African Review of Economics and Finance | ISSN 2042-1478 | Volume 8 | Issue 2 | December 2016

Determinants of bond yield spread changes in South Africa

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Abstract

This paper offers an emerging market perspective on the determinants of bond yield spread changes. The study covers the period 2005-2013 and it is based on a sample of 106 corporate vanilla bonds listed on the South African market. To capture the impact of the financial crisis of 2007-2008, the sample period is split into three sub periods, the pre-financial crisis (2005-2006), mid-financial crisis (2007-2009) and post financial crisis (2010-2013). The study shows that changes in equity volatility, interest rate level and the yield curve slope are significant determinants of bond yield spreads. The impact of equity volatility and interest rate level is more pronounced during the mid-financial crisis period. Controlling for credit ratings and bond convexity does not alter the findings. The study confirms the results documented in developed countries, and highlights the key determinants of bond values and returns of active bond trading strategies. For policy makers, the findings of this study call for further measures and reforms to address liquidity challenges on the bond market and volatility induced by non-resident investors.

Keywords: Equity volatility; Bond yield spread changes; Corporate bonds; South Africa; Emerging markets

1. Introduction

The purpose of this study is to investigate the empirical determinants of bond yield spread changes in the context of the South African market. In addition the study examines how the impact of these determinants were influenced by the financial crisis of 2007-2008. A yield spread is defined as the difference between the yield on a corporate bond and a comparable government bond. Yield spread changes are an important aspect of bond markets: they are key inputs in the pricing of corporate bonds and active management strategies; they are building blocks of understanding the risk-return trade-off in corporate bonds and management of credit risk (Avramov, Jostova and Philipov, 2007). Further, changes in yield spreads determine the returns of hedge fund managers who take highly levered long position in corporate bonds combined with a short position in government bonds to hedge against interest rate risk (Collin-Dufresne, Goldstein and Martin, 2001).

Yield spreads have long been considered to be driven primarily by expected default losses, tax and risk premiums on corporate bonds (Mann, Spreads and Error, 2001). However, recent studies following the Merton (1974) model, have shown that other factors play an important role in determining yield spreads. In Merton (1974)'s model, one of the determinants of bond yields is the probability of default as indicated by the equity volatility on the stock market. Jubinski and Lipton (2012), Hibbert et al (2011), Campbell and Taksler (2004), Kwan (1996) report evidence in support of Merton (1974)'s hypothesis. They report a positive relationship between equity volatility and bond yield spreads for a sample of bonds listed in United States of America (USA). In addition to equity volatility, the interest rate level or spot rates, the level and slope of the yield curve were found to be significant factors explaining yield spreads (Hibbert et al, 2011;Lepone and Wong, 2009; Avramov, Jostova and Philipov, 2007; Collin-Dufresne, Goldstein and Martin, 2001).

Collectively the studies mentioned above show that yield spread changes are driven by other factors in addition to the expected default risk, tax and risk premiums. However, the majority of these studies were conducted before the financial crisis of 2007-2008 with the exception of Hibbert et al. (2011). Hence, relatively little research examined how the financial crisis affected the impact of these yield spread determinants. In addition, the majority of the studies largely focused on developed markets (e.g. Jubinski and Lipton 2012; Hibbert et al, 2011; Lepone and Wong, 2009; Campbell and Taksler 200; Kwan 1996), mainly the USA and Australian markets while ignoring emerging markets like South

Africa. Developed markets in general, differ from emerging markets such as South Africa in several ways that can influence the impact of bond yield spread determinants. Firstly, the developed markets are more liquid and relatively bigger in size (Adelegan and Radzewicz-Bak, 2009; Mu, Phelps and Stotsky, 2013). Secondly, the South African Reserve Bank monetary policy is anchored on the inflation targeting framework. Hence, the changes to the repo rate which consequently affects the yield curve and interest rate levels is a function of the current and forecasted inflation. Some determinants of movements in inflation between USA and South Africa differ to some extent. Two of the key differentiating determinants of inflation in South Africa are labour costs and the Rand exchange rate fluctuations (Akinboade, Siebrits and Niedermeier, 2004). Lastly, the sovereign credit ratings issued by S&P Credit Rating Agency in June 2015 reflect a high credit quality for the USA, with an AA+ rating, while for South Africa the rating is above the junk status at BBB. This difference is important because the market incorporates the sovereign credit rating in corporate bond yields (Durbin and Ng, 2005).

In this study, we add to the literature by investigating the determinants of yield spread changes in an emerging market country, South Africa. In comparison to other bond markets in Africa, the South African market is considered to be relatively more, sophisticated, efficient in price formation, technologically advanced and fully developed with a global significance (Jefferis, 2009; Blommestein and Horman, 2007). Factors contributing to this include; (i) the presence of an electronic trading platform (ii) the availability of a series of total return indices for corporate and government bonds (iii)relatively large trading volumes and high turnover velocity (iv) a wide range of maturities (v) a large market size with high number of participants and instruments.

While the bond market in South Africa is considered to be fully developed, relatively advanced to have global significance, bond markets in Egypt, Kenya and Nigeria and Zimbabwe are considered to be reasonably well established with great potential. Angola, Botswana, Malawi, Mauritius, Mozambique, Namibia, Rwanda, Seychelles, Swaziland, Tanzania, Uganda, Zambia bond markets are considered to be newly established (Liu, 2013; Jefferis, 2009).

The contributions of this paper can be summarized along two dimensions. This is the first study to investigate daily yield spread changes in an emerging market country that uses the inflation targeting framework with the market size and liquidity relatively lower compared to developed markets. Secondly, the study adds and update the existing findings on bond yield determinants (Hibbert et al., 2011 and Lepone and Wong, 2009). The study documents a significant and

positive relationship between firm-specific equity volatility bond yield spread changes. The impact of equity volatility was found to be more pronounced during mid and post-financial crisis period of 2007-2008, reflecting the thin liquidity and vulnerability of the bond market to foreign capital flow movements. In addition, we find the interest rate level and the yield curve slope to be significant determinants of yield spread changes. However, the direction of the relationship was not consistent across the credit rating categories. The interest rate level exhibited a significant positive relationship with yield spread changes for the AA, A, and B rated bonds, however the relationship was negative relationship for the BBB rating. For the yield curve slope, the relationship is positive for all the credit rating categories except for the AA rating.

Next, Section 2 discusses the market and the institutional context under which the study is conducted. Section 3 presents the theoretical framework for the study. Section 4 discusses the empirical literature and develops the hypotheses. Section 4 describes the sample and data used. Section 5 outlines the research methods used. Section 6 reports and analyses the results. Finally, Section 7 concludes the study.

2. The South African institutional setting

2.1 The bond market in South Africa

The South African bond market is monitored and regulated by the Bond Exchange of South Africa (BESA), which is a subsidiary of the Johannesburg Stock Exchange (JSE) (JSE, 2013). During the 1970s and the early 1980s the trading of bonds in South Africa was happening on an informal basis. Bond trading was only formalised in the mid-1980s through the formation of Bond Market Association (BMA). BMA became BESA when it was granted an exchange license in 1996. In 2009 it became a subsidiary of the JSE. Since the granting of its exchange license, BESA has revolutionised the bond market in a number of ways; introduced an electronic trading platform, developed a series of total return indices for government and corporate bonds, and developed a more refined benchmark yield curve with a wide range of maturities (Mboweni, 2006). Relative to other African markets, BESA is considered to be relatively sophisticated, advanced and fully developed and to have global significance (Jefferis, 2009; Blommestein and Horman, 2007). The BESA trading system complies with international (G30) standards (Jefferis, 2009) and in 2008 it was named the most innovative capital markets regulator in Africa at the Africa investor's index series awards in USA(Department National Treasury South Africa, 2012).

The South African Bond market is the largest debt market in Africa, both by market capitalisation and by liquidity. It is worth (outstanding bonds) approximately US$180 billion, as of 2013, translating to 31% of GDP (JSE, 2013). A market size of US$100 billion and above is qualified to be large and liquid (McCauley and Remolona, 2000). The second and third largest bond market is the Egyptian and the Moroccan with market sizes of $66 and $44billion, respectively (Concerto, 2014).

The South African bond market is the most liquid in Africa (Capital, 2012). This is due to its bigger size and large number of participants. Trading on the BESA accounts for over 90% of turnover on the continent (Capital, 2012). Average daily trades average around R25billion (JSE, 2013), while velocity circulation is estimated to be above 20 times (Lawless, 2005). Kenya and Egypt are the second most active markets in Africa. However, the activity in the South African bond market is dominated by the benchmark government bonds which are estimated to make up more than 94% of the trading activity (Hassan, 2013). The secondary market for corporate bonds is illiquid with little market making activity (Lawless, 2005). Bond markets in most African countries remain underdeveloped, with low levels of liquidity, a narrow investor base, short maturities on the bonds issued and high borrowing costs (Jefferis, 2009). This is mainly driven by lack of institutional and operational infrastructure.

The BESA is a well-diversified market in terms of bond issues, bond classes, maturity structure and participants. The total number of instruments amount to around 1,600 instruments and the issuers include central and local government, parastatals, banks and corporates. The government bonds constitute a bigger portion (around 55%, or US$100billion) of the SA bond issues, the rest were issued by state-owned companies, corporates, and banks. The bond classes include; fixed rate notes, inflation indexed bonds, treasury bills, retail savings bonds and foreign currency bonds (Department of National Treasury South Africa, 2012). In terms of maturity structure, the government bonds cover a wide range of maturities, from one year to above 30-years, which provide a reliable bond yield curve for pricing corporate bonds and deriving forward rates (Liu, 2013).

The South African financial market regulation does not impose restrictions on the purchase and ownership of bonds by foreign investors (JSE, 2013). Consequently, foreign investor participation is high on the market and it constitutes more than 37% of government bond holdings (Department National Treasury South Africa, 2014). Foreign investor participation broadens the investor base and it adds stability, liquidity, efficiency in price discovery. On the other hand empirical research shows that foreign investor participation lowers

bond yields and induces high volatility in the bond market (Andritzky, 2012). The high volatility is induced through the frequent purchases (inflows) and sales (outflows) in search of high yields and in response to increased risk, while lower yields are a consequence of increased prices due to high demand.

South Africa is one of the 27 countries in the world that adopted the inflation targeting framework as the anchor of their monetary policy (Barnebeck Andersen, Malchow-Møller and Nordvig, 2014). Ghana was the second country in Africa to use this framework. Under the inflation targeting framework, the Reserve Bank adjusts the repurchase rate (repo rate) to control inflation and keep it within a targeted band of 3-6%. With this framework the South African Reserve Bank directly influences short-term rates by setting and adjusting the repo rate in response to forecasted deviations of inflation. The movements in the short term interest rates through changes in the repo rate, in turn affect two of the factors under consideration in this study, the yield curve slope and the interest rate level. Movements of short term rates due to changes in the repo rate affect the yield curve slope and the long term interest rates. In addition it also affects the level of interest rates which determine the risk, required rate of return and prices of bonds and interest rate derivatives (Hassan, 2013).

3. Theoretical framework

The yield spread is the difference between the yield on a corporate bond and a comparable government bond. Yield spreads have long been considered to be driven primarily by expected default losses of corporate bonds, tax premiums and risk premiums (Mann, Spreads and Error, 2001). Merton (1974) and recent empirical evidence have however shown that other factors, like equity volatility, interest rate levels and the yield curve slope, are significant drivers of yield spread changes.

3.1 Equity volatility

In Merton (1974)'s model, the bond value and consequently the yield spread of a corporate bond is determined by three factors; the return on risk-free debt, the characteristics of the bond (such as maturity, coupon rate, and call terms) and the probability of default as indicated by the equity volatility on the stock market. Based on Merton (1974), bondholders could be viewed as risk-free holders who sold put options on the firm's asset to equity holders. The exercise price of the put option will be equal to the par value of the debt. The model specifies a continuous stochastic process for the value of a corporate bond, where default is assumed to occur when the firm's value falls below the par

value of the outstanding debt. The probability of the firm reaching the default threshold increases with an increase in equity volatility. Therefore high equity volatility could harm bond holders by raising the probability of default, which will lead to bond holders demanding higher yields to compensate for increased risk. In this way, equity volatility is thought to have a positive correlation with yield spreads (Campbell and Taksler, 2004).

3.2 Yield curve slope

The slope of the yield curve is measured as the difference between the yield of a longer term bond and that of a shorter term comparable bond. The magnitude of the difference determines the steepness of the yield curve. The bigger the magnitude the steeper the yield curve and vice versa. The shape of the yield curve is upward sloping when the yield of the short term bond is lower than the yield of the long term. The yield curve is perceived to embody two sets of information for investors, information about future interest rates and an indication of broader economic conditions. Using this information, Avramov, Jostova and Philipov (2007) presented two contrasting hypothesis linking the yield curve to yield spread changes. The first one considers the link between the yield curve and future economic activity. A steep upward sloping curve is associated with high economic growth or an economic boom, which implies less default risk for corporates and consequently lowers yield spreads. An increase in the slope of the yield curve lowers the bond yield spreads and vice versa (Lepone and Wong, 2009). The second hypothesis considers the link between the yield curve and the future interest rates. The market perceives a steep upward sloping curve to be associated with expectations of higher future interest rates. Avramov, Jostova and Philipov (2007) suggest that an expectation of higher interest rates means an increase in the expected discount rate and consequently reduce the number of positive net present value (NPV) projects that can be undertaken by the company in future. This reduction would in turn lower the company's valuation and consequently increase yield spreads.

3.3 Interest rate level

Longstaff and Schwartz (1995) also explained the link between the levels of interest rates to yield spread changes through a default risk perspective. High levels of interest rates imply high reinvestment rates, which increases a company's future value (Avramov, Jostova and Philipov, 2007). In addition high interest rates raise the expected growth rate of the firm's cash flows and firm value, hence reducing the likelihood that the company's value will fall below a certain threshold (Boss and Scheicher, 2002). Therefore the impact of the high

cash flows, high growth rates and high expected firm values due to high interest rates is to lower the probability of the company defaulting and the firm value falling below a certain threshold.

4. Empirical literature and hypothesis development

4.1 Equity volatility

Merton (1974) predicts a positive relationship between equity volatility and yield spreads. Jubinski and Lipton (2012), Hibbert et al. (2011), Campbell and Taksler (2004), Kwan (1996) reported empirical evidence supporting Merton (1974). Campbell and Taksler (2004) found the relationship between equity volatility and yield spreads to be stronger than what Merton (1974) suggested, they found it to be explaining the yield variation as much as the credit ratings. The study by Hibbert et al. (2011) was unique, their proxy of equity volatility was based on aggregate market volatility (not firm specific equity/ idiosyncratic volatility), which they measured using the Chicago Board Options Exchange (CBOE) volatility index, (the VIX). However, on categorising and the testing the relationship by credit ratings, Jubinski and Lipton (2012), Kwan's (1996) reported contrasting results to Merton (1974)'s predictions. For bonds with a good credit rating Jubinski and Lipton (2012) reported a negative relationship between increases in equity volatility and yield spreads while for bonds with poor/lower credit rating they found a positive relationship, confirming Merton (1974). This seems to tie in with Kwan's (1996) observation that high quality bonds are almost insulated from equity market shocks while low quality bonds were affected more strongly by the equity market.

While there is a fair amount of literature on equity volatility and yield spreads, the case for equity volatility being the key driver of spreads is not clear-cut. The study by Collin-Dufresne, Goldstein and Martin (2001) show that only 25% of the variation in yield spreads (as measured by the adjusted R^2), is explained by equity volatility, even after controlling for other factors like firm leverage and liquidity. Additionally, the principal component analysis revealed the presence of an unknown factor that explained over 70% of the remaining variation, an indication that other unknown systematic factors were at play in driving the yield spread. While not entirely a contradiction, this finding does not completely reconcile with Campbell and Taksler (2004) assertion that equity volatility on its own could explain a third of the variation in yield spreads. Given the strong empirical support for the Merton's (1974) model, we hypothesise the following: *H1: There is a significant positive relationship between equity volatility and yield spreads.*

4.2 Interest rate level

The relatively few prior studies that examined the impact of interest rates level and bond yield spreads reported a negative relationship, in support of the theoretical predictions of Longstaff and Schwartz (1995). Using a sample of Australian bonds, covering the period from 2003-2007, Lepone and Wong (2009) documented a negative relationship between changes of interest rate level and the yield spread changes. Similar results were reported by following authors whose studies were based on listed USA corporate bonds; Avramov, Jostova and Philipov (2007) using a sample of 2,375 bonds over the period 1990-2003; Collin-Dufresne, Goldstein and Martin (2001) based on a sample of 688 bonds, listed over the period from 1988-1997 and the study by Longstaff and Schwartz (1995) covered the period from 1977-1992 with a sample size of 149 bonds. The proxy of interest rates used by these studies was based on the yield of a government or treasury bonds. However, the time to maturity of the bonds varied across the studies. Lepone and Wong (2009), Collin-Dufresne, Goldstein and Martin (2001) used the yield of a 10-year government bond, while Longstaff and Schwartz (1995), Avramov, Jostova and Philipov (2007) used the yield of a 30 year and 5-year bond, respectively. In line with the theoretical predictions of Longstaff and Schwartz (1995) and the supporting empirical evidence, we therefore hypothesise the following, *H2: There is a negative relationship between levels of interest rates bond yield spreads.*

4.3 Yield curve slope and yield spreads

The studies examining the effect of the yield curve slope on bond spread changes reported mixed results. A study by Hibbert et al (2011) reported a positive relationship between the slope of the yield curve and yield spreads. The result is consistent with the argument by Avramov, Jostova and Philipov (2007) that an increase in the slope of the curve reduces the number of positive net present value (NPV) projects that can be undertaken by the company and consequently increase yield spreads. The study by Hibbert et al (2011) was based on a sample of 2,524 corporate bonds issued over the period 2002-2008. The slope of the yield curve was measured by the difference between the yield of a two-year and a ten-year Treasury bond. Similar results were reported by Avramov, Jostova and Philipov (2007) using a sample of 2,375 US corporate bonds over the period 1990-2003. The slope of the yield curve was measured by the difference between the yield of a two-year and a thirty-year Treasury bonds.

However, Lepone and Wong (2009) reported contrasting results using a sample of bonds trading on the Australian market over the period from 2003 to

2007. They found the increase in the slope of the yield curve to be negatively related to yield spreads. In the study the yield curve slope was measured as the difference between the yield of a ten-year government bond and a three-year government bond. Studies by Huang and Kong (2003), Collin-Dufresne, Goldstein and Martin (2001) reported similar results using data from USA. However the results of the study by Collin-Dufresne, Goldstein and Martin (2001) were not statistically significant We therefore hypothesise the following: *H3: There is a significant relationship between slope of the yield curve and bond spreads.*

4.4 The impact of the financial crisis on the relationship between bond yield spreads and the determinants

The study by Hibbert et al (2011) went a step further to examine the impact of the financial crisis in influencing the relationship between various determinants discussed above and yield spread changes. Hibbert et al (2011) divided the sample over two periods. The first period covered the period before the financial crisis and the second period covered the post crisis period. The study found the impact of explanatory factors like equity volatility to be more pronounced during the financial crisis. We therefore hypothesise the following: *H4: The impact of equity volatility, interest rate levels and yield curve are more pronounced during the financial crisis period.*

5. Research design

5.1 Data and sample description

The sample period covers a nine-year period from 2005-2013. Prior studies on the subject cover periods ranging from 5-7 years (Jubinski and Lipton, 2012; Hibbert et al., 2011; Campbell and Taksler, 2004). We extend our sample to nine periods with the idea of increasing our sample population in light of the challenges of data availability in South Africa. The sample is also designed to cover the most recent period in order to make the results relevant to the current environment.

We restrict our sample to corporate vanilla bonds (non-callable, non-puttable, non-convertible, no sinking fund provision and with a fixed coupon rate) listed on the BESA. This will make it easy to compare the results to prior studies, (e.g Hibbert et al 2011; Avramov, Jostova and Philipov 2007; Collin-Dufresne, Goldstein and Martin 2001) which all focused on vanilla bonds. The initial sample comprised 7,617 bonds. The following criteria was applied to get to the final sample of 106 bonds; (1) fixed rate coupon; (2) listed, matured or

redeemed; (3) issued between 2005 and 2013; (4) issued locally; (5) no callable, convertible, sinking fund provisions; (6) no government guarantee; and (7) issued by a publicly traded company with ordinary equity. Bonds with missing data points were removed from the sample. The final sample consisted of 106 bonds from 18 issuers.

The following dataset was sourced from Bloomberg; daily bond yields for corporate and government bonds, interest rates levels. Firms were classified as either being financial firms or non-financial firms. The bond convexity variable is from the BESA market information.

To examine the impact of the financial crisis, (H_4), the sample period is broken down into three subsamples, the pre-crisis period from 2005-2006; the mid-crisis period from 2007-2008; and the post-crisis period from 2009-2013. The mid-crisis period was the height of the financial crisis period and its definition is consistent with studies by Aebi, Sabato and Schmid (2012), Erkens, Hung and Matos (2012), Hibbert et al (2011). Given the participation of non-resident or foreign investors on the South African bond market, the height of the financial crisis is of significance as it reflects the period of high risk aversion, by foreign investors, to emerging market assets. The risk aversion affects the outflows (sales) and purchases (inflows), consequently affecting the volatility of bond prices, yields and yield spreads.

5.1.1 Dependent variable

Our dependent variable is the bond yield spread. The yield spread is defined as the difference between the yield on a corporate bond and a comparable government bond (Campbell and Taksler, 2004). The study uses the yield spread for each bond, which is calculated by taking the difference between the corporate bond's yield in our sample and the yield on a government bond with the same maturity, as the dependant variable. This is in line with prior existing empirical literature (see Hibbert et al., 2011; Collin-Dufresne, Goldstein and Martin, 2001). In situations where there was no government bond of similar maturity, the study uses a government bond with the closest maturity but meeting the criteria given above.

5.1.2 Independent variables

Equity volatility data is also obtained from Bloomberg. The data used is the 180-day historical share price volatility for each issuer, measured as the standard deviation of equity returns. The choice of the 180-day historical volatility over any other n-day historical volatility was informed by Campbell and Taksler (2004)

methodology. A 180-day period ensures that all relevant market information is known to investors by the time bond trades are executed. To investigate the feasibility of using JSE All Share Index (JALSH) historical volatility as a measure of equity volatility, the study examines correlations between JALSH volatility and firm-specific volatility. While the correlations are positive, they were not consistently strong from firm to firm. The strength of the correlations varied from firm to firm with some firms displaying strong correlations and other weak correlations. The study choose firm-specific volatility instead of aggregate measures of volatility like South African Volatility Top 40 (SAVIT40) index because the Merton (1974) model itself presents a firm level assessment of corporate debt and volatility. Moreover, using an aggregate measure of volatility may risk averaging away some volatility effects specific to any given firm. In addition the SAVIT40 did not have sufficient data points since it was only launched in 2007, it could not cover the full sample period.

Interest rate level figures are obtained by taking the yield on a 10-year government bond. The yield curve slope figures are obtained by taking the difference between 10 and 2-year treasuries. The definition of these two variables is consistent with the study by Collin-Dufresne, Goldstein and Martin (2001).

5.1.3 Control variables

Credit ratings for most of the bonds in the sample were unavailable, so the study uses the issuer ratings instead. Where the issuer is missing a credit rating, the study uses the parent company's rating. In the case of such issuers, the parent either wholly owned the issuer or had a controlling stake. Only one issuer was not wholly owned but in this case the parent held an 80% stake in the issuer. None of the credit rating agencies had ratings for every issuer in the sample. Instead, a handful of issuers had a rating from Moody's, Standard & Poor's or Fitch, and the rest of the issuers had ratings from Global Credit Rating Co. (GCR)[1]. Credit ratings are therefore recorded and grouped into AA, A, BBB and BB categories in order to better match the GCR rating scale.

5.1.4 Summary statistics

Table 1 summarises the average yield spreads in basis points for the bonds in the sample by maturity and credit rating. Panel A covers the full sample period which is from 2005 to 2013, Panel B covers the pre-crisis period which is from 2005 to 2006, Panel C covers the mid-crisis period which is from 2007-2008 and Panel D covers the post-crisis period which is from 2009 to 2013.

1 GCR is a South Africa based credit rating agency that provides credit ratings for a majority of African institutions.

Table 1: Yield spreads

PANEL A: AVERAGE YIELD SPREADS (2005 TO 2013)

Maturity group Panel A: Full Sample	AA	A	BBB	BB
Short (Less than 5 years)	162	284	-	212
Medium (5 to 10 years)	143	235	257	287
Long (More than 10 years)	167	-	-	-
Total	152	251	257	281

PANEL B: AVERAGE YIELD SPREADS (2005 TO 2006)

Short (Less than 5 years)	50	-	-	-
Medium (5 to 10 years)	99	79	-	136
Long (More than 10 years)	88	-	-	-
Total	57	79	-	136

PANEL C: AVERAGE YIELD SPREAD OVER THE MID-CRISIS PERIOD FROM 2007-2008

Short (Less than 5 years)	103	219	-	-
Medium (5 to 10 years)	141	161	172	184
Long (More than 10 years)	100	-	-	-
Total	120	178	172	184

PANEL D: AVERAGE YIELD SPREAD OVER (2009-2013)

Short (Less than 5 years)	190	295	-	212
Medium (5 to 10 years)	143	253	269	323
Long (More than 10 years)	183	-	-	-
Total	160	267	269	312

As expected, yield spreads increase as credit rating quality decreases. In Panel A, medium-term AA rated bonds have an average spread of 143 basis points, A rated bonds have an average spread of 235 basis points and BB rated bonds have an average spread of 287 basis points.

Compared to the pre-crisis period, yield spreads are higher during the financial crisis and highest during the post-crisis period. For example, AA rated bonds have an average yield spread of 57 basis points before the financial crisis. This figure rises to 120 basis points during the crisis and then rises again to 160 basis points after the crisis.

Table 2 presents means and standard deviations of bond characteristics across rating groups as well as characteristics of the main variables to be used in later

regression analysis. Means and standard deviations of bond characteristics are displayed by rating group. Statistics for regression variables are also displayed. ΔVolatility is the daily change in issuer equity volatility, ΔTlevel is the daily change in the interest rate level and ΔSlope is the daily change in the slope of the yield curve.

Table 2: Descriptive statistics of the bonds in the sample population

		Mean			
		AA	A	BBB	BB
Coupon	%	10.551	10.704	10.039	11.277
Maturity	Yrs	7.644	5.102	6.414	5.146
Age	Yrs	5.722	3.170	4.459	2.905
Yield spread	Bp	151.701	250.648	256.593	280.956
Δ Yield spread	Bp	0.109	-0.015	-0.009	-0.062
Yield	%	8.744	9.268	9.706	9.845
N		62	31	5	8
		Standard Deviation			
		AA	A	BBB	BB
Coupon	%	2.108	1.712	1.690	1.985
Maturity	Yrs	5.884	1.471	0.894	0.719
Age	Yrs	5.791	1.938	1.457	1.593
Yield spread	Bp	70.689	124.057	133.539	145.559
Δ Yield spread	Bp	10.878	7.819	3.244	3.351
Variable	Observation	Mean	Std. Dev.	Min	Max
ΔYield spread	84370	.0000498	1.118311	-5.775	5.845
ΔVolatility	84370	-.0000229	.3649928	-1.63544	1.536332
ΔTlevel	84370	-9.49e-06	.1280647	-.5508696	.5394013
$(\Delta Tlevel)^2$	84370	-.0000389	.5241964	-2.290288	2.254923
ΔSlope	61957	-.0002552	.2692194	-1.623369	1.560449
Yield	%	1.351	1.786	1.754	1.985

As expected, coupons and yield spreads increase as credit rating quality decreases. AA rated bonds have a mean coupon of 10.5% and a mean yield spread of 151.7 basis points while BB rated bonds have a mean coupon of 11.2% and a mean yield spread of 280.9 basis points. The mean term to maturity hovers between five years and just over seven and a half years.

5.2 Empirical model

This section presents the methods used to analyse the data and draw conclusions. First is a discussion of the data vis-à-vis Ordinary Least Squares (OLS) regression assumptions and an explanation of the layout of regression results. Next, the paper's basic model is presented followed by an augmented version of the model that adds nonlinear convexity terms. Finally, an explanation of further analysis methods is presented.

5.2.1 Regression assumptions and analysis

The study follows Boss and Scheicher (2002), Collin-Dufresne, Goldstein and Martin (2001) in using OLS regressions to investigate the relationships between yield spreads and the independent variables (equity volatility, the interest rate level, and the yield curve slope).

Initial analysis of the data using the Dickey-Fuller test shows that it is non-stationary and therefore in need of stationarisation. For this reason, first differences of all the daily data were calculated and used in the regressions. All the assumptions were tested and the data was corrected for normality using various transformations. Interest rate and equity volatility was log transformed. For the yield curve slope, the unit root transformation was applied.

The study estimates the equations for each credit rating group in the overall sample and then repeated for each time period. For example, regressions were run for AA rated bonds in the overall sample (2005-2013), and then repeated for the pre-crisis period (2005-2006), the mid-crisis period (2007-2008), and then the post-crisis period (2009-2013). The same process was repeated for A, BBB, and BB rated bonds.

5.2.2 Basic model

Equation 1 states the basic model, used to investigate the determinants of bond yield spreads. This equation follows specification from existing empirical literature such as Lepone and Wong (2009); Collin-Dufresne, Goldstein and Martin (2001).

$$\Delta YS = \alpha + \beta_1 \Delta Volatility + \beta_2 \Delta Tlevel + \beta_3 \Delta Slope + \beta_4 Fin + \varepsilon, \quad (1)$$

where ΔYS is the change of the bond's yield spread between consecutives daily spread; $\Delta Volatility$ is the change of the bond issuer's historic share price volatility; $\Delta Tlevel$ is the change of the interest rate level as measured by the yield on a 10-year government bond; $\Delta Slope$ is the change of the yield curve slope as measured by the difference between 10 and 2-year treasuries. *Fin* is a

dummy to indicate that the bond was issued by a financial firm, ε is the error term. The expected sign of the different coefficients (βs) are as hypothesised above.

5.2.3 Nonlinear terms

Collin-Dufresne, Goldstein and Martin (2001) point out the need to consider bond convexity issues so as to account for this, squared term for the interest rate level is added to Model (equation) 1. The paper's second model is therefore:

$$\Delta YS = \alpha + \beta_1 \Delta Vol + \beta_2 \Delta Tlevel + \beta_3 (\Delta Tlevel)^2 + \beta_4 \Delta Slope + \beta_5 Fin + \varepsilon, \qquad (2)$$

The other variables are as defined above while $(\Delta Tlevel)^2$ is the square of $\Delta Tlevel$

6. Empirical results and discussion

6.1 Basic model results

Table 3: Regression results

PANEL A: MODEL 1 REGRESSION RESULTS (2005-2013)

	AA	A	BBB	BB
ΔVolatility	0.085***	0.55***	3.65***	0.91***
	(0.015)	(0.027)	(0.125)	(0.025)
ΔTlevel	0.56***	3.58***	-1.45***	4.29***
	(0.040)	(0.089)	(0.229)	(0.068)
ΔSlope	-0.0060	0.70***	0.28**	0.54***
	(0.019)	(0.039)	(0.111)	(0.028)
Fin	-	0.26***	-0.0023	-
	-	(0.021)	(0.097)	-
Constant	-0.00092	-0.093***	-0.0014	0.0041
	(0.005)	(0.013)	(0.029)	(0.008)
N	33980	18756	2743	6478
R^2	0.010	0.164	0.263	0.586

PANEL B: MODEL 1 REGRESSION RESULTS (2005-2006)

	AA	A	BBB	BB
ΔVolatility	-0.38***	0.046*	-	-0.041
	(0.043)	(0.024)	-	(0.055)
ΔTlevel	-0.39**	2.58***	-	2.16***
	(0.158)	(0.100)	-	(0.338)
ΔSlope	0.25***	0.95***	-	0.61***
	(0.048)	(0.026)	-	(0.056)
Fin	-	-0.21***	-	-
	-	(0.023)	-	-
Constant	0.0033	0.056***	-	0.0028
	(0.017)	(0.013)	-	(0.023)
N	2805	1673	-	789
R^2	0.048	0.645	-	0.284

PANEL C: MODEL 1 REGRESSION RESULTS (2007-2008)

	AA	A	BBB	BB
ΔVolatility	0.14***	0.67***	1.70***	1.02***
	(0.014)	(0.038)	(0.048)	(0.037)
ΔTlevel	0.21***	4.56***	1.80***	5.60***
	(0.053)	(0.187)	(0.117)	(0.124)
ΔSlope	0.014	0.54***	0.48***	0.66***
	(0.024)	(0.067)	(0.055)	(0.054)
Fin	-	0.62***	-	-
	-	(0.065)	-	-
Constant	-0.0029	-0.042**	-0.012	0.0015
	(0.006)	(0.019)	(0.014)	(0.014)
N	10243	6438	891	2921
R^2	0.020	0.226	0.793	0.649

PANEL D: MODEL 1 REGRESSION RESULTS (2009-2013)

	AA	A	BBB	BB
ΔVolatility	0.47***	0.50***	6.40***	1.10***
	(0.039)	(0.050)	(0.226)	(0.038)
ΔTlevel	0.78***	3.37***	-3.57***	3.13***
	(0.055)	(0.114)	(0.316)	(0.053)
ΔSlope	-0.21***	0.72***	0.14	0.50***
	(0.032)	(0.061)	(0.155)	(0.029)
Fin	-	0.33***	0.0020	-
	-	(0.029)	(0.111)	-
Constant	-0.000021	-0.18***	0.00048	0.00027
	(0.007)	(0.021)	(0.040)	(0.007)
N	20932	10645	1852	2768
R^2	0.021	0.125	0.308	0.720

PANEL A: MODEL 2 RESULTS (2005-2013)

	AA	A	BBB	BB
ΔVolatility	0.068***	0.082***	3.52***	0.81***
	(0.015)	(0.028)	(0.128)	(0.024)
ΔTlevel	-10.2***	-100.0***	-33.2***	-43.7***
	(1.205)	(2.642)	(7.904)	(1.988)
$(\Delta Tlevel)^2$	2.68***	25.8***	7.94***	11.9***
	(0.300)	(0.657)	(1.978)	(0.492)
ΔSlope	0.0092	0.78***	0.40***	0.52***
	(0.019)	(0.037)	(0.115)	(0.027)
Fin	0	0.20***	-0.0035	0
	(.)	(0.020)	(0.097)	(.)
Constant	-0.00080	-0.073***	-0.00074	0.0043
	(0.005)	(0.012)	(0.028)	(0.008)
N	33980	18756	2743	6478
R^2	0.012	0.227	0.268	0.621

PANEL B: MODEL 2 RESULTS (2005-2006)

	AA	A	BBB	BB
ΔVolatility	-0.36***	0.082***	-	-0.069
	(0.042)	(0.024)	-	(0.052)
ΔTlevel	27.5***	20.8***	-	-181.8***
	(4.601)	(2.935)	-	(16.314)
$(\Delta Tlevel)^2$	-6.85***	-4.47***	-	43.5***
	(1.130)	(0.720)	-	(3.858)
ΔSlope	0.26***	0.97***	-	0.67***
	(0.048)	(0.026)	-	(0.053)
Fin	0	-0.21***	-	0
	(.)	(0.023)	-	(.)
Constant	0.0013	0.056***	-	0.0058
	(0.017)	(0.013)	-	(0.021)
N	2805	1673	-	789
R^2	0.060	0.653	-	0.384

PANEL C: MODEL 2 RESULTS (2007-2008)

	AA	A	BBB	BB
ΔVolatility	0.14***	0.58***	1.46***	0.91***
	(0.014)	(0.041)	(0.042)	(0.036)
ΔTlevel	-8.46***	-25.1***	-55.0***	-52.9***
	(1.511)	(5.486)	(2.861)	(3.440)
$(\Delta Tlevel)^2$	2.14***	7.26***	14.1***	14.4***
	(0.372)	(1.340)	(0.710)	(0.847)
ΔSlope	0.0054	0.52***	0.47***	0.62***
	(0.024)	(0.067)	(0.046)	(0.052)
Fin	0	0.61***	0	0
	(.)	(0.065)	(.)	(.)
Constant	-0.0029	-0.041**	-0.010	0.0036
	(0.006)	(0.019)	(0.012)	(0.013)
N	10243	6438	891	2921
R^2	0.023	0.229	0.857	0.681

PANEL D: MODEL 2 RESULTS (2009-2013)

	AA	A	BBB	BB
ΔVolatility	0.40***	-0.64***	6.39***	0.93***
	(0.039)	(0.049)	(0.225)	(0.037)
ΔTlevel	-24.4***	-195.0***	-53.2***	-33.8***
	(1.872)	(3.733)	(15.204)	(1.815)
$(\Delta Tlevel)^2$	6.30***	49.7***	12.5***	9.22***
	(0.469)	(0.935)	(3.823)	(0.453)
ΔSlope	-0.10***	1.48***	0.48***	0.63***
	(0.033)	(0.057)	(0.187)	(0.027)
Fin	0	0.23***	0.0016	0
	(.)	(0.026)	(0.111)	(.)
Constant	-0.000018	-0.13***	0.00053	0.00029
	(0.007)	(0.019)	(0.040)	(0.006)
N	20932	10645	1852	2768
R^2	0.030	0.309	0.312	0.756

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6.1.1 Model 1 results: Full sample period (2005-2013)

Panel A presents results for the full sample which covers the period from 2005 to 2013. The coefficient of equity volatility is positive and significant at 1% level for the four credit rating categories, supporting H_1. The results show that equity volatility is an important determinant of the movements in bond yield spreads in South Africa, as predicted by Merton (1974)'s model. From the model, an increase in equity volatility increases the probability of the firm value reaching the default threshold, thereby increasing the yield spread (Merton, 1974), as corporate bond investors will demand a higher rate of return. Lepone and Wong (2009); Campbell and Taksler (2004); Collin-Dufresne, Goldstein and Martin (2001) also find a significant positive relationship between yield spread changes and equity volatility. The study by Kwan's (1996) found equity volatility to be a significant driver of yield spread changes but instead they reported a negative relationship, in contradiction to Merton (1974). Jubinski and Lipton (2012) also reported a negative a relationship but only for the subsample of bonds with low yields or high credit ratings. In our case the co-efficient for equity volatility is positive and significant across all the credit ratings categories, which attest to

the fact that its impact is not very different for low (high credit ratings) and high yield bonds (low credit ratings).

The coefficient of the interest rate level is significant at 1% for all the credit ratings categories but it carries a negative sign for the BBB rating category. The results for the BBB rating category support the theoretical predictions of Longstaff and Schwartz (1995), who argues that increasing interest rates tend to raise the expected growth rate and consequently firm value. This reduces the likelihood of the firm breaching its default threshold, which lowers the risk premium and yield spread. The results are consistent with Avramov, Jostova and Philipov (2007), Collin-Dufresne, Goldstein and Martin (2001), Longstaff and Schwartz, (1995) who all reported a negative relationship between the changes in interest rates and yield spreads changes. For the AA, A and BB rating groups, the coefficient for interest rate level is positive, indicating that the yield spreads increase with an increase in interest rates. This relationship is not supported by any theoretical and empirical literature. In addition, the inconsistent pattern of the results, which shows a negative sign for the second lowest rating BBB and a positive sign for the very lowest rating of BB and the highest ratings, makes it difficult to make a conclusion on whether the impact of interest rate level changes varies with the credit rating.

The coefficients of the yield curve slope are significant for all but one credit rating category, the AA. For the A and BB category, the coefficient is positive and significant. Which means the yield spread increases with the increase in the slope. This is consistent with the Avramov, Jostova and Philipov (2007)'s first argument, that an increasing slope of the yield curve increases the expected discount rate which decreases the expected NPV of available projects. The effect of this is to reduce company value and consequently increase credit spreads**.** Hibbert et al (2011) reported similar results from a sample of USA bonds. On the other hand, the coefficient of the yield curve is negative and significant for bonds in the AA rating category. This shows that the yield spread decreases as the yield curve slope increases and vice versa. The negative relationship support the findings of Lepone and Wong (2009), Huang and Kong (2003), Collin-Dufresne, Goldstein and Martin (2001) and it is consistent with the hypothesis that increasing the slope of an upward sloping yield curve is associated with high economic growth or an economic boom. An economic boom implies less default risk for corporates and consequently lowers yield spreads. Overall both results confirm the hypothesis that the yield curve slope is an important determinant of yield spread changes. The yield slope is not significant for the AA rating category, an indication that changes in the yield curve slope have low impact on low yields bonds.

6.1.2 Model 1 results: Pre-crisis period (2005-2006)

Panel B of Table 1 presents the results for the pre-crisis sample period (2005 to 2006). The equity volatility coefficient has the expected positive sign for A rated bonds but carries the negative sign for AA and BB rated bonds. The results for the A rating category are consistent with Campbell and Tasker (2004), Kwan, 1996), they reported a positive relationship between yield spread changes and equity volatility using the pre-crisis sample period. The negative relationship for the AA and BB rating category is supported by neither theory nor empirical findings. In addition, the inconsistent pattern of the results, which shows a positive sign for the second highest rating A and a negative sign for the very lowest rating of BB and the highest rating of AA, makes it difficult to make a conclusion on whether the impact of equity volatility during the pre-crisis period varies with the credit rating.

The interest rate level is found to be significant across all rating groups (the sample did not have BBB rated bonds in this time period). The coefficient is positive for A and BB rated bonds and negative for AA rated bonds. This shows that prior to the financial crisis, yield spreads of AA (low yield bonds) exhibited a positive relationship with yield spreads while relatively higher yield bonds (A and BB) exhibited a negative relationship. The positive relationship contrasts the theoretical predictions of Longstaff and Schwartz (1995). The negative relationship is consistent with prior studies that examined the relations over the period prior to the financial crisis (see Lepone and Wong, 2009; Avramov, Jostova and Philipov, 2007; Collin-Dufresne, Goldstein and Martin, 2001; Longstaff and Schwartz, 1995).

The yield curve slope is significant and positive for all rating groups. The result support Avramov, Jostova and Philipov (2007)'s argument, that an increasing slope of the yield curve increases the expected discount rate which decreases the expected NPV of available projects, causing the firm value to decrease while the spreads increase. Hibbert et al (2011) documented similar findings but their sample period did not only cover the pre-crisis period, it also covered the mid and post-crisis period. The results contradict the findings by Lepone and Wong (2009), Huang and Kong (2003), Collin-Dufresne, Goldstein and Martin (2001), as they find the yield spread to decrease with an increase in the yield curve slope for a sample that covered the period prior to the financial crisis.

6.1.3 Model 1 results: Mid-crisis period (2007-2008)

Panel C of Table 1 presents results for the mid-crisis period (2007-2008). The coefficients for equity volatility and interest rate variables are significant and positive for the four credit rating categories. The yield curve slope is positive and significant for all rating groups except for AA category, whose co-efficient is insignificant but positive. This shows that the changes in the yield curve slope have low impact on low yield bonds during a financial crisis. The only study to cover the mid-financial crisis period is by Hibbert et al (2011). They find equity volatility to be a significant determinant of yield spreads during the mid-crisis period.

6.1.4 Model 1 results: Post-crisis period (2009-2013)

Finally, panel D presents results for the post-crisis period which is 2009 to 2013. In this time period, the interest rate level is significant for all rating groups and the coefficient carries the expected sign for BBB rated bonds only, just like full sample results. The yield curve slope is significant for all rating groups except BBB rated bonds. It carries the expected negative sign for AA rated bonds. This negative sign generally implies that decreasing slope of the term structure may imply a weakening economy, which in turn may lower the expected growth rate of the firm value and hence lead to higher credit spreads (see Boss and Scheicher, 2002). The volatility coefficient is highly significant and carries the expected positive sign and the financial firm dummy is significant only for rating group A. The positive coefficient on the financial firm dummy suggests that yield spreads are marginally higher for financial firms than for non-financial firms. We did not find any empirical studies whose sample was limited to the post-crisis.

Overall, the regression results for Model 1 suggest that equity volatility is a significant driver of yield spreads. The interest rate level and the yield curve slope are also important drivers of spreads though they have inconsistent sign across rating groups. Finally, the financial firm dummy is mostly insignificant meaning that yield spreads do not appear to be significantly different between financial firms and non-financial firms. While the interest rate level and yield curve slope are found to be significant, there are generally no differences between credit rating groups. This is not entirely surprising because previous papers have only observed credit rating differences when looking at equity volatility. If equity volatility is the only factor that produces credit rating differentiation, then it is not surprising that no differentiation is observed when equity volatility is not found to be significant.

6.2 Nonlinear terms

Table 4 presents regression results for Model 2 which takes bond convexity terms into account.

TABLE 4: MODEL 2 REGRESSION RESULTS

PANEL A: MODEL 2 RESULTS (2005-2013)

	AA	A	BBB	BB
ΔVolatility	0.068***	0.082***	3.52***	0.81***
	(0.015)	(0.028)	(0.128)	(0.024)
ΔTlevel	-10.2***	-100.0***	-33.2***	-43.7***
	(1.205)	(2.642)	(7.904)	(1.988)
$(\Delta Tlevel)^2$	2.68***	25.8***	7.94***	11.9***
	(0.300)	(0.657)	(1.978)	(0.492)
ΔSlope	0.0092	0.78***	0.40***	0.52***
	(0.019)	(0.037)	(0.115)	(0.027)
Fin	0	0.20***	-0.0035	0
	(.)	(0.020)	(0.097)	(.)
Constant	-0.00080	-0.073***	-0.00074	0.0043
	(0.005)	(0.012)	(0.028)	(0.008)
N	33980	18756	2743	6478
R^2	0.012	0.227	0.268	0.621

PANEL B: MODEL 2 RESULTS (2005-2006)

	AA	A	BBB	BB
ΔVolatility	-0.36***	0.082***	-	-0.069
	(0.042)	(0.024)	-	(0.052)
ΔTlevel	27.5***	20.8***	-	-181.8***
	(4.601)	(2.935)	-	(16.314)
$(\Delta Tlevel)^2$	-6.85***	-4.47***	-	43.5***
	(1.130)	(0.720)	-	(3.858)
ΔSlope	0.26***	0.97***	-	0.67***
	(0.048)	(0.026)	-	(0.053)
Fin	0	-0.21***	-	0
	(.)	(0.023)	-	(.)
Constant	0.0013	0.056***	-	0.0058
	(0.017)	(0.013)	-	(0.021)
N	2805	1673	-	789
R^2	0.060	0.653	-	0.384

PANEL C: MODEL 2 RESULTS (2007-2008)

	AA	A	BBB	BB
ΔVolatility	0.14***	0.58***	1.46***	0.91***
	(0.014)	(0.041)	(0.042)	(0.036)
ΔTlevel	-8.46***	-25.1***	-55.0***	-52.9***
	(1.511)	(5.486)	(2.861)	(3.440)
$(\Delta Tlevel)^2$	2.14***	7.26***	14.1***	14.4***
	(0.372)	(1.340)	(0.710)	(0.847)
ΔSlope	0.0054	0.52***	0.47***	0.62***
	(0.024)	(0.067)	(0.046)	(0.052)
Fin	0	0.61***	0	0
	(.)	(0.065)	(.)	(.)
Constant	-0.0029	-0.041**	-0.010	0.0036
	(0.006)	(0.019)	(0.012)	(0.013)
N	10243	6438	891	2921
R^2	0.023	0.229	0.857	0.681

PANEL D: MODEL 2 RESULTS (2009-2013)

	AA	A	BBB	BB
ΔVolatility	0.40***	-0.64***	6.39***	0.93***
	(0.039)	(0.049)	(0.225)	(0.037)
ΔTlevel	-24.4***	-195.0***	-53.2***	-33.8***
	(1.872)	(3.733)	(15.204)	(1.815)
$(\Delta Tlevel)^2$	6.30***	49.7***	12.5***	9.22***
	(0.469)	(0.935)	(3.823)	(0.453)
ΔSlope	-0.10***	1.48***	0.48***	0.63***
	(0.033)	(0.057)	(0.187)	(0.027)
Fin	0	0.23***	0.0016	0
	(.)	(0.026)	(0.111)	(.)
Constant	-0.000018	-0.13***	0.00053	0.00029
	(0.007)	(0.019)	(0.040)	(0.006)
N	20932	10645	1852	2768
R^2	0.030	0.309	0.312	0.756

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel A lays out results for the full sample which is 2005 to 2013. The interest rate coefficient carries the expected negative sign and is significant. The coefficients are generally larger than the previous model. The squared interest carries positive sign and as expected. This signifies the turning point, as interest rate increases it reaches a point where it will not lead to decrease in bond spread.

The interest rate is generally negative for all the period sub periods. The negative sign of the interest rate level coefficients suggests that yield spreads decrease as the interest rate level increases. This makes sense because a growing economy is linked to lower spreads (Hibbert et al., 2011). Further, as Longstaff and Schwartz (1995) pointed out, higher interest rate levels should lead to higher reinvestment rates and thus higher firm value. Higher firm value lowers the probability of default and the yield spread.

The volatility coefficient is significant and positive for all rating groups. This is also generally observed across almost sub sample periods except for pre-crisis period. The financial firm dummy is significant for rating group A and has a positive coefficient, except during the pre-crisis period suggesting that financial firms have marginally higher yield spreads than non-financial firms.

Overall, nonlinear interest rate level terms are significant. This suggests that bond convexity is also an important influencing factor in determining yield spreads. Collin-Dufresne, Goldstein and Martin (2001) also found nonlinear interest rate level terms to be significant.

6.3 The impact of the financial crisis

In order to examine the impact of the financial crisis in influencing the relationship between the independent variables (volatility, the interest rate level and the yield curve slope) and yield spreads, we analyse the average coefficient from regressions of Model 1 and Model 2. These average coefficient are analysed over the three sub periods, pre-financial crisis (2005-2006) period the mid-crisis period (2007-2008), and then the post-crisis period (2009-2013).

Table 5 presents the Model 1 average coefficients for volatility, the interest rate level, and the yield curve slope over the sample's different time periods.

Table 5: Average coefficients from model 1 for the three sub-sample periods

	Pre-crisis	Mid-crisis	Post-crisis
ΔVolatility	-0.125	0.883	2.118
ΔTlevel	1.45	3.043	0.928
ΔSlope	0.603	0.455	0.288

Equity volatility coefficient is negative and not statistically significant in the pre-crisis period. The size of the co-efficient show that the variable had a small and negative impact. This is expected since the markets were stable during this period. However, during the mid-crisis and post crisis equity volatility coefficient carries the expected positive sign and is significant. The behaviour of the equity volatility variable during the pre, mid and post crisis are consistent with hypothesis 4. Overall, the comparison of the three sub periods show that the impact of equity volatility in driving changes in yield spreads is more pronounced during and after the financial crisis.

The interest rate level has a positive coefficient throughout the sample periods but is higher during the financial crisis and lower in the post-crisis period. This means that the impact of this variable is greatest during the financial crisis but has a low impact during the post-crisis period.

The yield curve slope term has a positive coefficient throughout the sample periods. The impact of the yield curve slope is greatest during the pre-crisis and lowest in the post-crisis period. The results show that the impact of the yield curve slope is less pronounced during post-crisis period.

Table 6 presents the Model 2 average coefficients for volatility, the interest rate level and its nonlinear terms, and the yield curve slope over the sample's different time periods.

Table 6: Average Coefficients From Model 2

	Pre-crisis	Mid-crisis	Post-crisis
ΔVolatility	-0.116	0.593	1.77
ΔTlevel	-44.5	-35.365	-76.6
$(\Delta Tlevel)^2$	10.727	9.475	19.43
ΔSlope	0.633	0.404	2.49

Volatility and yield curve slope display the same trends as discussed in the analysis of Table 5 above. What is interesting is that the impact of the interest

rate level is negative throughout all the periods. The impact is stronger during the post crisis period. The greater impact of the higher order interest rate level terms suggests that convexity has an important role in influencing yield spreads.

6. Summary and conclusion

In this study we use daily data to examine the importance of firm-specific equity volatility, the interest rate level and the yield curve slope in determining changes in yield spreads. Using data drawn from the South African market over the period 2005-2013 inclusive, we split the sample period into three sub periods (pre-financial crisis, mid-financial crisis and post-financial crisis) to capture the impact of the financial crisis of 2007-2008. Credit ratings, bond convexity and issuer sector are controlled for. The paper finds that firm-specific equity volatility, the level of interest rates, and the yield curve are significant determinants of bond yield spread changes.The variables are significant across different ratings categories and the three sub-periods. However, the impact of equity volatility was more pronounced during and post the financial crisis period. The impact of interest rate level is stronger during the financial crisis but declines post-the financial crisis period. For the yield curve slope, the impact is lower during the mid-financial crisis compared to the pre-financial crisis and it's at its lowest during the post-financial crisis period.

Notwithstanding the low R-squared for some of the categorised subsamples, the findings of those with high R-squared[2] have implications to theory, bond investors and policy makers. From a theoretical perspective our findings provide support for the Merton (1974) model, which is one of the widely used structural models of estimating the distance to default for listed firms (Bharath and Shumway, 2008). Based on the Merton (1974) model, yield spreads changes are driven by changes in equity volatility, interest rates (risk free-rate) and bond characteristics.

For bond investors, the findings provide information about the factors that affect the prices of bonds and the returns of active bond strategies. We show that movements in yields, and consequently spreads and prices are driven by changes in equity volatility, interest rate level and yield curve slope. For bond investors who seek arbitrage opportunities by taking a long/short position in a corporate bond position and a short/long position in government bond, the results of the study show that the potential returns of such a strategy will be

2 The reported high R^2 are for the following subsamples; pre-crisis A rated firms, 65%, mid-crisis, BBB rated firms-86%, BB rated 68% and post-crisis BB rated firms, 76%.

affected by changes in equity volatility, yield curve slope and interest rate level. In addition, the amount of returns driven by changes in equity volatility and interest rates levels will be more magnified during a financial crisis period compared to periods of stability. For policy makers, the findings of this study call for the need to introduce further measures and reforms to address liquidity challenges on the bond market and volatility induced by non-resident investors on the bond market. Our results show that the effect of the equity volatility on yield spreads to be more pronounced during the 2007-2008 global financial crisis. This is a reflection of vulnerability of the South African bond market to external shocks and risk aversion by international investors. In addition it reflects the thin liquidity of the SA corporate bond market. With high levels of liquidity, the impact of international investor risk aversion, inflows and outflows, will be minimised.

Our study is not without limitations. Firstly, the sample size is 106 bonds issued by 18 companies, this is relatively low compared to sample sizes of some studies covered in the USA (e.g Jubinski and Lipton, 2012; Hibbert et al, 2011; Avramov, Jostova and Philipov, 2007; Campbell and Taksler, 2004). Apart from potentially giving biased estimates, a smaller sample size provides little room or opportunities to conduct further analysis by splitting the data into subsamples with enough statistical power (Lin, Lucas Jr and Shmueli, 2013; Maas and Hox, 2005). With 106 bonds and 18 issuers, further analysis by issuer and or industry sector will reduce the statistical power of each subsample. Future research can revisit this topic by examining a larger sample size and go further to provide a detailed analysis on various factors like, issuer, industry etc. A large sample provide sufficient data to create subsample and then conduct further and detailed analysis, while maintaining sufficient statistical power in each subsample (Lin, Lucas Jr and Shmueli, 2013). Secondly, the regression results for some credit rating categories show a low R-squared, (for the full sample period the R-squared is 1% and 16% for AA and A category, respectively). This implies that the other factors not included in the regression could be at play in driving the yield spreads. In a similar study, Collin-Dufresne, Goldstein and Martin, (2001) reported a low R-squared of 25%, a further investigation revealed the presence of a single unobserved factor, common to all corporate bonds, as one of the key determinants of yield spread changes. In light of this, future research can contribute by including other macro-economic and systematic factors like market wide volatility, business climate, supply and demand shocks.

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Acknowledgments

We are indebted to two anonymous referees who provided excellent comments and suggestions on previous drafts of the article. We are also grateful to Prof. Collins G. Ntim and Prof. Paul Alagidede, the Editors of this journal, for sharing our enthusiasm for this article.

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