INTEREST RATE ASYMMETRIES IN THE LENDING-DEPOSIT SPREAD: A CASE STUDY

1. Introduction

The South African Reserve Bank (SARB) relies on the idea that changes in the policy rate (the repo) prompt similar changes in short-money market instruments and retail rates (loan and deposit). Under perfect information with no uncertainty, adjustments costs, and perfect competition, loan and deposit rate responses to policy rate would be immediate, symmetric and one-for-one. Asymmetries do arise because deposit supply or loan demand functions faced by banks may not be equally elastic or due to uncertainty induced by strategic behavior in the banking industry. Although the fundamental question (not dealt with in this paper) is whether retail rates respond the same way to changes in the policy rate, a useful related inquiry is whether the loan-deposit spread is stationary. We use the threshold unit root tests of Enders and Siklos (2001) to test for asymmetric adjustments in the spread between the South African lending rate and the deposit rate. To be specific, we want to test if the null of a unit root can be rejected if asymmetric adjustments are present.

The motivation for examining the loan-deposit spread is two-fold. First, loan and deposit pricing over business cycles may indicate whether banks exploit market power in certain deposit market segments (such as ordinary savings deposits) in order to dampen adverse shocks to other more competitive market segments (time deposits) or to their loan customers. Second, the amplitude of business cycle fluctuations depends heavily on banks' pricing of loans at different stages of the business cycle. The main reason for this is that if financial distress and bankruptcies for firms and consumers are countercyclical, and loan rates should mirror these. In addition there are informational frictions in credit markets that may be exacerbated during recessions due to a 'financial accelerator' mechanism in formal models. Bernanke and Gertler (1989), Mandelman (2006), and Nikitin and Smith (2009) show that cyclical downturns negatively impact borrower's net worth or collateral which, in turn, increases the cost of borrowing and hence amplifies the downturn. When loan or deposit rates are not competitive, these rates may plausibly exhibit marked cyclical behavior as banks asymmetrically adjust loan and deposit rates.

There are two main hypotheses tying bank market power to cyclical behavior of bank spreads. First, there is the *relationship hypothesis* – banks with market power exploit this power to smooth loan rates as part of long-term relationships between banks and their customers. Market power in deposit markets can support loan-rate-smoothing contracts as banks utilize deposit market power to insulate themselves from changes in the cost of smoothing loan rates (Berlin and Mester, 1999). Second, in less than fully competitive loan and deposit markets, the *cyclical competitiveness hypothesis* suggests that banks exploit market power in certain deposit markets to buffer adverse shocks to bank's cost of funds in more competitive segments of the deposit market. It is also possible that a bank might exploit loan market power to buffer adverse funding shocks. When this is the case, the hypothesis is that loan rates and competitive deposit rates may have cyclical effects. These two hypotheses and others underpin the gist of the paper that examines the loan-deposit spread.

The empirical analysis in this paper leads to three main conclusions. First, threshold cointegration (TAR) with and without lags reveals asymmetric adjustment in the loan-deposit rate spread. Specifically, we find that adjustment is faster above the threshold. Second, for the symmetric TAR model, the error-correction term is barely significant (0.059 with t=-1.96 in equation 8). While this result seems to support linear cointegration, the results are not as strong as the asymmetric case. Third, the MTAR-Consistent unit root tests do not reject the null in both symmetric and asymmetric cases. In other words, there is no evidence that adjustments in the lending-deposit spread in South Africa depends on previous changes in the spread or that it captures 'sharp' movements in the spread as suggested in Sichel (1993). Similarly, asymmetric error-correction consistent MTAR models reveal both adjustment parameters to be insignificant.

The paper employs the Thompson (2006) and Nguyen and Islam (2010) framework to investigate the asymmetric effects of bank behavior in setting deposit and lending rates in South Africa for the 1990-2010 period using monthly data. We focus on three issues. First, we examine whether the spread – the difference between loan and deposit rates – has experienced a structural break during the period under study. If there is (are) a break(s) in the spread, it is incorporated as a dummy in regressing the spread on a constant and dummy (with values of zero to the break date and 1 after the break date) to obtain residual series that are used in the TAR and MTAR models. Second, we test for asymmetries in the banking sector given that South Africa's financial industry has undergone notable financial reforms following the De Kock Commission recommendations (De Kock, 1985). Finally, if asymmetries exist, we estimate error-correction models to capture short-run and long-run dynamics.

The paper is organized as follows. Section 2 provides a preliminary discussion of threshold unit tests in addition to ARDL cointegration. There is also a presentation of data sources. Section 3 surveys the relevant literature on asymmetric behavior in interest rates and specific methodology of TAR and MTAR as presented in Enders and Siklos (2001). Section 4 has estimation and a discussion of the results. Section 5 concludes and summarizes the main results.

2. Threshold unit tests and ARDL cointegration

Following Enders and Granger (1998), we consider both the TAR and MTAR versions of the test. Enders *et al*. (2010) point to an increasing use of threshold regression in capturing nonlinear relationships in many financial time series data. As in linear regression, estimation results from nonlinear relationships may be spurious if they are non-stationary (that is, I(*1*)) and non-integrated. According to Li and Lee (2010), Balke and Fomby (1997) test for threshold effects while assuming cointegration rather than testing directly for the existence of threshold integration. Li and Lee (2010) point out they assume threshold integration within a certain range of deviations from the long-run equilibrium implied in the null but they do not present a formal test. Enders and Siklos (2001) remedy this situation by presenting a formal test for threshold cointegration where they use the Engle and Granger (1987) (hereafter EG) type testing procedure. Enders and Siklos (2001) also employ the EG type testing regression but contribute to this literature by presenting a formal test for the joint hypothesis of the absence of both nonlinearity and cointegration.

In fact, they also provide critical values for threshold cointegration for TAR and MTAR specifications depending on whether a threshold variable is stationary or non-stationary, and also permit asymmetric adjustment of the error term. Since testing for threshold cointegration entails nonstandard inference, the threshold variable is often not identified under the null hypothesis (the Davies (1977) problem). A way around this problem is to calculate a Wald statistic over the range of the empirical distribution of the threshold variable. The resulting Sup Wald statistic is obtained by searching only over the range of the threshold parameter. Like other threshold models, we use indicator functions that capture regime changes if a threshold variable exists.

Li and Lee (2010) suggest that in nonlinear long-run equilibrium models, researchers must deal with two issues that are closely related: (a) the existence or nonexistence of nonlinearity, and (b) whether there exists a long-run relationship (threshold cointegration). Balke and Fomby (1997) employ the two-step Engle and Granger (1987) approach. The first step involves testing the null of no cointegration using the linear cointegration test of EG. The second step uses the residuals from the first step to test the null of no threshold cointegration. This two-step approach raises a fundamental problem. If nonlinearity exists and one employs a linear cointegration approach in the first step, the linear test often fails to reject the null largely because nonlinearity (issue (a)) tends to reduce the power of most unit roots tests (DF, ADF and similar tests).

Perron (1989) suggested that the failure to reject the null of a unit root might be due to inability to account for structural breaks in the data. However, the failure to reject the null in a linear test does not necessarily imply the absence of a long-run relationship (issue (b)), since nonlinear cointegration is still possible. When one tests for nonlinearity, the approach is valid only if cointegration holds and when the cointegrating vector is known. In other words, if cointegration does not exist due to non-stationarity, the null of linearity can be rejected. Thus, the Balke and Fomby (1997) approach to threshold cointegration assumes cointegration. We employ the ARDL bounds test to test for cointegration in the paper. The results are presented in Table 1 in the Appendix.

2.1 ARDL Bounds Test

In order to establish whether there is cointegration between lending and deposit rates, we employ the bounds test from Pesaran *et al*. (2001)[1]. The first step in the ARDL approach to cointegration

[1] The bounds test or ARDL modeling is not discussed in detail here. The purpose of the exercise is to simply establish cointegration as discussed

is to estimate and test whether long-run multipliers of the lagged variables are zero against the alternative that at least one is non-zero using lower and upper bound F-statistics. We found that $F_{DR}(DR|LR)$: *F-statistic* (2,207) = 1.10[0.389] and $F_{LR}(LR|DR)$: *F-statistic* (2,207) = 6.33.10[0.027]. The tabulated upper bound F = 5.77 and the lower bound = 4.93, all at 5% level of significance. It is clear that LR and DR are cointegrated when $F_{LR}(LR|DR)$ since 6.33 is greater than 5.77. The next step is to select the optimal lag ARDL model using the Schwarz Bayesian criterion as presented in Table 1 (see appendix). Panel B has long-run coefficients and Panel C presents short-run dynamic coefficients. Of significance is the error-correction (ECM) term in Panel C. It has the correct sign and it is statistically significant. Thus, we find evidence of linear cointegration without imposing common factor restrictions. It is important to note that the ARDL results indicate an optimal lag of 2, similar to threshold cointegration results in Table 4. The next step is to establish whether there is threshold cointegration.

Enders and Siklos (2001) proposed two different sets of threshold cointegration tests with threshold autoregressive (TAR) and momentum threshold autoregressive (MTAR) unit root tests that depend on whether a threshold variable is stationary or non-stationary. Li and Lee (2010) suggest that that any Engle and Granger (EG) type of threshold cointegration has a major drawback. It imposes a strong restriction where coefficients in the long-run model are set to be equivalent to short-run coefficients termed common factor restrictions by Kremers *et al*. (1992) and Enders *et al*. (2010).

We use two different indicator functions that use change or deviations from the long-run equilibrium as a threshold variable. The deviations are obtained from OLS estimation of the following model, $LR_t = \beta_0 + \beta_1 DR_t + \varepsilon_t$ in the first stage, where LR_t, DR_t represent the lending rate and deposit rates at time t respectively, and β_0 and β_1 are parameters to be estimated. The disturbance term, ε_t, may be serially correlated. The long-run equilibrium involves the stationarity of ε_t given by $\Delta\varepsilon_t = \rho\varepsilon_{t-1} + u_t$ where u_t is the white noise distribution. The residuals obtained from the stage one are used to derive $\Delta\varepsilon_t$. However, it is important to check for structural breaks in the data to avoid the failure to reject a null hypothesis of a unit root. The

in this section. Further details and results beyond those in Table 1 are available upon request.

lending-deposit spread ($SP_t, = \varepsilon_t$) is regressed on a constant and a dummy to obtain residuals denoted as SP^P that are used in the TAR and MTAR specifications. The dummy (D) captures an endogenous break date which is incorporated in deriving SP^P used in the threshold unit root tests. Thus, by definition, the error-correction term is $SP^P = SP_t - \kappa D$. Hansen and Seo (2002) present an efficient algorithm for searching for a threshold value. Since the cointegrating vector is $\hat{\omega} = (1, -\hat{\kappa})'$ this implies that $\hat{\omega}$ will be a super-consistent estimate of the cointegrating vector if LR_r and DR_t are cointegrated as shown in Table 1, particularly the ECM term in Panel C.

2.2 Data, Sources, and Methodology

The study on the lending-deposit rate spread (SP) employs monthly data obtained from the International Financial Statistics published by the IMF over the period 1990:1 to 2010:7. The spread is the difference between the lending rate (LR) and the deposit rate (DR). Table 3 below shows descriptive statistics for all the variables.

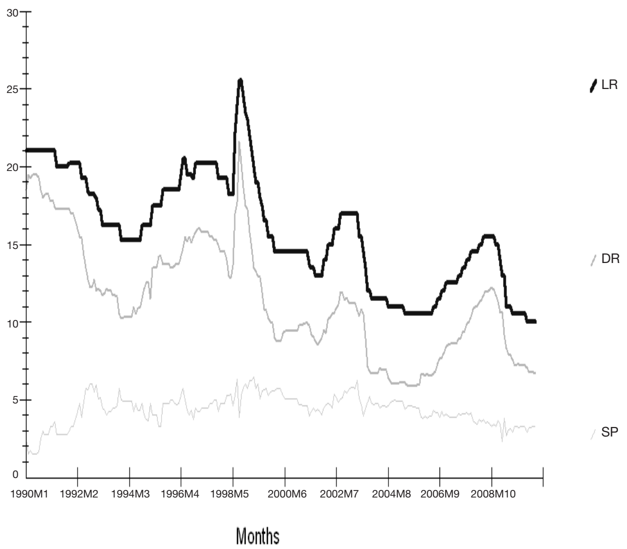
Table 3 - *Descriptive Statistics*

Series	Observations	Mean	Standard Deviation	Minimum	Maximum	Skewness	Kurtosis
DR	246	11.50	3.73	5.87	21.60	0.41	-0.67
LR	246	15.87	3.67	10.00	25.50	0.15	-0.84
SP	246	4.37	0.97	1.50	6.50	-0.51	0.31

The deposit rate reached a maximum of 21.60% in August 1998 and the lending rate a maximum of 25.50% in August and September 1998. The deposit rate achieved a minimum of 5.87% in July 2005, while the lending rate has hovered at 10% from March 2010 to July 2010. The data points to the lending and deposit rates decreasing in tandem from 1998. The lending-deposit spread has also narrowed over time.

Figure 1 shows the behavior of all the variables. It shows that prior to 1998, the spread was large as both the LR and DR spiked in response to the Asian Crisis in 1997-98. After May 1998, the spread has remained relatively smooth, albeit with a negative slope. Thus, LR and DR exhibit a very close relationship. This may suggest that the downward trend in the rates is associated with significant reforms in South Africa's banking sector, where financial and non-financial firms and households now have a more competitive system than before. Thus, banks and non-financial firms are no longer limited to deposits for funding loan growth. The funds can now be sourced from a thriving bond market as well.

FIGURE 1 - *SA's Lending Rate (LR), Deposit Rate (DR), and the Spread (SP)*



However, Figure 1 also shows the spread in South Africa is relatively higher than that of comparable emerging economies except Brazil. One possible explanation is the high concentration of banking sector. With such a market structure, banks have few incentives to increase their operating efficiency and as a result they operate with high spreads either as a way of generating revenues to cover their expenses or as a result of their ability to asymmetrically adjust loan and deposit rates (Costa da Silva *et al.*, 2007). Table 2 (Appendix) confirms the concentration of banks in South Africa. In 1991, the big four banks controlled 68% of total assets and by 2008, this ratio had risen to 91%. If the hypothesis of bank's market power is to be credible, then loan rates charged by banks should be upwardly flexible, resulting in high returns on assets. In other words, increases in loan rates but upward rigidity in deposit rates allow for a stable or slight increase in the spread, as can be seen in Figure 1 between 1998 and 2004. Of course, the actual spread in South African banks is influenced by a host of factors such as the policy rate, bank overhead, risk and taxes, loan-loss expenses, inflation, and economic activity.

3. Asymmetric behavior in interest rates and threshold unit tests

Many analysts have suggested that banks adjust their lending rates asymmetrically. However, few studies have *specifically* examined the relationship between deposit and lending rates[2]. In fact, it is plausible that banks may set their lending rates as a 'mark-up' relative to the deposit rates. If the mark-up is deemed low or high by the market, there will be pressure on the banking sector to adjust back to some equilibrium. The adjustment may be asymmetric depending on some unknown threshold that has to be estimated along with adjustment parameters. If the lending-deposit spread is stationary subject to some threshold value, then the spread returns to its long-run equilibrium following a shock.

Lim (2001) found upward rigidity in lending and deposit rates for Australia whereas Iregui *et al*. (2002) found downward rigidity for both rates in Mexico and Columbia. These two studies support bank collusive pricing. Fang and Thanh Bihn (2010) found upward rigidity in the deposit rate and upward rigidity in the lending rate for both Taiwan and Hong Kong. Green (1998) claims that the rigidity is due to the fact that bank interest management is based on a two-tier pricing scheme; banks offer accounts at market-related rates and at posted rates that are changed at discrete time intervals. In examining price (retail interest rates) setting in Turkey, Ozdemir (2009) found IRPT from money market rates to deposit and lending to be complete in the long-run, but found that in the short-run the lending rate was more flexible relative to the deposit rate. The explanations for stickiness in retail rates were information asymmetries, customer reaction, and collusive pricing behavior.

Stiglitz and Weiss (1981) offer information asymmetries as an explanation that generates rationing in otherwise competitive markets. For the loan rate available to identical borrowers, some get loans and some do not. Expected earnings of banks from loans

[2] The exceptions are Thompson (2006), Nguyen and Islam (2010), Su *et al*. (2010), and Nguyen *et al*. (2010).

sold are a function of the loan rate. A rise in the loan rate increases the probability of default because of increased risk due to adverse selection or moral hazard. Thus, increases in the loan rate do not increase lending even if banks face higher costs (deposit rate) on the liability side of the balance sheet. The customer reaction hypothesis assumes downward rigidity of deposit rates and upward rigidity of loan rates. The hypothesis suggests that asymmetric adjustment in lending rates could benefit customers in the sense that banks that operate in an environment of high rates may fear negative reaction of consumers if they increase loan rates even if there is a policy rate increase by monetary authorities. The collusive pricing hypothesis states that in a concentrated banking sector, deposit rates exhibit upward rigidity while loan rates exhibit downward rigidity. The empirical evidence on the interest rate pass-through (IRPT) is mixed on these two hypotheses.

Besides two influential papers by Hannan and Berger (1991) and Neumark and Sharpe (1992) on interest rate pass-through (IRPT), Scholnick (1996, 1999) provides three main theories on interest rate asymmetries. The three theories are based on consumer behavior, industry concentration, and adverse selection in the market for loans. The link between market concentration and asymmetric interest rate adjustment (for deposit rates) suggests that, where banks have market power, rates are sticky or rigid upward when the costs of funds increase. However, empirical evidence from Canada dominated by six large banks finds no asymmetries. The consumer reaction hypothesis is largely built on characteristics of consumers. For all practical purposes, the hypothesis gives reasons why a bank may have market power to asymmetrically change interest rates to its own advantage due to the presence of search costs, switching costs faced by customers, and the level of customer sophistication (could apply to loan rates as well).

Suppose that we can divide customers into 'unsophisticated' (denoted by β) who only know of the current and previous interest rates of their own bank and 'sophisticated (denoted by γ) who are aware of all interest rates. Rosen (2002) pointed out that if the proportion β/γ is large, the greater is the power of banks to asymmetrically adjust their rates to their advantage. However, the 'unsophisticated' group may simply indicate the opportunity cost of searching and other switching costs[3]. However, as pointed out

[3] South Africa's unbanked class is very large, often paying high loan

by Hannan and Berger (1991), rates could adjust asymmetrically to benefit consumer under the *negative reaction hypothesis*. That is, if consumers believe that banks are not adjusting rates to their favor, they can simply take their funds to alternative financial institutions. Stiglitz and Weiss (1981) provide a well-known theory that links asymmetric information and interest rate adjustment. However, it applies to loan markets only and suggests that loan rates are sticky or rigid upwards.

3.1 Threshold Unit Root Tests

We first consider the Threshold Autoregressive Test (TAR):

$$\Delta SP^P{}_t = I_t\rho_1 SP^P{}_{t-1} + (1-I_t)\rho_2 SP^P{}_{t-1} + \varepsilon_1 \tag{1}$$

where I_t is an indicator function. In cases where there is evidence of autocorrelation of the error term beyond one lag, the equation can be augmented by a term $\sum_{t-1}^{n}\omega_i \Delta SP^P{}_{t-i}$ to obtain uncorrelated residuals. The regime is specified through an indicator variable that is expressed as the Heavyside function such that

$$I_t = \begin{cases} 1 & if\ SP^p{}_{t-1} \geq \tau \\ 0 & if\ SP^p{}_{t-1} < \tau \end{cases} \tag{2}$$

Even if the threshold variable (SP^P) is known, the threshold value τ is usually unknown. This means that non-standard procedures are needed for testing for the presence of nonlinear or asymmetric cointegration between loan and deposit rates. In the threshold variable $SP^P{}_{t-d}$ we assume that the delay parameter $d=1$ and that the SP^P is *non-stationary*. Thus, we seek threshold values in the ranked series of the threshold variable. The existing threshold cointegration literature usually uses the lagged disequilibrium ($SP_{t-1}{}^P$) or changes in this disequilibrium ($\Delta SP_{t-1}{}^P$) where SP^P are residuals. The unknown threshold value τ is the estimated from the data using Chan's (1993) procedure that yields τ by minimizing the sum of squared residuals after arranging SP^P in ascending order

rates due to search costs. Greyvenstein (2010), "*R12 billion still unbanked in South Africa: Banks still seem too 'elitist and inaccessible*'". The unbanked in South Africa have put about R12 billion 'under mattresses', the Banking Association of SA's inaugural summit in Johannesburg heard on Tuesday, 07 September 2010, SAPA.

and trimming off 15% of largest and smallest values[4]. Based on the estimate for τ, the indicator variables for TAR or MTAR are used in testing for asymmetric cointegration. According to Li and Lee (2010), the SupW statistic as an order statistic and the grid search approach relegate the nuisance parameter to appear under the alternative hypothesis.

Figure 2 shows changes in SP and possibilities of a structural shift or break in the data. Changes in the spread are clearly more pronounced in May-August 1998 and November-December 2008. To allow for such a possibility it is important to test for a break in the SP. We follow Perron (1997) and test for the possibility of a unit root in SP. We tested for such a possibility and results suggest that the spread is stationary.

FIGURE 2 - *Percent Change in SP = 100* (SP – SP(-1))/SP(-1)*

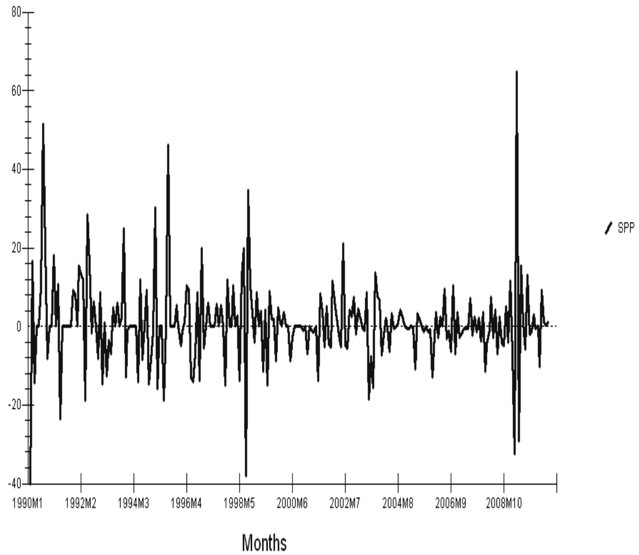


Figure 2 shows that the lending-deposit spread (SP) may have experienced a structural change (shift) over the sample period particularly in May 1998. We follow Perron (1997) and Nguyen and Islam (2010) and allow for an endogenous break by specifying and

[4] We tested for the possibility of two thresholds. Besides May 1998 there was one in November 2008 but it was not significant. Thus, we examined the case of one threshold in May 1998.

estimating the slope, intercept and the trend function to test the null hypothesis that the lending-deposit rate spread (SP) has a unit.

$$SP_t = \mu + \theta DU + \alpha T + \gamma DT + \delta D(T_b) + \beta SP_{t-1} + \sum_{i-1}^{k} c_i \Delta SP_{t-i} + \varepsilon_t \qquad (3)$$

where $DU = 1(t > T_b)$ represents a post-break dummy, $DT = 1(t > T_b)$ dummy for post-break slope, T a linear time trend, $D(T_b) = 1(t = T_b + 1)$ a break-dummy variable. The null hypothesis is that SP has a unit root stated as $\beta = 1$ and the selection of the break date ($D(T_b)$) is based on the minimum t-statistic when testing whether $\beta = 1$.

The results of the Perron (1997) endogenous unit root test are reported in Table 4 below. The post-slope dummy DT is negative (=-0.004) and the post-break intercept DU is positive (=1.422). The break date dummy $D(T_b)$ is negative (=-2.323) and significant at 1%. The null hypothesis of a unit root in SP is strongly rejected. This means that SP is stationary with a break date of May 1998[5]. Having found that the lending-deposit spread is stationary, the next step is to obtain residuals to be used in TAR and MTAR models to test for interest rate asymmetries (if any). We construct a dummy variable with values of zero from 1990M1 to 1998M4 and values of one from 1998M5 to 2010M7[6]. The lending-deposit spread (SP) is regressed on a constant and this new dummy to obtain residuals denoted as SP^P that are used in the TAR and MTAR specifications.

TABLE 4 - *Endogenous Unit Root Test, 1990M1 to 2010M7*

SP_t=0.506+	1.422DU+	0.0002T−	0.004DT−	2.323$D(T_b)$+	0.788SP_{t-1}+ε_t
(3.112)*	(2.278)*	(0.069)	(-2.965)*	(-6.626)*	(9.772)*

Augmented lags =8, Break date: May 1998, $t(\beta = 1) = -3.751$.
Critical values for t-statistics are based on n=100 from Perron (1997).
* represents significance at 1%.

As pointed out in Enders and Granger (1998), Enders (2001), Enders and Siklos (2001), Nguyen and Islam (2010), and many others, the use of the Dickey-Fuller (DF) unit root test and its extensions assume that the adjustment process is symmetric (Dickey

[5] The stationarity of SP is confirmed by an ADF test with a value of -4.4975 against a critical value of -2.8825.

[6] The November-December 2008 potential break date was not statistical significant. Thus, we proceeded by estimating a one-threshold model.

and Fuller, 1979). However, they point out that the assumption of symmetry leads to a wrong model if the long-run relationship is only stationary under the assumption of asymmetry. Equation (2) shows that if the SP^P value is greater (or equal) to the threshold value, the adjustment coefficient is ρ_1 and the adjustment margin is $\rho_1 SP^p_{t-1}$. But if the SP^P value is less than the threshold value, the adjustment coefficient is ρ_2 and the adjustment margin is $\rho_2 SP^p_{t-1}$. Note that (3) suggests a lag length of either zero or one in the level variable SP^P. The MTAR allows the spread to decay by the *first difference* of SP^P_{t-1}, that is ΔSP^P_{t-1}. In other words, the autoregressive decay depends on whether the spread (SP) is increasing or decreasing. This specification allows the MTAR to accomodate 'sharp' movements in the lending-deposit spread.

3.2 The Momentum Threshold Autoregressive Model (MTAR)

The MTAR model is useful when there is a possibility that the adjustment exhibits more momentum (M) in one direction than the other. Equations (4) and (5) comprise the MTAR model.

$$\Delta SP^P_t = M_t \rho_1 SP^P_{t-1} + (1-M_t)\rho_2 SP^P_{t-1} + \varepsilon_t \tag{4}$$

$$\mathrm{M}_t = \begin{cases} 1 & \text{if } \Delta SP^P_{t-1} \geq \tau \\ 0 & \text{if } \Delta SP^P_{t-1} < \tau \end{cases} \tag{5}$$

Equation (5) shows that if the ΔSP^P value is greater (or equal) to the threshold value, the adjustment coefficient is ρ_1 and the adjustment margin is $\rho_1 SP^p_{t-1}$. But if the ΔSP^P value is less than the threshold value, the adjustment coefficient is ρ_2 and the adjustment margin is $\rho_2 SP^p_{t-1}$. In both the TAR and MTAR models, the null hypothesis of a unit root is stated as $\rho_1 = \rho_2 = 0$. For the TAR and MTAR models, the rejection of a null hypothesis at some chosen level of significance would point to a stationary spread and the presence of asymmetric adjustments.

Enders and Granger (1998) use the F-distributed Φ_μ (TAR) and the Φ^*_μ (MTAR) to test for asymmetric threshold cointegration. If the null hypothesis is rejected, then one is certain that there is cointegration. In cases where the threshold is unknown and therefore must be estimated, the F-tests that consistent (c) are denoted as $\Phi_\mu(c)$ and $\Phi^*_\mu(c)$. Furthermore, the F-test is used to test the null hypothesis of symmetry ($\rho_1 = \rho_2$). Enders and Granger (1998) use $\Phi_\mu(c)$ (for TAR) and ($\Phi^*_\mu(c)$ for MTAR) test statistics. If the null hypothesis of symmetric adjustment is accepted, then the long-run relationship between variables or the spread can be estimated by any linear cointegration method. However, if the null hypothesis is rejected, there exists asymmetric cointegration. With cointegration, the adjustment of short-run deviations from a long-run equilibrium for LR and DR is undertaken by using an error-correction model for each series.

4. Model estimation and results

Before the estimation of threshold models (1 and 2) for TAR, and (4 and 5) for MTAR, the presence of nonlinearity or asymmetry should be established. In both (1) and (3), the null hypothesis of no cointegration, $\rho_1 = \rho_2 = 0$ is tested against the alternative of threshold cointegration. As the threshold value, τ which defines I_t is unidentified under the null hypothesis, the test statistics Φ_μ and Φ^*_μ are tabulated in Enders and Granger (1998). The spread between the lending and deposit rates is analyzed using a modified Enders and Granger (1998) model[7]. We report unit root test results for the TAR-Consistent and Momentum-consistent models that test null hypotheses $\rho_1 = \rho_2 = 0$ and $\rho_1 = \rho_2$[8]. The results of the estimates of the lending-deposit spread are reported in Table 5 below.

A consistent estimate of the threshold is 1.45. Since our sample size is 244 (close to the tabulated value for n=250), we see that for the TAR model with zero lags, the $\Phi_\mu(c)=F$ for the null hypothesis $\rho_1 = \rho_2 = 0$ exceeds 6.03 in 5% of the 45000 trials. Alternatively, F=11.52 exceeds the critical value of 6.03. For a one lag TAR model, the null hypothesis is rejected since F=7.856 exceeds 6.03. For the TAR model without lags, the point estimates show that the spread tends to decay at the rate of $|\rho_1|$=0.504 for SP^p_{t-1} above the threshold value, τ=-1.45 and at the rate of $|\rho_1|$=0.044 for SP^p_{t-1} below the threshold value. As to the speed of adjustment, it is clear that $|\rho_1|>|\rho_2|$ which means the adjustment is faster when there

[7] We used RATS Version 8 package to estimate a modified Enders and Granger (1998) model.

[8] Since we estimated a consistent threshold, we report results for these tests only. The Akaike Information Criteria (AIC) is calculated as T*log(SSR)+2*n where T = the number of usable observations, SSR = sum of squared residuals, and n = number of regressors. The Bayesian Information Criteria (BIC) is calculated as T*log(SSR)+n*log(T).

is an increase in the spread. Clearly, it appears that the model is adequately supported by the indicator function (2) – based on the *level* of the spread. For the TAR model with one lag, it remains true that $\rho_1|>|\rho_2|$ as well. In case of the MTAR model with one lag, the null hypothesis of a unit root cannot be rejected since 0.041 is less than the critical value of 5.64.

TABLE 5 - *Tests of Asymmetric Adjustment of the Lending-Deposit Spread*

	Adjustment if above τ	Adjustment if below τ	Estimated Threshold Value	Null that Adjustment of Unit Root (*)	Null that Adjustment is Symmetric (**)	
Model	ρ_1	ρ_2	τ	H_0:$\rho_1=\rho_2=0$	H_0:$\rho_1=\rho_2$	Information Criteria
TAR-Consistent (0 -lag)	-0.504 (t=-4.32)	-0.044 (t=-2.09)	-1.45	$\Phi_\mu(c)$=F=11.52 (p=0. 0)	F=15.1 (p=0.00)	AIC=920.8 BIC = 931.3 Q(4)=14.62 Q-signif=0.01
TAR-Consistent (1 -lag)	-0.402 (t=-3.54)	-0.038 (t=-1.88)	-1.45	$\Phi_\mu(c)$=F=7.86(p=0.00)	F=10.0 (p=0. 01)	AIC=889.1 BIC =903.1 Q(4)=2.6 Q-signif=0.6
MTAR-Consistent (1-lag)	-0.000 (t=-0.05)	-0.000 (t=-0.26)	0.26	$\Phi^*_\mu(c)$=F=0.04 (p=0.9)	F=0.03 (p=0.87)	AIC=904.404 BIC=918.360 Q(4)=4.583 Q-signif=0.3

Q(4) is the Ljung-Box statistic that the first four of the residual correlations jointly equal to zero; (*) are sample values of Φ_μ or Φ^*_μ which are really F-statistics; (**) are sample F-statistics for the null that adjustment coefficients are equal.

The MTAR model allows for the adjustment to depend on the *previous period's change* in the spread. The point estimates show that $\rho_1=\rho_2=0$ and are insignificant. Thus, there seems to be no asymmetric threshold adjustment in the MTAR model. The results suggest that banks might not adjust their lending rates differently to rising or falling rates. The MTAR model is not consistent with Stiglitz and Weiss (1981). Given that SP^P is stationary, we can test the null $\rho_1=\rho_2$ using the normal distribution. In the case of the TAR model without any lagged changes, $\Phi_\mu(c)$=F=15.1, which is bigger than the critical value. For a one lagged change, the value of 10.04 is more than the critical value of 6.12. The Akaike Information Criterion (AIC) chose the TAR model regardless of lags. For MTAR with one lag it is not possible to reject the null of symmetric adjustment. In any cases, both adjustment parameters (ρ_1,ρ_2) in the MTAR model are both zero.

4.1 Consistent MTAR Model with Two Lags

$$\Delta dr_t=-0.242-0.112\Delta dr_{t-1}-0.086\Delta dr_{t-2}+0.415\Delta lr_{t-1}+0.350\Delta lr_{t-2}+$$
$$(-0.940)\quad(-1.032)\quad(-0.983)\quad(3.541)\quad(3.876)$$
$$+0.026I_tSP^P_{t-1}+0.040(1-I_t)SP^P_{t-1} \qquad (6)$$
$$(0.709)\quad(0.295)$$

Equation 6 can be written in compact form as

$$\Delta dr_t=-0.242+A_{11}(L)\Delta dr_{t-1}+A_{12}(L)\Delta lr_{t-1}+0.026I_tSP^P_{t-1}+0.040(1-I_t)SP^P_{t-1}$$
$$F_{11}=0.792(p=0.454);\ F_{12}=11.675(p=0.000)$$

Let $A_{11}=0.112\Delta dr_{t-1}-0.086\Delta dr_{t-2}$ and $A_{12}=0.415\Delta lr_{t-1}+0.350\Delta lr_{t-2}$ where $A_{ij}(L)$ are first-order polynomials in the lag operator L and F_{ij} equals the p-value for the null hypothesis that all coefficients of $A_{ij}(L)$ are zero.

Although the MTAR does not account for asymmetry at all (see the Table 4 above), the asymmetric error-correction models were estimated nonetheless. The MTAR captures any 'sharp' movements in the spread by using the indicator in (5). The model is useful when adjustment exhibits more momentum in one direction than the other. This means that the speed of adjustment depends on whether the spread is increasing (widening) or decreasing (narrowing). Since $\rho_1=0.0261|<|\rho_2=0.040$ this means that increases in the spread tend to persist whereas decreases force a return to the threshold ($\tau=0.26$). However, both adjustment coefficients are positive and not significant. The lagged coefficients of changes in the loan rate are properly signed and significant. This means that increases in the loan rate that increase the spread lead to an adjustment of 0.415 (one lag) and 0.350 (two lags) in the deposit rate. The important issue here is the persistence of the spread as the deposit rate adjusts upward in response to changes in the loan rate.

$$\Delta lr_t=0.390+0.224\Delta dr_{t-1}-0.030\Delta dr_{t-2}+0.105\Delta lr_{t-1}+0.187\Delta lr_{t-2}-$$
$$(1.625)\quad(2.211)\quad(-0.375)\quad(0.961)\quad(2.222)$$
$$-0.062I_tSP^P_{t-1}-0.052(1-I_t)SP^P_{t-1} \qquad (7)$$
$$(-1.826)\quad(-1.487)$$

Equation 7 can be written in compact form as

$$\Delta lr_t=0.390+A_{11}(L)\Delta dr_{t-1}+A_{12}(L)\Delta lr_{t-1}-0.062I_tSP^P_{t-1}-0.052(1-I_t)SP^P_{t-1}$$
$$F_{11}=2.989(p=0.052);\ F_{12}=2.629(p=0.074)$$

Let $A_{11}=0.224\Delta dr_{t-1}-0.030\Delta dr_{t-2}$ and $A_{12}=0.105\Delta lr_{t-1}+0.187\Delta lr_{t-2}$ where $A_{ij}(L)$ are first-order polynomials in the lag operator L and F_{ij} equals the p-value for the null hypothesis that all coefficients of $A_{ij}(L)$ are zero.

For the loan rate, $|\rho_1=0.062|>|\rho_2=0.052|$ means that increases in the spread tend to revert back to the equilibrium or threshold. Although both coefficients are not significant, they do carry the correct negative sign. The F-statistic for the loan rate change is 2.63, which points to at least one non-zero term in (7). An increase in the one lag change in the deposit rate tends to increase the loan rate. Specifically, a one-period lagged deposit rate change induces momentum in the loan rate and thus changes the spread but not one-for-one. The same holds for the two-period change in the loan rate. The models represented by (6) and (7) are selected by a multivariate AIC=-808.815 and SBC =-760.086.

4.2 Symmetric Error-Correction Models with Two Lags

The positive finding of cointegration in the TAR but not the MTAR model permits the construction of an asymmetric error correction model to capture short- and long-run dynamics with respect to the lending rate (lr_t) and the deposit rate (dr_t). Given that the TAR model detected asymmetry in the spread, the asymmetric error correction model is replaced by a single symmetric error correction term.

$$\Delta dr_t = \beta_0 + \sum_{i=1}^{n} \omega_i \Delta lr_{t-i} + \sum_{i=1}^{n} \alpha_i \Delta dr_{t-i} + \rho RESIDS_{t-1} + u_{dr,t} \tag{8}$$

$$\begin{aligned}\Delta dr_t = &-0.023 - 0.043\Delta dr_{t-1} - 0.073\Delta dr_{t-2} + 0.341\Delta lr_{t-1} + 0.347\Delta lr_{t-2} +\\ &\;(-0.697)\quad(-0.087)\qquad(-0.848)\qquad(3.615)\qquad(3.845)\\ &+0.029(lr_{t-1} - dr_{t-1})\\ &\qquad(0.807)\end{aligned}$$

Equation 8 can be written in compact form as

$\Delta dr_t = -0.023 = A_{11}(L)\Delta dr_{t-1} + A_{12}(L)\Delta lr_{t-1} + 0.029(lr_{t-1} - dr_{t-1})$

$F_{11}=0.399(p=0.671)$; $F_{12}=11.567(p=0.000)$

Let $A_{11}=-0.043\Delta dr_{t-1}-0.073\Delta dr_{t-2}$ and $A_{12}=-0.341\Delta lr_{t-1}+0.347\Delta lr_{t-2}$ where $A_{ij}(L)$ are first-order polynomials in the lag operator L and F_{ij} equals the p-value for the null hypothesis that all coefficients of $A_{ij}(L)$ are zero. RESIDS represent the residuals. The results from the deposit rate adjustment equation (8) show that the deposit changes by 0.029 units multiplied by any positive or negative discrepancy in the spread. However, the error-correction term is not significant (t = 0.81). The results further support the asymmetric results from TAR in Table 5. A result worth noting shows that the deposit rate responds to a positive spread. That is, for two-lagged loan rates, increases in the loan rate result in an upward adjustment in the deposit rate by 0.341 and 0.35 units respectively. The F-statistic at 11.6 (with a p-value of 0.000) points to the significance of both loan rate terms

$$\Delta lr_t = \tilde{\beta}_0 + \sum_{i=1}^{n} \tilde{\omega}_i \Delta lr_{t-i} + \sum_{i=1}^{n} \tilde{\alpha}_i \Delta dr_{t-i} + \rho RESIDS_{t-1} + u_{lr,t} \tag{9}$$

$$\underset{}{\Delta lr_t} = \underset{(-0.515)}{-0.016} + \underset{(3.397)}{0.275\Delta dr_{t-1}} - \underset{(-0.264)}{0.021\Delta dr_{t-2}} + \underset{(0.565)}{0.040\Delta lr_{t-1}} + \underset{(2.199)}{0.185\Delta lr_{t-2}} - \underset{(-1.959)}{0.059(lr_{t-1} - dr_{t-1})}$$

Equation 9 can be written in compact form as

$\Delta lr_t = -0.016 + A_{11}(L)\Delta dr_{t-1} + A_{12}(L)\Delta lr_{t-1} - 0.059(lr_{t-1} - dr_{t-1})$
$F_{11} = 6.460 (p = 0.002)$; $F_{12} = 2.426 (p = 0.091)$

Let $A_{11} = 0.275\Delta dr_{t-1} - 0.021\Delta dr_{t-2}$ and $A_{12} = 0.040\Delta lr_{t-1} + 0.185\Delta lr_{t-2}$ where $A_{ij}(L)$ are first-order polynomials in the lag operator L and F_{ij} equals the p-value for the null hypothesis that all coefficients of $A_{ij}(L)$ are zero. The results from the loan rate adjustment equation (9) show that the loan changes by 0.059 units multiplied by any positive or negative discrepancy in the spread. However, the error-correction term is barely significant (t=-1.959). Changes in the loan rate respond to a positive spread in the case of a twice lagged change in the loan rate of 0.185 units. The F-statistic at 6.5 (with a p-value of 0.002) points to the significance of both loan rate terms. A one lag increase in the deposit rate increases the adjustment in the loan rate by 0.275 with t-statistics of -3.4. However, a twice lagged increase in the deposit rate reduces the loan adjustment by -0.021, although the term is insignificant. The F-statistic for loan rate is barely significant unlike that of the deposit rate.

The models represented by (8) and (9) selected a multivariate AIC =-811.609 and SBC =-769.841. The SBC chose a two-lag model whereas the AIC chose a four-lagged model. The lags were all set to 2 since there was no improvement in the coefficient of the error-term in (9).

5. Summary and conclusions

This paper employed the Thompson (2006) and Nguyen and Islam (2010) methodology to examine whether there exists asymmetries in lending-deposit spread in South Africa given extensive reforms since 1980. We employed the Perron (1997) test that allows for an endogenous break date. We found a structural break in May 1998 in the spread following the Asian crisis. If the spread has a structural break and we employ a Dickey-Fuller unit root test to test for stationarity the procedure results in misspecification if the true adjustment is asymmetric. Having found that the lending-deposit spread is stationary, the next step was to obtain residuals to be used in TAR and MTAR models to test for interest rate asymmetries (if any). We constructed a dummy variable with values of zero from 1990M1 to 1998M4 and values of one from 1998M5 to 2010M7. The lending-deposit spread (SP) is regressed on a constant and this new dummy to obtain residuals denoted as SP^P that are used in the TAR and MTAR specification.

The TAR model revealed asymmetric adjustments ('deep movements' as in Sichel, 1993) in the spread and rejected symmetric adjustment. This result parallels the results from both papers from Thompson (2006) and Nguyen and Islam (2010). With an estimated threshold value of -1.45, we found that the adjustment is faster if there is an increase in the spread (ρ_1=|0.504| in both TAR models, Table 5). On the other hand, with a decrease in the spread (ρ_2=|0.044|) the adjustment towards equilibrium is much slower. The TAR-consistent symmetric error-correction results in (8) and (9) have insignificant error-correction terms (0.029 for the Δdr equation and 0.059 for the Δlr equation respectively). However, (8) shows that in the short-run changes in the loan rate tend to increase the spread and in (9) there is limited evidence that a one-lag change in the deposit rate increases the spread as well. This appears to support the view that the deposit rate may not be as rigid upwards as suggested in some of the literature.

The MTAR-Consistent unit root tests in Table 5 mean that we cannot reject the null in both symmetric and asymmetric cases. In other words, there is no evidence that adjustments in the lending-deposit spread in South Africa depends on previous changes in the spread or that it captures 'sharp' movements in the spread as suggested in Sichel (1993). Similarly, asymmetric error-correction consistent MTAR models (6) and (7) reveal both adjustment parameters to be insignificant. The power of the MTAR tests relative to other unit root tests clearly rejects all the hypotheses in examining the lending-deposit hypothesis.

The main result is that the lending-deposit spread in South Africa can be fully examined by cointegration and threshold adjustment using the TAR model instead of the MTAR model.

Given the asymmetries in the spread, the results could influence the way the South African Reserve Bank (SARB) assesses the impact of the interest rate mechanism and the conduct of monetary policy within an inflation-targeting regime.

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ABSTRACT

The paper examines the asymmetric behavior of the lending-deposit spread in South Africa over the period 1990M1 to 2010M7. The paper employs threshold autoregressive (TAR) and momentum threshold autoregressive (MTAR) unit root tests to detect any asymmetries in the lending-deposit spread. We find the spread (SP, the difference between the lending and deposit rates) to be a stationary process after we endogenously determine May 1998 as a break date. The TAR model indicates that the spread is characterized by asymmetric adjustment. The asymmetric error-correction model indicates that the deposit rate adjusts to changes in the loan rate, as does the loan rate in response to one-period lagged changes in the deposit rate. The MTAR model fails to capture any asymmetries and hence the notion that adjustments depend on the previous period changes is not captured in South Africa's lending-deposit spread.

Keywords: Asymmetric Adjustment, MTAR, Spread, TAR, Threshold

JEL Classification: E43, E44, G2, G21

RIASSUNTO

Asimmetrie del tasso di interesse nello spread prestiti-depositi: studio di un caso

Questo studio esamina il comportamento asimmetrico dello spread prestiti-depositi in Sud Africa nel periodo 1990-2010. I test utilizzati sono quello a radice unitaria con soglia autoregressiva (TAR) e quello a radice unitaria con soglia momentum autoregressiva (MTAR), al fine di trovare eventuali asimmetrie nello spread. I risultati hanno evidenziato che lo spread (cioè la differenza tra i tassi di prestito e di deposito) è un processo stazionario dopo che la data *break* è stata endogenamente fissata a maggio 1998. Il modello TAR indica che lo spread è caratterizzato da aggiustamenti asimmetrici. Il modello asimmetrico *error-correction* indica che il tasso di deposito si adegua alle variazioni del tasso di prestito, così come quest'ultimo si adegua in risposta alle variazioni temporali unitarie del tasso di interesse. Il modello MTAR non riesce a cogliere ogni asimmetria e pertanto l'opinione che gli aggiustamenti dipendono dalle variazioni del periodo precedente non è considerata nello spread prestiti-depositi in Sud Africa.

APPENDIX

Table 1

Panel A

Autoregressive Distributed Lag Estimates: ARDL (2, 2) Selected based on Schwarz Bayesian Criterion

Dependent variable is LR
222 observations used for estimation from 1991M2 to 2009M7

****

Regressor	Coefficient	Standard Error]	T-Ratio [Prob]
LR(-1)	.73849	.066638	11.0820[.000]
LR(-2)	.16571	.064890	2.5538[.011]
DR	.63719	.045297	14.067[.000]
DR(-1)	-.23651	.074909	-3.1573[.002]
DR(-2)	.29984	.060336	-4.9694[.000]
C	.36848	.17283	2.1320[.034]

****

R-Squared	.98906	R-Bar-Squared	.98881
S.E. of Regression	.36283	F-stat. F(5, 216)	3906.8[.000]
Mean of Dependent Variable	15.8976	S.D. of Dependent Variable	3.4300
Residual Sum of Squares	28.4362	Equation Log-likelihood	-86.8978
Akaike Info. Criterion	-92.8978	Schwarz Bayesian Criterion	-103.1058
DW-statistic	2.0109		

****

Panel B

Estimated Long Run Coefficients using the ARDL Approach: ARDL (2, 2) Selected based on Schwarz Bayesian Criterion

Dependent variable is LR
222 observations used for estimation from 1991M2 to 2009M7

****

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
DR	1.0527	.079647	13.2174[.000]
C	3.8464	.95156	4.0421[.000]

****

Panel C

Error Correction Representation for the Selected ARDL Model: ARDL (2, 2) Selected based on Schwarz Bayesian Criterion

Dependent variable is dLR

222 observations used for estimation from 1991M2 to 2009M7

****

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
dLR1	-.16571	.064890	-2.5538[.011]
dDR	.63719	.045297	14.0670[.000]
dDR1	.29984	.060336	4.9694[.000]
dC	.36848	.17283	2.1320[.034]
ecm(-1)	-.095799	.031677	-3.0242[.003]

****

List of additional temporary variables created: dLR = LR-LR (-1), dLR1 = LR(-1)-LR(-2), dDR = DR-DR(-1), dDR1 = DR(-1)-DR(-2), dC = C-C(-1), ecm = LR -1.0527*DR -3.8464*C

****

R-Squared	.57613	R-Bar-Squared	.56631
S.E. of Regression	.36283	F-stat. F (4, 217)	73.3961[.000]
Mean of Dependent Variable	-.045045	S.D. of Dependent Variable	.55096
Residual Sum of Squares	28.4362	Equation Log-likelihood	-86.8978
Akaike Info. Criterion	-92.8978	Schwarz Bayesian Criterion	-103.1058
DW-statistic	2.0109		

****

R-Squared and R-Bar-Squared measures refer to the dependent variable dLR and in cases where the error correction model is highly restricted, these measures could become negative.

Table 2 - *Composition of Assets of Major South African Banks*

Year	1991	1992	1993	1994	1995	1996	1997	1998
Assets (million rand)								
ABSA	53372	80306	81742	91705	108493	123156	133011	148507
FNB	37704	42844	52192	59676	67230	78722	89778	93209
Investec	2786	3,550	4481	6889	9916	13008	20007	32541
Nedcor	32304	35947	40900	44929	52282	63144	74932	82465
Standard	49234	53160	57,395	69738	82923	101800	112747	127818
Others	79516	54533	56196	46554	53657	58522	83203	128554
Big 5	175400	215807	236710	272937	320844	379830	430475	484540
Big 4	172614	212257	232229	266048	310928	366822	410468	451999
Total Assets	254916	270360	292906	319591	374501	438352	513678	613094
Percentage of Total Assets								
Absa	20.9	29.7	27.9	28.7	29.0	28.1	25.9	24.2
FNB	14.9	15.8	17.8	18.7	18.0	18.0	17.5	15.2
Investec	1.1	1.3	1.5	2.2	2.7	3.0	3.9	5.3
Nedcor	12.7	13.3	14.0	14.1	14.0	14.4	14.6	13.5
Standard	19.3	19.7	19.6	21.8	22.1	23.2	21.9	20.9
Big 5	*68.8*	*79.8*	*80.8*	*85.4*	*85.7*	*86.6*	*83.8*	*79.0*
Big 4	*67.7*	*78.5*	*79.3*	*83.2*	*83.0*	*83.7*	*79.99*	*73.7*
Others	31.2	20.2	19.2	14.6	14.3	13.4	16.2	21.0

Number of banks								
Registered Banks	35(11)	35(8)	35	35	34	39	40	39
Foreign Bank Branches	0	0	0	0	4	6	9	12
Controlling Companies	26	17	23	23	27	26	32	34
Local Rep Offices	30	31	33	40	46	58	60	58

The big five are ABSA, FNB, Nedbank (Nedcor), Standard and Investec while the Big 4 excludes Investec.

Sources: Aziakpono and Wilson (2010).

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
150921	169961	202484	227685	260686	295803	358607	446402	579199	700168
127006	141,828	195764	212536	255533	263262	307310	388171	492760	607766
43161	50627	62977	63964	83837	72396	97129	117836	146394	170528
98412	113665	144698	161,090	280541	308955	303225	379331	436698	506359
137518	150988	184724	215717	318306	385397	436281	530761	659110	861396
137739	139760	128953	180873	115655	65212	83723	62467	214428	259275
557018	627069	790647	880992	1198903	1325613	1502552	1862501	2314196	2846217
513857	576442	727670	817028	1115066	1253217	1405423	1744665	2167802	2675689
694757	766829	919600	1061865	1314558	1390825	1586275	1924968	2382230	2934964
21.7	22.2	22.0	21.4	19.8	21.3	22.6	23.2	24.3	23.9
18.3	18.5	21.3	20.0	19.4	18.9	19.4	20.2	20.7	20.7
6.2	6.6	6.8	6.0	6.4	5.2	6.1	6.1	6.1	5.8
14.2	14.8	15.7	15.2	21.3	22.2	19.1	19.7	18.3	17.3
19.8	19.7	20.1	20.3	24.2	27.7	27.5	27.6	27.7	29.3
80.2	*81.8*	*86.0*	*83.0*	*91.2*	*95.3*	*94.7*	*96.8*	*97.1*	*97.0*
74.0	*75.2*	*79.1*	*76.9*	*84.8*	*90.1*	*88.6*	*90.6*	*91.0*	*91.2*
19.8	18.2	14.0	17.0	8.8	4.7	5.3	3.2	2.9	3.0
41	41	39	28	20	18	18	17	17	17
12	15	15	14	15	15	15	14	14	14
40	38	37	27	19	16	15	15	15	15
57	61	56	52	44	44	47	43	46	43