

***Econometric Determinants of Liquidity of the Bond Market:  
Case Study of South Africa***

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## Abstract

*This article analyses the main determinants of liquidity of the South African bond market applying the Vector Error Correction technique (VECM). The Two Stage Least Squares estimation (TSLS) was also applied to check for the robustness of our results. Both the impulse response and variance decomposition from the VECM show that innovations in repo rate, stock market index, volume of trading, foreign investor participation and volatility impact on bond market liquidity. The results highlight the importance of both macroeconomic and market microstructure variables as major determinants of liquidity of the South African bond market.*

### 1. Introduction

Liquidity has become an important element for the healthy functioning of the bond market. The market for government securities dominates the securities market in most African countries and thus plays an important role in providing a basis for a robust and efficient financial system as a whole. This sector contributes mostly to the transformation of savings into investment, disseminating information, managing risk, and supporting activities in other securities (Chabchitichaidol & Panyanukul 2005). In addition, the yield curve which is a leading indicator of business cycle (as it provides the vital guide to the future behaviour of inflation and interest rates) has its genesis in the government bond market. However, one major constraint in this market is the issue of liquidity.

Illiquidity in this important market is likely to cause massive price volatility and complicate the open market operations of the central bank. This arises as the transmission mechanism of monetary policy which allows the central bank to infer inflation and interest rate expectations of market participants, and contribute to the promotion of economic growth, by facilitating more efficient pricing of borrowing and lending is obscured (Mminele 2009). In addition, the Asian Development Bank (ADB 2005) suggests that outright purchases and repurchases of securities are important instruments of monetary policy. If market liquidity is not sufficient, central banks might not be able to provide or absorb the necessary amount of funds smoothly through their open market operations. This could produce unintended effects such as excessive price volatility. Therefore bond market liquidity provides encouragement to the tools of financial mediation, making these tools very essential as they are related to market pricing, effective borrowing and investment practises (Maps of the World Finance (MOWF), 2010).

The South African bond market is relatively efficient compared to most African bond markets as indicated by the 2009 Fitch ratings. In addition, there are a number of factors which qualifies the South African bond market relative to other African bond markets. Firstly, Hove (2008) argues that Bond Exchange of South Africa (BESA) has not had any liquidation default and no claims have been made on the Guarantee Fund in its history. Secondly, Jones (2002) shows that BESA did not close its market during market disruptions

such as the Russian and Asian problems in 1998 as well as the 11 September 2001 tragedy. Thirdly, the South African bond market has a turnover ratio equivalent to other mature markets. BESA's 2007 market performance report shows that turnover on the bond exchange reached a record R13.8 trillion, with R13 trillion occurring in government bonds. Thus, this paper seeks to investigate the determinants of liquidity in this market as this might provide some useful insights for other African countries where the bond market is still in its infancy.

In contrast to the available literature, this study analyses liquidity at both the macroeconomic and market microstructure level using two measures of liquidity, volume and the bid-ask spread. In addition to the carry-over for other African economies, identifying the determinants of liquidity will help policy makers to focus on this segment of the economy in order to further enhance its efficiency by avoiding price volatility, encouraging macroeconomic stability and achieving long-term economic growth.

The paper is organised as follows: Section II focuses on the overview of the South African bond market; Section III literature review; Section IV discusses the theoretical framework and econometric methodology used to carry out the study; Section V presents the VECM and Two-Stage least squares results; and Section VI presents concluding remarks.

## **II. Overview of the South African Bond Market**

The South African bond market has undergone major developments since its inception. This has resulted in enhanced efficiency and safety in the market thus attracting investors to it. Due to the developments in the market, it is described (Ambrosi 2010) as one of the leading emerging bond markets in the world.

Ambrosi (2010) indicates that the South African debt market when measured in terms of debt issued comprises but a fraction of the world's debt markets combined, yet it constitutes the lion's share of the African debt market. It boasts of a level of sophistication and efficiency that matches those of many of the bigger debt markets in the developed world.

The South African bond market compares favourably to other emerging market economies in terms of outstanding bonds as shown in table II.1 below

**Table II.1: Size of Domestic bond markets at the end of 2010 (Billions of US dollars)**

<i>Country</i>	<i>Amounts Outstanding By sector and residence of Issuer</i>			<i>Changes in Stocks</i>	
	<i>2008</i>	<i>2009</i>	<i>2010</i>	<i>2009</i>	<i>2010</i>
<i>Australia</i>	<i>639.6</i>	<i>874.9</i>	<i>1043.6</i>	<i>42.2</i>	<i>48.5</i>
<i>Denmark</i>	<i>591.1</i>	<i>691.2</i>	<i>659.9</i>	<i>95.0</i>	<i>17.8</i>
<i>Germany</i>	<i>2592.8</i>	<i>2806.7</i>	<i>2615.9</i>	<i>107.4</i>	<i>10.2</i>
<i>Switzerland</i>	<i>259.0</i>	<i>259.5</i>	<i>291.0</i>	<i>-9.5</i>	<i>5.6</i>
<i>United Kingdom</i>	<i>1219.3</i>	<i>1548.8</i>	<i>1647.0</i>	<i>182.5</i>	<i>148.4</i>
<i>South Africa</i>	<i>93.8</i>	<i>140.4</i>	<i>189.0</i>	<i>6.4</i>	<i>10.0</i>
<i>Mexico</i>	<i>319.5</i>	<i>362.8</i>	<i>429.0</i>	<i>30.8</i>	<i>44.6</i>
<i>Argentina</i>	<i>66.2</i>	<i>57.3</i>	<i>58.9</i>	<i>-5.3</i>	<i>3.2</i>

<i>Malaysia</i>	<i>172.7</i>	<i>189.3</i>	<i>239.9</i>	<i>14.2</i>	<i>28.9</i>
<i>South Korea</i>	<i>863.5</i>	<i>1066.1</i>	<i>1111.0</i>	<i>118.5</i>	<i>16.5</i>
<i>Finland</i>	<i>88.5</i>	<i>93.2</i>	<i>87.4</i>	<i>2.4</i>	<i>0.5</i>
<i>Indonesia</i>	<i>70.7</i>	<i>97.7</i>	<i>93.4</i>	<i>13.7</i>	<i>-8.9</i>
<i>Czech Republic</i>	<i>65.2</i>	<i>80.3</i>	<i>74.2</i>	<i>12.1</i>	<i>-4.6</i>

**Source:** *Bank of International Settlements (2011)*

It will be observed from Table II.1 that the size of the bond market in South Africa is relatively large compared to some of the emerging countries (Czech Republic & Indonesia).

The South African authorities have adopted a number of initiatives to increase trading volume so as to promote market liquidity. Firstly, the appointment of primary dealers/market makers by the government in 1998 who are involved in quoting firm prices (bid and offer) in certain government bonds improved transparency and overcame shortcomings which were inherent in the tap issue method, in which the Reserve Bank was issuing bonds on behalf of government<sup>1</sup>. This system was flawed since the Reserve Bank in its market making role was always a net seller and the process at times conflicted with the Reserve Bank's monetary policy function. Secondly, BESA also facilitated the development of an active repo market, which has made a major contribution to the secondary market. It is argued that traders have used repos to fund their positions, hedge short positions in the capital markets, facilitate settlement and employ cash for the short-term between investment decisions. Thirdly, the Exchange developed a system in terms of which firm bid and offer prices and traded prices are entered into a central price discovery screen which is available to all the Exchange's users. This has further improved liquidity by promoting price dissemination (Greubel 2008).

The development of the South African bond market has mirrored developments in economic development as well as other markets (equity and futures) as indicated in the correlation matrix in Table II.2. Table II.2 shows that the correlation between growth, equity market and the derivative market with the bond market is above 90%. It is also evident that the bond market has benefited from the growth of other financial markets. This is consistent with Adelman (2009), who suggest that the growth in the bond market and equity market have contributed to the growth of the futures market in South Africa by facilitating the introduction of a number of equity and bond market related instruments. This shows that a well-developed financial system with all financial markets operating promote economic growth as each segment plays its role in terms of mitigating risks, resource mobilization and efficient allocation of scarce resources resulting in sustainable economic growth.

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<sup>1</sup> It must be noted however that this market making role of the central bank at the initial stages of the development of the bond market facilitated the transfer of this function to commercial banks at a later stage and improved liquidity in the market.

**Table II.2: Growth of the South African Financial Markets**

	GDP	EQUITY	BONDS	FUTURES
GDP	1.000	0.981	0.924	0.858
EQUITY	0.981	1.000	0.905	0.895
BONDS	0.924	0.905	1.000	0.905
FUTURES	0.858	0.895	0.905	1.000

**Source:** *Author's Computation*

Another important factor contributing to the growth of the South African bond market as pointed by Faure (2008) has been the surge in long-term borrowing. The increase stems from the difficulties with short term issues which entail a series of borrowings that could be administratively burdensome. Also, an issuer's creditworthiness may decline at some stage in the short term borrowing cycle, and funds may not be available under this changed circumstance.

Faure (2007) also shows that companies in South Africa have traditionally relied on equities as a source of finance. This has been due to a number of factors. Firstly, the existence of exchange controls prevented institutional investors such as retirement funds, insurers and unit trusts from investing offshore. This resulted in a "*financial hothouse effect*" which is an artificially high local demand for equities, resulting in equities being over-priced. However, with exchange controls being progressively relaxed in South Africa, through permitting institutional investors to invest offshore, this has resulted in equity being more realistically priced. Consequently, companies are considering long-term debt finance as an alternative to equity finance.

The second reason why firms in South Africa relied on equities was lack of a ratings culture. As of 2008 there were three rating agencies in South Africa and a number of companies have been rated. The lack of a secondary corporate debt market is the third reason. However, this is being addressed by investment banks and also the emergence of securitisation has played an important role as companies are able to borrow via securitisation vehicles (Faure 2008).

A report by Fitch ratings (2009) indicates that steady growth in the nominal value of listed bonds has been supported by a reasonably diverse investor base that includes pension funds, asset managers, insurance companies and international investors. This has improved both the depth and tightness of the local bond market over the last five years.

Fitch ratings also attribute the development of the South African bond market to stable and supportive macroeconomic and fiscal policies; a healthy banking sector; and an advanced regulatory framework.

The South African economy has witnessed a process of structural transformation since the advent of democracy in 1994. The authorities adopted and implemented policies seeking to promote domestic competitiveness, growth and employment and increase the outward orientation of the economy. These measures have resulted in the country achieving macroeconomic stability. The government also embarked on a fiscal reform programme to restructure government expenditure towards social services that will contribute to a better quality of life for all South Africans. This move resulted in the fiscal deficit being reduced

from 5.6% in 1998/99 to an estimated 0.5 for 2005/06. By 2006 the country had achieved a low foreign debt/GDP ratio of 27% compared to most other emerging markets. This coupled with strong export growth and FDI inflows, made the risk of default on foreign debt negligible. This is also reflected in 2006 upgrades in investor ratings by Moody's (Baa2 to Baa1) and Standard and Poor (from BBB stable to BBB positive). In addition, the country has been enjoying investment grade status from the rating agencies. This has contributed positively to the growth of the bond market by boosting investor confidence (The DTI 2006).

The regulatory framework in South Africa has been another major important ingredient towards the development of the bond market. The South African bond market has experienced major changes in its regulation. This includes the move from Over the Counter (OTC) markets to exchange-traded market. Exchange driven-market eliminates or lessens a number of risks inherent in OTC markets. These risks include counterparty risk, settlement risk, broker-dealer fraud risk and tainted scrip risk<sup>2</sup>. The elimination or lessening of risk goes hand-in-hand with efficiency of trading. Faure (2008:92) attests that the elimination or lessening of risk and efficiency of trading maybe subsumed under "*a secure and efficient dealing environment*". Faure goes on to point out that such an environment attracts more participants, both local and foreign, which leads to higher turnover, thus higher liquidity and ultimately to efficient price discovery, and possibly lower transaction costs.

Central to BESA operations, has been its regulatory and supervisory obligations. These obligations were met by the Market Regulation Division (MRD), which was established in 2004 as a totally ring-fenced division separate from BESA's commercial operations. However, with the acquisition of BESA, the MRD has been integrated into the Surveillance Division and the Clearing and Settlement Division of the JSE (BESA 2010).

In the past, the MRD has played a major role in BESA's success through its three principal foci. These include cultivating a culture of compliance amongst its members. This is achieved by BESA adopting a policy of zero tolerance to any contraventions of its regulatory requirements with imposition and enforcement of strict penalties for any contraventions. Also, the MRD is responsible for both the regulatory supervision and surveillance of the trading activities, including reviews of the previous day's, alert to market manipulation or abuse, changes in spreads and the open positions of users. The aim of the supervision is to promote open, transparent and fair trading. Lastly, the MRD's legal function ensures that the regulatory requirements of the Financial Services Board (FSB) are consistent, aligned as well as included in the rules of the exchange, compiled by the users of the exchange as well. It is clear therefore that through its independent compliance, surveillance and regulatory support role, the MRD strived to ensure market stability, credibility and integrity (BESA 2006).

BESA has ensured that the rules of the exchange are G<sub>30</sub>-compliant and continuously strives to formulate its rules against international best practice (BESA 2005:14). This has improved the efficiency and effectiveness of the market and hence liquidity. This has also encouraged both local and foreign investors to participate in the bond market.

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<sup>2</sup> Counterparty risk is reduced as the investor deals with a broker-dealer who is under constant surveillance; Settlement risk refers to deals being settled efficiently by the exchange through a deal booking system, BTB here in South Africa; Broker-dealer fraud risk is reduced because of surveillance and tainted scrip risk is eliminated in a dematerialised environment.

### III. Literature Review

A number of studies have been carried out to establish the determinants of liquidity in bond markets. However, the conclusions vary from market to market. According to Borio (2000) the increasing interest in liquidity stems from the need for an efficient financial system. Choudhry (2010) describes liquidity as an important factor underpinning the smooth functioning of the financial system and conditioning the daily activities of economic agents, including pricing, trading and risk management. Das *et al* (2003) describes the importance of liquidity to markets as oxygen is to humans as it is only noticeable by its absence. Overall, liquidity is important for the efficient performance of financial markets and the economy at large.

There are many ways in which liquidity is defined in the literature. Gravelle (1998) defines liquidity as being “the ease with which large-size transactions can be effected without impacting market prices”. Borio (2000) on the other hand describes a liquid market as one where “...transactions can take place rapidly and with little impact on price”. However, the Committee on the Global Financial System (CGFS) (1999) shows that the concept of liquidity can be further elaborated in a number of dimensions. These include tightness, depth/size, resiliency, and immediacy.

The need to establish the determinants of bond market liquidity has attracted a number of empirical studies. Ganapolsky and Schmukler (2001) examined the reaction of Argentina’s stock market index, Brady bond prices, and peso-deposit interest rates to specific policy announcements and news reports received by markets during the Mexican crisis of 1994–1995. Announcements such as the agreement with the International Monetary Fund, the dollarization of reserve deposits in the central bank, and changes in reserve requirements were perceived as increasing securities market returns.

This is consistent with Kaminsky and Schmukler (1999) who found that news about agreements with international organizations and credit rating agencies changes were most important in explaining large movements in security prices.

The above result is supported by Andritzky *et al.* (2007) discovered that domestic data and policy announcements have systematic effects on the level of international bond spreads for emerging market countries. Global emerging bond markets appear to respond mainly to announcements of changes in international ratings, which are designed to serve as composite forward-looking indicators of domestic fundamentals and policy developments and a broad measure of country risk. The authors discovered that changes in global interest rates also tend to affect the level of spreads, possibly because they lower the cost of funding for international bond investors and the cost of financing for emerging market sovereigns.

Chabchitrchaidol and Panyanukul (2005) looked at the key determinants of liquidity in the Thai bond market, measured by bid-ask spreads on government bonds. Empirical results using EGARCH estimation revealed that a rise in the volatility of bond yields leads to a larger bid-ask spread. Volatility is therefore negatively related to bond market liquidity.

Garcia (1989) argue that monthly stance of the Federal Reserve Bank can affect liquidity by altering the terms of margin borrowing and alleviating the borrowing constraints of dealers. The author found that monetary expansions are associated with increased liquidity during crisis periods. This was consistent with Fujimoto (2004) who also discovered that monetary

variables are significant drivers of securities market liquidity. This suggests therefore that monetary policy has an impact on bond market liquidity.

He and Nasser (1999) analysed factors affecting bond liquidity in the Thai Secondary bond market, focusing at bond characteristics as well as macroeconomic factors using monthly data. The authors used bond turnover as a proxy for liquidity and used the SPSS programme for analysis. Empirical results revealed that credit rating is the most significant factor to the investors when selecting bond as an investment. Macroeconomic factors were also seen as important factors impacting on bond market liquidity. This result is consistent with the South African experience as bond market liquidity improved after the establishment of rating agency.

Goyenko, Subrahmanyam and Ukhav (2008) looked at the term structure of bond market liquidity of the US from November 1967 to December 2005 using Vector Autoregression analysis on illiquidity of three maturity ranges, thus short, medium and long. Empirical results indicated that on-the-run and off-the-run illiquidity has different time series determinants. On-the-run illiquidity across all maturities is largely affected by volatility. On the other hand off-the-run illiquidity is driven by inflation, monetary policy surprises, bond returns and volatility. Overall, off-the-run illiquidity is affected by a larger set of economic variables. Their results were consistent with the idea that the effect of macroeconomic variables on dealer costs is most relevant in the less liquid off-the-run sector.

The above literature shows that establishing the determinants of liquidity in the bond market has attracted academic attention. However much of the studies have been undertaken in developed countries and less have been done in developing countries due to underdevelopment of developing countries financial markets.

Most of the studies have not been very helpful in identifying microstructure determinants as against determinants related to macroeconomic factors. This has implications for the short run and long run determinants. This makes carrying out this study necessary so as to identify the key determinants of liquidity in the South African bond market based on the criteria suggested above as the few studies available are essentially of the former category, yet microstructure factors are becoming increasingly important for South Africa. This will enable us to identify policy variables that policy makers can focus upon to further deepen liquidity in this important segment of the market. The next section presents the theoretical model used in the study.

#### **IV. Theoretical Framework and Model Specification**

In this study two measures of liquidity will be used in our empirical analysis. The two measures are volume and the bid-ask spread. We shall elaborate further on these two measures of liquidity.

##### **A. Liquidity Proxies**

Volume is regarded by Abdourahmane and Tonny (2002) as the best in measuring breath. It is argued that markets that are deep are able to foster breath since larger orders can be divided into several smaller orders to minimize the impact of transaction prices. Abdourahmane and



Tonny (2002) also point out that trading volume is traditionally used to measure the existence of numerous market participants and transactions. This can be illustrated as follows:

$$V = \sum P_i + Q_i \dots\dots\dots 1$$

Where: V = Rand Volume traded  
 $P_i$  = Prices of the  $i$ th instrument traded during a specified period  
 $Q_i$  = quantity

A variation of the volume based approach is the turnover rate. The turnover rate gives an indication of the number of times the outstanding volume of the asset changes hands. Thus,

$$Tn = \frac{V}{S \times P_i} \dots\dots\dots 2$$

Where:  $Tn$  = Turnover  
 $V$  = Rand volume traded  
 $S$  = outstanding stock of the asset.

The other measure which will be utilised in this study is the bid-ask spread which falls under the transaction costs measures. This measure aims at capturing costs of trading financial assets and trading friction in the secondary market. Abdourahmane and Tonny (2002) shows that the bid-ask spread is the absolute difference between bid and ask prices or it can be as a percentage. This can be illustrated as follows:

$$BAS = (P_A - P_B) \dots\dots\dots 3$$

Where: BAS= bid-ask spread  
 $P_A$  = the ask price  
 $P_B$  = the bid price

Or,

$$BAS = \frac{(P_A - P_B)}{\left(\frac{P_A + P_B}{2}\right)} \dots\dots\dots 4$$

According to Abdourahmane and Tonny (2002), ceteris paribus, the larger the trades that can be concluded at a quoted spread, the more the depth and breadth of the market.

This study will use the first measure of volume which is the summation of price and volume of bonds traded and the bid-ask spread discussed in equation 3. There are a number of reasons why volume could be a better measure of liquidity in emerging markets. First, bond trading in many of these economies are very infrequent mainly because there are few players in the market as opposed to the stock market. This reduces competition and thus renders the bid-ask spread suspect in underdeveloped bond markets. Second, capturing data on bid-ask spread is complex as it requires sophisticated equipment which is yet to be implemented in many developing countries. However, this is not a serious issue in South Africa as trading especially in government bonds is fairly frequent and there is a broad base of participants in the market.

**Theoretical Framework**

Our theoretical framework on bond market liquidity will be categorised into two: the impact of macroeconomic factors on bond market liquidity and the adverse selection hypothesis. Our

theoretical analysis and the estimation that follows are derived from this analytical framework.

### **Impact of Macroeconomic factors on bond market liquidity**

Das *et al* (2003) suggest that there are three types of news shocks common to bond markets. These are intra-day calendar effects, public information effects and GARCH effects. Nevertheless, Das *et al.* points out that unlike stock and corporate bond markets, the government bond market is driven mainly by public information or macroeconomic news events.

Consistent with Das *et al.* (2003), Nasser and He (2003) states that macroeconomic variables determine liquidity in bond markets. According to Nasser and He (2003), investors have become concerned with overall trends than with individual company fundamentals. Since both stocks and bonds are investment alternatives that compete for the investor's funds, the funds flow from one market to another due to a change in market situation and macroeconomic factors. Nasser and He pointed out that a number of studies have reported a negative relationship between long-term government bond rate and the stock prices in the US and UK. Davis (1999) concurs with Nasser and He (2003) and revealed movements of the economy and/or of interest rates as of overriding importance in the purchase of fixed-income securities. A rise in interest rates, due for instance, to monetary policy tightening may lead to a financial crisis, with liquidity collapses in security markets. In addition, in the presence of uncertainty, adverse surprises may trigger shifts in confidence, affecting markets and institutions more than appears, thus introducing the potential for a liquidity crisis.

The major participants in the South African secondary bond market include the dealing banks, insurance companies, retirement funds and investment companies. For dealing banks and investment companies, some of their funds are obtained from short-term deposits, and they may have to trade more frequently and demand capital gains from trading in addition to fixed coupon interest. It is most likely that a change in the inter-bank rate affects their trading activities. Usually the rise in the South African overnight inter-bank rate may result in high borrowing costs to those with deficit cash requirements resulting in the decline of funds available for investment in bonds and a lowering of the secondary bond market liquidity.

Mukherjee and Atsuyuki (1995) propose that there is a positive relationship between exchange rates and stock prices. Exchange rate fluctuation is regarded as a critical factor for the foreign investor in the security market. The secondary security market liquidity increases when foreign currency appreciates. However, exchange rate fluctuation increases the exchange rate risk of the investment when foreign investors transfer their investment back to their mother countries. In South Africa, exchange rate fluctuation has a major impact on the secondary bond market liquidity considering that foreign investors play an active role in bond trading.

Further, Nasser and He (2003), shows that economic prospects have increasingly affected the world's capital markets. It is suggested that inflationary pressures appear to play a key role in pushing up bond yields. Rutledge (1995) shows that growth in the world economy in the past caused intensive competition for capital, giving investors attractive alternatives to fixed-income instruments. However once inflation become more visible, the nominal risk-free rate was raised as interest rates rose. This affected the bond market negatively as bond prices fell due to a high yield required by the investors. Nasser and He (2003) goes on to point that the fear of inflation has made many bond managers to shorten the duration of their portfolio and

seek relative safety in the short to intermediate term sectors which in turn may also affect liquidity.

The discussion above clearly shows that macroeconomic variables do have an impact on bond market liquidity. Thus in modelling our empirical regression, macroeconomic factors will be included in our model.

### **Adverse selection hypothesis**

Chabchitrchaidol and Panyanukul, (2005) suggest that adverse selection problems do impact on bond market liquidity as well. The authors suggest that adverse selection problems arise when informed traders who possess private information on the value of an asset not currently reflected in prices, are in the market. Such traders will want to trade only if the current ask price they face is below or the bid price above the fundamental value of the asset.

There are two hypotheses under the adverse selection theory. Under the first hypothesis, suggested by Easley and O'hara (1992), higher trading volume will be a signal of the presence of informed traders and will result in increased spreads. In this scenario, increased trading volume will be a signal to market makers that an information event has occurred. As uninformed traders, dealers specifically, always lose when dealing with informed traders, they have to recoup the losses from other investors by charging a larger bid-ask spread. Thus an unusual number of trades will result in the dealer widening the spread. According to this hypothesis therefore, higher trading volume will lead to higher spreads.

Under the second hypothesis, proposed by Harris and Raviv (1993), higher trading volume reveals an increase in liquidity, signalling higher overall market liquidity. In this case dealers will interpret that a volume shock is due to a change in the demands of "liquidity" traders such as through mutual fund redemption, and would not be expected to decrease liquidity and have little to no effect on bid-ask spread.

However, Chabchitrchaidol and Panyanukul (2005) argue that existing models of adverse selection of the type discussed above have mainly looked at liquidity in equity markets, partly due to the fact that data is more easily available due to the nature of exchange-traded markets. As discussed, adverse selection models are based on the assumption that some investors have superior information on the payoff of the asset than others. However, this is unlikely to be the case for government bonds where cash flows are perfectly known (Lee *et al.* 1993). Even though it is unclear which of the two scenarios of adverse selection theory is appropriate for our case, it is clear that both volatility and trading volume are two of the main factors which determine spreads and hence liquidity in bond markets and will therefore be included in our model.

### **C. Model Specification**

In establishing the main determinants of liquidity in the South African bond market, two questions are posed. First, whether market microstructure factors such as volume and spreads influence liquidity in the bond market. Secondly, whether macroeconomic factors such as inflation, exchange rate, interest rate, foreign investor participation and stock market index affect bond market liquidity.

We will focus only on the government bonds traded on the South African secondary bond market, because South African corporate and state enterprises bonds are not active in the secondary bond market. In addition, looking at government bonds when measuring liquidity

is what is regarded as ideal. Choudhry (2010) proposes that any investigation into market liquidity should focus first on government bonds since with corporate bonds a number of other issues such as credit risk which is unrelated to liquidity may influence the results. This is consistent with Kamara (1994) who concluded that government bonds are fundamentally identical and credit-risk-free and thus could help focus on liquidity issues.

#### D. Estimation Techniques

Two models will be specified for robust results. The first model which will be used to empirically test the determinants of liquidity in the South African bond market will benefit from Chabchitichaidol and Panyanukul (2005), Ngugi (2003) and Abdourhmane and Tony (2002) models.

##### *Restricted Vector Autoregression Model*

The examination of the dynamic and causal interactions between bond market liquidity and its determinants is done by applying a restricted Vector Autoregression model (VAR). This is due to the fact that the variables of analysis, particularly volume and bid-ask spread, and other regressors (Volatility and Bid-Ask spread) are simultaneously related. VAR models have proved to be a convenient method of summarizing the dynamic relationships among variables in such circumstances, since once estimated they can be used to simulate the response over time of any variable in the set to either an ‘own’ disturbance or a disturbance to any variable in the system (Ramaswamy & Slok 1998). The VAR approach recognizes explicitly the simultaneity between bond market liquidity and its determinants (Benston & Hagerman 1974 and Subrahmanyam 1994). Hence, the need to treat each variable symmetrically and allow feedbacks among them.

Restricted VAR models have also been found to be most suitable in capturing the feedback relationships among macroeconomic variables. Moreover, restricted VAR analysis is superior to a single equation approach for capturing the long-run equilibrium of variables while it incorporates an error correction mechanism to track the short run dynamics among the variables (Feasel, Kim & Smith 2001). More importantly, the structural version of the reduced-form VAR (which separates the influence of shocks from those of structure to capture the interactions among the variables of interest) is employed in the study. This method explicitly calculates the disturbances by inverting an estimated structural VAR of the relationship among the contemporaneous VAR residuals. The VAR model for the study is discussed as follows:

Assuming that  $X_t$  is the  $n \times 1$  vector of variables, the intra-impulse transmission process of which is to be captured by the study, the dimension of  $X_t$  (that is  $n$ ) is 8, given the eight variables of the analysis.

Using matrix algebra notations, an 8-variable structural dynamic economic model for the study can be stated as:

$$BX_t = \mu + \Gamma X_{t-1} + \varepsilon_t \dots\dots\dots 5$$

Where B is the matrix of variable coefficients

$X_t$  is the  $8 \times 1$  vector of observations at time t of the variables of the study, that is vector X is defined as  $X_t = (Bid\ Ask\ Spread_t, Volume_t, Volatility_t, Consumer\ Price\ Index_t, Repo\ rate_t, Exchange\ rate_t, Stock\ Market\ Index_t, Foreign\ Investor\ Participation_t)$

Also,  $\mu$  is the vector of constants

$\Gamma$  is a matrix polynomial of appropriate dimension

$\varepsilon_t$  is a diagonal matrix of *structural innovations* that has zero means, constant variance, and are individually serially uncorrelated, i.e.

$$\varepsilon_t \sim (0, \Sigma)$$

The ordering of the variables used in the study follows that discussed by Goyenko (2008) in which variables are in the order in which they influence the other variables. Policy variables are placed first followed by macroeconomic variables since while financial markets respond to monetary policy, monetary policy is relatively exogenous to the financial system. The view of placing monetary policy instruments before financial variables are supported by Thorbecke (1997) and Chordia, Sarkar and Subrahmanyam (2005).

The empirical exercise is to model and estimate the dynamic interactions among the variables in a VECM. The dynamic interactions between the bid-ask spread, volume of bonds and macroeconomic variables in the South African economy are obtained by presenting the estimated reduced-form equation of the VAR model, the analysis of variance decomposition and impulse response functions.

*Two Stage Least Squares Estimation (TSLS)*

A two-stage least squares method is also estimated to check the robustness of the VECM results. This follows on the work of George and Longstaff (1993) who analysed if trading activity is related to the bid-ask spread.

Brooks (2008:282) suggest that “*the intuition that the bid-ask spread may be simultaneously related arises since a wider spread implies that trading is relatively more expensive so that marginal investors would withdraw from the market. On the other hand, market makers face additional risk if the level of trading activity falls, and hence they may be expected to respond by increasing their fee (spread)*”.

Thus we adopt the model to simultaneously determine the size of the bid-ask spread and volume, referred as “*the time between trades*” by George and Longstaff (1993).

The 2SLS model suggested can be represented by the following equations:

$$VOL_t = \beta_0 + \beta_2CPI + \beta_3REP + \beta_4EX + \beta_5SMI + \beta_6FIP + \varepsilon_t \dots \dots \dots 6$$

$$BAS_t = \alpha + \beta_1 VOL(X) + \beta_2VOL + \varepsilon_t \dots \dots \dots 7$$

In the first equation VOL which is volume of bonds traded is a dependent variable and the same variable is an explanatory variable in the second equation. The two equations make it possible to run a two-stage least squares method since volume which is a dependent variable in equation 6 becomes an independent variable in equation 7. It is evident therefore that there is feedback between the two equations and the equations may be over-identified. The question of identification is closely related to the problem of estimating the structural parameters in a simultaneous equation model. In the case of over-identified equations the two-stage least squares (TSLS) method is commonly used.

**E. Data and Definition of Variables**

The study will utilise monthly time series secondary data on government bonds with maturity of more than one year from 1995- 2009 (180 observations). For macroeconomic data (CPI, Repo rate, Stock Market Index and Foreign Investor participation) the main sources of data

are the South African Reserve Bank (SARB) online statistical queries, Bond Exchange of South Africa's (BESA) online publications, Department of Trade and Industry's (DTI) Economic Statistics publications and Statistics South Africa online query. Average bid-ask spread of government bonds with maturity of more than one year, data on trading volume, and derived data on monthly average volatility will be obtained from SARB online statistical query and BESA publications. Monthly bid-ask spread was obtained from BESA.

Bid-ask spread (*BAS*) and volume *SQR(VOL)* represents our two measures of liquidity. An increase in the *BAS* amounts to illiquidity of the bond market whilst an increase in volume of bonds traded is an indication of liquidity in the market. When there is a high degree of liquidity, resulting from a high level of demand for trades, the spread between bid and offer prices will narrow and in the event that buyers and sellers are reluctant to trade, buyers are likely to bid lower prices, as they would require a liquidity risk premium as compensation for the increased risk resulting from the lack of liquidity. On the other hand, sellers are likely to set a higher offer price for the same reason. The result will be a bid-ask spread that is wider than in times of normal liquidity. We thus expect a negative relationship between volume and bid-ask spread. Volume enters our estimation as a square root in order to scale down the impact of volume on bid-ask spreads.

*VOLX* is volatility. High volatility poses higher risks which need to be compensated directly through higher bid-ask spreads. High volatility will result in a decrease in bond market liquidity. We expect a positive relationship between volatility and the bid-ask spreads.

*CPI* represents monthly inflation as measured by the Consumer Price Index (*CPI*). A rise in the level of inflation which forces the monetary authorities to increase the repo rate will increase yields and hence cause price of bonds to fall. This is likely to decrease bond market liquidity. It is thus negatively related to bond market liquidity.

*REP* represents the South African Reserve Bank (SARB) monthly repo rate, a tool which is currently used by the South African Reserve bank in monetary policy. An increase in the repo rate (contractionary monetary policy) results in high yields and hence low bond prices thus reducing bond appetite hence reduced liquidity. We thus expect a negative relationship between *REP* and volume of bonds traded.

*EX* represents exchange rate volatility. It is measured as the deviation from the average of four weekly exchange rate of the US dollar in terms of the rand. Exchange rate volatility leads to uncertainty in the foreign exchange market. This adds to risk premium to the forward market transactions and these uncertainties adversely affect the foreign participation in domestic bond markets and hence the development of the benchmark yield curve. The exchange rate is of importance in the case of South Africa since foreign buyers are active participants in our bond market. We expect a negative relationship between *EX* and volume of bonds traded.

*SIM* is the monthly Johannesburg All share stock market Index. Shares are another form of investment which competes for the same investor's funds. An investment in shares may mean disinvestment from bonds hence reduced liquidity.

*FIP* represents net foreign buyers of bonds on BESA. An increase in Foreign Investor Participation (*FIP*) results in the broadening of the investor base and enhanced liquidity in the secondary bond market. We thus expect a positive relationship between *FIP* and bond market liquidity.

#### IV. Econometric Procedure and Results

Time series properties of the data were carefully evaluated through the Augmented Dickey Fuller (ADF) and Phillip-Peron (PP) tests and the results suggested that all our variables are  $I(1)$ . The optimal lag order was determined empirically. Based on several criteria (AIC, SIC, FPE, LR and HQ), a lag order of 1, which produced a stable VECM, was selected.

The Johansen (1990) cointegration tests, suggest that the variables are cointegrated, meaning that there exists a long run stable relationship amongst the variables.

Having established cointegration, we estimated a VECM and the reduced-form estimation results revealed that all our variables except EX have coefficients that are negative indicating that these variables converge to their long-run equilibrium. Our empirical results suggest that all variables with the exception of BAS and SMI are significant.

The short-term relationship between variables was also illustrated by means of the correlation matrix shown in Table V.1.

**Table V.1: Correlation matrix**

	BAS	SQR (VOL)	VOLX	CPI	REP	EX	SMI	FIP
BAS	1.000000	-0.078172	0.012360	0.048964	0.406691	-0.153556	-0.021684	0.196055
VOLUME	-0.078172	1.000000	-0.021681	-0.122813	-0.003170	-0.213483	-0.293797	0.893894
VOLX	0.012360	-0.021681	1.000000	-0.039393	0.115478	-0.017792	-0.009029	0.025076
CPI	0.048964	-0.122813	-0.039393	1.000000	0.258948	-0.451065	0.043525	-0.125473
REP	0.406691	-0.003170	0.115478	0.258948	1.000000	-0.211879	-0.352442	0.255375
EX	0.153556	-0.213483	-0.017792	-0.451065	-0.211879	1.000000	-0.254544	-0.058617
SMI	-0.021684	-0.293797	-0.009029	0.043525	-0.352442	-0.254544	1.000000	0.232162
FIP	0.196055	0.893894	0.025076	-0.125473	0.255375	-0.058617	0.232162	1.000000

**Source:** Author's Computation using *EViews 7 Econometric Software*

Table V.1 presents the contemporaneous relations between innovations in the variables. It is evident that innovations in the REP are negatively related with liquidity of the South African bond market as measured by both the bid-ask spread and volume of bonds traded. This is consistent with results of Goyenko *et al.* (2008) for the Term structure of bond market liquidity. The same applies to CPI, EX and SMI which drain liquidity in the bond market as indicated in the correlation matrix. The negative correlation between EX and Volume points to the negative effects of exchange rate volatility, which is a characteristic of many African countries, on bond market liquidity. On the other hand, shocks on FIP is positively correlated with liquidity in the South African bond market. The correlation between BAS and SQR (VOL) is negative indicating that an increase in the volume of bonds traded results in a decrease in the BAS. This result is consistent with Easley and O'hara (1992)'s second hypothesis of the relationship between bid ask spread and volume. VOLX is positively related to BAS and negatively related to volume of bonds traded which is consistent with theoretical propositions as well as Benston and Hagerman (1974)'s suggestion.

For the bid-ask spread, the correlation between CPI and BAS is the highest. This supports Andritzky *et al.* (2007) propositions that CPI announcements are important for bond market liquidity. As for volume, in consonance with theoretical expectations, the correlation between VOL and FIP which is the highest supports Shanaka's propositions that foreign investors do

play an important role in enhancing liquidity in secondary bond markets. In the same vein, the contemporaneous relations between SQR(VOL) and CPIX, EX PEP and SMI are consistent with theoretical positions on the role of the four macroeconomic variables in enhancing liquidity in the bond market. Studies by Nasser and He (1999) and Goyenko *et al.* (2008) corroborate this finding. Thus the participation of foreign investors in the South African bond market is of importance as they enhance liquidity in the market.

### **Impulse Response**

The impulse responses show the dynamic response of each variable to a one-period standard deviation shock to the innovations of each variable. The interpretation of the impulse response function does take into account the use of the first differencing of the variables as well as the vector error correction estimates. Thus, a one-time shock to the first difference in a variable is a permanent shock to the level of that variable.

This allows issues to be addressed concerning the effects of market microstructure and macroeconomic variables on bond market liquidity in the South African bond market. Of particular interest in this study are the dynamic responses of Bid-Ask spread (BAS) and Volume (SQR (VOL)) of bonds traded on BESA to themselves and to innovations in each microstructure and macroeconomic variable.

Appendix B first panel illustrates the response of bid-ask spread to a unit standard deviation change in a particular variable, traced forward over a period of 24 months. In the figures, months 1-24 plots the effect from +1 to +24 months. We will focus on the response of the bid-ask spread and volume of bonds traded only as they are our measures of liquidity.

The first panel indicates that liquidity as measured by the bid-ask spread decay within two periods in response to its own shock, with the response increasing in the second period and remaining constant over the remainder of the period. On the other hand a shock to volume reduces the bid-ask spread in the third period peaking marginally in the fourth period remaining negative over the twenty four periods. Volatility increases the bid-ask spread from the first month reaching its peak in the second period decaying in the fourth period and remaining constant thereafter. The same applies to CPI which increases the bid-ask spread remaining above the baseline over a 24 period. The response of BAS to a one S.D shock to the repo rate is inconsistent as it decays in the second period and increasing in the third period decreasing again and becoming insignificant from the seventh period thereafter. The same applies to the FIP. Shock to exchange rate reduces the bid-ask spread in the second period becoming insignificant from the sixth period.

The response of SQR(VOL) to REP is consistent with the apriori expectation as innovations associated with an increase in the repo rate decreases the volume of bonds traded in the fourth period and remain below the base line. This is consistent with Goyenko *et al.* (2008) who attributed the increase in illiquidity to an increase in inventory-holding and order processing costs due to higher interest rates which is reflected in higher transactions costs. The same applies to innovations in EX which negatively impact on the liquidity of the bond market as indicated in panel 3 for all the twenty four months. Innovations in FIP results in a mixed response in bond market liquidity. Bond market illiquidity increases from the first to the third period decreasing in the third and fourth periods to increasing again in the eighth period. This suggest that even though foreign investors play a role in enhancing liquidity in the bond market, increased participation of foreign investors could make emerging markets more susceptible to market volatility because such investments may accentuate financial market responses to existing macroeconomic imbalances.



Overall, impulse responses indicate that bond market liquidity is strongly negatively affected by REP, SMI, EX and VOLX. Thus, active trading in government bonds may cause the market to be more responsive to macro innovations which is consistent with Goyenko *et al.* (2008).

### **Variance Decomposition**

“Variance decompositions give the proportion of the movement in the dependent variables that are due to their own shocks, versus shocks to the other variables. A shock to the  $i^{\text{th}}$  variable will directly affect that variable and will be transmitted to all of the other variables in the system through the dynamic structure of the VAR” (Brooks 2008:300).

Appendix C illustrates the variance decomposition of the bid-ask (BAS) spread and volume (VOL) which is the focus of our study with a 24 month horizon using Choleski decomposition method in order to identify the most effective instrument to use in targeting each variable of interest. This helps in separating innovations of the endogenous variables into portions that can be attributed to their own innovations and to innovations from other variables.

First panel (see Appendix C) indicates that the predominant sources of variations in BAS forecast errors is own shocks, which account for between over 87 per cent and 100 per cent of the forecast errors in BAS over a 24 month horizon which is consistent with empirical evidence (Goyenko *et al.* 2008). Innovations in VOLX and CPI are also important as a source of forecast error variance.

The second panel indicates that between 89 per cent and 75 per cent of the forecast errors in volume of trade is own shocks. Innovations in CPI and REP are other important sources of forecast error variance in SQR(VOL) as far as macroeconomic factors are concerned. In the first month, all EX, SMI and FIP account for zero per cent. However, from the second month REP has a greater influence as it explains about 3.5 per cent decreasing to 2.7 per cent in the medium term and 2.6 per cent in the 24<sup>th</sup> month. Consumer Price Index (CPI) on the other hand increases from the short-term, through the medium and long-term. FIP, SMI and EX are relatively insignificant throughout the twenty four months.

The results suggest that own shock explains the greater part of the variability of bond market liquidity as measured by both bid-ask spread and volume of bonds traded.

### **VEC Granger Causality/ Block Exogeneity Wald Test**

The interest of this section is to examine the causal relationships between our two measures of liquidity and all the explanatory variables. Of significant interest is to test for bi-directional causality, if it exists, between the bid-ask spread, volume of bonds traded and volatility.

The empirical results show evidence of lead-lag interaction between our series. However, there is no evidence of bidirectional causality. For the bid-ask spread, there is evidence of unidirectional causality from volatility (p 0.0689) and CPI (p 0.0789) at 10 per cent level of significance. Exchange rate is significant at 5 per cent level. This emphasises the importance of the exchange rate in the South African bond market. The same result is exhibited on the volume measure though at 10 per cent level of significance. There is also evidence of causality from volume to volatility at 10 per cent level of significance supporting Easley and O’hara (1992)’s assertions that changes in volume of bonds may impact on volatility in the securities market.

## VAR Diagnostic Checks

The VAR model was subjected to rigorous tests. Diagnostic checks are crucial in this analysis because if there is a problem in the residuals from the estimation of the model, it will be an indication that the model is not efficient such that parameter estimates from such a model may be biased.

The VAR was tested for AR Roots. The AR Roots Graph reports the inverse roots of the characteristic AR polynomial. The AR Roots graph indicated that all roots lie inside the unit circle which indicates that our VAR is stable. Our impulse response and standard errors are valid therefore.

The model was tested for serial correlation as well and the results (p-value of 0.2461) suggest that there is no serial correlation in the variables. We also failed to reject the hypothesis of normality distribution as the JB test of 14.30264 and a p-value of 0.5718 is a clear indication of normality at all levels of significance. The result of the White Heteroskedasticity (no cross terms) p-value is 0.1415 implying that the null of homoskedastic residuals cannot be rejected.

## Two-Stage Least squares Regression Results

**Stage 1 regression:** We first regressed the variable  $SQR(VOL)$  on the predetermined variables, VOLX, CPI, REP, EX, SMI and FIP and obtained the following results Table IV.4.

**Table V.4: First regression results**

$SQR(VOL)$	Constant	VOLX	CPI	REP	EX	SMI	FIP
Coefficient	99714.67	-29341.53	-82273.29	-36586.10	-48096.86	-5.470735	3.544872
Se	221642.0	21966.96	16668.18	24740.34	23569.16	4.881336	0.419198
t-statistic	0.449891	-2.335712	-4.935949	-1.478803	-2.040669	-1.120746	8.456322
						R <sup>2</sup>	0.890921
						Adjusted R-squared	0.876693

**Stage 2 regression:** We went on to estimate the BAS function, replacing the endogenous  $SQR(VOL)$  with  $\hat{SQR}(VOL)$  estimated from the first equation. The results are as shown in table V.5.

**Table V.5: Second Stage regression results**

BAS	Constant	$\hat{SQR}(VOL)$
Coefficient	1.87547	-202E-06
Se	0.1519768	3.84E-07
t-statistic	3.496841	-5.273916
		R <sup>2</sup>
		0.890921
		Adjusted R-squared
		0.876693

**Source:** Author's computation using *EViews 7 Econometric software*.

The empirical results from the two-stage least squares model indicate that the explanatory variables are significant. The R-squared (0.890921) and Adjusted R-squared (0.876693) are highly significant which indicates that the variables selected do a “good job” of explaining the determinants of volume of bonds traded in the South African bond market. The high R<sup>2</sup> also suggest that the fitted  $\hat{SQR}(VOL)$  variable is a very good proxy for  $SQR(VOL)$  in the first equation.

The first stage regression indicates that volatility and all macroeconomic variables with the exception of REP and SMI do explain liquidity in the South African bond market. However, even though REP and SMI are insignificant, they are correctly signed. The second stage regression results do suggest that volume is negatively related to the spread as indicated by the signs of the coefficients. In other words an increase in volume of bonds traded results in a reduction in spreads.

These results replicate the VECM results with the exception of REP which is significant under VECM. Thus, both market microstructure and macroeconomic factors (volatility, volume, consumer price index, exchange rate, and foreign investor participation) captured in the estimated  $\hat{SQR}(VOL)$  do explain liquidity in the South African bond market.

### Diagnosics Checks

The results of the Two-Stage Least squares method were subjected to various diagnostic checks and the results are shown in table V.6.

Table V.6 Diagnostic checks

Test	Test Statistic	p-Value	Conclusion
Jarque-Bera	1.399905	0.496609	Normally distributed
Breusch-Godfrey	1.400762	0.2567	No Serial Correlation
ARCH LM	1.740516	0.1042	Homoskedasticity
Ramset Reset	0.127827	0.7223	No Misspecification

**Source:** Author's Computation using Eviews 7 Econometric Software

In all the tests in table V.6 the null hypothesis could not be rejected suggesting that our model did not violate any of the classical linear regression model assumptions.

We also carried out an omitted variable test on our first equation to see if the omission of the bid-ask spread in our first equation did not affect the results. The results indicated an  $F$  statistic of 1.625561 with a probability value of 0.1169. The high value of the probability value suggests that the bid-ask spread is not an omitted variable in the first equation. We did not test for omitted variables in the second regression since we replaced the right hand side (RHS) endogenous variables with their fitted Volume values from stage 1.

## VI. Conclusion

In this paper, the determinants of liquidity in the bond market were articulated through a VECM and 2SLS model. The 2SLS was used to check the robustness of the VECM results. Both the impulse response and the forecast error variance decomposition were constructed. Our results from both methods suggest that volume of bonds traded is negatively related to innovations in inflation, repo rate, exchange rate volatility and the stock market index. On the other hand the volume of bonds traded was seen to be positively related to an increase in foreign investor participation. These results were consistent with theoretical predictions as well as prior empirical analysis (Goyenko *et al.* 2008 and Nasser and He 1999).

From the market microstructure perspective, the bid-ask spread was established to be positively related to volatility whilst negatively related to volume of bonds traded. This again is consistent with prior studies (Elton and Green 1998 and Chabchitichaidol and Panyanukul 2005) as well as the a priori expectations.

In terms of policy choice, authorities should keep inflation at low and stable levels as well as maintain a stable currency. These will boost bond market liquidity as far as macroeconomic factors are concerned. Removing restrictions on foreign investor activities should be encouraged as their activities do have a positive effect on bond market liquidity. The negative relationship between the stock market index and volume of bonds suggest that the bond market as an investment is affected by developments in the stock market. Policy makers must therefore be aware of the implications of policy measures that promote one market at the expense of the other depending on the stage of development of the financial market and the structure of the economy.

As far as market microstructure factors are concerned, the study identified volume and volatility as important determinants of liquidity in the South African bond market. This suggests that ways to safe-guard against bond market volatility should be encouraged. The creation of a vibrant derivative market which would allow effective hedging of interest rate risk as well as credit risk should be encouraged. This attracts more participants into the market thus deepening the market. Other tools to reduce the impact of volatility on bond market liquidity include the development of a more active and well-functioning repurchase market as well as short-selling transactions. This is consistent with Mares (2002) and Chabchitrchaidol and Panyanukul (2005), who proposed that highly liquid futures market generates liquidity for the cash market for both bonds deliverable against futures contracts and the rest of the yield curve.

Some of these measures have been implemented in the South African bond market and resulted in greater liquidity in the market. Other African countries can also improve their bond markets by implementing the same measures.

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