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Driving Swap Spreads in South Africa

An investigation into the dominant factors influencing swap spreads in the South African market

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Abstract

The theoretical drivers of interest rate swap spreads identified in studies conducted in the United States and United Kingdom markets were applied to the South African market and were found to be largely consistent with the former. The drivers identified include: liquidity associated with trading government stock, default risk, the general level of interest rates, the slope of the bond yield curve, bond yield volatility, the level of government bond issuance, and the level of corporate borrowing. The regression results indicated that the slope of the bond yield curve dominates as a predictor variable with the level of corporate borrowing and the level of government bond issuance playing a significant role as well.

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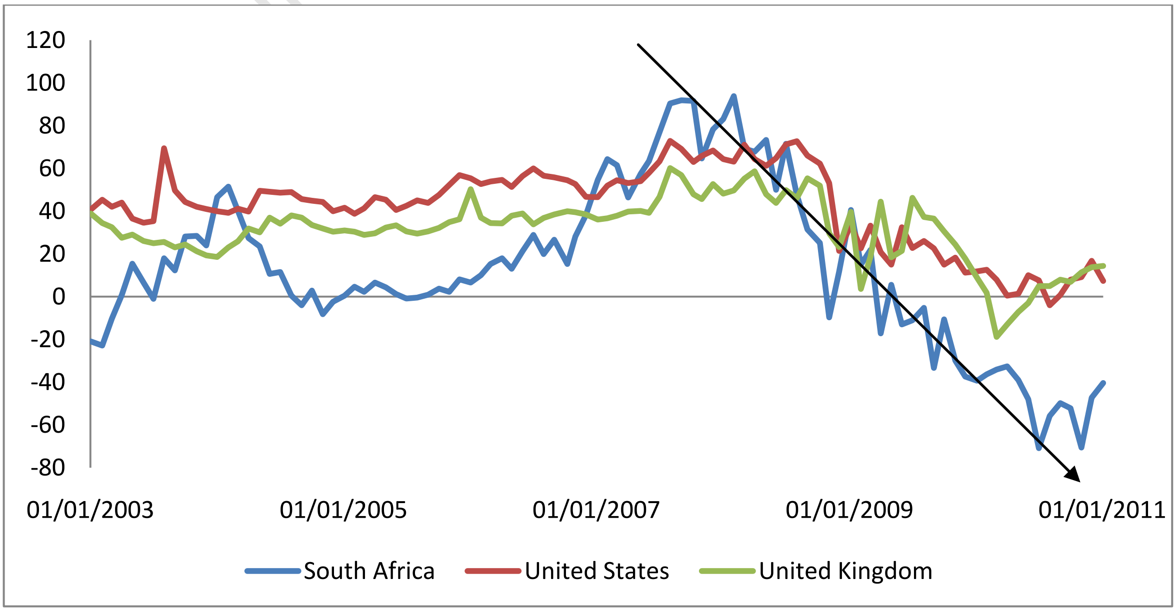
Introduction

The interest rate swap is one of the most widely used financial innovations in today's market. Since the 1980s swaps have grown in popularity amongst market participants worldwide. As at June 2010 it is estimated, according to the Bank for International Settlements (2010) that the notional amount outstanding in interest rate swaps amounted to US$ 347.5 trillion, US$ 300 trillion of which was added between 2000 and 2010. The multitude of applications, from hedging to the creation of synthetic instruments, has made the interest rate swap an instrument of choice for many market participants.

Swap spreads may be defined as the spread of the swap rate, or fixed rate in a swap contract, over the treasury yield of equal maturity. Usually swap spreads are positive due to premiums associated with risk and liquidity. These spreads impact the pricing of interest rate swap instruments and therefore makes the understanding of swap spread dynamics an important feature of trading such instruments. Not only are swap rates and their associated spread important from a pricing perspective but also for their use as a discount rate for future liabilities such as pensions and insurance.

Globally swap spread dynamics have reacted sharply to the turbulence of the market crisis conditions experienced over recent years. Graph 1.1 below indicates the movements in the 10 year swap spreads for the United States, United Kingdom, and South African markets.

Graph 1.1 *(Source: Bloomberg)*



Since the onset of the financial crisis the swaps spreads from all three markets declined significantly from around 50-60 basis points into negative territory most noticeably in the South African swap market. The market variables that have been most widely theorised as the driving forces behind swap spread movements include liquidity (of government bonds), default risk and credit risk, the general level of interest rates, the slope of the bond yield curve, volatility in the bond yield curve, expectations about government bond issuance and the level of corporate debt.

The objective of this paper is to determine the predominant driving variables behind swap spreads in the South African market during the stable conditions leading up to the 2008 market crash and the volatile market conditions that were experienced thereafter. The study is conducted using data from a seven year period from 2003 to 2010 and is split into two sub periods, namely the pre-crisis period and the crisis period. Simple and multiple linear regression techniques are employed in the analysis of the identified theoretical swap spread determinants.

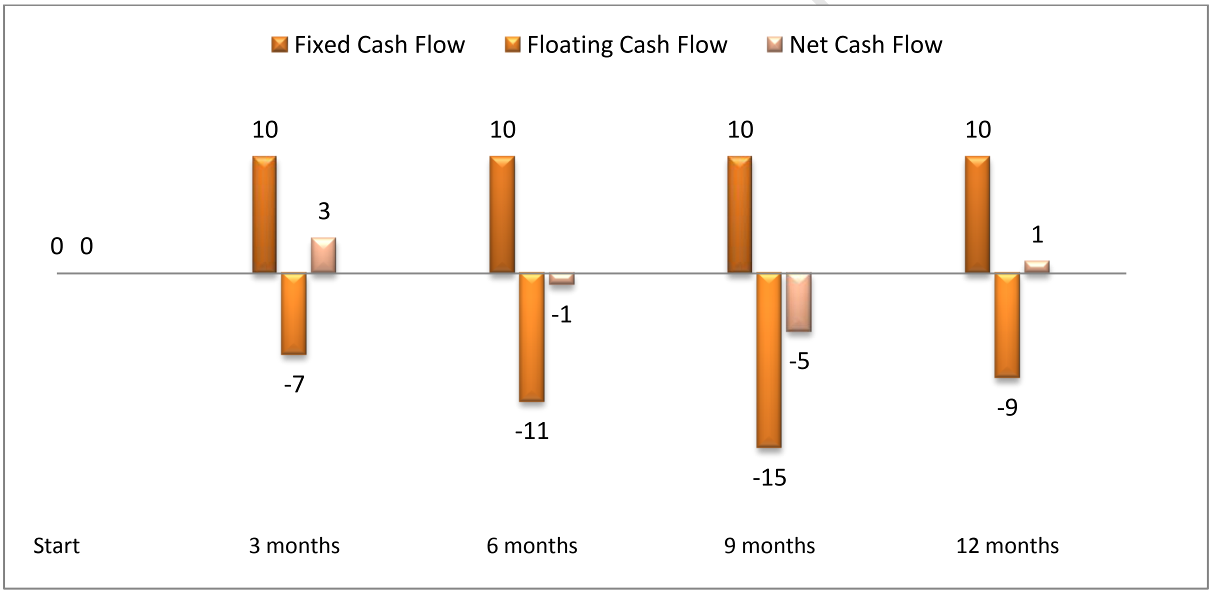
The paper is divided into 5 chapters. Chapter 1 introduces basic swap principles such as valuation, risk and rational. Chapter 2 analyses the major contributing theories of swap spread determinants. Chapter 3 outlines the objective and hypotheses of the study. Chapter 4 discusses the methodology followed in the study. Chapter 5 presents the results and findings of the study.

1. Basic principles of interest rate swaps

Interest rate swaps are agreements between two parties to exchange interest payments based on a notional principal. The most common type of interest rate swap is the fixed for floating swap where one party agrees to pay interest on the notional principal based on a predetermined fixed rate and to receive interest from a second party on the notional principal based on a floating rate over the same period. In the South African market the floating rate is usually linked to JIBAR (Johannesburg Interbank Acceptance Rate) and is reset every 3 to 6 months.

The diagram below illustrates an example of a cash flow profile for a floating rate payer of a 1 year fixed for floating interest rate swap resetting every 3 months:

Diagram 1.1:



At the start of the swap there is no exchange of the principal. The floating rate set for T + 3 month payment is set at time 0, thereafter the floating rate for the next due payment is set at the beginning of each payment period. Initially the fixed rate (swap rate) is set so that the value of the swap is equal to zero, after which movements in interest rate cause the swap value to become either positive or negative. Operationally only the net differences between the fixed and floating payments are made between counterparties;

$$Net\ Settlement = (Swap\ Rate - Jibar) \times Principal \qquad (1.1)$$

The swap rate may be expressed as a treasury yield of the same duration with an added spread, giving the following equation:

$$Swap\ rate = treasury\ yield + swap\ spread \qquad (1.2)$$

Valuation

From a valuation perspective the two different counterparty cash flows can be seen as two non-callable bond payment profiles where one bond pays fixed coupons and the other bond pays variable coupons. The inclusion of principal payments between the two counterparts would have zero effect on the valuation of the swap as they would simply net off. The value of the swap can therefore be expressed as the difference between the value of the floating rate bond and the value of the fixed rate bond, (Hull, 2006).

Similarly, Smith et al (1988) express the value of a swap as follows:

$$V.Swp = V.FrN - V.FxN \qquad (1.3)$$

V.Swp is the swap value, V.FrN is the value of the floating rate bond and V.FxN is the value of the fixed rate bond. The value of both the floating and fixed rate bonds can be broken down into the net present value (NPV) of the coupon payments and the NPV of a zero coupon bond with a face value of P. In the equations below FrC refers to the floating rate coupons and FxC refers to the fixed rate coupons.

$$V.FrN = NPV[FrC] + NPV[P], and \qquad (1.4)$$

$$V.FxN = NPV[FxC] + NPV[P] \qquad (1.5)$$

Further, Hull (2006) explains that because the value of the floating rate bond is equal to its face value immediately after an interest payment we can therefore value the floating rate bond as if it had only one payment. The following equation illustrates this point:

$$V.Swp = \left[\frac{FxC}{(1+r)^1} + \frac{FxC}{(1+r)^2} + \cdots + \frac{FxC+P}{(1+r)^n}\right] - \frac{FrC+P}{(1+r)^1} \qquad (1.6)$$

Note that the principal is included in the equation due to the difference in discounting periods. The discount rate is represented by r.

Should market rates increase on reset date the value of the fixed rate bond will decrease and the value of the floating rate bond will remain unchanged. Thus the value of the swap will increase for the fixed rate payer and decrease for the floating rate payer. As mentioned above this is only evident on reset dates, in between settlement dates the floating rate payment for the next period is known and therefore the increase in market rates will decrease the value of the floating rate bond as well, (Smith et al, 1988). The relative contribution to the swap value from the NPV[FxC] and the NPV[FrC] depends on the maturity of the swap. The change in NPV[FxC] will dominate in longer dated swaps and the change in NPV[FrC] will dominate shorter dated swaps, (Smith et al, 1988).

Alternatively, swaps can be valued as a portfolio of forward rate agreements (FRA's). At the start of the swap the first payment would already be known; thereafter the cash flows between the counterparts would be calculated as a series of FRA's, with one FRA maturing at each settlement date, (Hull, 2006). The values from each payment period are simply added together to derive the final value of the swap. The value of the swap may be expressed as follows:

$$V.Swp = PV(net\ payment\ 1) + FRA_1 + FRA_2 + \cdots + FRA_n \qquad (1.7)$$

Breaking down the equation further we obtain the following:

$$V.Swp = \frac{FxC - FrC_1}{(1+r)^1} + \frac{FxC - FrC_{f1}}{(1+r)^2} + \cdots + \frac{FxC - FrC_{fn}}{(1+r)^n} \qquad (1.8)$$

The coupons on the floating rate leg of the swap, FrC_{fn}, are calculated using an implied forward rate calculated from the JIBAR/swap zero curve. The floating rate payments are then calculated assuming that the forward rates will equate to the JIBAR rates realised in the next period, (Hull, 2006). The forward rates r_f are calculated as follows:

$$Forward\ rate\ (r_f) = \left[\frac{(1+r_2)^{\frac{n_2}{12}}}{(1+r_1)^{\frac{n_1}{12}}}\right]^{\frac{12}{n_f}} - 1 \qquad (1.9)$$

Where:

$n_1 = number\ of\ months\ in\ the\ short\ period$

$n_2 = number\ of\ months\ in\ the\ long\ period$

$n_f = number\ of\ months\ in\ the\ forward\ period$

$r_1 = rate\ on\ the\ short\ period,$

$r_2 = rate\ on\ the\ long\ period$

Initially, the value of the swap will equal zero (ignoring bid offer spreads). Depending on the shape of the term structure of interest rates some of the FRA's will have positive values and some will have negative values. If the term structure of interest rates is upward sloping then the values of the FRA's for the party that receives fixed will be positive for the short dated FRA's and will steadily decline into the negative as the term of the FRA's increase. For the swap to equate to zero the sum of all the FRA's will equal zero, (Hull, 2006). As market interest rates change the sum of the FRA's will no longer equate to zero, thereby giving the swap value.

Risk

The fluctuation in value of swap contracts brings about credit risk and default risk. Unlike a bond or a loan the loss given a default event in an interest rate swap contract is limited to the NPV of the coupon payments only and does not include the principal. If the value of the swap is positive to the financially troubled party then, at worst, the counterpart will remain unaffected. In other words the probability of loss given a default event is comparatively smaller to that of the bond market. Should the swap value be negative to the defaulting party then the counterpart will be at risk of losing the entire portion of the positive value of the swap. For the counterpart to remain hedged either a new swap agreement will need to be entered into with a third party or alternatively the third party would need to take over the existing swap, (Hull, 2006). In both cases the prevailing market rates would lead to a loss in value for the counterpart to an amount close to that of the positive value from the previous swap.

According to Smith et al (1988), swap default risk can be likened to that of futures and forward contracts because of the three default control mechanisms in place in that market. The mechanisms include contract value distribution; trading of the contracts and market makers; and performance bonds or margining. The changing of contract value with regards to swaps refers to the periodic net settlement payments that occur between the two contracted parties. These value distributions or difference checks lower the potential default risk within the swap agreement. Trading swaps usually involves banks or other intermediary institutions therefore creating economies of credit evaluation together with an increase in the ease at which swaps may be transferred or unwound, (Smith, 1988). In general interest rate swaps are marked to market daily and any exposures are collateralised to an extent that is consistent with the credit rating of the party that is posting collateral.

Contributing factors to swap default risk include the shape of the term structure of interest rates, the terms of the swap with regards to duration and the frequency of reset dates, interest rate volatility and the use of the swap, (Smith et al, 1988). The shape of the term structure of interest rates impacts the expected net settlement payout profile of each counterpart. If the term structure is upward sloping then the fixed rate payer is expected to make the first few net settlement payments, thereafter receiving the remaining net settlement payments. The greater the slope of the term structure of interest rates means that the risk borne by the fixed rate payer is greater than that of the floating rate payer, (Smith et al, 1988). The longer the term of the swap the greater the risk to the fixed rate payer. As mentioned above the greater the number of contract value distributions or reset dates the lower the probability of default.

The use of the swap by a party will impact the default probability from a hedging perspective. If the swap is used to hedge the cash flows from another security then the impact of a potential cash flow liability from holding the swap will be offset against the increased cash flow from the hedged asset, at least to the extent that there is cash flow matching between instruments, (Smith et al, 1988). If the swap is a speculation trade for one of the parties then the probability of default is greater for the counterpart. Daily marking to market and collateralisation of exposures in a swap agreement significantly lowers the above mentioned upside risks in the probability of default. However, significant daily interest rate volatility makes default risk more difficult to manage.

Banks that act as intermediaries in swap arrangements absorb counterparty risk and receive a spread taken from the difference between the bid and offer rates. The bid side of the swap is the side where the bank pays the swap rate and the offer side is where the bank receives the swap rate. The credit rating of the bank itself determines the size of the swap spread, (Sun et al, 1992). The higher the credit rating of the bank the greater the spread taken in the swap transaction, in other words a bank with a higher credit rating can charge more on the offer side and pay less on the bid side, (Sun et al, 1992). In addition to the bid-offer spreads, banks may charge an upfront fee that varies depending on the respective client’s credit rating in conjunction with a minimum collateral requirement.

Rational for interest rate swaps

Swap literature explains that the popularity of interest rate swaps can be explained by a comparative advantage argument, (Hull, 2006). Simply put the comparative advantage stems from the differential between the difference in fixed funding rates and the difference in floating funding rates between two counterparts with different credit ratings. Consider table 1 below:

Table 1.1:

Party	Rating	5 Year Fixed Funding Rate	Floating Funding Rate
ABC	AAA	6.00%	JIBAR + 0.3%
XYZ	BBB	8.00%	JIBAR + 1.8%
	difference	2.00%	1.50%

Source: original table

The funding rates represent the rates that the two different parties can borrow at. The AAA rated party can borrow more cheaply in both the fixed and floating rate markets however the difference between the funding spreads is not the same. To take advantage of this difference ABC can agree to pay JIBAR to XYZ and receive 6% fixed. Therefore ABC pays 6% to outside lenders, receives 6% from XYZ, and pays JIBAR to XYZ, giving a net cash out flow of JIBAR. XYZ on the other hand pays JIBAR + 180bps to outside lenders, receives JIBAR from ABC, and pays 6% to ABC, giving a net cash outflow of 7.8%. ABC is better off by 30 basis points and XYZ is better off by 20 basis points.

The reason for the spread differentials stems from the difference in borrowing terms between the fixed rate market and the floating rate market. The fixed rates are rates that are quoted for the term of the asset whilst the floating rates are rates quoted for 3 or 6 month periods. Usually floating rate loans carry the value of an option in that the loans include periodic credit reassessments whereby the borrower's default probability is re-examined. Should there be credit deterioration then the spread on the loan will ratchet upward to compensate the lender for the added risk. The fixed rate lenders do not have the option to change the terms of the loan, (Hull, 2006). In reality the interest rate dynamics are not as clear cut as set out in the above example. Interest rate volatility, risk appetite and market liquidity will affect the spread differential significantly.

In addition to the comparative advantage theory swaps are great mechanisms for restructuring cash flows and debt, and the hedging of interest rate and basis risk. Asset and liability mismatches or otherwise known as balance sheet gaps can be reduced via the use of interest rate swaps. Firms that have fixed liabilities and floating rate asset returns can swap their floating rate returns into fixed rate returns to match those cash out flow obligations thereby reducing their interest rate exposure. Swaps provide a tool to restructure a firm's debt profile. During an easing monetary cycle high fixed rate non-callable debt can be transformed into floating rate debt via the use of interest rate swaps therefore reducing the cost of funding for the firm.

Not only can the swaps alter cash flows and debt profiles but they can add value through the reduction of interest rate volatility. Firms that are highly sensitive to interest rate volatility can generate value via the use of the swap market because the reduction in interest rate exposure will lead to a reduction in expected costs of financial distress. Swaps may also be used to manage basis risk on a firm's balance sheet. Basis risk can be defined as the risk to the hedger arising from uncertainty about the basis at a future time, (Hull, 2006). A basis swap will have two floating rate legs, each referenced to a different floating rate. A lending institution for example might have mortgage assets linked to prime and liabilities linked to JIBAR. The institution can manage the risk of diverging movements between the two rates via the use of a basis swap, (Bicksler and Chen, 1986).

2. Previous contributions to swap spread theory

There have been numerous studies conducted on the determinants of swap spreads particularly in the US and UK markets, although little academic literature on the subject has been published in South Africa. Swap spreads have been analysed using a variety of different modelling techniques and across significantly different market conditions spanning over decades in some studies. Although the plethora of studies modelling swap spreads have been met with varied success; there has been a significant amount of overlap in results. Liquidity, credit risk, the level of interest rates, the shape of the government bond yield curve, interest rate volatility and demand/supply factors emerge as the most dominant factors driving swap spreads. This section introduces some of the well known contributors of swap spread theory followed by a theoretical overview of the dominant drivers of swap spreads.

With regards to liquidity Grinblatt (2002) explains that swap spreads are driven by a convenience yield that is linked to liquidity rather than default. In his paper it is argued that swaps spreads are essentially the difference between short term risk free rates. The thinking behind this argument is that although swap maturities may be long term the swap spread represents a credit spread that is refreshed as AA or AAA every 3 to 6 months and in the absence of default risk the only thing that is left driving the swap spreads is the liquidity difference between government and corporate assets.

Grinblatt (2002) argues that LIBOR (London Interbank Offer Rate) is representative of the corporate risk free rate (AAA) and when compared with the government risk free rate the differential is equivalent to the liquidity premium paid by an investor for the more liquid asset. The liquidity premium embedded in government bonds is the basis for the convenience yield earned on those securities. Due to volumes traded, treasury securities tend to be the preferred vehicle for hedging interest rate risk. Therefore, lending treasuries to investors for hedging purposes via the repo market implies that there is an additional cash flow earned on Treasury notes by those able to make use of the repo market. When there is a short squeeze on a government bond the government bond will trade with less liquidity however, this is the point where the additional cash earned for holding a treasury is at its greatest. In other words there is a convenience yield earned through holding these more liquid government assets. It must be noted that in order for a security to have a convenience yield it must have been liquid to begin with as illiquid securities would not be shorted as interest rate hedging vehicles to start with.

Next Grinblatt (2002) models swap spread as an annuity payment that is equal to the present value of the liquidity based convenience yield. In other words the government yield curve is derived by subtracting the annuitized present value of the liquidity factor from the all-in-cost of the swap or otherwise known as the LIBOR term structure. Grinblatt does acknowledge that there is a small amount of compensation for default risk built into LIBOR however, it is small and explains about 10% to 20% of the swap spreads.

Duffie and Singleton (1997) developed a multi-factor econometric model of the term structure of interest rate swap yields. Their paper focuses directly on swap yields as opposed to the swap spreads over the default free term structure or treasury yield curve. The idea behind their approach is to develop a model of the swap market directly. Thereafter, the properties of the zero coupon yields implied by the swap market can be analysed against the default free or treasury zero coupon yields. The paper shows that the swap fixed rate payment (assuming a floating rate of LIBOR) can be represented by the present values of net cash flows of the swap contract using a discount rate that is based on a risk adjusted and liquidity adjusted short rate. Default and liquidity risk is essentially collapsed into one short rate. The Duffie and Singleton Model provides an alternative to the conventional swap valuation methods used by many banking institutions. Instead of deriving discount rates via the use of forward rates obtained from the interpolation between fixed maturity points on the swap yield curve, Duffie and Singleton's approach leads to the construction of a model based zero curve that can be used in the valuation of swaps and other related derivatives.

Next Duffie and Singleton (1997) compare the 10 year swap zero-coupon yield against the 10 year Treasury yield. The swap spreads are studied in conjunction with proxies for credit risk and liquidity in the US market. Their findings reveal that liquidity effects are short lived and that credit shocks have a weak influence initially, thereafter gaining in importance over a period of a few months.

Liu et al (2002) complements and extends the work done by Duffie and Singleton (1997). Their findings are consistent in that swap spreads incorporate both default risk and liquidity components. With regards to liquidity Liu et al find that the liquidity component of on-the-run bond prices can be significant and with regards to credit there is, on average, a positive relationship between swap spreads and credit spreads.

Cortes (2003) argued that if the bond and swap markets are priced correctly then the spread between the swap yields and bond yields would be indicative of systematic risk of the banking sector due to the fact that the risk of banking sector failure is incorporated in the Libor rates. Therefore in theory swap spreads should track the spread between the LIBOR rate and the general collateral (GC) repo rate as this spread reflects the additional return required as compensation for the probability of bank failure. Cortes showed that there were significant deviations in the swap spread versus GC-LIBOR spread relationship and concluded that bank sector risk was not one of the dominant drivers of swap spreads. Rather, alternative drivers such as expectations of government bond issuance, the slope of the yield curve, volatility, and mortgage prepayment hedging demand (United States) were found to be linked to swap spread movements during the time frame of the study. Cortes focused his study on the 10 year swap spreads in the US and the UK markets.

Huang and Neftci (2003) examined whether liquidity or credit is the main determinant of swap spread dynamics. Their findings are consistent to that of Grinblatt's work as they to find that liquidity is the predominant force behind swap spreads. However, it must be noted that Huang and Neftci (2003) found that swap spreads are strongly influenced by credit over the long end of the term structure and liquidity less so. Their paper builds on the work done by Duffie and Singleton (1997) and examines the time series dynamics of swap spreads, LIBOR credit spreads, and on-the-run (OTR) US Treasury yield curve with the aim of determining the effects on swap spreads (10 year maturity) individually and then in terms of cointegrating vectors, (Huang and Neftci, 2003). The results obtained by Huang and Neftci were much sharper than that of Duffie and Singleton (1997) due to the improvement on the quality and availability of data in conjunction with pronounced market movements between 1999 and 2002.

Huang and Chen (2007) analyse 4 determinants of the 2 and 10 year US swap spreads during different economic cycles and monetary policy regimes. They argue that the drivers of swap spreads vary depending on the prevailing economic conditions and outlook. The 4 determinants of swap spreads analysed include slope of the Treasury yield curve, a default premium, interest rate volatility and liquidity. The major findings of Huang and Chen include: during periods of easing monetary policy the slope of the yield curve plays a significant role in swap spread movements, liquidity is the overwhelming driving force behind swap spreads in the short end of the curve during periods of rising interest rates, the impact of default risk is not specific to economic cycles nor areas on the swap curve, and the role of interest rate volatility on swap spreads is more apparent during periods of declining interest rates.

Brown et al (1994) explain that volatility in swap spreads translate directly to the mark-to-market value of a swap position. To study swap spread volatility they used weekly and monthly data across different swap maturities. Their study begins by assuming, what they refer to as a pure expectations setting. This setting implies that expectations are the determinants of the shape and level of the term structure of interest rates and that swaps are initially priced such that the present value of the fixed rate payments equates to the present value of the floating rate payment. Therefore, their initial hypothesis says that the swap spread equals the coupon bias in the Treasury yield curve. Brown et al (1994) explain that the coupon bias can be represented by the difference between the yields on a pure discount and par value bond of the same maturity, and by the average level of the spread between the London Inter Bank Offer Rate (LIBOR) and the Treasury bill rate over the life of the swap. The spread between LIBOR and the Treasury bill rate is referred to as the Treasury Eurodollar (TED) spread. Next the model is relaxed to incorporate hedging costs, proxied by the overnight repo rate. They find that there is much more of an impact of hedging costs on longer term swap prices. To incorporate a default premium Brown et al (1994) used the differential between the corporate fund spread over Treasuries for long term bond market and the funding spread over LIBOR in the short term credit markets. It was concluded that default risk does impact swap spreads particularly at the back end of the curve. Overall, Brown et al found that short term 1 and 3 year swaps are priced differently from longer term 5, 7 and 10 year swaps and that the pricing dynamics for all 5 year maturities changed substantially from 1985 to 1991.

In, Brown and Fang (2003) investigate the determinants of changes in US swap spreads between 1998 and 2001. They make use of the Exponential General Autoregressive Conditional Heteroskedastic (EGARCH) model developed by Nelson (1991). It was argued that the use of the EGARCH model provides a basis upon which they can study the effect that swap spreads have on themselves across different maturities. In addition the model provides an estimation of the interdependence and volatility effects across different swap maturities. They find that there are significant volatility interactions across the four different swap spread maturities studied and that the volatility transmission is highly persistent across all maturities. Further, they examine 5 determinants of swap spreads. These include: the general level of interest rates, the slope of the Treasury yield curve, volatility in the 90 day T-bill rate, change in the default premium, and change in liquidity using the TED spread.

Lang et al (1998) argue that swaps create a surplus that counterparties share in lieu of compensation for the risk undertaken when entering into the swap contract. The surplus is created by factors such as reduced financing costs and hedging of interest rate risk. According to Lang et al (1998) the bargaining between counterparties to share these surpluses effects the swap spreads. Their findings indicate that when lower credit rating bond spreads increase then a surplus is created when the lower credit quality firm, that issued floating rate bonds, locks in a fixed rate via the use of a swap. The lower credit quality firm would need to offer part of this surplus to entice higher credit quality firms to enter into a swap agreement. The requirement to offer this surplus widens the swap spread. Similarly, when a higher rated firm's spreads increase they need to demand more surplus as compensation for the higher risk borne thereby increasing swap spreads. In a less competitive environment these firms are able to demand more surplus from lower credit quality firms.

Tonge (2001) examined four drivers of asset swap spreads in 3 emerging market countries, namely the Czech Republic, Poland and South Africa. Asset swap spreads are different to the spreads between the swap yield curve and Treasury yield curve. Asset swap spreads relate to the constant spread added to a floating reference rate such as LIBOR over the life of an asset swap package. An asset swap package is explained as follows: a dealer buys a government bond in the market and overlays that with a swap that pays fixed and receives floating plus a spread. The fixed cash flows from the swap are designed to exactly off set that of the bond and the buyer of the package will therefore be left with the floating rate return with a spread.

The inclusion of Tonge's findings on drivers of asset swap spreads has been included in this paper due to the similarity of their findings to the above mentioned authors in respect of their study of swap spreads as calculated by the yield differential between the swap yield curve and the Treasury yield curve. The drivers examined by Tonge (2001) were yield level, yield curve shape, supply and demand factors and liquidity. His findings indicate that whilst the three countries studied have relatively immature swap and credit markets compared to that of more developed markets such as the US and UK, they still pose similar characteristics in relationship between asset swap spreads and the four swap drivers examined, to those of more mature markets. With regards to South Africa the asset swap market is less volatile than the other two countries studied. In addition South African government bonds were found to trade flat to cheap against swaps although at the long-end the R186 asset swap spreads are narrower (more negative) due to the strong demand for duration, (Tonge, 2001).

Ito (2010) examined the 2 and 10 year US swap spreads during the stable market conditions from 2005 to early 2007 and during the market crisis period from 2007 to 2009. He identified 4 determinants of swap spreads that include the following: default risk, the slope of the yield curve, TED spread and volatility.

Apart from publications from the major banks there appears to be limited published academic work done on swap spreads in South Africa. Despite the thin literature available there is a strong overlapping in the component drivers of swap spreads in South Africa to that of the more mature markets. Research conducted by Nel (2010) concluded that the major swap spread drivers in South Africa include the level of interest rates, the shape of the yield curve, corporate borrowing, and government borrowing. Their sample data taken from 2003 to 2010 indicated that the change in corporate debt had significant positive correlation and consistent to the above mentioned authors, both the change in government borrowing and the steepness of the bond yield curve had significant negative correlation. The analysis of the drivers of swap spreads was conducted using the 10-year spread.

The Theoretical Drivers of Swap Spreads

1. Liquidity

Grinblatt (2002) uses the liquidity premium to explain 80% to 90% of the swap spread. He asserts that swap spreads are closely linked to the spreads between short term borrowing rates of the highest credit quality corporate and the borrowing rates of the government; in other words the TED spread. As explained above, Grinblatt's convenience yield upon which swap spreads are calculated is closely linked to a liquidity premium.

Based on Grinblatt's work, In et al (2003), Duffie and Singleton (1997), and Huang and Chen (2007) utilise the TED spread in their respective studies. Their results are consistent to that of Grinblatt to the extent that the liquidity premium as proxied by the TED spread is positively correlated to swap spreads. The results of Duffie and Singleton (1997) agree with that of Grinblatt however, their findings indicate that the positive liquidity effect explains only about 20% of the variation in ten year zero spreads and that other determinants of swap spreads are present. Further, Huang and Chen (2007) find that the liquidity premium is the only determinant for the 2-year maturity swap spreads during monetary tightening cycles.

Ito (2010) argues that during weak economic periods government securities trade with more liquidity due to flight for quality rational adopted by market participants. The increased liquidity premium therefore drives the swap spreads wider during these periods. His findings, consistent with the above, illustrated that the liquidity premium measured by the 3 month TED spread positively impacted swap spreads for both short and long term maturities in the period leading up to the financial crisis and only for short term maturities during the period of financial crisis. The observation may be interpreted as a greater need to manage liquidity in the short term as opposed to the long term.

2. Default risk and credit risk

Various authors have found compelling evidence that default risk does play a role in the determination of swap spreads. Default risk has been proxied by the spread of the corporate bond yields to default free or government bond yields. Ito (2010) noted that the proxy is imperfect in that the characteristics of the swap market are not fully comparable to that of the corporate bond market. Credit spreads are found to have had a negative relationship to that of swap spreads during the financial crisis period. Ito (2010) suggests that his findings can be attributed to lowered price discovery in the market due to the crisis conditions. The 10 year spreads realised stronger negative results than that of the 2 year spreads.

Huang and Neftci (2003) used the benchmark spread of LUCI (Credit Suisse First Boston Liquid US Corporate Index) as their proxy for credit. The LUCI is a market capitalisation weighted index containing over 500 high grade US corporate bonds. The index is separated into rating categories based on Moody's Investor Service and Standard & Poor's. Consistent with both Ito (2010) and Duffie and Singleton (1997) Huang and Neftci find that widening credit spreads are associated with narrowing swap spreads and that credit spreads are a determinant of swap spreads over a longer maturities. Huang and Neftci explain that the first couple of weeks post a credit shock swap spreads widen in conjunction with credit spreads thereafter the inverse relationship of credit spreads to swaps spreads can be explained via hedging and position unwinding by investors using swap markets. The relationship was observed again in the South African market during the 2008 financial crisis. The findings are present in chapter 5.

Duffie and Singleton (1997) suggest that the correlation between credit spreads and swap spreads appear to be through the short term risk free rate. They use the spread between 6 month AAA rated commercial paper and BAA rated commercial paper as a proxy for credit spread. During a recession default probability increases and hence the credit spread of the commercial paper widens even though the spread between the commercial paper and the Treasury bill rates tend to narrow.

Therefore, if the widening of credit spreads reflects a weakening economy then the resultant effect on swap spreads would be narrowing.

Liu et al (2002) found that whilst credit spreads implicit in swap spreads were negative for most of the nineties they became significantly positive after the hedge fund crisis of 1998. The explanation offered by Liu et al (2002) for the negative credit spreads is that possibly most of the credit risk reflected in swap spreads may be represented in the liquidity risk of government bonds. On average the credit premium ranged from 0.1 basis point for a 1 year horizon to 45 basis points for a 10 year horizon. Overall the findings of Liu et al (2002) suggest that there have been major changes over the past two decades in the expected returns from bearing default and liquidity risk inherent in swap spreads.

Brown et al (1994), In et al (2003), and Huang and Chen (2007) used the spread between the yield on a portfolio of AAA-rated corporate bonds and BAA-rated corporate bond portfolio as a proxy for a default premium. Consistent with Liu et al (2002), Brown et al (1994) and In et al (2003) also found a positive relationship between swap spreads and the spreads between bonds with different credit ratings. Huang and Chen (2007) argued that whilst a positive relationship is the general expectation the prevailing market conditions may alter the severity of the credit premium impact on swap spreads.

Lang et al (1998) uses the sharing of surplus argument whereby counterparties are compensated for the risk borne in the swap arrangement. The increase in credit risk of lower rated firms leads to the increase in swap spreads via the additional compensation required/demanded by the higher rated firms for the additional risk. Lange et al (1998) conclude that both lower and higher rated bond spreads have positive impacts on swap spreads.

3. General level of interest rates

Based on previous works In et al (2003) argue that the general rise in interest rates leads to higher hedging costs for market makers. The higher hedging costs translate into lower swap spreads. In et al (2003) examine the change in the 90 day T-bill rate as a proxy for the change in interest rates. They find that swap spreads do narrow during periods of elevated interest rates which is consistent with the above explanation of a negative relationship between swap spreads and the general level of interest rates.

4. Slope of the government bond yield curve

Cortes (2003) explains that the expectation is for swap spreads to narrow during periods of a steep yield curve and to widen during periods of a flatter yield curve. Two explanations are offered for the above mentioned relationship. Firstly, the impact on the level of demand for swaps during periods of a steeper sloping yield curve is greater. The greater demand for swaps can be attributed to the requirement of issuers of debt to swap their long dated liabilities from fixed payments in the long end to floating rate liabilities in the short end by paying floating in the short end and receiving fixed in the long end. As swap prices equate to the amount that a market participant is willing to pay to receive floating payments, the increase in demand to receive fixed rate payments will drive down swap prices thereby narrowing swap spreads, (Cortes, 2003). Secondly, economic growth expectations drive the shape of the curve to a certain extent. For example, an economic slowdown or recession increases the demand for long term government bonds thereby forcing the prices up and yields down creating a downward sloping curve. The opposite would be expected to happen in an economic upswing, (Cortes, 2003).

Cortes (2003), Ito (2010), and Huang and Chen (2007) quantified the slope of the yield curve by the differential between the 2 and 10 year US Treasury note yields. Similarly, In et al (2003) examines the differential between the 10 year and the 3 months Treasury rates. Cortes (2003) and In et al (2003) found that the slope of the yield curve had a significant negative relationship to swap spreads. Ito (2010) found a negative relationship between the steepness of the yield curve and the swap spreads during normal market conditions however the relationship reversed during the financial crisis period. Huang and Chen (2007) noted that the slope of the term structure of the Treasury curve plays a large role in swap spread determination during periods of aggressive interest rate easing.

Huang and Neftci (2003) findings are consistent with the above works and assert that the slope of the yield curve is highly significant in the determination of swap spread variation. Further, they explain that their sample period was dominated by an increasing steepness in the yield curve driven by the reduction of short term financing costs.

The findings of Tonge (2001) with regards to yield level and yield curve shape are consistent with the above mentioned authors. Tonge (2001) explains that the yield level impact on swap spreads hinges on the idea that a lower yield reflects reduced inflation expectations, lower yield volatility and other risk premia. Analysing the 5 year Poland Government bond versus the Polish 5 year swap rate Tonge

(2001) found that as swap yields fell, swaps outperformed bonds and asset swap spreads cheapen (widen). His data indicated that a 100 basis point fall in yield was accompanied by a 12 basis point widening in asset swap spreads, (Tonge, 2001). Tonge used the differential between the 5 year swap yield and the 6 month yield as a proxy for the slope of the swap curve. Based on his regression results he found that in the Polish market a 100 basis point reduction in slope lead to a 10 basis point widening in asset swap spreads.

Findings by Nel (2010) were consistent with the above mentioned works in the US and UK markets. The differential between the 10 year and 2 year yields were modelled first followed by the difference between the 20 year and 10 year yields. The second regression test using the 20 year versus 10 year yield differential produced significantly better results.

5. Volatility

Market uncertainty increases the prevalence of flight for quality in the market place. Investors increase their appetite for safer asset classes such as government bonds. Government bond yields will therefore fall during these periods thereby widening swap spreads. Cortes (2003) used the VIX index (Chicago Board Options Exchange Volatility Index), a measure of equity implied volatility, as a proxy for market volatility. The regression study produced a positive relationship for both the US and UK markets to the 10 year swap spread. Ito (2010) and Huang and Chen (2007) incorporated volatility by using the EGARCH model. The EGARCH model was applied to the 2 year US Treasury note. As expected the volatility result was positive during the period of financial crisis. Based on the work of Lekkos and Milas (2001), In et al (2003) used the squared change in the 90 day T-bill rate as a proxy for volatility. The theory behind using interest rate volatility as a determinant of swap spreads is that as interest rate volatility increases so too should the demand to hedge increase. The increased demand for fixing interest rates using swaps will push swap rates higher therefore widening the swap spread (In et al, 2003).

6. Expectations of government issuance

Economic downturns lead to reduced tax revenue and consequently increases the governments need for bond issuance. The increase in government issuance drives bond prices down and yield up therefore compressing swap spreads. The opposite would occur during periods of economic upswings. Therefore, rising government debt is associated with a narrowing swap spread. Cortes (2003) proxied the expectations of government issuance using a monthly average estimate of budget balance expectations. He found that in both the US and UK markets there was a negative relationship to swap spreads however, the relationship was not significant for both markets at the 5% level.

Nel (2010) proxied the expectations of government issuance by using a 12 month change in the ratio of government borrowing to GDP. Her results proved consistent to the above mentioned studies conducted in the US and UK markets. It is noted that the increase in government debt over the recent years in conjunction with the lengthening of the South African Government's bond portfolio has had a large impact on the longer end of the yield curve. This impact, according to Nel (2010), resulted in the dis-inversion in the long end of the bond and swap yield curves.

In addition to analysing government debt levels Nel (2010) analysed the extent of non-government borrowing. The reason for the inclusion of the corporate sectors borrowing requirement is twofold. Firstly the comparative analysis of corporate borrowing versus government borrowing provides an indication of the credit quality in the market. The lower credit quality is consistent with wider swap spreads. Secondly the level of corporate debt provides a proxy for hedging demand especially when the corporate sector borrows relative to JIBAR, (Nel, 2010). Of late the decline in credit extension to the corporate sector in conjunction with the easing monetary policy has lead to a reduction in hedging activity by corporate entities therefore removing the upward pressure on the swap rate as the demand for swaps that pay fixed has been reduced, (Nel, 2010).

7. Mortgage prepayment hedging in the United States

Cortes (2003) discussed the implications of refinancing options embedded in mortgaged contracts to swap spreads. Mortgage refinancing by home owners during troughs in the interest rate cycle in the US caused owners of mortgaged-backed assets such as Freddie Mae and Fannie Mac to be exposed to interest rate risk through the reduction of the duration on their assets relative to their liabilities, (Cortes, 2003). The purchase of long dated bonds would counteract this duration mismatch. The increase in demand for bonds would lead to a widening of the swap spreads. The converse would happen during periods of interest rate peaks. A strong positive relationship was found between the effective duration of mortgage-backed assets to the 10 year swap spreads in the US market however no relationship was evident in the UK market. Cortes (2003) attributed the lack of correlation in the UK market to the fact the majority of UK investors tend to hold more floating rate mortgages than their US counterparts therefore making refinancing less impacting. The South African mortgage market is similar to that of the UK in that the majority of mortgages are linked to floating rates therefore, the impact from mortgages prepayment hedging on swap spreads in South Africa would be negligible or non-existent.

3. Hypotheses and Objective

The research object is to determine the predominant drivers of swap spreads in the South African market. Based on the identified theoretical drivers of swap spreads this paper's hypotheses include the following: (All hypotheses refer specifically to swap spreads in South Africa)

1. Liquidity will have a positive effect on swap spreads in the pre-crisis period and a stronger positive effect on swap spreads in the crisis period.
2. Default risk will have a negative effect on swap spreads in the pre-crisis period and a stronger negative effect on swap spreads in the crisis period.
3. The general level of interest rates will have a negative effect on swap spreads in both the pre-crisis period and the crisis period.
4. The slope of the government bond curve will have a negative effect on swap spreads in the pre-crisis period and a negative effect on swap spreads in the crisis period.
5. Yield volatility will have a positive effect on swap spreads in the pre-crisis period and a stronger positive effect on swap spreads in the crisis period.
6. Government bond issuance will have a negative effect on swap spreads pre-crisis and a stronger negative effect during the crisis period.
7. The level of corporate debt will have a positive effect on swap spreads in both the pre-crisis and post-crisis periods.

The table below illustrates the proxies used to measure the various determinant drivers of swap spreads in South Africa:

Table 3.1

Determinant	Abbreviation	Proxy
Liquidity Premium	TBJ	Differential between the 3-month T-bill rate and 3-month JIBAR
Default Risk	DFR	The difference between the OTHI and GOVI index
General level of Interest Rates	RATES	Change in the 3-month T-bill rate
Slope of Bond Curve	SLOPE	The differential between the 10-year bond yield and the 2 year bond yield on the government curve
Yield Volatility	VOL	10-year bond yield volatility
Expectation of Government Issuance	ISSUANCE	Change in the ratio of government borrowing to GDP
Level of Corporate Debt	PVdebt	Change in ratio of corporate loans to GDP

4. Methodology

A two phased approach was employed to analyse the determinants of swap spreads in South Africa. The initial phase utilised simple linear regression to analyse each proxy against the swap spreads in both the pre-crisis period and the crisis period. The pre-crisis period is defined as the period from 01/08/2003 to 30/05/2008 and the crisis period is defined as the period from 01/06/2008 to 31/08/10. Thereafter, a multivariate regression model was built using a step wise approach for both periods.

The simple linear regression model can be stated as follows:

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i \qquad (4.1)$$

Where:

Y_i *is the value of the response variable in the ith trial*

β_0 *and* β_1 *are parameters*

X_i *is the value of the predictor variable in the ith trial*

ε_i *is the error term*

In the simple linear regression model there is only 1 predictor variable for the criterion or otherwise known as the dependant variable. The equation above represents the trend line that best represents the relationship between the dependent and independent variable on a scatter plot. The parameters β_0 and β_1 represent the y-intercept and gradient of the trend line respectively. The method of least squares is used in selecting the best parameters for the regression model. The least squares method refers to the way in which the trend line is fitted to a scatter plot of Y_1 and X_i . In the method the squared differences between the realised observation of Y and $_{Y1}$ as calculated by the linear regression model is minimised. In other words the estimators of the parameters are those values that minimize the criterion in a given data set. The equation below illustrates the least squares method where Q is minimised from n squared deviations:

$$Q = \sum_{i=1}^{n} (Y_i - \beta_0 - \beta_1 X_i)^2 \qquad (4.2)$$

Deriving the estimator's b_0 and b_1 for the parameters to minimise Q is calculated as follows:

$$b_1 = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sum(X_i - X)^2} \quad and \qquad (4.3)$$

$$b_0 = \bar{Y} - b_1\bar{X} \qquad (4.4)$$

According to the Gauss Markov theorem under the conditions of the regression model as represented by equation 4.1, the estimator's b_0 and b_1 for the least squares are unbiased and have minimum variance among all unbiased estimators, (Kutner et al, 2005). Therefore, neither estimate overestimates nor underestimates the respective parameter, giving:

$$E[b_0] = \beta_0 \;\; and \;\; E[b_1] = \beta_1$$

The linear regression analysis for phase 1 includes the following:

$SS_i = \beta_0 + \beta_1 TBJ_i + \varepsilon_i$ (4.5)
$SS_i = \beta_0 + \beta_1 DFR_i + \varepsilon_i$ (4.6)
$SS_i = \beta_0 + \beta_1 RATES_i + \varepsilon_i$ (4.7)
$SS_i = \beta_0 + \beta_1 SLOPE_i + \varepsilon_i$ (4.8)
$SS_i = \beta_0 + \beta_1 VOL_i + \varepsilon_i$ (4.9)
$SS_i = \beta_0 + \beta_1 ISSUANCE_i + \varepsilon_i$ (4.10)
$SS_i = \beta_0 + \beta_1 PVdebt_i + \varepsilon_i$ (4.11)

Note: Swaps Spreads are denoted by SS and as discussed above each of the above regressions are run in both periods.

The next phase in the study was building a multivariate regression model that explains swap spreads in terms of a combination of underlying factors. A step wise approach to building the final model was employed. The multivariate model incorporates more than 1 predictor variable for the criterion. The multivariate regression model is expressed as follows:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \; .... \; \beta_{p-1} X_{ip-1} + \varepsilon_i \qquad (4.12)$$

The parameters or regression coefficients have similar meanings to the parameters in the simple linear regression model. The important difference however, is the parameters now represent a partial gradient coefficient. In other words parameter β_1 is now split over several coefficients. Therefore, for each change in X_1, Y_1 changes by β_1 amount given that variables X_2 through to X_{p-1} are kept constant. The model provides a way of identifying the unique contribution of each particular variable to the prediction equation, (Tredoux, 2009).

To identify the best possible combination of contributing variables for the criterion a stepwise regression procedure is used. The starting point in the procedure is to identify the variable that has the largest t-statistic or equivalently the one that provided the greatest R^2 (coefficient of determination). Additional variables are added to the model one at a time until such a point where the addition of another variable makes no significant contribution to the prediction of y. In addition variables will be removed should those particular variables lose significance as other variables are added to the model. The removal of variables eliminates overlap in the prediction model. The following equation represents the multivariate regression model, should all the swap spread variables be included:

$$SS_i = \beta_0 + \beta_1 TBJ_i + \beta_2 DFR_i + \beta_3 RATES_i + \beta_4 SLOPE_i + \beta_5 VOL_i + \beta_6 ISSUANCE_i + \beta_6 PVdebt_i \qquad (4.13)$$

Note: The model for each period will be built using the same stepwise procedure.

To assist with model selection Akaike's information criterion (AIC) was utilised. AIC is a measure of how well a particular regression model fits compared to other models involving different combinations of predictor variables. In a sense the AIC penalises the model for adding too many predictor variables. The model with the lowest AIC is assumed to be the best fit model, (Kutner et al, 2005). The AIC is expressed as follows:

$$AIC_P = n\, ln\, SSE_P - n\, ln\, n + 2p \qquad (4.14)$$

Where:

n = the sample size

SSE = residual sum of squares = $\sum_{i=1}^{n} e_i^2$

p – 1 = the number of predictor variables

When using time series data in regression models 4.1 and 4.13 it is important to check for autocorrelation in the error terms. A major cause for autocorrelation in the error term is due to the omission of one or more key predictor variables. When key variables are omitted the error terms usually show up as positively autocorrelated as the error term includes the effects of the missing variable, (Kutner et al, 2005). The error term for both regression models 4.1 and 4.13 is expressed as follows:

$$\varepsilon_i = p\varepsilon_{i-1} + u_i \qquad (4.15)$$

Where:

p is a parameter such that $|p| < 1$

u_t *are independent* $N(0,\sigma^2)$

Note: The parameter *p* is called the autocorrelation parameter.

The Durbin-Watson test is used to test for autocorrelation in the regression models. The test analyses whether or not the parameter *p*, as described above, is zero. If $p = 0$ then the error term is said to be independent. The Durbin-Watson test statistic is depicted below:

$$D = \frac{\sum_{t=2}^{n}(e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2} \qquad (4.16)$$

Where:

$e_t = Y_t - \bar{Y}_t$

n = the number of cases

To determine whether or not there is autocorrelation present in the regression the test statistic D is compared to lower and upper bounds. If the test statistic falls below the lower bound then $p > 0$ and positive autocorrelation is present. If the test statistic D falls between the lower and upper bound then the test is inconclusive. Finally, if the test statistic D fall above the upper bound then it may be concluded that $p = 0$, (Kutner et al, 2005).

The degree to which the predictor variables are correlated among themselves and with other variables not included in the model but which are related to the dependent variable is referred to as mulicollinearity, (Kutner et al, 2005). Correlation among predictor variables is common and generally does not inhibit the ability to obtain a regression model with a good fit. However, when there is a high degree of multicollinearity present in the model the regression coefficients tend to vary greatly leading to a less precise indication of how the independent variables individually impact the dependent variable. Variance inflation factors (VIFs) are used to test for multicollinearity between the predictor variables in the regression model. The inflation variance factor is represented as follows:

$$(VIF)_k = (1 - R_k^2)^{-1} \qquad (4.17)$$

Where:

k = 1, 2, 3, ..., p-1

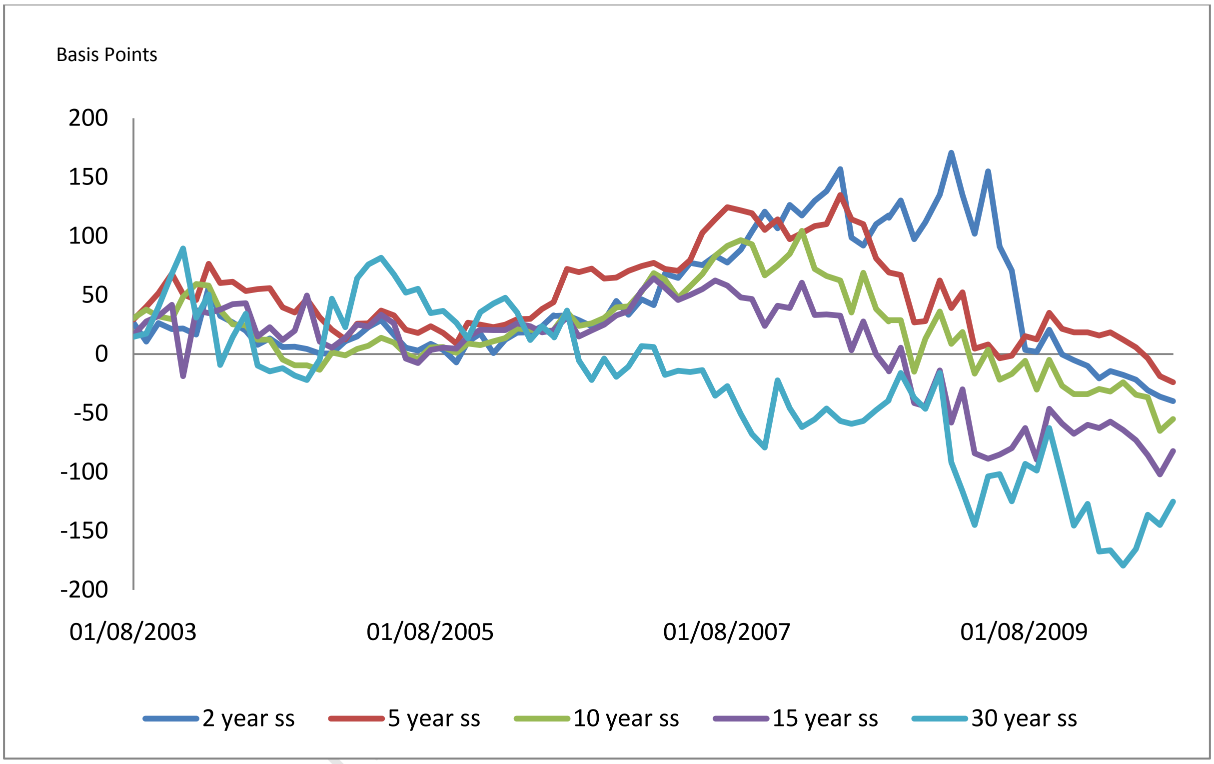
R_k^2 *Is the coefficient of multiple determination when X_k is regressed on the p – 2 other X variables in the model, (Kutner et al, 2005).*

The largest VIF value across all X variables is taken to represent the magnitude of multicollinearity. Should the VIF yield a value of 10 or more then the multicollinearity present may be influencing the least squares estimates, (Kutner et al, 2005).

5. Results and Findings

The study was conducted using monthly data for a seven year period commencing in August 2003. All data in the study was obtained from I-Net. The swaps spreads were calculated as the difference between the perfect fit zero bond curve and the perfect fit zero swap curve for selected maturities. The swap spreads for the South African market are presented in graph 5.1 below:

Graph 5.1



The spreads across the maturities except at the very long end of the curve traded fairly tight around the 2003-2005 period after which they widened during the bull market years leading up to the market crash in 2008. Since the crash the spreads across all maturities compressed into negative territory.

Initially, each of the six indentified predictor variables were regressed individually against the 2, 5 and 10 year swap spreads for the pre-crisis and crisis periods separately. Thereafter, the predictor variables were analysed together in a multiple regression analysis for all three maturity buckets in both periods. As mentioned above the pre-crisis period is defined as the period from 01/08/2003 to 30/05/2008 and the post crisis period is defined as the period from 01/06/2008 to 31/08/10.

Individual variable testing:

The following three tables illustrate the simple linear regression results for each of the seven predictor variables over the pre-crisis and crisis periods.

(Note: refer to table 3.1, page 25 for predictor variable details)

Table 5.1

Pre-Crisis period						
2 year maturity						
Variable	β_0	β_1	R Square	t Statistic	p value	D Statistic
TBJ	-6.78	0.84	0.60	8.32	0.00000	1.25
DFR	54.55	-0.95	0.18	-3.15	0.00285	0.40
RATES	24.46	3.93	0.03	1.18	0.24533	0.36
SLOPE	33.24	-0.16	0.46	-6.32	0.00000	0.80
VOL	6.65	1.41	0.03	1.14	0.26156	0.31
ISSUANCE	18.54	-2.41	0.37	-5.22	0.00000	0.70
PVdebt	15.47	1.44	0.24	3.83	0.00039	0.54
5 year maturity						
Variable	β_0	β_1	R Square	t Statistic	p value	D Statistic
TBJ	19.49	0.74	0.37	5.24	0.00000	0.67
DFR	61.96	-0.48	0.04	-1.32	0.19252	0.24
RATES	47.20	4.52	0.03	1.21	0.23163	0.25
SLOPE	55.00	-0.15	0.31	-4.53	0.00004	0.37
VOL	10.10	3.00	0.10	2.25	0.02943	0.22
ISSUANCE	42.39	-1.84	0.16	-3.11	0.00319	0.36
PVdebt	40.74	0.98	0.09	2.12	0.03909	0.28
10 year maturity						
Variable	β_0	β_1	R Square	t Statistic	p value	D Statistic
TBJ	-6.50	0.82	0.47	6.35	0.00000	0.72
DFR	60.01	-1.14	0.21	-3.47	0.00116	0.27
RATES	23.02	-0.86	0.00	-0.23	0.82037	0.17
SLOPE	32.84	-0.16	0.39	-5.40	0.00000	0.25
VOL	3.06	1.67	0.03	1.22	0.22987	0.17
ISSUANCE	18.86	-2.02	0.22	-3.55	0.00090	0.28
PVdebt	14.47	1.52	0.22	3.63	0.00071	0.25

Table 5.2

Crisis period						
2 year maturity						
Variable	β_0	β_1	R Square	t Statistic	p value	D Statistic
TBJ	12.75	1.00	0.51	6.18	0.00000	0.80
DFR	140.11	-1.22	0.43	-5.27	0.00001	0.35
RATES	71.91	-1.57	0.00	-0.13	0.89485	0.15
SLOPE	81.96	-0.23	0.25	-3.49	0.00126	0.29
VOL	15.06	4.24	0.08	1.75	0.08823	0.34
ISSUANCE	74.67	-4.17	0.78	-11.58	0.00000	0.75
PVdebt	70.31	5.17	0.52	6.38	0.00000	0.33
5 year maturity						
Variable	β_0	β_1	R Square	t Statistic	p value	D Statistic
TBJ	9.02	0.76	0.52	6.34	0.00000	0.63
DFR	118.89	-1.17	0.70	-9.21	0.00000	0.60
RATES	59.19	32.44	0.37	4.62	0.00004	0.35
SLOPE	67.39	-0.31	0.82	-12.85	0.00000	0.75
VOL	49.22	0.36	0.00	0.19	0.84991	0.12
ISSUANCE	55.76	-2.83	0.64	-8.13	0.00000	0.36
PVdebt	52.37	4.75	0.79	11.72	0.00000	0.69
10 year maturity						
Variable	β_0	β_1	R Square	t Statistic	p value	D Statistic
TBJ	-24.08	0.72	0.46	5.65	0.00000	0.70
DFR	86.05	-1.21	0.75	-10.48	0.00000	0.92
RATES	22.72	26.28	0.24	3.40	0.00162	0.33
SLOPE	30.96	-0.29	0.70	-9.31	0.00000	0.74
VOL	16.67	0.14	0.00	0.07	0.94129	0.17
ISSUANCE	20.36	-2.99	0.71	-9.57	0.00000	0.60
PVdebt	16.78	5.00	0.87	15.46	0.00000	1.40

The results from the regression analysis illustrate the impact that the prevailing economic climate has on the swap spreads. The economic cycle influences the level of contribution of the different predictor variables on the three respective swap spread maturities analysed. The t-statistic across all variables, except volatility and rates, provides strong evidence that the effect of the identified predictor variables on the 2 year, 5 year and 10 year swap spreads are statistical significant at the 5% level.

The Durbin-Watson test statistic illustrates the presence of auto-correlation for most of the individual variables indicating an omission of one or more other predictor variables in each regression model. The bounds for the Durbin-Watson statistic for the pre-crisis period and the crisis period are presented in table 5.3 below. If the statistic falls below the lower bound there is an indication of autocorrelation present, if the statistic falls between the bonds the presence of autocorrelation is undeterminable and if the statistic fall above the upper bound the presence of autocorrelation is unlikely. Table 5.3 below illustrates the Durbin-Watson test statistic bounds for the two respective sample periods. The addition of more variables into the regression model as discussed later in this section will positively impact the test statistic.

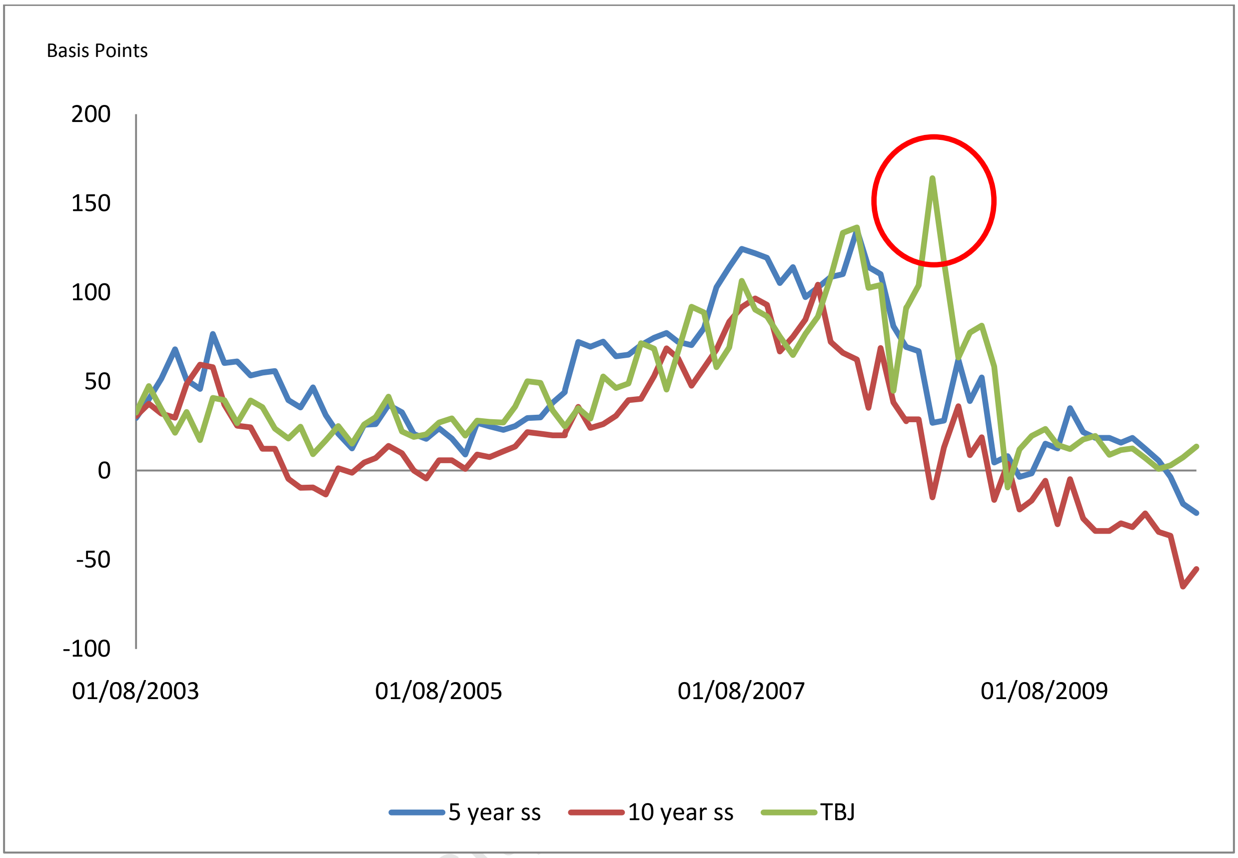
Table 5.3

Durbin-Watson Bounds			
Period	Number of Variables	Lower Bound	Upper Bound
Pre-Crisis	1	1.32	1.40
Pre-Crisis	2	1.23	1.44
Pre-Crisis	3	1.25	1.49
Pre-Crisis	4	1.21	1.54
Pre-Crisis	5	1.16	1.59
Pre-Crisis	6	1.12	1.64
Pre-Crisis	7	1.08	1.69
Crisis	1	1.24	1.34
Crisis	2	1.19	1.39
Crisis	3	1.14	1.45
Crisis	4	1.09	1.52
Crisis	5	1.03	1.58
Crisis	6	0.98	1.66
Crisis	7	0.93	1.73

The proxy for liquidity (TBJ) as calculated by the differential between JIBAR and the 3-month Treasury bill rate has a strong positive correlation with all three swap spread maturities in both periods which is consistent with the works of Grinblatt (2002), Duffie and Singleton (1997) and Huang and Chen (2007). It appears that the impact of liquidity on swap spreads in the pre-crisis period was stronger compared to the crisis period for the 2 year maturity. In addition the impact of liquidity on swap spreads appears to be greater in the short end of the curve for both periods. The results of the stronger impact of liquidity on swap spreads at the short end of the curve for the pre-crisis period compared to that of the crisis period is similar to the findings of Ito (2010).

Graph 5.2 illustrates the liquidity profile over the full period of study including the 5 and 10 year swap spreads:

Graph 5.2



Source: INET

Note: The 2 year spread was omitted intentionally to reduce noise.

The increase in liquidity premium during weaker economic conditions on the back of higher demand for riskless government securities was evident during the financial crisis period, although only for a short period of time. The red circle in graph 5.2 indicates the spike in the liquidity premium during the onset of the financial crisis. A widening of the liquidity premium should be associated with a widening of the swap spread however at the back end of 2008 when the liquidity premium spiked the swap spreads for both maturities plummeted into negative territory indicating the presence of another more dominant influence over swap spreads during those months. Thereafter, the aggressive easing by the South African Reserve Bank (SARB) [1] to counter the economic slow-down is evident in the sharp decline of 3-month JIBAR rate. The rate of decline in the 3-month JIBAR far exceeded that of the 3-month T-Bill rate and therefore driving the liquidity premium lower. The

[1] The repo rate cycle is presented in graph A1 in the appendix with the red circle marking the period of sharp decline.

liquidity premium fell sharply from early 2009 and stabilised toward the end of 2009 and beginning of 2010 and has since remained relatively stable at around 10 to 15 basis points.

Other proxies considered for the liquidity variable included the differential between a government bond and a parastatal bond that carries a government guarantee and the differential between the general collateral (GC) repo rate and JIBAR. The differential between a government bond and a parastatal bond of a similar maturity and backed by the government should isolate the liquidity premium specifically as the default risk premium is neutralised due to the government guarantee. The two bonds analysed in lieu of the proxy was the R186 and the SZ25 (National Road Agency). The liquidity premium calculated as the differential between the R186 and SZ25 averaged around 50 basis points. The major drawback from the proxy is the low number of comparative bonds available for analysis therefore making the analysis susceptible to bond specific trading irregularities. The GC repo rate JIBAR spread proved to be the better of the two alternatives. The regression results of the two alternative liquidity proxies are presented in tables A1 and A2 in the appendix. The parastatal/government bond proxy displayed weak positive correlations for all three maturities in the pre-crisis period and strong negative correlations for all three maturities in the crisis period. The results are statistically significant at the 5 % level. The GC repo spread over JIBAR proxy displayed weak positive correlations across all three maturities for both periods. The results are statistically significant at the 5% level except the 10 year maturity in the pre-crisis period and the 2 year maturity in the crisis period. Graph A2 in the appendix provides a graphical representation of all three liquidity premium proxies and the 5 and 10 year swap spreads.

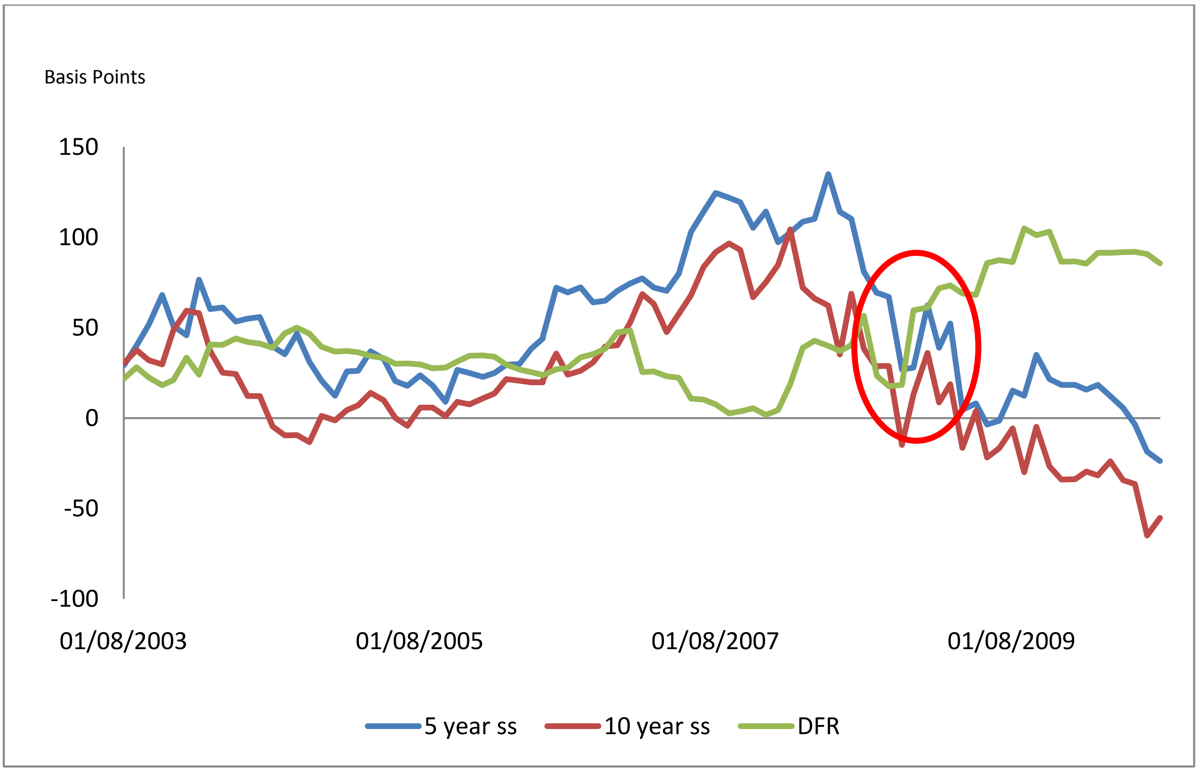
The proxy for default risk (DFR) as calculated by the differential between the Other Bond Index (OTHI) and the Government Bond Index (GOVI) displayed negative correlation with all three swap spread maturities in both periods[2]. Default risk appears to have had a far greater impact during the crisis period as opposed to the pre-crisis period especially for the 5 and 10 year maturities. These findings are consistent with Ito (2010), Huang and Neftci (2003) amongst others. In graph 5.3 below the relationship between the DFR variable and the swap spreads appeared to be very weakly negative until the beginning of 2007 where the relationship became distinctly inverse and has remained as such ever since. The change in relationship may be explained by the significant increase in risk adverse behaviour by market participants. As the expectation of the financial crisis grew in certainty the requirement to hedge and unwind positions using the swap market would have gained

[2] The All Bond Index (ALBI) consists of the top 20 listed bonds, ranked by market capitalisation and liquidity where the GOVI consists of those RSA bonds found in the ALBI and the OTHI consisting of the remainder of the bonds in the ALBI.

momentum. It must be noted that the rate cycle was at its peak when the inverse relationship took effect perhaps signalling that the inversion of the yield curve was more dominant in driving the swap spreads especially in light of the aggressive monetary easing that ensued thereafter. The regression results using the slope of the yield curve will be discussed later in this section.

Graph 5.3 illustrates the default risk profile over the full period of study including the 5 and 10 year swap spreads: The red circle indicates the market crash of 2008 where for a brief period both the swap spreads and the default premium widened notably.

Graph 5.3



Source: INET

Note: The 2 year spread was omitted intentionally to reduce noise.

Other proxies examined in lieu of a default premium included the differential between a basket of 5 year bank paper and 5 year government bonds and the J.P. Morgan Emerging Market Bond Index (EMBI) spread over the US treasury curve[3]. The results from the regression analysis using the first of the alternative proxies indicated little to no correlation across the three swap spread maturities, in

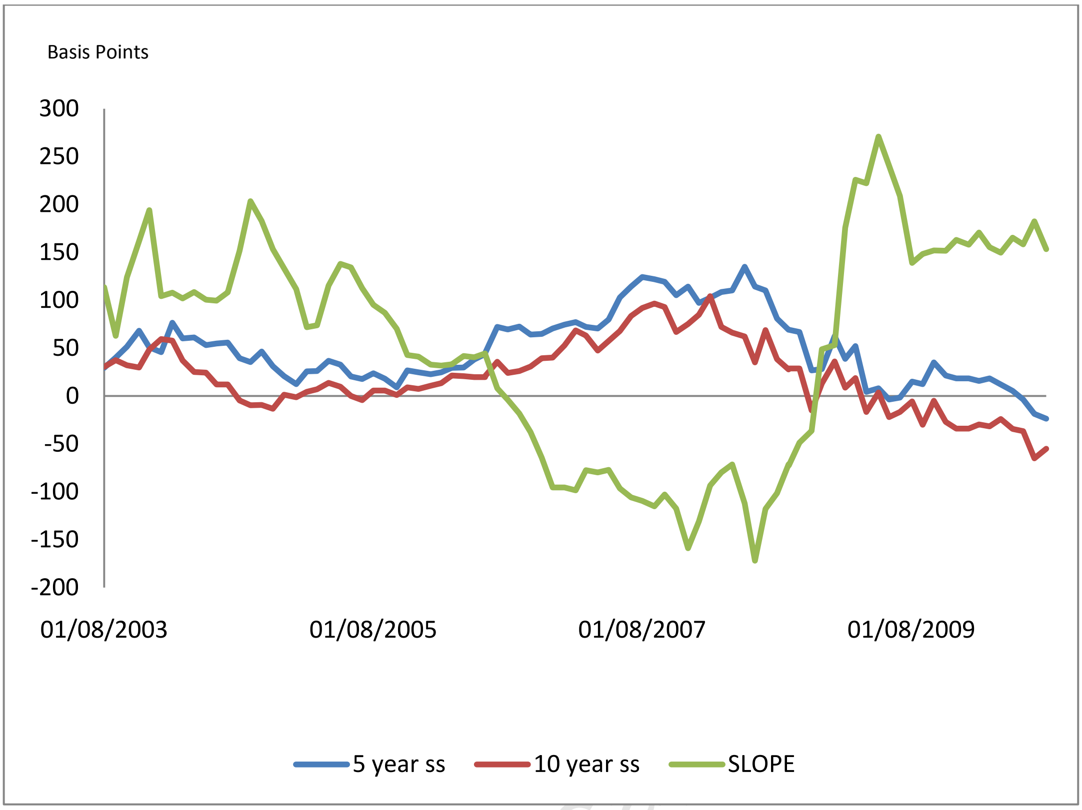
[3] The EMBI is a benchmark bond index produced by J.P. Morgan that covers Brady Bonds. Brady bonds refer to US Dollar denominated bond that is issued by an emerging market particularly those in Latin America.

addition the results from the 2 and 10 year maturities in the pre-crisis and the 10 year maturity in the crisis period are not statistically significant at the 5% level. The second alternative proxy produced weak negative correlations for all swap spread maturities in both periods except for the 2 year maturity in the crisis period. The results are not statistically significant at the 5% level except for the pre-crisis 2 year maturity and the crisis 5 year maturity. The regression results and a graphical representation are presented in tables A3 and A4 and Graph A3 in the appendix.

The proxy for the general level of interest rates (RATES) as calculated by the change in the 3-month T-Bill rate displayed mixed results. The results from the pre-crisis period indicated weak positive correlation for the 2 and 5 year swap spread maturities and no correlation for the 10 year maturity. The results however were not significant at the 5% level. The results from the crisis period indicated good positive correlation for the 5 and 10 year maturities and no correlation for the 2 year maturity. The results in this period for the 5 and 10 year maturity were statistically significant at the 5% level. The results are a contradiction to the inverse relationship found by In et al (2003). In et al (2003) attributed the inverse relationship to higher hedging costs for market makers during periods of elevated interest rates driving down swap spreads. With no inverse relationship present the argument is not statistically valid in the South African context.

The proxy for the slope of the yield curve (SLOPE) as calculated by the differential between the 10 year yield and the 2 year yield on the perfect fit zero bond curve showed a strong negative correlation with all three swap spread maturities in both periods. The results are especially strong for the 5 and 10 year spreads in the crisis period. The results are consistent with that of Cortes (2003), Huang and Neftci (2003), Huang and Chen (2007), Tonge (2001) and Nel (2010).

Graph 5.4



Source: INET

Note: The 2 year spread was omitted intentionally to reduce noise.

Graph 5.4 illustrates the change in the slope of the yield curve in conjunction with the size of the swap spreads over the full period of study. The inverse relationship becomes increasingly pronounced from 2006 onwards. The yield curve inverted towards the end of 2006 and steepened (negatively) until mid 2008, thereafter the curve un-inverted and steepened quickly (positively). The steepening of the yield curve, in the short end, from mid 2008 is associated with a sharp decline in the swap spreads over the same period. The slope of the yield curve was at its steepest in March 2009 the same time that the swap spreads entered negative territory. The findings confirm the theory discussed in chapter 2 whereby the increase in the slope (positive) of the yield curve drives the level of demand for swaps and secondly whereby the slope of the yield curve is closely associated with growth expectations of the economy. The slope of the yield curve appears to be a dominant factor driving swap spreads in South Africa.

An alternative proxy for the slope of the yield curve was to use a parametrically parsimonious model. A model of this sort has the ability to represent the shape of the entire yield curve in a few parameters. The attraction of a model of this nature is its ability to represent the multitude of shapes the yield curve may take such as monotonic, humped and S shaped. In their paper

Parsimonious Modelling of Yield Curves, Nelson and Siegel identify a model that explains the shape of the yield curve in 3 parameters; $\beta_0, \beta_1\ and\ \beta_2$, (Nelson and Siegel, 1987). The model is expressed as follows:

$$r(m) = \beta_0 + \beta_1 \times \exp\left(-\frac{m}{\tau}\right) \times \beta_2[\left(\frac{m}{\tau}\right) \times \exp\left(-\frac{m}{\tau}\right)] \qquad (5.1)$$

Where:

r(m) is the yield to maturity and

τ is a time constant

The alternative proxy involved using the differential between the short term component and the medium term component β_1 and β_2 respectively. The regression results were very similar to that of the 10 year and 2 year yield differential. The regression results and a graphical representation are presented in tables A5 and A6 and Graph A4 in the appendix. Given that the regression results for both slope proxies were similar it was decided to revert to using the initial proxy for the study for simplicity.

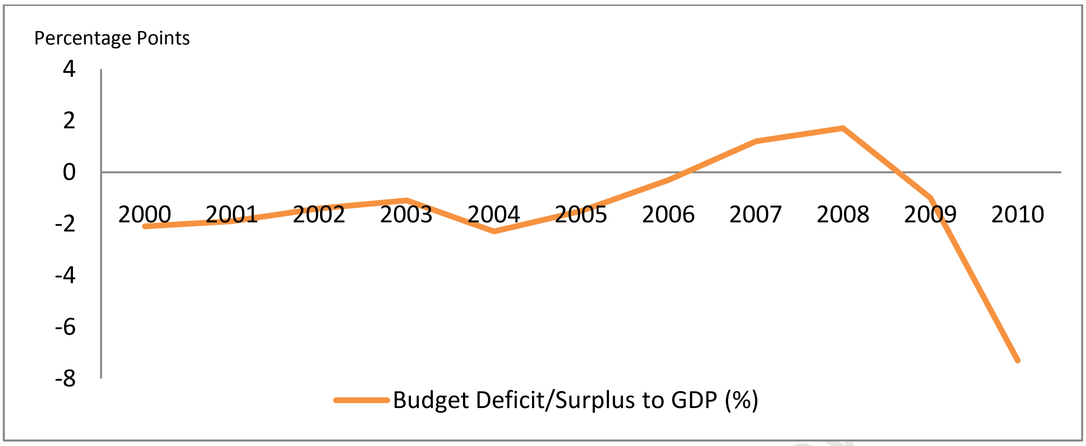
The proxy for volatility (VOL) as calculated by using the GARCH (1,1)[4] model on the 10 year yield displayed a weak positive correlation with all swap spread maturities in both periods except for the 10 year maturity in the crisis period where no correlation was found. The regression results although weak, are somewhat consistent with In et al (2003) and may be attributed to the increase in demand to hedge the yield volatility. However, the results for the crisis period for all three maturities and the pre-crisis 10 year maturity were not statistically significant.

The proxy for government bond issuance (ISSUANCE) as calculated by the 12 month change in the ratio of government borrowing to GDP displayed strong negative correlations across all three swap spread maturities. The negative correlation was noticeably stronger in the crisis period. The results are statistically significant at the 5% level. This proxy was adopted from Nel (2010) and the findings of this paper are similar with her study and with that of Cortes (2003). The regression results support the notion that the expectation of greater government issuance would drive bond yields up thereby narrowing the swap spread. The size of the budget deficit increased significantly during the onset of the financial crisis. The reduction in tax revenue due to loss in earnings exacerbated the

[4] GARCH (1,1): $\sigma_n^2 = \gamma V_L + \alpha u_{n-1}^2 + \beta\sigma_{n-1}^2$ (Hull, 2006). GARCH (1,1) is used as a measure for volatility where volatility is a function of lagged squared variances and returns.

widening budget deficit. Graph 5.5 illustrates the change in budget deficit/surplus over the period of study.

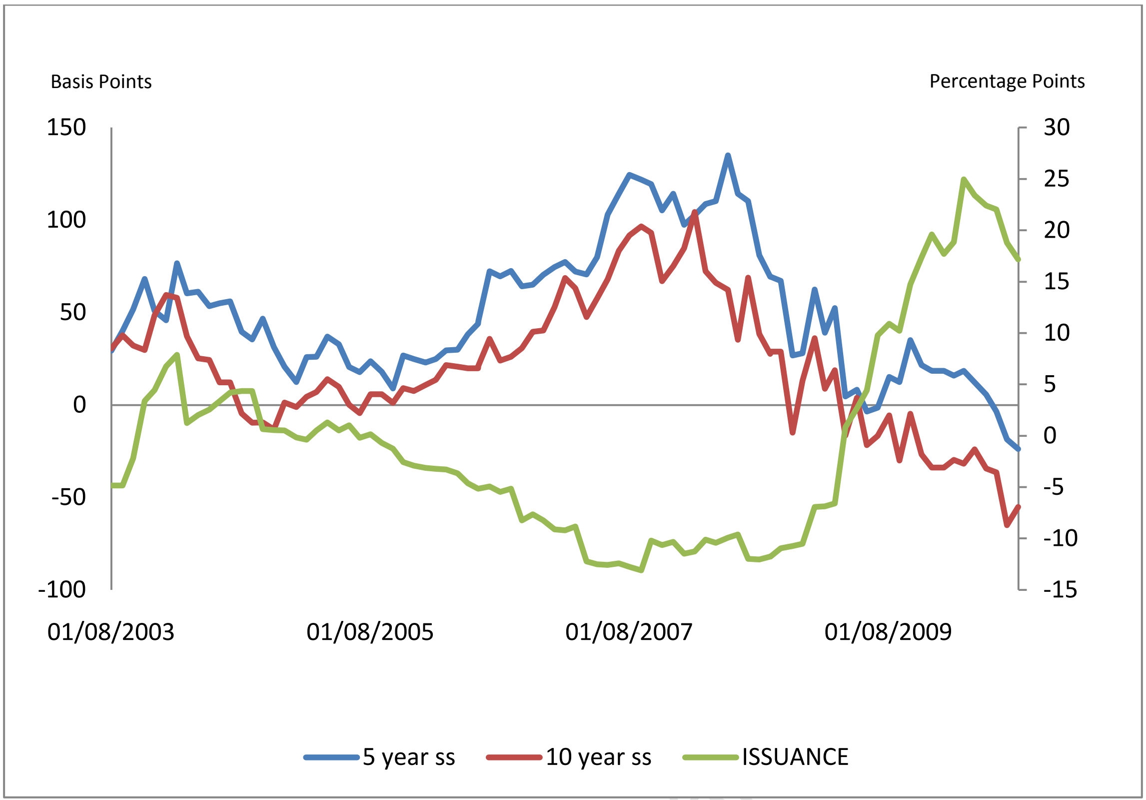
Graph 5.5



Source: National Treasury

Graph 5.6 illustrates the 12 month change in the level of government borrowing over the full period of study including the 5 and 10 year swap spreads: *(Note: the change in the level of government borrowing (ISSUANCE) is plotted against the right-hand vertical axis in percentage points whilst the swap spreads are plotted against the left-hand vertical axis in basis points)*

Graph 5.6



Source: INET

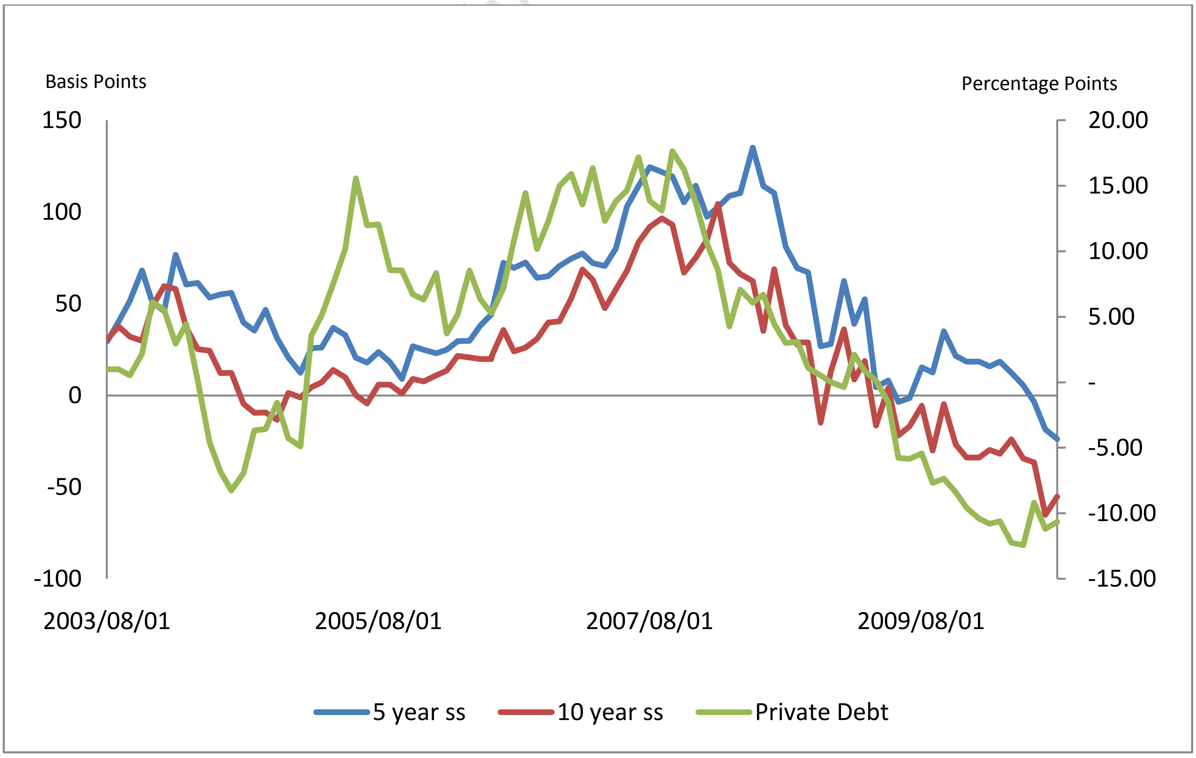
Note: The 2 year spread was omitted intentionally to reduce noise.

The graph indicates a complete reverse of the government borrowing levels over the period of study. The budget surplus years from 2006 through to 2008 enabled the government to be in a negative borrowing position however, the combination of the financial crisis and the large bill of expenses incurred improving public infrastructure going into the 2010 soccer world cup caused an astronomical rise in government borrowing levels starting at the back end of 2008 going into 2009.

An alternative proxy examined for government issuance was to use the ratio of the national budget deficit/surplus to GDP. This proxy would have provided an estimation of the requirement by government to fund the gap between revenue and expenditure. The regression results displayed positive correlation across all three maturities in the pre-crisis period and significantly stronger positive correlation across all three maturities in the crisis period. The results were statistically significant at the 5% level across all maturities in both periods except for the 5 maturity in the pre-crisis period. The alternative proxy is expected to a positive correlation rather than a negative correlation as displayed by the ratio of government borrowing to GDP because the movement in the budget position is inversely related to the level of required government borrowing. In other words as the budget deficit becomes more negative the more the government would need to borrow. The regression results and graphical representation are presented in table A7 and A8 and Graph A5 in the appendix. The alternate proxy is forward looking and provides a rough indication as to how much funding the government needs to raise however, it does not indicate how much funding the government actually raised. The 12 month change in the level of government borrowing to GDP is a retrospective analysis of the actual level of government borrowing and therefore perhaps a better fit to proxy issuance.

The proxy for the level of corporate debt in the market (PVdebt) as measured by the 12 month change in the ratio of corporate borrowing to GDP displayed positive correlations across all swap spread maturities in both periods. The relationship was significantly stronger in the crisis period across all three maturities. The results were all significant at the 5% level. The results are consistent with the works of Nel (2010) and confirm theory that lower credit quality in the market as well as a higher demand for hedging causes a tightening of swap spreads. Graph 5.7 illustrates the 12 month change in the level of corporate borrowing over the full period of study including the 5 and 10 year swap spreads: *(Note: the change in the level of corporate borrowing (PVdebt) is plotted against the right-hand vertical axis in percentage points whilst the swap spreads are plotted against the left-hand vertical axis in basis points)*

Graph 5.7



Source: INET

Note: The 2 year spread was omitted intentionally to reduce noise.

Table 5.4 summarises the findings from the linear regression with regards to the hypotheses outlined in section 3.

Table 5.4

Findings			
Hypotheses	**2 Year**	**5 Year**	**10 Year**
Liquidity will have a positive effect on swap spreads in the pre-crisis period and a stronger positive effect on swap spreads in the crisis period.	No statistical reason to accept	Statistically Significant at the 5% level	No statistical reason to accept
Default risk will have a negative effect on swap spreads in the pre-crisis period and a stronger negative effect on swap spreads in the crisis period.	No statistical reason to accept	Statistically Significant at the 5% level	Statistically Significant at the 5% level
The general level of interest rates will have a negative effect on swap spreads in both the pre-crisis period and the crisis period.	No statistical reason to accept	No statistical reason to accept	No statistical reason to accept
The slope of the government bond curve will have a negative effect on swap spreads in the pre-crisis period and a negative effect on swap spreads in the crisis period.	Statistically Significant at the 5% level	Statistically Significant at the 5% level	Statistically Significant at the 5% level
Yield volatility will have a positive effect on swap spreads in the pre-crisis period and a stronger positive effect on swap spreads in the crisis period.	No statistical reason to accept	No statistical reason to accept	No statistical reason to accept
Government bond issuance will have a negative effect on swap spreads pre-crisis and a stronger negative effect during the crisis period.	Statistically Significant at the 5% level	Statistically Significant at the 5% level	Statistically Significant at the 5% level
The level of corporate debt will have a positive effect on swap spreads in both the pre-crisis and post-crisis periods.	Statistically Significant at the 5% level	Statistically Significant at the 5% level	Statistically Significant at the 5% level

Liquidity had a positive effect in both the pre-crisis and crisis periods however the effect was stronger in the pre-crisis period as opposed to the crisis period for the 2 year and 10 year swap spreads. As previously mentioned the liquidity premium did spike during the early stages of the financial crisis as expected however, this was not met with a corresponding narrowing of swap spreads. Apart from the 10 year pre-crisis spread and the 2 year crisis spread the level of interest rates was positively correlated to the swap spreads in both the crisis and pre crisis period. Although the results from the proxy were largely not significant at the 5% level they did indicate a direct contradiction to the swap spread literature. A possible explanation could be that the slope of the bond yield curve dominates as a proxy for the prevailing and expected market conditions. Yield volatility displayed a stronger relationship to swap spreads in the pre-crisis period which was not the expectation especially evident in the 5 and 10 year swap spread buckets. The results from the regression test involving default risk, the slope of the yield curve, government bond issuance and the level of corporate debt proved to be consistent with the preceding literature.

Multiple Regression analysis:

The next phase in the study involved the use of multiple regression analysis. The analysis was conducted on the 2, 5 and 10 year swap spread maturities for both the crisis and pre-crisis periods. Initially all seven variables were included in the each of the six models. Table 5.5 illustrates the regression results.

Table 5.5

Data Set	β0	β1 (TBJ)	β2 (SLOPE)	β3 (DFR)	β4 (ISSUANCE)	β5 (VOL)	β6 (RATES)	β7 (PVdebt)	R Square	DW
2 year Pre-Crisis	16.28	*0.66	-0.06	*-0.74	0.35	1.15	2.14	-0.28	0.72	1.34
2 year Crisis	62.15	-0.07	0.08	0.27	*-5.48	-0.22	-12.57	0.67	0.88	1.32
5 year Pre-Crisis	21.00	0.38	*-0.20	-0.19	1.14	*2.97	-2.48	-0.70	0.54	0.75
5 year Crisis	28.94	0.08	*-0.26	*0.76	0.06	-0.91	-2.57	*4.02	0.92	1.65
10 year Pre-Crisis	47.46	0.30	*-0.35	-0.61	*3.29	0.95	*-11.27	-0.24	0.77	1.12
10 year Crisis	31.07	-0.18	*-0.17	0.43	-1.02	-1.48	-5.13	*3.86	0.90	1.69

*Coefficients marked with * are statistically significant at the 5% level.*

The correlation coefficients represent strong correlation between the predictor variables and the swap spreads except for the pre-crisis 5 year maturity model. The directional relationship of the statistically significant predictor variables with the respective swap spreads are consistent to the results obtained in the simple linear regression models except for the ISSUANCE variable in the 10 year Pre-Crisis model. The slope of the yield curve appears to be consistently significant in explaining the movements in swap spreads in the 5 and 10 year swap maturities. The Durbin-Watson test statistics indicate the presence of autocorrelation in the 5 year pre-crisis model only although the remaining 5 statistics fail to rule out the presence of autocorrelation. Based on the above results a step wise approach was used to determine the best fit multiple regression models. As mentioned previously Akaike's information criterion was employed to assist in the optimisation of each model.

Tables 5.6 and 5.7 illustrate the multiple regression results after optimization for the 2 year swap spread maturity:

Table 5.6

Pre-Crisis period				
2 year maturity				
R Square	0.674			
AIC	221			
Durbin Watson	1.2			
Observations	48			
Variable	**Coefficients**	**t statistic**	**P value**	**VIF**
Intercept	15.58	1.9	0.06	
TBJ	0.78	8.3	0.00	1.04
DFR	-0.62	-3.2	0.00	1.04

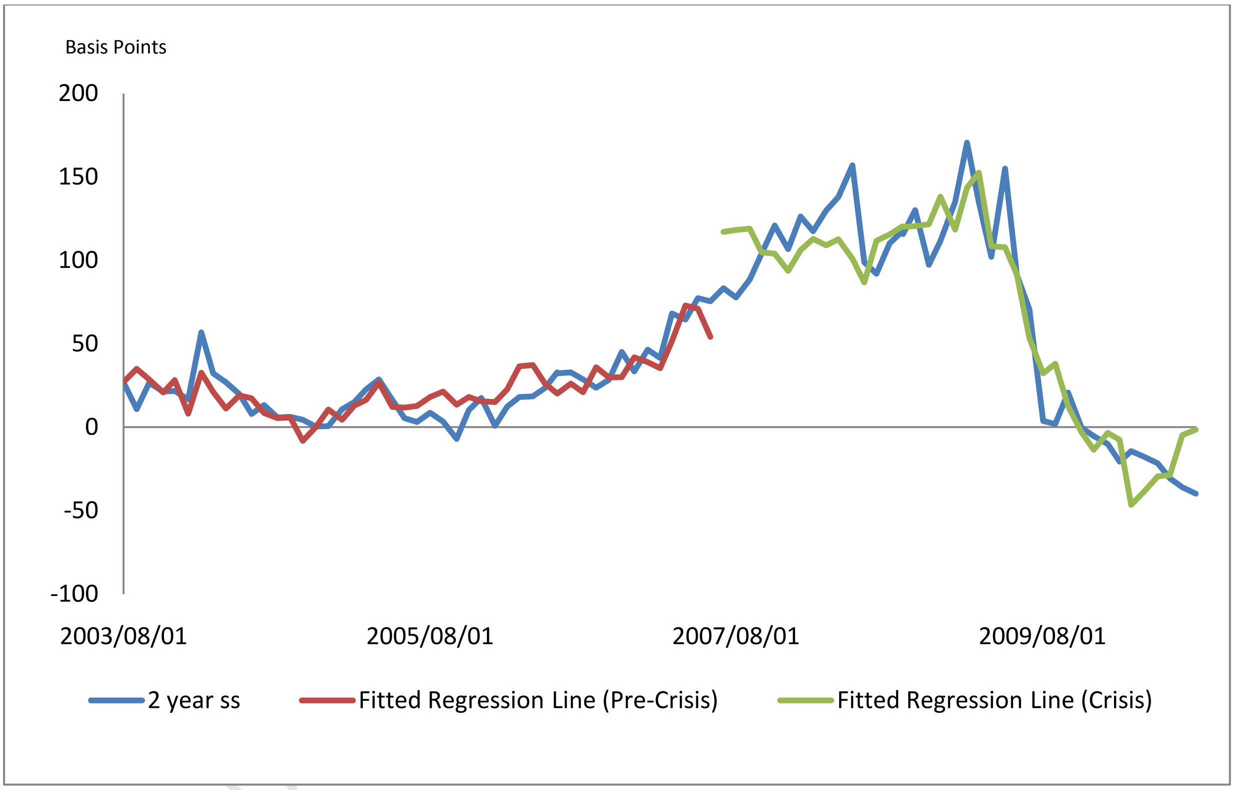
For the 2 year pre-crisis swap maturity liquidity and default risk appear to be the dominant factors driving the swap spreads. The two variables explain 67.4% of the movement in swap spreads. Both variables are statically significant at the 5% level. For every 1% positive move in TBJ the swap spreads will widen by 0.78% and for every 1% negative move in DFR the swap spreads will widen by 0.62%. The directional relationships are consistent with the findings in the individual single linear regression models. The variance inflation factors indicate some multicollinearity although the values are all below 10 indicating no significant effect on the coefficients. The lower and upper bounds for the Durbin-Watson statistic for this particular model is 1.197 and 1.398 respectively therefore the presence of autocorrelation is undeterminable.

Table 5.7

Crisis period				
2 year maturity				
R Square	0.869			
AIC	251			
Durbin Watson	1.2			
Observations	39			
Variable	**Coefficients**	**t statistic**	**P value**	**VIF**
Intercept	66.67	15.8	0.00	
SLOPE	0.21	4.8	0.00	2.47
ISSUANCE	-5.84	-13.0	0.00	2.47

The drivers of the crisis 2 year swap maturities are dominated by the slope of the yield curve and the issuance of bonds by the government. The two variables explain 86.9% of the 2 year swap spread movement during this period. For every 1 % move in the slope variable and issuance variable the swap spread moves 0.21% and 5.84% respectively. Both variables are statistically significant at the 5% level. The variance inflation factors indicate some multicollinearity although the values are all below 10 indicating no significant effect on the coefficients. The lower and upper bounds for the Durbin-Watson statistic for this particular model is 1.187 and 1.392 respectively therefore the presence of autocorrelation is undeterminable. Graph 5.8 below illustrates the fitted regression line for both periods against the 2 year swap spread:

Graph 5.8



Source: INET and regression models

The results from the two regression models indicates that the drivers of the 2 year swap spreads under stable market conditions appear to be that of liquidity and default risk. During periods of aggressive yield curve steepening and a sharp negative widening of the fiscal position as experienced over the recent financial crisis period the slope of the yield curve and the level of government borrowing dominate as drivers of the 2 year swap spreads.

Tables 5.8 and 5.9 illustrate the multiple regression results after optimization for the 5 year swap spread maturity:

Table 5.8

Pre-Crisis period				
5 year maturity				
R Square	0.460			
AIC	225			
Durbin Watson	0.50			
Observations	48			
Variable	Coefficients	t statistic	P value	VIF
Intercept	10.74	0.8	0.41	
SLOPE	-0.16	-5.5	0.00	1.02
VOL	3.73	3.5	0.00	1.02

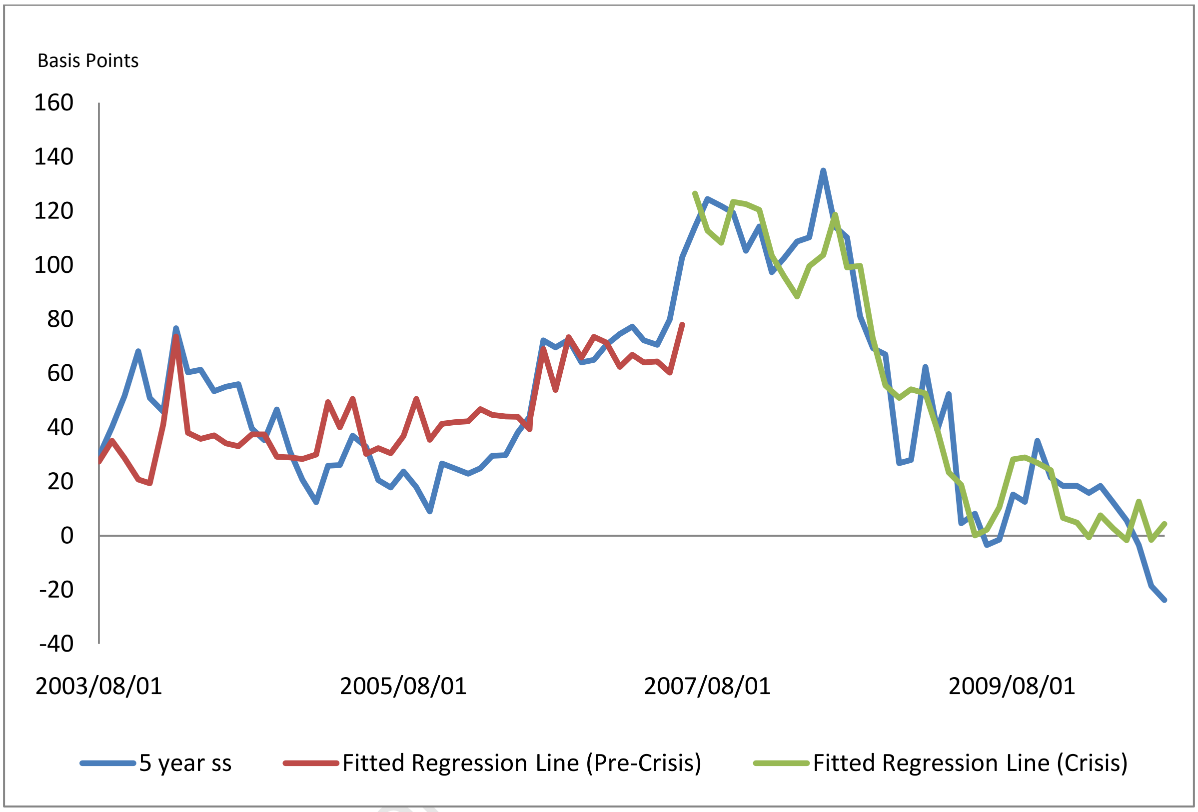
In the 5 year pre-crisis space the two dominate variables are the slope of the yield curve and yield volatility. The two variables explain 46% of swap spread movements in that period. The Durbin-Watson statistic however, indicates the presence of autocorrelation. As noted earlier a major cause of autocorrelation (in the error terms) is the omission of another or other variables that have time ordered effects on the response variable. The 5 year pre-crisis period model is therefore inconclusive in that the coefficients are no longer accurate and that the confidence intervals using the t statistic no longer apply.

Table 5.9

Crisis period				
5 year maturity				
R Square	0.907			
AIC	217			
Durbin Watson	1.51			
Observations	39			
Variable	Coefficients	t statistic	P value	VIF
Intercept	28.80	2.5	0.02	
SLOPE	-0.24	-6.6	0.00	4.33
DFR	0.62	2.8	0.01	9.05
PVdebt	3.83	5.6	0.00	6.22

The 5 year crisis model is driven by the slope of the slope of the yield curve, default risk and the level of corporate debt. The three variables explain the 90.7% of the 5 year swap spread. All three variables are statistically significant at the 5% level. The variance inflation factors indicate some multicollinearity although the values are all below 10 indicating no significant effect on the coefficients. The Durbin-Watson test statistic falls above the upper bound of 1.452 therefore ruling out the presence of any autocorrelation. Graph 5.9 below illustrates the fitted regression line for both periods against the 5 year swap spread:

Graph 5.9



Source: INET and regression models

The slope of the yield curve appears to be a dominant driver behind the 5 year swap spreads in both periods. Surprisingly, yield volatility was a strong determinant of the 5 year swap spread in the pre-crisis-period but did not feature in the crisis period where market volatility was at its highest. Along with the slope of the yield curve, the level of corporate debt and default risk were the main drivers behind the 5 year swap spread in the crisis period. As mentioned earlier the level of corporate bond issuance relative to government bond issuance affects swap spreads due to the change in credit quality in the market. The crisis period was marked by both a large increase in government borrowing and a comparatively large drop off in corporate borrowing therefore creating significant downward pressure on swap spreads.

Tables 5.10 and 5.11 illustrate the multiple regression results after optimization for the 10 year swap spread maturity:

Table 5.10

Pre-Crisis period				
10 year maturity				
R Square	0.755			
AIC	220			
Durbin Watson	0.93			
Observations	48			
Variable	**Coefficients**	**t statistic**	**P value**	**VIF**
Intercept	56.14	5.2	0.00	
TBJ	0.35	2.1	0.04	3.27
SLOPE	-0.34	-5.4	0.00	9.97
DFR	-0.62	-2.6	0.01	1.52
ISSUANCE	3.59	4.8	0.00	5.11
RATES	-10.92	-3.5	0.00	2.59

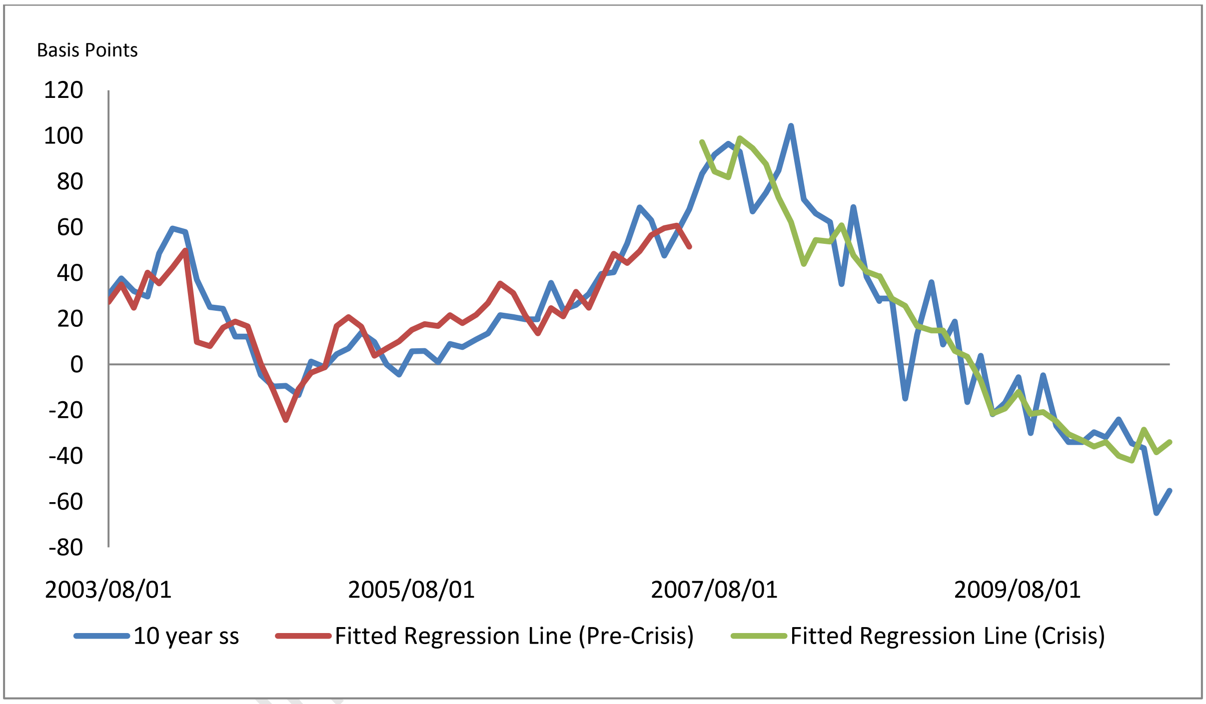
For the 10 year maturity in the pre-crisis period 5 variables appear to be the driving factors behind swap spreads. The variables explain 75.5% of the movement in swap spreads. All the variables are statically significant at the 5% level. Apart from the ISSUANCE and RATES variable the directional relationships are consistent with the findings in the individual single linear regression models. The variance inflation factors indicate some multicollinearity although the values are all below 10 indicating no significant effect on the coefficients. The Durbin-Watson Statistic just misses the lower bound and therefore, is the case in the pre-crisis 5 year model, the 10 year pre-crisis period model is inconclusive in that the coefficients are no longer accurate and that the confidence intervals using the t statistic no longer apply.

Table 5.11

Crisis period				
10 year maturity				
R Square	0.885			
AIC	224			
Durbin Watson	1.60			
Observations	39			
Variable	**Coefficients**	**t statistic**	**P value**	**VIF**
Intercept	20.64	6.5	0.00	
SLOPE	-0.08	-2.4	0.02	2.97
PVdebt	3.97	7.6	0.00	2.97

The 10 year swap spread in the crisis period was driven by the slope of the yield curve and the level of corporate debt. The two variables account for 88.5% of the swap spread movement. Both variables are statistically significant at the 5% level and the directional relationship with the swap spreads are as expected. The variance inflation factors are below 10 and the Durbin-Watson test statistic falls above the upper bound of 1.392 therefore indicating no problems of multicollinearity and autocorrelation. Graph 5.10 below illustrates the fitted regression line for both periods against the 10 year swap spread:

Graph 5.10



Source: INET and regression models

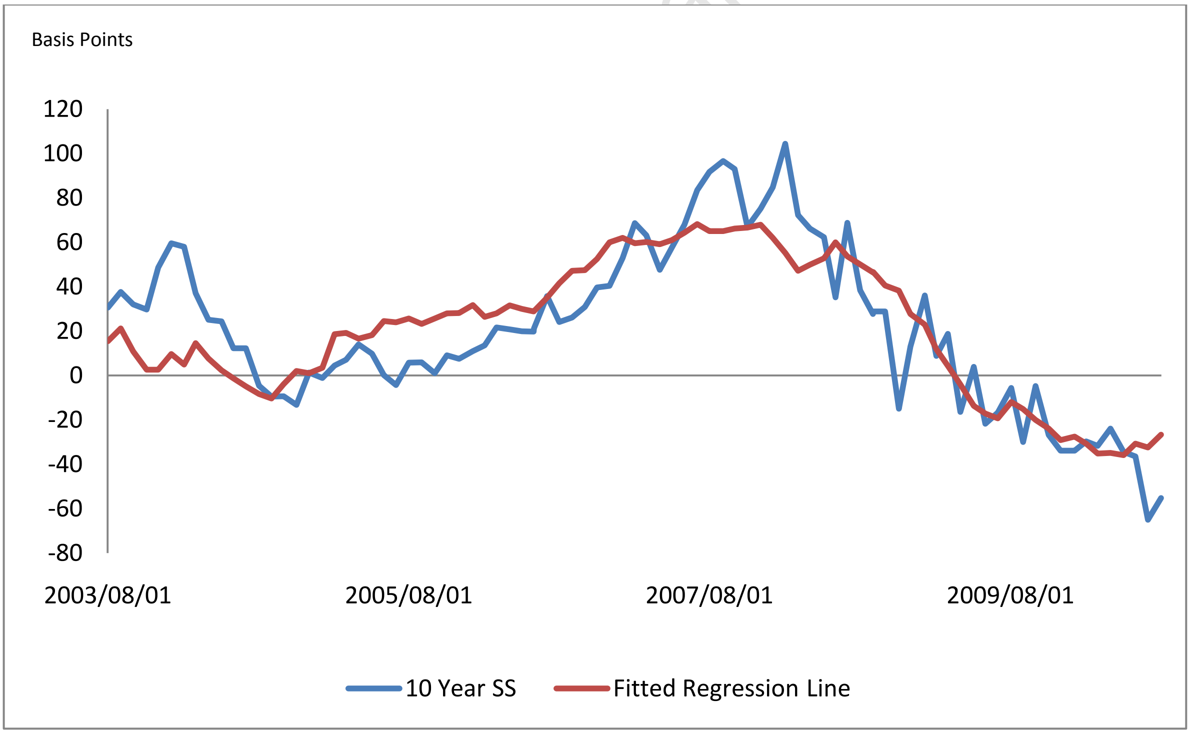
Similar to the 5 year swap spreads, the 10 year swap spread appears to be driven by the slope of the yield curve and the level of corporate debt during the crisis period. Although the 10 year swap spread in the pre-crisis period is driven by 5 variables, the slope of the yield curve is once again a contributing factor. When regressing the 7 variables against the 10 year swap spreads over a combined pre-crisis and crisis period the slope of the yield curve, the level of government bond issuance and the level of corporate borrowing emerge as the dominant driving factors. The regression results are displayed in table 5.12 below:

Table 5.12

Full period				
5 year maturity				
R Square	0.710			
AIC	456			
Durbin Watson	1.03			
Observations	87			
Variable	Coefficients	t statistic	P value	VIF
Intercept	22.04	6.8	0.00	
SLOPE	-0.11	-3.8	0.00	2.55
ISSUANCE	-1.06	-2.7	0.01	3.30
PVdebt	1.22	2.8	0.01	2.74

Graph 5.11 below illustrates the fitted regression line for a combined period against the 10 year swap spread:

Graph 5.11



Source: INET and regression models

Conclusion

The South African market is significantly smaller in comparison to the UK and US markets and is therefore more susceptible to market frictions and irregularities. Despite the lower relative size and sophistication of the South African market the drivers of the swap spreads appear to be, for the majority, consistent with the previous studies conducted in the larger more mature markets. The study was conducted using monthly data for a 7 year period broken into 2 sub-periods namely the pre-crisis period and the crisis period. The analysis of the swap spreads over these two periods highlighted the variable degree to which swap spreads are driven by specific determinants. The major swap spread determinants identified are presented below in no particular order:

1. **Liquidity premium**: a premium associated with trading more liquid assets such as government stock
2. **Default premium**: a premium associated with the level of default risk in the market
3. **Level of interest rates**: the prevailing interest rate cycle
4. **Slope of the bond yield curve**: the expectations of market conditions
5. **Volatility**: the indication of instability in the market
6. **Government bond issuance**: the degree to which the government is adding to the supply of government bonds in the market
7. **Level of corporate debt**: Indications of the level of demand for hedging using interest rate swaps and (in relation to government bond issuance) the level of credit quality in the market.

The change in market conditions leading into the 2008 financial crisis affected the magnitude of importance of the various swap spread drivers, although the directional impact remained unchanged for the majority of the drivers. The predicted directional impact of an increase in the measure of each determinant variable of the swap spread and the actual impact obtained from the simple linear regressions are presented in table C1 below:

Table C1

Swap Spread Impact from Variable Increase			
Determinant	Expected Impact	Pre-Crisis Impact	Crisis Impact
Liquidity	widening	widening	widening
Default	narrowing	narrowing	narrowing
Level of rates	narrowing	mixed	mixed
Slope	narrowing	narrowing	narrowing
Volatility	widening	widening	widening
Government bond issuance	narrowing	narrowing	narrowing
Level of corporate debt	widening	widening	widening

The liquidity variable as measured by the differential between the 3-month Treasury bill rate and 3 month JIBAR was found to impact the 2 year swap spread maturity the most especially during the pre-crisis period when interest rates were increasing. The impact of the default variable as measured by the differential between the OTHI and GOVI indices had varied effects across the 3 swap spread maturities over both periods. The default premium in the pre-crisis period displayed a weak negative relationship with the 5 and 10 year swap spreads whilst the crisis period indicated a much stronger negative relationship across all three swap spread maturities. Although the default premium is inversely related to swap spreads, the market shock in October 2008 caused a strong widening effect in both the default variable and the swap spreads themselves. The change in directional relationship lasted for several weeks after which the expected inverse relationship continued. The general level of interest rates as proxied by the change in the 3-month Treasury bill rate displayed varied results across the swap spread maturities in both periods. The directional relationship to the various swap spreads was mixed and was not consistent to previous literature. Market volatility proxied by the volatility of the risk free 10 year yield indicated consistency in the directional relationship however, the results obtained in this study conclude that volatility had relatively little or no impact on swap spreads.

The slope of the yield curve as proxied by the differential between the 10 year bond yield and the 2 year bond yield explained the majority of swap spread movements in both periods. The slope of the yield curve is driven to a large extent by prevailing economic cycles. The impact on swap spreads by the movement of the yield curve is explained by the change in demand for swaps in conjunction with the change in demand for government bonds, particularly longer dated bonds. Yield curve steepening is generally associated with an increase in the demand for swaps and a decrease in demand for bonds thereby narrowing swap spreads accordingly. Given the extreme changes in the economic cycle over the past 7 years the slope of the yield curve has therefore been a considerable driver of swap spreads.

Closely linked to the slope of the yield curve are the levels of government issuance and the levels of corporate borrowing. The fiscal position in South Africa deteriorated considerably over the seven year period therefore, increasing the level of government bonds issuance. The impact by the level on swap spreads is explained by the altered supply of government bonds. The level issuance was proxied by the change in the ratio of government borrowing to GDP. In conjunction with the level of government bond issuance was the level of corporate borrowing. The level of corporate borrowing was proxied by the change in the ratio of corporate borrowing to GDP. The impact of this variable on swap spreads is explained by the change in credit quality of the market and by the level of demand for hedging by corporate. The period of study was marked by both a large increase in government borrowing and a comparatively large drop off in corporate borrowing therefore creating significant downward pressure on swap spreads. The study revealed that both the level of government bond issuance and the level of corporate borrowing contributed significantly to swap spread variation across all maturities in both the pre-crisis and crisis period.

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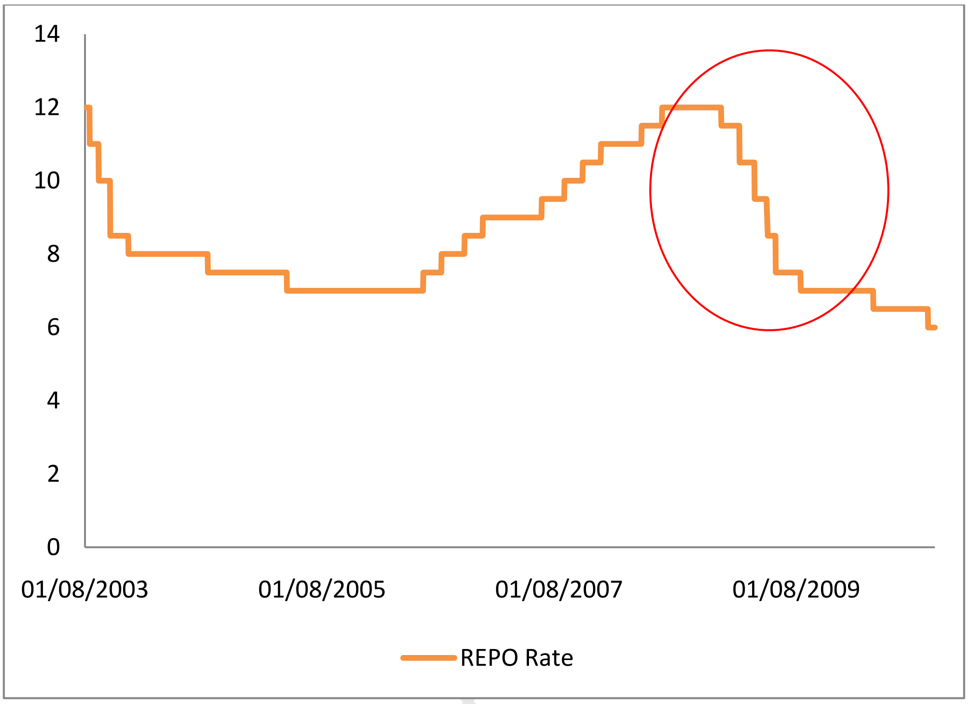
Appendix

Graph A1



Source: SARB

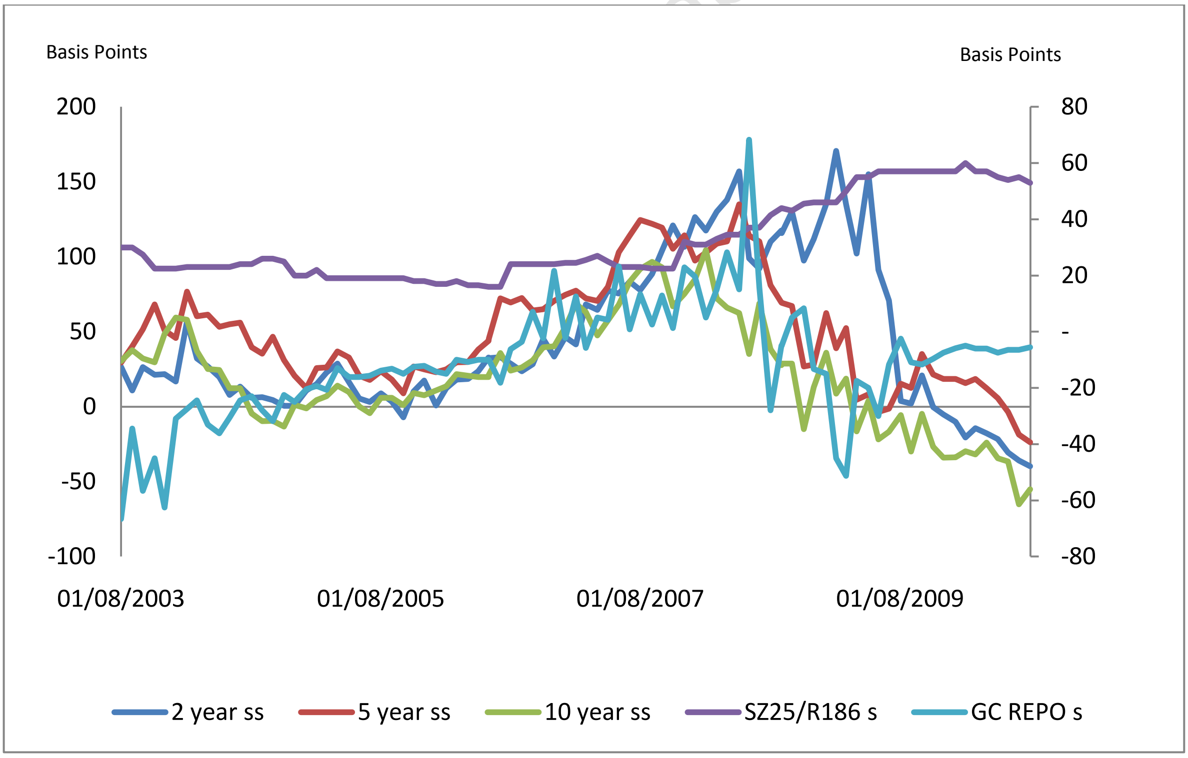
Table A1

Pre-Crisis period					
2 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Parastatal vs. Gov	-9.67	1.53	0.08	2.02	0.04955
GC Repo vs JIBAR	31.58	0.45	0.17	3.12	0.00309
5 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Parastatal vs. Gov	-12.49	2.69	0.20	3.42	0.00133
GC Repo vs JIBAR	53.01	0.38	0.10	2.27	0.02777
10 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Parastatal vs. Gov	-21.05	2.03	0.12	2.47	0.01736
GC Repo vs JIBAR	28.02	0.28	0.05	1.61	0.11327

Table A2

Crisis period					
2 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Parastatal vs. Gov	210.70	-3.09	0.35	-4.42	0.00008
GC Repo vs JIBAR	72.71	0.22	0.00	0.42	0.67650
5 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Parastatal vs. Gov	215.80	-3.61	0.84	-13.87	0.00000
GC Repo vs JIBAR	57.47	1.35	0.32	4.13	0.00020
10 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Parastatal vs. Gov	183.43	-3.68	0.86	-15.32	0.00000
GC Repo vs JIBAR	21.21	1.05	0.19	2.94	0.00566

Graph A2



Source: INET

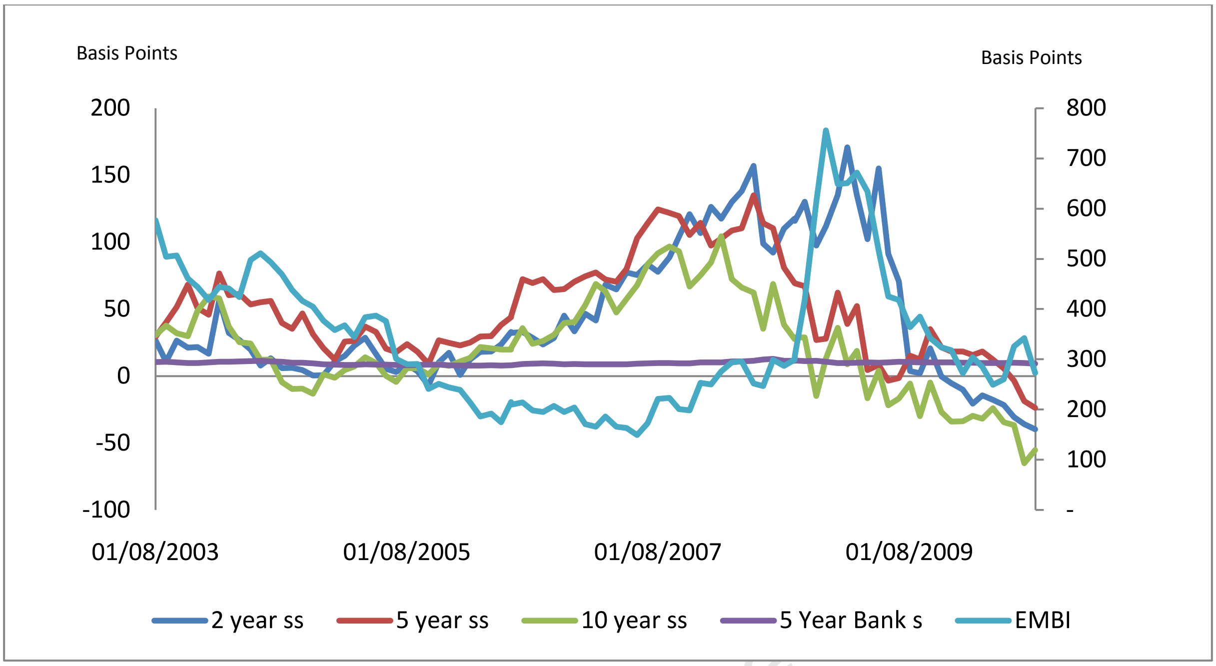
Table A3

Pre-Crisis period					
2 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
5 year bank paper	24.48	-0.09	0.00	-0.03	0.97621
EMBI spread over US Treasury	44.69	-0.07	0.17	-3.10	0.00331
5 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
5 year bank paper	-24.89	7.76	0.13	2.60	0.01234
EMBI spread over US Treasury	59.01	-0.04	0.05	-1.57	0.12421
10 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
5 year bank paper	-7.29	3.32	0.02	1.06	0.29277
EMBI spread over US Treasury	38.67	-0.05	0.08	-1.96	0.05651

Table A4

Crisis period					
2 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
5 year bank paper	-231.87	29.33	0.14	2.40	0.02130
EMBI spread over US Treasury	25.53	0.13	0.09	1.93	0.06194
5 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
5 year bank paper	-149.72	19.66	0.11	2.12	0.04080
EMBI spread over US Treasury	100.64	-0.13	0.16	-2.68	0.01106
10 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
5 year bank paper	-109.76	12.38	0.04	1.28	0.20766
EMBI spread over US Treasury	53.04	-0.10	0.09	-1.89	0.06664

Graph A3



Source: INET

Note: The EMBI proxy is graphed against the right-hand vertical axis with the swap spreads and 5 year bank paper against the left-hand vertical axis.

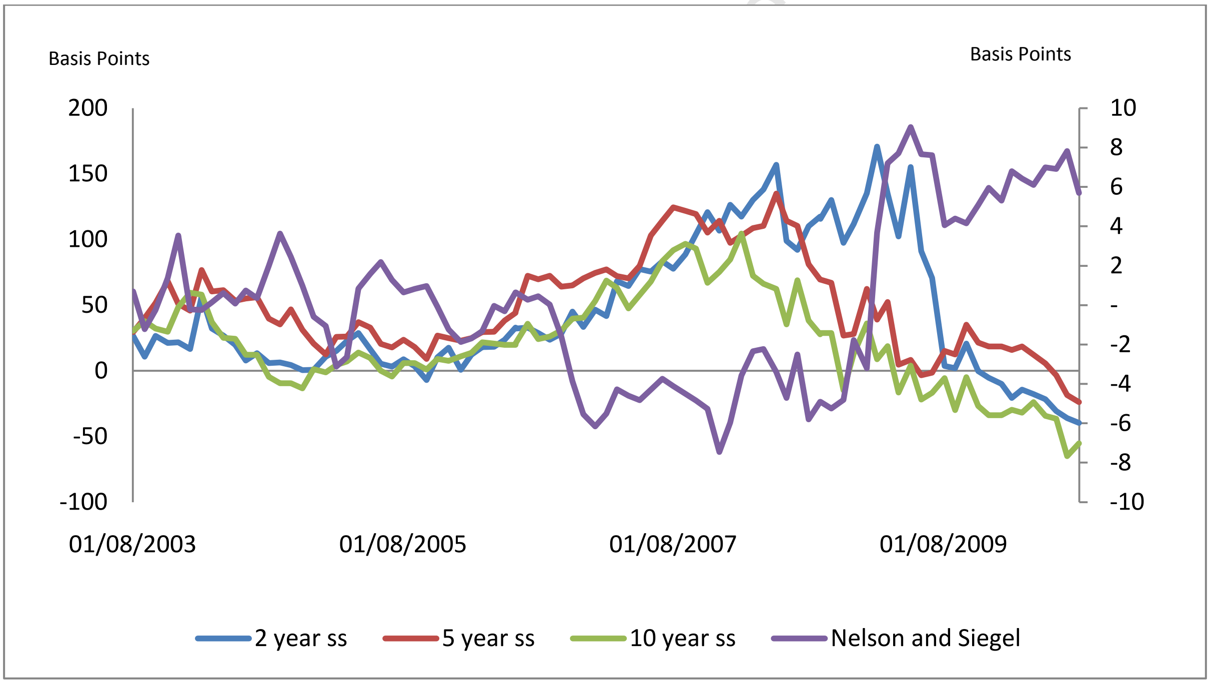
Table A5

Pre-Crisis period					
2 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Nelson and Siegel	20.40	-5.35	0.41	-5.64	0.00000
5 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Nelson and Siegel	43.74	-4.19	0.20	-3.40	0.00142
10 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Nelson and Siegel	19.81	-5.48	0.35	-4.99	0.00001

Table A6

Crisis period					
2 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Nelson and Siegel	78.15	-7.02	0.35	-4.51	0.00006
5 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Nelson and Siegel	60.47	-7.51	0.72	-9.81	0.00000
10 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Nelson and Siegel	24.73	-7.23	0.66	-8.54	0.00000

Graph A4



Source: Swap spreads INET and Nelson Siegel data is own calculation based on INET data

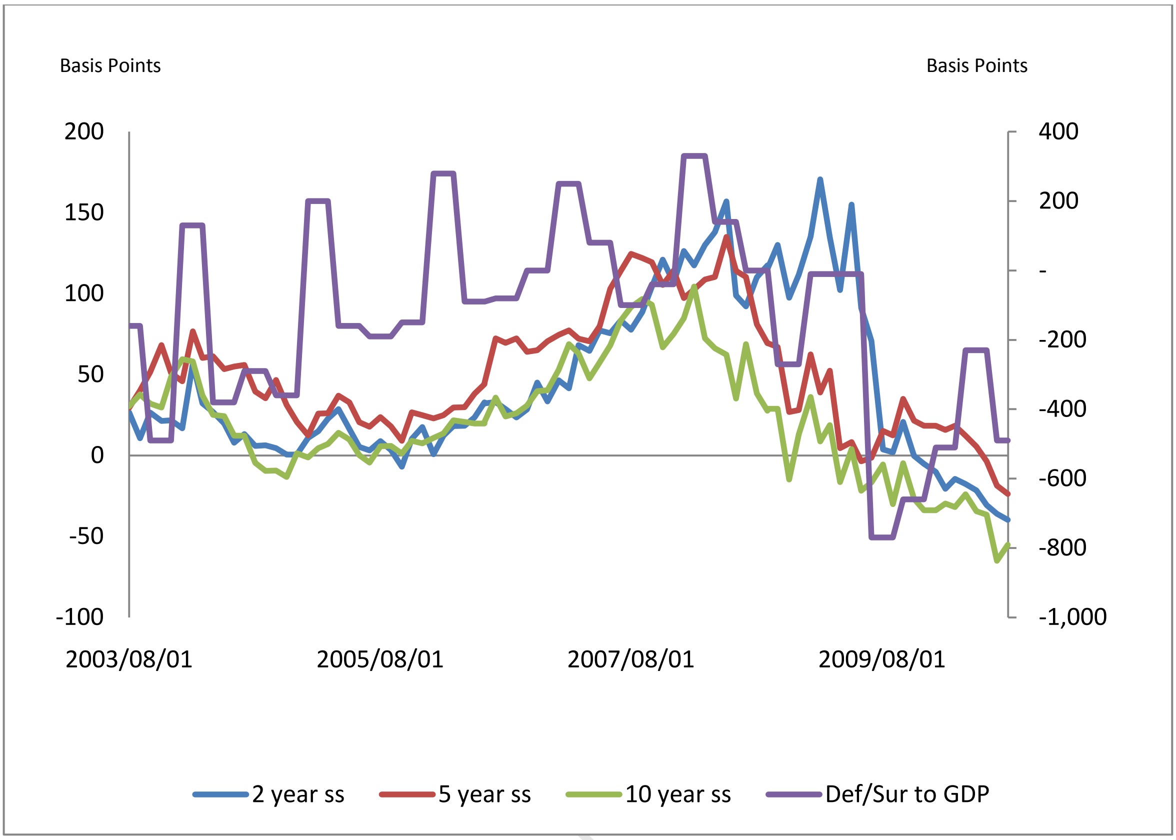
Table A7

Pre-Crisis period					
2 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Ratio of budget deficit/surplus to GDP	26.81	0.04	0.17	3.07	0.00360
5 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Ratio of budget deficit/surplus to GDP	47.34	0.01	0.01	0.83	0.41220
10 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Ratio of budget deficit/surplus to GDP	26.41	0.04	0.15	2.83	0.00689

Table A8

Crisis period					
2 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Ratio of budget deficit/surplus to GDP	101.36	0.15	0.56	6.83	0.00000
5 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Ratio of budget deficit/surplus to GDP	73.58	0.10	0.44	5.43	0.00000
10 year maturity					
Variable	β_0	β_1	R Square	t Statistic	p value
Ratio of budget deficit/surplus to GDP	39.45	0.11	0.50	6.13	0.00000

Graph A5



Source: INET