Implementing the Bond Convergence Trade in South Africa

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ABSTRACT

Convergence trade, by definition, is buying an asset now to be delivered at some date in the future and selling a similar asset, to be delivered at the same future date, at a higher price. In this paper, implementation of bond convergence trade is explored in the South African market. This is in spite of the features of the South African bond market. The South African bond market is significantly different from markets where bond convergence trade has previously been tested. Duration was subsequently introduced in identifying similarities between bonds, and this is the major difference introduced compared to prior work in the literature. The results showed that the trades give, on average, negative returns. However, further investigation into the impact of interest rates not only on the trade, but over the period of investigation and future expected interest rates, is required, before the results can be appropriately interpreted.

KEYWORDS

South African Bond Market; Government bonds; Convergence trade; Bond duration

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1. INTRODUCTION

A convergence trade by definition is buying an asset now to be delivered at some date in the future and selling a similar asset also to be delivered at the same future date at a higher price now. This is done with the expectation that at the future delivery date, the prices will converge, that is be close to equal, and investors will be indifferent between the two assets. Therefore the asset delivered from the purchase is used to settle the sale agreement and the positions are closed out. The investor therefore profits by the differences in selling and buying prices.

The setup condition, that is the set of rules or conditions that identify a potential trading opportunity, is the existence of two similar assets that trade at significantly different prices in the market. The existence of convergence trading opportunities is usually referred to as arbitrage, even though technically arbitrage refers to trading in identical assets, and convergence trading can occur when trading in just similar assets. Yet what exactly constitutes similarity is not usually defined, but is context-specific. Lamont and Thaler (2003) look at a couple of examples of when similar assets trade at different prices, and the theory of the "law of one price" that pushes prices to converge.

When the asset refers to bonds, we can structure a new bond-old bond convergence trade. When a bond is issued, it is referred to as the "new" bond, and the similar bond that was issued previously is referred to as the "old" bond. One of the interesting features observed is the premium at which the "new" bond trades compared to the similar "old" bond currently in the market. Therefore in being in line with the notion of buying cheap and selling expensive, bond convergence trade involves short selling the new bond when it is issued and buying the cheaper and similar old bond with identical cash flows as the new bond (Kondor, 2006) and profit by the amount of convergence as described above.

The purpose of the paper is to study the implementation of the bond convergence trade in the South African market. This work is derived from a similar paper by Krishnamurthy (2002) in which he studied the profitability of the bond convergence trade in the US market. Krishnamurthy studied the spread between newly issued 30 year Treasury bonds and old 30 year Treasury bonds that were issued every six months between June 1995 and November 1999. He observed that the spread followed a systematic pattern over each auction cycle, whereby it begins high at an auction date and converges toward zero at the next auction date. The profit on going short the new bond and long the old bond is established, and the trade is rolled over the investigation period. He takes account of differences in repo market financing rates, which are important in carrying out the trade. There he observed that the apparent arbitrage opportunity was merely a mispricing that was corrected when transaction costs were taken into account. Even without transaction costs the expected profitability was zero. Krishnamurthy then attempts to establish economic reasons for the apparent mispricing, one of which is the liquidity argument. He claims that the new bonds are more liquid than the old bonds hence trade at a premium to the old bonds. Secondly is the fact that the new bonds may be imperfect substitute of the old bonds at auction, and therefore should not be expected to trade at equal prices at onset.

The trade could not be replicated perfectly in South Africa because of how different the South African bond market operates compared to the US market. For starters bonds of the same term and coupon had to be issued at a regular pattern, yet in South Africa there has not been a time where bonds have been issued at a regular pattern in the recent history (See for example the *Schedule of Domestic Government Bonds* as of different years on the South African National Treasury website, 2010). Duration was subsequently introduced as a means of identifying similar bonds. Therefore we would select "new" and "old" bonds with similar duration, as bonds with similar duration have similar volatility. In wanting to maximise expected returns whilst maintaining the volatility of a bond portfolio within an acceptable range, one can switch between bonds of similar duration.

The remainder of the paper proceeds as follows. In order to fully appreciate market differences, section two outlines the features of the South African bond market and the process of the issuance of Government bonds. Section three discusses bonds issued by the national government in the recent history. Understanding how bonds were issued in the recent history helped in identifying an appropriate period for investigation and bonds to use in the trade. Section four analyses the yield spread between new and old bonds. In section five the actual trade is implemented and section six discusses the outcome of the investigation, and concludes in section seven.

2. THE SOUTH AFRICAN BOND MARKET

2.1 HISTORY AND SOME MARKET STATISTICS

Prior to 2009, the South African secondary bond market was regulated by the Bond Exchange of South Africa (BESA). BESA was formally licensed in 1996 as an independent exchange until June 2009 when it became a wholly-owned subsidiary of the Johannesburg Stock Exchange (JSE) (JSE, 2009). BESA operates under the JSE's Interest Rate Markets Division. The market enables investors to trade in both the cash and the derivatives markets (JSE, 2009).

The South African bond market is a leader in terms of number of bonds listed and turnover compared to other emerging market economies. Prior to the conclusion of the transaction with the JSE in June 2009, there were 1102 listed debt instruments in 2008 with a total nominal value of R825 billion (JSE, 2009). In 2008, the bond market turnover reported on BESA reached an annual record of R19.2 trillion. The market is also one of the most liquid in the world. The turnover ratio can be used as a measure of the liquidity of a bond market. For instance for government bonds it reflects the total value of government bonds traded in a particular year of interest divided by the total value of government bonds outstanding at the end of the previous year. The higher the turnover ratio, the easier it becomes for an investor to sell a bond in the secondary market. In 2008, the overall turnover ratio for bonds traded on BESA was 23 up from 17.7 reported in 2007, which is quite high compared to developed and emerging markets (JSE, 2009).

Of interest in this project are bonds issued by the national government that will form the basis for the implementation of the convergence trade in South Africa. In 2007 government bonds accounted for 56.43 per cent of the total nominal value of bonds issued and semi-government institutions accounted for 10.29 per cent. Government bonds are also the most actively traded and hence highly liquid; they contributed 93 per cent to total nominal turnover in 2006 (van Zyl et al., 2009: 291).

South Africa has a relatively large domestic market, even compared to some developed countries. Table 1 shows the sizes of the securities markets at the end of 2006 of some developed and emerging countries. The table shows that only South Korea has a larger domestic bond market compared to South Africa, of the emerging countries shown on the table (van Zyi et al., 2009: 292).

Table 1: Size of securities markets at the end of 2006 (in billions of US dollars)

Country	International debt securities market			Domestic debt securities market		
	Issuer			Issuer		
	Government	Financial Institutions	Corporations	Government	Financial Institutions	Corporations
Australia	10.6	371.9	16.9	97.1	215.4	144.8
Denmark	256.6	2221.8	110.7	1222.7	881.8	143.2
Germany	1.3	326.6	9	111.3	98.2	13.8
Switzerland	6.4	1749.9	255.4	835.1	379.4	23.1
United Kingdom	8	12.2	5.6	69.8	25.3	14.3
South Africa	44.9	28.9	19.8	169.1	112.5	27.4
Mexico	55.3	2.3	3.9	60.4	4.9	11.4
Argentina	3.7	22.4	6	59.2	33.9	53
Malaysia	33.8	6.1	0.4	129.5		
South Korea	7.7	64.9	28.2	459.9	291.9	258.2

Source: van Zyl et al. 2009

2.2 ISSUANCE OF GOVERNMENT BONDS THROUGH AUCTIONS

The National Treasury, which is responsible for managing South Africa's national government finances, has been using a system of primary dealers to issue government bonds since 1998, to ensure effective distribution of government bond issues. The issues occur through regular pronounced auctions that take place on Tuesdays, unless Tuesday is a public holiday in which case the auction would take place on the following business day. The auctions occur in terms of a calendar schedule issued at the beginning of the year which includes structured nominal amounts to be issued in that upcoming year. Only primary dealers can participate in such auctions. The South African Reserve Bank (SARB) acts as an agent for the National Treasury and deals with the primary dealers.

Primary dealers are reputable banking institutions and foreign banks with a branch office registered in South Africa. These banking institutions must be a member of BESA, apply in writing to the National Treasury in order to become primary dealers and must fully comply with regulations set by the National Treasury. As of June 2008, nine banks were operating as primary dealers'.

Primary dealers must participate actively in auctions by bidding at market-related yields on a competitive basis. There is a certain minimum and maximum amount that each dealer can take of the newly auctioned bonds. The minimum is calculated as one divided by the number of primary dealers plus two percentage points rounded to the nearest one percent. As there are nine primary dealers, each dealer must bid for at least 13 per cent of the amount of bonds issued and not more than 40 per cent of the amount of each bid (van Zyl et al., 2009: 297).

On the Wednesday prior to the auction, invitations to tender are made out which include bonds to be issued, amounts to be auctioned, closing time for the bids and the announcement time of the results of the bidding process. Bids are on a yield basis and would usually close on the following Tuesday at 11h00 a.m. Results of the auctions are announced publicly within thirty minutes of the closing time. The announcements include amounts selected by bidders, number of offers to purchase received, number of bids received, number of successful bids, highest and lowest yield bids, average yield and percentage allocation at cut-off yield. Following the auction date, 15 per cent of the auction amount is made available for bidding on a non-competitive basis, whereby the bonds are issued to interested parties at the average yield of the competitive bids.

Primary dealers in government bonds in South Africa: ABN Bank Limited, Absa Bank Limited, Citibank, Deutshe Morgan Grenfell, Investec Bank, JP Morgan, Nedbank, Rand Merchant Bank and Standard Bank.

The primary dealers are then required to quote bid and ask prices in the secondary market for government bonds; they play a central role in insuring liquidity in the secondary market for government bonds. Buyers in the secondary market include dealing banks, insurance companies, retirement funds and investment companies. These institutions buy through brokers who charge brokerage fees which forms part of transaction costs for the trade, even though these costs are not included in the analysis that follows.

3. BONDS ISSUED BY THE NATIONAL GOVERNMENT

3.1. THE SELECTION OF INVESTIGATION PERIOD AND BONDS

In deciding on the period of investigation and bonds for the implementation of the convergence trade in South Africa, three main constraints had a major impact on the decision made.

3.1.1 NATIONAL TREASURY STOPPED ISSUING NEW BONDS

The National Treasury of South Africa is organised into nine divisions2; of interest being the Asset and Liability Management Division. At the end of each month the Asset and Liability Management Division publishes a *Schedule of Domestic Government Bonds* in issue. According to the latest schedule for November 2009, the government has not issued a new bond since 30 September 2007 when the bonds R154 and the R155 were issued, which mature on the 31 August 2010 and 31 August 2011. respectively (Treasury, 2010). Instead what the government has been doing is reopening existing bonds, whereby an additional nominal amount of a bond already trading in the secondary market is auctioned at scheduled auctioned dates. This essentially increases the outstanding nominal amount of the bond, with no change to the coupon rate and term to maturity. The additional amount can be cleared at a higher or lower yield at auction compared to the yield the same bond is trading in the secondary market. This would probably depend on demand forces of the primary dealers at auction. However as soon as the additional amount becomes available in the secondary market, it cannot be differentiated from the equivalent bond already being circulated in the secondary market, and therefore does not start a new series of yields but is added to the old series. Hence if the primary dealer obtained the bond at a higher yield compared to what it is trading in the secondary market, he will immediately make a profit when he makes the new lot available in the secondary market.

[2] The nine divisions that comprise the South African National Treasury: Asset and Liability, Budget Office, Tax, Finance Sector and International Economics, Inter-government Relations, Office of the Accountant General, Public Finance, Specialist Functions comprising Supply Chain Management and Contract Management.

However this scenario may not be appropriate for the convergence trade as it involves immediate convergence, and the investor may not have time to set up the long and short positions for the convergence trade. As soon as the new amount becomes available in the secondary market, its yield converges to the "old-bond" yield.

3.1.2 IRREGULAR SCHEDULE OF BOND ISSUES

The National Treasury does not issue bonds at a fixed regular schedule. In the article by Krishnamurthy (2002), "The Bond/Old-Bond Spread", he focused on 30 year Treasury bonds issued over a period from June 1996 to November 1999 by the US government over six month auction cycles. In the South African government bond market, there has not been a period where bonds have been issued in this manner of late. In fact there is no fixed schedule for the issue of bonds that is repeated each year, instead the government issues a new schedule at the beginning of the year for scheduled bond issues. It is likely that these would be based on the budgetary constraints of the government in that particularly year.

3.1.3 VARIABLE BOND ISSUES

Bonds issued of late vary in coupon size and term to maturity. In analysing the schedules available on the Treasury website, the year 2002 was the only year recently where new bonds with the same coupon rate and term to maturity of an existing bond in the secondary market were issued (Treasury, 2009). This would be an ideal scenario for the convergence trade; however there were two constraints. Firstly this was the only year that this was observed and in none of the years that followed, so the trade would not be capable of being repeated. Secondly it was not possible to obtain auction yields for these bonds. It appears that the data providers used (Rueters, MacGregar and Datastream) started to formally archive auction data for South Africa auction yields from 2003 onwards, as the majority of bonds issued prior to 2003 only have archives of auction yields for re-openings and not the first auction date.

The above three constraints restricted the period of analysis in South Africa from 2003, as it was from then auction data was available, to 2007 as no new issues were made after 2007. This is a relatively short period with only five cycles included in the analysis, but do show intriguing results as shown below.

Table 2: Data Summary

Number of auction cycles	5
Average size of issue	R 330 million
Average days between auctions	297.5
Average yield spread	-0.03%
Average new bond repo rate	8.36%
Average old bond reverse repo rate	8.00%

3.2 USING DURATION AS A SELECTION CRITERIA

As the bonds issued of late vary in coupon size and term to maturity, another basis for selecting bonds to use in the trade had to be used. Duration, which can be interpreted as a measure of how long on average the bondholder has to wait before receiving cash flows (Hull, 2009: 87), came to mind to use as basis. The argument for using duration was as follows; given the following relationship:

$$\frac{\Delta B}{B} = -D\Delta y$$

Where

$$B = \sum_{i=1}^{n} c_i \, e^{-yt_i}$$

And

$$D = \frac{\sum_{i=1}^{n} t_i c_i e^{-yt_i}}{B}$$

Where B equals the price of the bond obtained by discounting future bond cash flows ci that occur at times ti, discounted at the yield to maturity Y; and D equals duration.

The relationship states that for a one unit change in the yield OA the relative change in the bond price ($\frac{\mathrm{LIB}}{\mathrm{B}}$) equals the negative of the duration (D). This relationship is good for small parallel changes in yield, however for larger movements in yield there is a need to look at higher order terms in the Taylor series expansion of the bond price B (Wilmott, 2006: 236). Therefore bonds with similar duration will experience similar percentage changes in price due to the same small change in yield. The duration of a bond portfolio is equal to the weighted average of the durations of individual bonds in the portfolio, with weights proportional to bond prices (Hull, 2009: 87). In wanting to maintain the sensitivity of a bond portfolio to small parallel changes in the yield within a specific range, whilst adapting the convergence trade, this can be achieved by switching between bonds with similar duration, that fall within a specific range.

This is the rationale for using duration as a selection criterion. This should theoretically limit the exposure of the portfolio to small changes in yield within a specific range. The aim is to enhance the expected return of the bond portfolio whilst maintaining the sensitivity of the portfolio to small yield changes within acceptable bounds. However this would only work for small parallel changes in the yield curve. When the yield curve changes shape, the argument may no longer hold.

In analysing bonds issued between 2003 and 2007, it was noted that the majority of bonds had duration that fell between 7-9 years. Therefore in wanting to maximise the number of cycles and therefore the number of times positions are switched; switch positions between new and old issues with duration of between 7-9 years. If in any year no issues occur, unwind the positions once duration of the previous new bond drops below seven years. Over the period 2003 to 2007, the bonds shown on table 3 were selected that satisfied the above criteria with each pair representing a cycle pair. The duration is calculated as at the settlement date. In appendix A the calculations are given for other bonds as at the settlement date. Hence the bond with the closest duration to the new bond and with duration between 7-9 years was selected as the old bond.

Table 3: Bond Data for Convergence Trade					
New Bond			**Old Bond**		
2003_R201			R 157		
Settlement date	27-May-03		Settlement date	27-May-03	
Maturity date	21-Dec-14		Maturity date	15-Sep-16	
Coupon (%)	8.75%		Coupon (%)	13.50%	
Yield	0.0964		Yield	0.094902117	
Duration	7.077701454		Duration	7.158650634	
Modified duration	6.752243326		Modified duration	6.834353336	
2004_R203			R 201		
Settlement date	05-May-04		Settlement date	05-May-04	
Maturity date	15-Sep-17		Maturity date	21-Dec-14	
Coupon (%)	8.25%		Coupon (%)	8.75%	
Yield	0.0996		Yield	0.098912363	
Duration	7.869139301		Duration	6.743905039	
Modified duration	7.495846162		Modified duration	6.426094921	
2004_R204			R 203		
Settlement date	10-Aug-04		Settlement date	10-Aug-04	
Maturity date	21-Dec-18		Maturity date	15-Sep-17	
Coupon (%)	8.00%		Coupon (%)	8.25%	
Yield	0.09845		Yield	0.0986	
Duration	8.226496481		Duration	7.625353002	
Modified duration	7.840545623		Modified duration	7.267085678	
2005_R207			R 204		
Settlement date	17-Jun-05		Settlement date	17-Jun-05	
Maturity date	15-Jun-20		Maturity date	21-Dec-18	
Coupon (%)	7.25%		Coupon (%)	8.00%	
Yield	0.0802		Yield	0.0804	
Duration	9.166621959		Duration	8.167702043	
Modified duration	8.813212152		Modified duration	7.852049647	
2006_RR208			R 207		
Settlement date	29-Aug-06		Settlement date	29-Aug-06	
Maturity date	31-Mar-21		Maturity date	15-Jun-20	
Coupon (%)	6.75%		Coupon (%)	7.25%	
Yield	0.08605		Yield	0.0859	
Duration	8.736425416		Duration	8.497382211	
Modified duration	8.376046036		Modified duration	8.147449265	

4. ANALYSIS OF THE BOND SPREAD

For each bond issue, there is an auction date and an issue date. According to G-30 recommendations [3], financial settlement has to take place three working days after the transaction date, in this case the auction date. The bonds are then issued to successful bidders on the issue date. In an electronic trading system, there is no need to wait until the bond certificates are issued for trading on the bond to commence. Hence each auction cycle begins on the auction date and not on the issue date. Figure 1 provides a record of the spread between old and new bonds over the historical period of interest defined as (yield of old bond — yield of new bond). If indeed the liquidity argument (Krishnamurthy, 2002) holds, whereby he argues that bidders have a high demand for new bonds because the new bonds are more liquid than the old bonds, than the yield of new bonds should be lower than the yield of the old bond. This is because bidders will bid the price of new bonds higher than the old bond due to high demand, and therefore by the inverse relationship between bond price and yield, produce a lower yield.

The trade begins with the R201 as the new bond auctioned on the 27 May 2003, and the R157 which was issued on the 24 October 2001. as the old bond. The spread starts at -0.15 per cent and diverges to -0.215 per cent on the day of the next auction date, which is 4 May 2004. The next cycle has the R203 as the new bond auctioned on the 4 May 2004, and the previous new bond the R201 as the old bond. In this case the spread starts at -0.069 per cent and again diverges to -0.264 per cent on the day before the next auction date, which is 9 August 2004. These two cycles violates the conditions for the convergence trade as the spreads and hence prices must converge not diverge. Than on the 10 August 2004 the R204 is auctioned, with the R203 as the old bond. The spread of the yields for these two bonds does not show any significant pattern. This also holds for the last two auction cycles, with the R207 auctioned on the 17 June 2005 and the R204 being the old bond, and when the R208 is auctioned on the 29 August 2006 with the R207 as the old bond.

[3] The Group of 30 (G-30) is a private organisation which is sponsored by central banks and major commercial and investment banks. The group developed an international task force that developed fast, standardised clearance and settlement of domestic and international securities transactions.

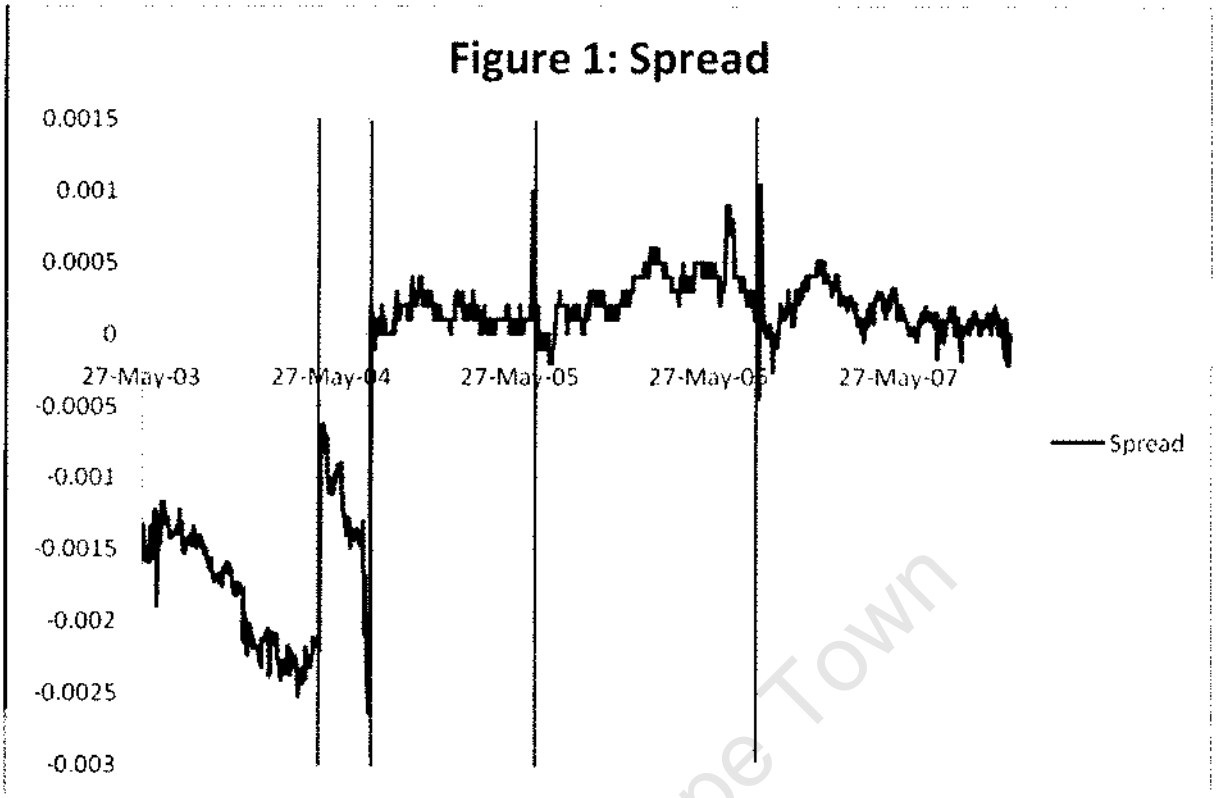


Table 4: Spread Summary Data

Date	New bond	Old bond	Spread at auction	Spread at next auction
27-May-03	R201	R157	-0.0015	-0.00215
04-May-04	R203	R201	-0.0069	-0.00264
10-Aug-04	R204	R203	0.00015	0.0002
17-Jun-05	R207	R204	0.0002	0.0003
29-Aug-06	R208	R207	-0.00015	0.0000052

5. TRADE DYNAMICS

The convergence trade essentially involves the shorting of the newly issued bond, and purchasing the old bond on an auction date. Both these positions are financed in the repo market, using repo and reverse repo rates to finance the long and short positions respectively. The positions are then unwound on the next auction date, or when duration of the new bond falls below seven years if no issue occurs in a particular year. But firstly the dynamics for creating short positions in the trade and the criteria used to select reverse repo rates are outlined below.

5.1 THE REPO MARKET AND CREATING A SHORT POSITION IN A BOND

Creating a short position in a bond involves two transactions, namely a sale and a reverse repo. The bond is sold in the Treasury market and settlement is the following day. When it is ti me to deliver on the bond the following day, the investor borrows the bond from another investor who owns the bond and agrees to return the bond the following day. This would typically involve the borrower depositing cash equal to the value of the bonds with the investor from whom he borrowed the bonds. This borrowing transaction is known as the reverse repo. Settlement on this transaction is the same day. Therefore the investor establishes a short position as he has sold a bond that he has borrowed from another investor. lithe short position is reversed the following day, the investor purchases back the bonds for settlement the following day, and deliver the bond to the investor from whom he borrowed the bonds. The investor would then receive the cash deposited with the bond owner plus interest at the reverse repo rate. The cash would be used to settle the purchase.

What is important to note is the limitation of the number of shorts that can be achieved in the repo market, which is limited by the quantity of new bonds available for shorting. In practice the quantity of new bonds available for shorting may be different from the quantity newly issued by the government, mainly because of two reasons. First not all new bonds will be available for lending in the repo market, yet as the repo market clears throughout the day it may be possible for the quantity available to service more shorts to increase.

Therefore if demand for the new bond equals the supply, an investor holding the new bond is indifferent between lending out the bond at the risk-free rate and holding the bond. This is due to the fact that when demand equals supply, the overnight financing rate on the amount deposited with him, in other words the amount of interest he must give to the investor who deposited the funds with him, equals the risk-free rate which is the rate he would earn if he were to deposit the funds obtained from the borrower at the risk-free overnight rate.

However if demand for the bonds exceeds supply, than the bondholder makes a premium on lending out the bond as the financing rate falls below the risk free rate, in which case he makes an extra premium equal to the difference between the two rates. This is known as "special" and the extent of specialness is measured as

$$s(t) = r(t) - f(t)$$

Where $r(t)$ is the risk-free rate and $f(t)$ is the overnight repo rate.

Therefore only bonds with a high demand in the repo market will have repo rates below overnight riskless rates, enabling the holder of the bond to make a premium on lending out the bonds and to enable the ration of the scarce supply of the bonds. This implies that the higher the demand for the new bond, which would result in a higher yield spread at auction to the old bond, the higher the specialness of the new bond and hence the cost of creating a short position. This argument was used in suggesting that a high spread at auction between the new and old bond does not imply that the trade would be profitable, as the cost of shorting the bond in the repo market would subsequently increase (Krishnamurthy, 2002).

The theory behind the convergence trade is that because the newly issued bond is more expensive than the equivalent old bond in the market, then by normal economic intuition, we should buy cheap and sell expensive. Therefore the trade involves a long position in the old bond and a short position in the new bond. The long position is financed using repo rates, as the investor borrows money in the repo market and purchases the old bond. For

the reverse repo, the South African overnight deposit rate was used as a proxy for the reverse repo rate used to finance the short position. This is because the investor borrowing the bonds deposits an amount equivalent to the value of the bonds with the bondholder and unwinds the position the following day. It is interesting to note that the overnight deposit rate is consistently below the repo rate (see appendix B). In the appendix (B) the profits on the trade had both positions been financed using the repo rate is given. The profitability graph shown in the appendix does not differ significantly as compared to that shown in section six below.

5.2 THE TRADE MECHANICS

Let us define the following quantities for one auction cycle:

- Let t_n for $n = 1,2, \ldots, N$ equal the sequence of business days for which the bonds are traded. Hence if n is a Friday and $n+1$ is a Monday, $t_{n+1} - t_n = 3$. t_1 is the first business day following an auction and t_N the first business day following the next auction.

- Let $\theta(t_n)$ be the number of units of the old bond held from date t_n to date t_{n+1}, and similarly let $\widehat{\theta(t_n)}$ be the number of units of the new bond held from date t_n to date t_{n+1}.

- Let $P(t_n)$ be the price of the old bond at date t_n. This price includes accrued interest and is for standard settlement. Similarly let $\widehat{P(t_n)}$ be the price of the new bond at date t_n.

- Let $f(t_n)$ equal the repo rate for either borrowing or lending the old bond from t_{n+1} to t_{n+2} in the repo market.

- And let $\widehat{f(t_n)}$ equal the reverse repo rate for financing the short position.

- Let $y(t_n)$ be the yield to maturity of the old bond, and let $DP(t_n)$ be the derivative of $P(t_n)$ with respect to $y(t_n)$, that is:

$$DP(tn) = \left[\frac{\partial P(y, tn)}{\partial y}\right]_{y=y(tn)}$$

And similarly define the above quantity for the new bond with a hat above it, that is $\widehat{DP(t_n)}$.

Than the profit from purchasing $\theta(t_n)$ units of the old bond at date t_n, financing the position at the repo rate $f(t_n)$ and unwinding the position at t_{n+1} is:

$$\theta(t_n)\left(P(t_{n+1}) - P(t_n) - P(t_n)f(t_n)\frac{(t_{n+2} - t_{n+1})}{365}\right)$$

Where $P(t_{n+1}) - P(t_n)$ is the capital gain from holding the bond and $P(t_n)f(t_n)\frac{(t_{n+2} - t_{n+1})}{365}$ is the interest that must be paid to finance the position, as would have borrowed cash to finance the purchase. It is assumed that no coupon occurs on date t_{n+1} and that the above cash flows occur at date t_{n+2}.

Similarly the profit from short selling $\widehat{\theta(t_n)}$ units of the new bond at date t_n, financing the position at the reverse repo rate $f(t_n)$ and unwinding the position at t_{n+1} is:

$$-\widehat{\theta(t_n)}\left(\widehat{P(t_{n+1})} - \widehat{P(t_n)} - \frac{\widehat{P(t_n)}\widehat{f(t_n)}\left((t_{n+2} - t_{n+1})\right)}{365}\right)$$

Where $\widehat{P(t_{n+1})} - \widehat{P(t_n)}$ is the capital loss from short selling the bond and $\frac{\widehat{P(t_n)}\widehat{f(t_n)}((t_{n+2} - t_{n+1}))}{365}$ is the interest earned from depositing cash with the **bondholder.**

The total profit from the convergence trade at date $_{tit+1}$ is the sum of the above two quantities.

The holdings for the new bond are restricted by the size of the new issue, however we can select the position size of the old bond such that the profits are not sensitive to an equal

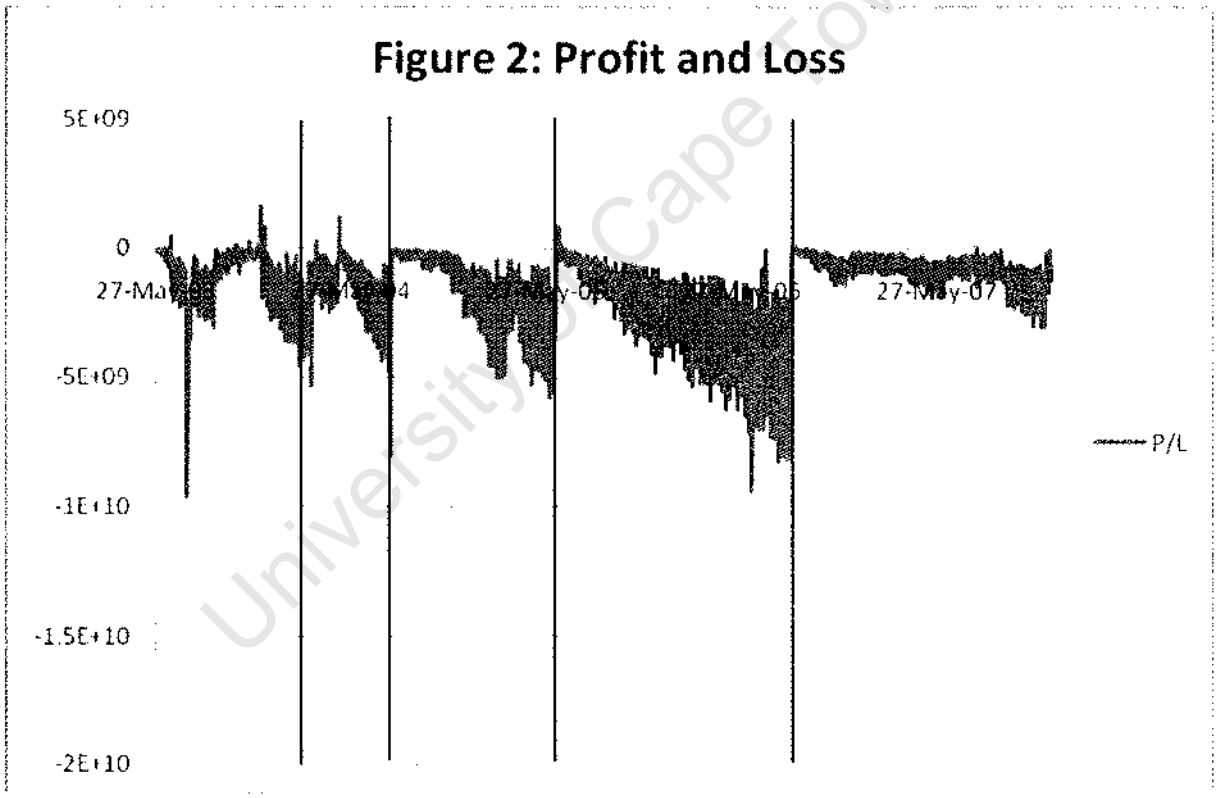
level change in yields of each bond, but only change due to a change in the yield spread. Hence select $\theta(t_n)$ such that:

$$\theta(t_n)DP(t_n) = \widehat{\theta(t_n)}\widehat{DP(t_n)}$$

6. DISCUSSIONS

6.1 AVERAGE PROFITABILITY

Previous implementation of the convergence trade in the United States market (Krishnamurthy, 2002) show that on average the trade had expected return of zero, even when transaction costs were not taken into account. However implementation of the trade in South Africa shows that the trade would give on average negative returns. Figure 2 below shows the daily profits from the implementation of the trade, with the vertical lines representing auction dates.



There is a distinct pattern in the results, but what stands out is the fact that the trade is not profitable; in fact it gives consistently negative returns. For all auction cycles, the daily profits start at some level that is close to zero, and diverges to negative territory. These results suggest that the trade could be profitable in South Africa if the holdings are reversed, that is short the old bond instead of the new bond and long the new bond instead of the old

bond. However it still remains questionable on how to interpret this outcome. The question is whether to conclude that the convergence trade is profitable in the South African market or not. This is hard to conclude because a modification was introduced in implementing the trade in the South African market. As such it would be doubtful to claim that the convergence trade is profitable in South Africa, even though previous implementation in other markets (Krishnamurthy, 2002) showed otherwise, without appreciating the fact that duration was introduced in selecting bonds to use in the trade due to limitations of the South African bond market.

7. CONCLUSIONS

In the paper the bond convergence trade was implemented in the South African market. This was done in spite of the features of the South African market that did not support the implementation of the original trade. Duration was introduced as selection criteria because of the rationale that investors wanting to increase the expected return of a bond portfolio, whilst maintaining the volatility of the portfolio within an acceptable range can implement the trade with bonds of similar duration. The duration term chosen was purely data specific in that over the selected period of investigation the majority of the bonds had duration that fell between seven to nine years.

The trade showed negative average profitability. The convergence trade could perhaps be profitable if the bond positions were reversed. Yet further investigations need to be done in this regard. In particular we would need to investigate the impact of interest rates not only on the trade, but over the period of investigation and future expected interest rates. Future interest rates impacts on the duration calculation and on the profits made on each position.

There were limitations in attempting to implement the convergence trade in the South African market. Obtaining data, particularly auction and yield data for the older issues, was the biggest obstacle. In some cases we combined segments of the time series from various sources to obtain the full history. As mentioned, the use of the duration term was data specific, and that pattern need not be repeated in the future. Therefore an investor wanting to replicate the convergence trade in South Africa needs to appreciate the limitations as outlined in the paper.

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APPENDIX

A. GOVERNMENT BONDS

Each column represents a list of government bonds with duration calculated as at the settlement date of the new bond, which is the first bond given in which column. At settlement the bond whose duration was similar to the newly issued bond and was between 7-9 years was selected to be the old bond.

Cycle one	Cycle two		
2003 R201	2004 R203		
Settlement date	27-May-03	Settlement date	05-May-04
Maturity date	21-Dec-14	Maturity date	15-Sep-17
Coupon (%)	8.75%	Coupon (%)	8.25%
Average yield (%)	0.0964	Average yield (%)	0.0996
Frequency	2	Frequency	2
Basis	3	Basis	3
Duration	7.077701454	Duration	7.869139301
Modified duration	6.752243326	Modified duration	7.495846162

R159P	R 201		
Settlement date	27-May-03	Settlement date	05-May-04
Maturity date	15-Sep-16	Maturity date	21-Dec-14
Coupon (%)	13.50%	Coupon (%)	8.75%
Average yield (%)	9.66%	Average yield (%)	0.098912363
Frequency	2	Frequency	2
Basis	3	Basis	3
Duration	7.123692398	Duration	6.743905039
Modified duration	6.795471142	Modified duration	6.426094921

R 157	R 159P		
Settlement date	27-May-03	Settlement date	07-May-04
Maturity date	15-Sep-16	Maturity date	15-Sep-16
Coupon (%)	13.50%	Coupon (%)	13.50%
Average yield (%)	0.094902117	Average yield (%)	10.08%
Frequency	2	Frequency	2
Basis	3	Basis	3
Duration	7.158650634	Duration	6.816992401
Modified duration	6.834353336	Modified duration	6.489901372

R009P	
Settlement date	27-May-03
Maturity date	15-Sep-14
Coupon (%)	13.50%
Average yield (%)	9.66%
Frequency	2
Basis	3
Duration	6.525810148
Modified duration	6.225136075

R 197	
Settlement date	07-May-04
Maturity date	07-Dec-23
Coupon (%)	5.50%
Average yield (%)	10.08%
Frequency	2
Basis	3
Duration	9.698006887
Modified duration	9.232679824

R179	
Settlement date	27-May-03
Maturity date	01-Aug-13
Coupon (%)	10.00%
Average yield (%)	9.66%
Frequency	2
Basis	3
Duration	6.459806526
Modified duration	6.162173544

R189	
Settlement date	07-May-04
Maturity date	31-Mar-13
Coupon (%)	6.25%
Average yield (%)	10.04%
Frequency	2
Basis	3
Duration	6.603564741
Modified duration	6.28791158

R 189	
Settlement date	27-May-03
Maturity date ,	31-Mar-13
Coupon (%)	6.25%
Average yield (%)	10.00%
Frequency	2
Basis	3
Duration	7.02412713
Modified duration	6.689644886

Cycle three 2004_R204	
Settlement date	10-Aug-04
Maturity date	21-Dec-18
Coupon (%)	8.00%
Average yield (%)	0.09845
Frequency	2
Basis	3
Duration	8.226496481
Modified duration	7.840545623

Cycle four 2005_R207	
Settlement date	17-Jun-05
Maturity date	15-Jun-20
Coupon (%)	7.25%
Average yield (%)	0.0802
Frequency	2
Basis	3
Duration	9.166621959
Modified duration	8.813212152

R203	
Settlement date	10-Aug-04
Maturity date	15-Sep-17
Coupon (%)	8.25%
Average yield (%)	0.0986
Frequency	2
Basis	3
Duration	7.625353002
Modified duration	7.267085678

R204	
Settlement date	17-Jun-05
Maturity date	21-Dec-18
Coupon (%)	8.00%
Average yield (%)	0.0804
Frequency	2
Basis	3
Duration	8.167702043
Modified duration	7.852049647

R201	
Settlement date	13-Aug-04
Maturity date	21-Dec-14
Coupon (%)	8.75%
Average yield (%)	10.46%
Frequency	2
Basis	3
Duration	6.710322939
Modified duration	6.376815489

R186	
Settlement date	17-Jun-05
Maturity date	21-Dec-25
Coupon (%)	10.50%
Average yield (%)	8.03%
Frequency	2
Basis	3
Duration	9.489900906
Modified duration	9.123588815

R159P	
Settlement date	13-Aug-04
Maturity date	15-Sep-16
Coupon (%)	13.50%
Average yield (%)	10.46%
Frequency	2
Basis	3
Duration	6.480961107
Modified duration	6.15885309

R 189	
Settlement date	13-Aug-04
Maturity date	31-Mar-13
Coupon (%)	6.25%
Average yield (%)	10.46%
Frequency	2
Basis	3
Duration	6.298880279
Modified duration	5.985821799

Cycle five

2006_RR208

Settlement date	29-Aug-06
Maturity date	31-Mar-21
Coupon (%)	6.75%
Average yield (%)	0.08605
Frequency	2
Basis	3
Duration	8.736425416
Modified duration	8.376046036

R 207

Settlement date	29-Aug-06
Maturity date	15-Jun-20
Coupon (%)	7.25%
Average yield (%)	0.0859
Frequency	2
Basis	3
Duration	8.497382211
Modified duration	8.147449265

R 204

Settlement date	01-Sep-06
Maturity date	21-Dec-18
Coupon (%)	8.00%
Average yield (%)	8.67%
Frequency	2
Basis	3
Duration	7.801807455
Modified duration	7.477651272

R 186

Settlement date	01-Sep-06
Maturity date	21-Dec-25
Coupon (%)	10.50%
Average yield (%)	8.67%
Frequency	2
Basis	3
Duration	9.200798692
Modified duration	8.818516022

B. OVERNIGHT DEPOSIT RATES AND REPO RATES