beechey *et al*, 2000).

The extent to which exchange rate markets can be characterised as approximately efficient market remains an interesting question that can best be answered through formal econometric analysis (Wesso, 1999). One popular hypothesis of foreign exchange market efficiency is the unbiased forward rate hypothesis. In the "simple efficiency" specification of forward exchange markets, it is often argued that the forward rate "fully reflects" available information about the future spot exchange rate expectations; consequently, the forward rate is typically viewed as an

unbiased predictor of the future spot rate. The expectations theory posits that the economic agents are able to process information rapidly. Through the arbitrage activities of the economic agents and market adjustments, the forward rates reflect the information that is expected to determine future spot rates (Wesso, 1999).

Foreign exchange market efficiency therefore contends that economic agents fully incorporate all available information efficiently in their forecasts of different exchange rates. Therefore, exploring agents' behaviour and explicitly the way they form their expectations is of outermost importance to the monetary policy authorities.

Therefore, Kohlhagen (1979) and Levich (1985) argue that one cannot neglect the activities of central banks in foreign exchange markets in conventional tests of efficiency since these activities may have a very strong and decisive effect leading to the movements of exchange rate as well as on the efficiency of the market relative to the activities of arbitrageurs and speculator.[1]

> *Accordingly, it has become increasingly necessary to have a flexible monetary implementation framework which, by acting on sufficiently efficient money markets, gently guides interest rate movements, transmitting rapidly and clearly the messages imparted by the authorities and thus contributing to a better transmission of monetary policy* (Sanz and Val, 1993).

In February 2000 the Governor of the South African Reserve Bank (SARB), announced that South Africa was to formally introduce Inflation Targeting (IT) as the new monetary policy framework. Under this new policy regime, monetary policy aims at pre-announced inflation targets, with the interest rate as the instrument variable for achieving them. This has essentially stabilized interest rates by making them more predictable. Moreover, the implementation of the policy has required the authorities to abandon pre-commitment to any exchange rate parity, particularly using exchange rate interventions; it has effectively made the exchange rate regime a free float. Since the inflation-targeting regime stabilizes interest rates, such a reduction in volatility of a key nominal variable should improve information processing by the market. To that extent, therefore, the regime switch to inflation targeting should anchor the market's expectations to pricing of the exchange rate based on economic fundamentals (Mtonga, 2011).

[1] See Sarno, L. and Taylor, M.P. (2002). "The Economics of Exchange Rates". First edition. *Cambridge University Press.*

Two particular reasons stand out as to why the monetary authorities made the decision to switch to a framework of formal inflation targeting, first the system of informal inflation targeting at times created uncertainties among the public about the monetary policy stance adopted by the authorities; and secondly the application of inflation targeting affects inflationary expectations, which should facilitate a reduction in inflation. If inflation targets are perceived to be credible, they form the basis for future price and wage setting. Inflation targets, in theory, should therefore influence the increase in the operational cost of enterprises as well as their price setting (van der Merwe, 2004)[2]

One of the key elements of inflation targeting involves the increased transparency of the monetary policy strategy through communication with the public and the markets about the plans and objectives of the monetary policy committee (Mishkin, 2001). Furthermore, adherence to a nominal anchor such as inflation and interest rates which keeps the nominal variable within a narrow range promotes price stability by directly promoting low and stable inflation expectations.[3]

Upon the adherence of the inflation targeting framework the SARB has put considerable stress on the need to make monetary policy transparent and to maintain regular channels of communications with the public through publications such as the SARB monthly release of selected data[4], the Reserve Bank Quarterly Bulletin, Monetary Policy Committee (MPC) Meetings or statements where the governor of the SARB gives the general public a review of the state of monetary economy, current and future path of inflation rates, exchange rates, interest rates amongst other variables.

The ability of central banks to convey their medium-term intentions regarding money market conditions, as well as their longer-term objectives in a convincing and credible manner to market participants is of outmost importance to the success of their objectives as this allows market participants to rationally and consistently form their expectation about future values on key variables such as inflation, interest and exchange rates; this further contributes to easing the uncertainty part of the decision making process. This signalling capacity of the central bank can

[2] For further discussion, see Van der Merwe E. J., (2004) "Inflation targeting in South Africa" South African Reserve Bank Occasional Paper no 19.
[3] Evidence that adoption of inflation targeting leads to an immediate fall in inflation expectations is however not strong. For example, Bernanke et al. (1999) and Levin, Natalucci and Piger (2004) do not find that inflation targeting leads to an immediate fall in expected inflation, but Johnson (2002, 2003) does find some evidence that expected inflation falls after announcement of inflation targets. See F.S. Mishkin (2006)
[4] The release is divided into sections covering: Money and banking; Banks and mutual banks; International economic data; Capital market; National government finance; and Economic indicators.

be of considerable importance to the behaviour of increasingly integrated financial markets, which at times display unexpected volatility and even turbulence. One market which is especially sensitive to the signalling capacity of the central bank is the foreign exchange market, which is our focus in this paper. Changes in monetary operating procedures in some cases have been made with the specific intent of improving this signalling capacity.

Inflation targeting is thus expected to anchor market expectations to pricing the currency based on economic fundamentals, since it stabilises interest rates by make them more predictable; it is also supposed to eliminate the uncertainty element in the decision making process, by reducing the risk premium required by the market participants. Furthermore, inflation targeting should allow and induce the market to form more consistent, homogenous and rational expectations about the future level of key economic variables such as interest rates, inflation and exchange rates (Mtonga, 2011). A number of authors have linked foreign exchange market efficiency to the existence of a long-run relationship between the future spot and forward rates. For example, Razzak (1999) tested the UFRH for New Zealand, Canada, UK and Sweden as the inflation targeting countries and Germany and Japan as the non-inflation targeting countries. The author rejected the UFRH in almost all countries except for New Zealand and the UK during the inflation targeting period. The author concludes that that inflation targeting improves the efficiency of the foreign exchange market. Thus, the purpose of this study is to investigate whether the adoption of inflation targeting, as the new anchor of monetary policy by the SARB, has had an impact in the South African foreign exchange market efficiency by testing the Unbiased Forward Rate Hypothesis. The study applies the autoregressive dynamic lag (ARDL) cointegration technique to the South African foreign exchange market by testing the long-run relationship between the future spot and forward rates of the rand dollar exchange rate in two distinct periods, namely the period before inflation targeting and the period after inflation targeting.

The rest of this paper is organised as follows, section 2 presents the methodology of the paper; section 3 includes a description of the data and the empirical results of the paper; and section 4 concludes the paper.

II. METHODOLOGY

The statistical test of the UFRH relies of the relationship between the future spot rate and the forward rate. The econometrics relationship that defines the hypothesis is often expressed as:

$$S_{t+k} = \alpha + \beta f_t + \varepsilon_t \quad (1)$$

Where S_{t+k} refers to the future spot rate and f_t represents the forward rate. The UFRH holds under the condition that $\alpha = 0$ and $\beta = 1$.

Equation 1 can be reformulated by subtracting S_t from each side of the equation. In which case the following expression is obtained:

$$S_{t+k} - S_t = \alpha + \beta(f_t - S_t) + \varepsilon_t \quad (2)$$

One of the advantage of using Equation 2 is that variables may become integrated of order one and its estimation by the ordinary least square (OLS) method can then be consistent and robust, thus, avoiding the possibility of spurious regression. Nonetheless, it may be possible that Equation 2 includes variables with different level of integration. In such conditions, the ARDL cointegration, as proposed by Pesaran and Pesaran (1997) will be robust and efficient to estimate Equation 2 in the context of the UFRH.

It is important to note that while the above-discussed restriction are important for testing the UFRH, a number of authors contend that the UFRH is a long-run relationship obscured by short-term deviation. As such, econometric methods that assess the long-run relationship between variables are proper to test the UFRH (Moosa and Bhatti, 1995). Thus, this paper employs the ARDL cointegration technique to test the long-run the relationship between future spot and forward rates in the South African foreign exchange market to infer whether the foreign exchange market has become efficient with the inflation targeting regime.

The main advantage of the ARDL approach to cointegration is that it can be applied when the variables are of different order of integration (Pesaran and Pesaran, 1997). The authors show

that for a vector $Z_t = (Y_t, X_t)$, there exists at most one long-run level relationship between Y_t and X_t, irrespective of the level of integration.

Assume the ARDL (p,q), whereby p represents the autoregressive order and q is the number of lags. If X_t represents the forcing variable Y_t can be written as:

$$\Delta Y_t = a + bt + \pi_{yy} Y_{t-1} + \pi_{xyy} X_{t-1} + \sum_{i-1}^{p-1} \psi i \Delta Z_{t-i} + \omega \Delta X_t + \mu_t \quad (3)$$

With $i = 1, \ldots, p-1$.

It follows from the relation (3) that if $\pi_{yy} \neq 0$ and $\pi_{xyy} \neq 0$, a non-degenerate long-run relationship exists between Y_t and X_t that is defined by:

$$Y_t = \Phi_0 + \Phi_{1t} + \Phi_x X_t + \eta_t \text{ with t= 1, 2,…n} \quad (4)$$

Where $\Phi_0 = \frac{-a}{\pi_{yy}}$; $\Phi_1 = \frac{-b}{\pi_{yy}}$ and $\Phi_x = \frac{\pi_{xyy}}{\pi_{yy}}$ η_t is a zero mean stationary process. Equation (4) assumes the presence of the deterministic trend.

In order to test for the absence of a long-run level relationship between Y_t and X_t Pesaran *et al.* (2001) adopted a method that consists of the examining of the joint hypothesis $\pi_{yy} = 0$ and $\pi_{xyy} = 0$ in the error correction model given in equation (3). A non-standard F-critical is used to test for the above joint hypothesis, irrespective of whether the explanatory variables are stationary or non-stationary.

III. DATA, METHODOLOGY AND EMPIRICAL RESULTS

a. Data

The data set contains weekly data for the spot rand/dollar (R/$) exchange rate as a dependent variable as well as 1-month, 3-month, 6-month and 9-month forward exchange rates as the different explanatory variables where all variables are expressed in logarithms. All data was obtained from I-net Bridge. Our data set is evenly divided into two data sets distinguishing the period before (from 4/23/1993 to 02/07/2000) and after (from 02/14/2000 to 11/27/2006) the

implementation of the inflation targeting framework.[5] The ARDL approach to cointegration is applied to test the long-run relationship implies by Equation 2. As from this equation, $k = 1, 3, 6$ and 9 for the equivalent of 1-month, 3-month, 6-month and 9-month forward exchange rates. For example, the constructed variable $dspot_{kt} = S_{t+k} - S_t$ represents the k-month change in exchange rate. However, $dforw_{kt} = f_t - S_t$ represents the k -month forward premium/discount, where f_t is a 1-month forward rate.

As per Equation 2, the following equations will be estimated using the ARDL approach to cointegration:

$$dspot_{1t} = \alpha_1 + \beta_1 dforw_{1t} + \varepsilon_t \quad (5)$$

$$dspot_{3t} = \alpha_3 + \beta_3 dforw_{3t} + \varepsilon_t \quad (6)$$

$$dspot_{61t} = \alpha_6 + \beta_6 dforw_{6t} + \varepsilon_t \quad (7)$$

$$dspot_{9t} = \alpha_9 + \beta_9 dforw_{9t} + \varepsilon_t \quad (8)$$

b. Empirical Results

b1. Augmented Dickey Fuller and Phillips-Perron Unit root test

Table 1 and Table2 present the Augmented Dickey-Fuller and Phillip-Perron tests of stationarity for the level and first difference variables respectively. The results of the stationarity test show that the null hypothesis of no stationarity at level is not rejected for all the change of exchange rate series. Nonetheless, the hypothesis is not rejected for the forward premium/discount series. This indicates that are dealing with series of different level of integration. As such the ARDL cointegration is justified to assess the long-run relationship between variables represented in Equations 5 to 8.

The next step of our empirical analysis consists of assessing the long-run relationship between future spot and forward rates of different maturities as per Equations 5 to 8.

[5] Each data set contains a total of 355 observations. The years beyond 2006 were not included in our research on purpose to avoid the spillover effects of the Global financial crises that occurred in those years.

Table 1. Augmented Dickey-Fuller and Phillips Perron tests for stationarity on the level

Series	Period before inflation targeting		Period after inflation targeting	
	ADF	PP	ADF	PP
	Adj. t-Stat (p-value)	Adj. t-Stat (p-value)	Adj. t-Stat (p-value)	Adj. t-Stat (p-value)
dspot1	-16.8151 (0.0000)	-16.9294 (0.0000)	-17.3003 (0.0000)	-17.3002 (0.0000)
dspot3	-5.2589 (0.0000)	-5.6754 (0.0000)	-5.3473 (0.0001)	-6.7154 (0.0000)
dspot6	-4.8687 (0.0000)	-5.4531 (0.0000)	-3.2220 (0.0013)	-5.8087 (0.0000)
dspot9	-4.5408 (0.0015)	-4.7466 (0.0000)	-2.8794 (0.0040)	-4.5434 (0.0000)
dforw1	-1.1699 (0.9141)	-1.7010 (0.7491)	-1.2929 (0.8879)	-1.3003 (0.8861)
dforw3	-1.3304 (0.8786)	-1.2062 (0.9070)	-1.2589 (0.8958)	-1.2711 (0.8930)
dforw6	-1.7187 (0.7411)	-1.3837 (0.8643)	-1.3167 (0.8820)	-1.3589 (0.8711)
dforw9	-1.6507 (0.7707)	-1.4219 (0.8531)	-1.5328 (0.8166)	-1.4130 (0.8558)

Table 2. Augmented Dickey-Fuller and Phillip-Perron tests for stationarity on first difference

Series	Period before inflation targeting		Period after inflation targeting	
	ADF	PP	ADF	PP
	Adj. t-Stat (p-value)	Adj. t-Stat (p-value)	Adj. t-Stat (p-value)	Adj. t-Stat (p-value)
dforw1	-10.7144 (0.0000)	-28.1303 (0.0000)	-25.4796 (0.0000)	-26.0728 (0.0000)
dforw3	-8.2643 (0.0000)	-20.5208 (0.0000)	-19.9374 (0.0000)	-19.9153 (0.0000)
dforw6	-7.9919 (0.0000)	-20.7030 (0.0000)	-16.7824 (0.0000)	-16.9277 (0.0000)
dforw9	-8.1080 (0.0000)	-19.8899 (0.0000)	6.6437 (0.0000)	-20.0368 (0.0000)

b2. ARDL cointegration: test of long-run relationship

Table 3 presents the results of the Bound test for ARDL cointegration to test the long-run relationship implied by Equation 2. For example, the calculated F-statistics of $F(dspot_i / dforw_i)$ provide the null hypothesis of whether there is long-run relationship (cointegration) between

dspot1 and *dforw1* when the relationship is normalised for *dspot1*. The same applied for all other different maturities. The bounded F-critical for the test is proposed by Pesaran and Pesaran (1997). The F-critical applied in this paper refers to the case of intercept and no trend, which values are 3.793 and 4.855 for lower and upper bounds, respectively. The results reported in Table 3 indicates that the null hypothesis of 'no long-run relationship' or 'no cointegration' between the future spot and forward rates of different maturities (1,3,6 and 9) is rejected in the period after inflation targeting. This indicates that there is equilibrium between the forward rate and the future spot rate. The finding indicates an equilibrium between the two rates and thus, the proof of efficiency of the forward exchange market for all the maturities. Nonetheless, during the period before inflation targeting, there is no evidence of a long-run relationship between the future spot and forward rates for 6-month maturity. Although efficiency or equilibrium relationship is found between the spot and forward rates for the 1-, 3- and 9-month maturities.

Table 3. The ARDL cointegration test for long-run relationship

	Period before inflation targeting		**Period after inflation targeting**	
	F- statistics	outcome	F-statistics	Outcome
F(dspot1/dforw1)	64.96*	Cointegration	73.86*	Cointegration
F(dspot3/dforw3)	12.96*	Cointegration	42.64*	Cointegration
F(dspot6/dforw6)	3.66	No cointegration	11.14*	Cointegration
F(dspot9/dforw9)	7.63*	cointegration	4.89*	Cointegration

* denotes rejection of the null hypothesis of no long-run relationship (cointegration) given the bound F-critical (3.793 – 4.855).

These results indicate that the efficiency of the foreign exchange, proxied by the long-run relationship between the future spot and the forward rates, has improved during the period after inflation targeting in South Africa. This finding is in line with the conclusion of a number of studies that show that inflation targeting monetary regime has improved expectations of economic agents in South Africa. For example, Eijffinger and Geraats (2006) provided detail evidence of significant improvement in central bank transparency in South Africa in the period after the adoption of inflation targeting. The authors show that the anticipation of important financial and economic variables has improved considerably during the same period. This reality has definitely contributed to our finding that the future spot rate traces the movement of the forward rate in the foreign exchange rate, indicating an improvement of expectation by economic agents in South Africa. It is important to note that the evidence of efficient forward

exchange market during the inflation targeting monetary regime should imply that the regime precludes all possibilities of arbitrage opportunities in the forward exchange market.

IV. CONCLUSION

This paper examined the question whether the implementation of the inflation targeting framework by the South African reserve bank has in any way contributed to the achievement of foreign exchange market efficiency. The study applied the ARDL cointegration technique to test the long-run relationship between the future spot and forward rates in the periods before after the implementation of inflation targeting monetary policy in South Africa. The results of the empirical analysis show that the null hypothesis of no long-run relationship between the two variables is rejected for all forward rate maturities during the period after the implementation of inflation targeting monetary policy but could not be rejected in the period before the implementation of inflation targeting. These results together with the findings of other authors such as Eijffinger and Geraats (2006) confirm that inflation targeting policy has improved expectation, especially in the foreign exchange market in South Africa.

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