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UNIVERSITY OF CAPE TOWN

**An Empirical Investigation of the Relationship between the
Exchange Rate and Interest Yields:
A Case Study of South Africa**

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Degree of
Master of Financial Management**

DECLARATION

I, Andrew Sikwanda, hereby declare that this study is my own original work and that all references have been duly acknowledged.

I further declare that this research report in part or in its entirety has not been submitted to any other University for degree purposes or any other educational purposes.

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ABSTRACT

This study analyses the relationship between the Dollar/Rand exchange rate and the interest yields rates in South Africa. It makes use of data available from 1998 through to 2010. Using statistical analysis of regression analysis and co integration, the study found that a positive correlation exists between the dollar/rand exchange rate and Interest rate yields. Further, it notes that the level of correlation is much stronger with the 5-10 years interest rate yields and much lower with the 0-3 year's rate yields, with the level of correlation decreasing after the 10 year period. Following a comprehensive inspection of the results this study concludes that the statistical relationship that exists is not very significant and investors should include other factors in order to forecast the exchange rates with regard to the changes in interest rates.

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1.0 INTRODUCTION

1.1 Background

Following the first ever democratic elections, in 1994, South Africa has witnessed an increase in interest rate product transactions on the Bond Exchange of South Africa. Foreign buyers as well as sellers are now considered a big part of the South African Investment environment. According to the Johannesburg Stock Exchange (JSE) for instance, foreign inflows into the South African government bonds denominated in Rand, as at 31 December 2010, were R61 billion (US\$9.2 bn), up from R26.5bn in 2009¹. This number outweighed the investment in stocks which reported net international investment inflows of R35.6 billion. Bloomberg² suggested that this was the first time that inflows into bonds had been more than those into equities since 1994, when apartheid ended in South Africa and was more than the net cumulative bond purchases in the previous 15 years. At the same time, the rand recorded a sustained appreciation against the American dollar and recorded an appreciation of 10.5% (7.36 at the start of the year against 6.54 at the end).

The appreciation of the rand in 2010 coincided with a marked reduction in the short and long-term nominal interest rates as expressed by the Repo rate that was reduced by the Reserve Bank to a low record of 5.5% from 9% at the beginning of 2010. This led to the view, especially popular in the financial press, that “the rates are low because the rand is much stronger in relation to other currencies”. This raises significant questions. Was the happening of 2010, a mere coincidence or not? Did the rand position against the dollar contribute to increasing the attractiveness of the South African Bonds? Do investors really need to be aware about the value of the currency they invest in when buying bonds or any interest related products? Should an investor use the shifts in one of the variables as an explanatory for the expected behaviour of the other? All these questions are what this study hopes to unravel as it progresses.

The relationship between interest rates and exchange rates has had an important area of focus among International Economics and Finance scholars owing to their importance in the econ-

¹ www.jse.co.za accessed on 17 January 2011

² www.bloomberg.com; accessed on 15/01/2011

omy of their countries. Using standard models of exchange rates, it is widely accepted that exchange rates are influenced by fundamental economic factors; among them is the difference in the interest rates between the home country and the comparative country abroad. However, a consistent result in the empirical literature is that a random-walk exchange rate forecasting model usually outperforms fundamental-based forecasting models like these. In other words, most models on exchange rates do not seem to explain the movements in exchange rates any better than what can be attributed to random movements in the exchange rates.

Further, early studies that have looked at the relationship between interest rates and exchange rates have produced results that are not consistent with each other. Some have supported the fact that a relationship exists, some clearly have found no relationship at all while others have found a relationship but only under certain given conditions. According to Hnatkovska et al (2007) the absence of a clear empirical relationship between interest rates and the exchange rate is even more pronounced from the perspective of applied practitioners. So if this is the case, why is it that typical policy instruments, such as short term rates, are often used by Central Banks, among others, to affect a currency's value? Or, for example, why do observers today argue that the shifts in the South African Repo rate are partly responsible for the continuous shifts in the Rand against - international currency markets?

The aim of this research study is to explore in a greater conceptual detail the relationship between nominal interest rates (both Central Bank-controlled and market determined), the nominal exchange rate and in the process clarify the trade-offs that are typically faced by policy makers and Investors.

1.2 Focus and Purpose of Research

The research will focus on the capital and financial markets in South Africa. In particular, the capital market will refer to the interest rate yields represented by the interest yields on government bonds issued by the government of the republic of South Africa (RSA); while the financial markets focus will be on the foreign currency markets represented by the dollar to rand exchange rates. The research's focus will be in terms of an international investor.

1.3 Research Questions

This research study seeks to answer the following questions:

1. Does any relationship exist between the nominal exchange rate of the rand/dollar and the nominal bond yield in the South Africa?
2. What is the correlation between the exchange rate volatility and the different categories of the bond terms?
3. Does the appreciation (depreciation) increase (decrease) the yield realised on the South African Bonds?

1.4 Significance of research

This study aims to contribute to the academic literature by analysing the relationship of interest rate yields and exchange rates in the South African context. While many studies have been carried out in various countries and regions to determine this relationship, not much has been done in South Africa. To my knowledge, this is the first time such a study has being done in South Africa.

The knowledge of the relationship is important for use by investors in the following ways:

1. Correlation matrix: By knowing the correlation between interest rates and rand/dollar exchange, a portfolio manager will be in a better position to calculate his/her correlation matrix for structural risk models that indicate the exposure of different assets/stocks to each other. Interest rates and exchange rates are among the most widely used factors in structural risk models such as the BARRA models and many other modern portfolio management.
2. Hedging: Knowing the relationship will ensure foreign investors as well as financial managers become more aware of how to hedge currency related products and interest related product. By knowing the relationship between these variables, Investors will be well informed on whether to use currency or interest rates hedging when trading in either the foreign currency market or the bond market.
3. Policy makers: The results can also go a long way in helping policy makers in emerging markets on how to react if there was a change in one of these variables.

2.0 LITERATURE REVIEW

This section begins by providing the context of the research which is located in South Africa. It proceeds to review theories on the relationship between exchange rates and interest yields and finally reviews empirical research on the matter.

2.1 South Africa as a Research Context

South Africa boasts of many factors that make it ideal for this research. Of particular interest is the stable and strong financial market among other emerging markets economies and Africa in particular and hence an idea investment destination for many external investors. It has several features in common with many industrial countries, including a well-developed local-currency, bond market and a stable banking system. Further, It has a sophisticated financial structure with the JSE Securities exchange as its hub which is ranked 18th in the world in terms of total market capitalisation as of March 2009³. The exchange's market includes Equity, Interest rates as well as the currency derivative markets.

The South African Interest rate market is one of the most promising and fast growing among the emerging-market economies. The market has many interest-influenced products such as Spot Bonds, Bonds Indices, Derivatives, Bond Futures, Options on Bond Futures', Jibar Futures and Jibar Futures Trading Strategies among others. These all depend on the country's interest rate and hence the results of the study will be highly important for South Africa and international investors seeking entry into the JSE.

The currency market is also well developed and this has helped in making the rand an international currency that can be traded almost in every major financial market in the world. The rand has been quoted as one of the most actively traded emerging market currency in the world⁴ alone with the other fifteen currencies. It was also the best-performing currency against the United States dollar (USD) between 2002 and 2005, according to the Bloomberg Currency scorecard and was one of the best performers against the dollar in 2010.

³ Based on the World Federation of Exchanges rankings

⁴ Based on Bloomberg and traderslog (www.bloomberg.com) and <http://www.traderslog.com/exoticcarrytrade/>)

The activities of the Central Bank are to use interest rates and exchange rates to control or attain a target inflation rate and also make the country an ideal research ground. With more investments coming into the country, the Reserve Bank of South Africa has at times opted to use its monetary policies to stabilize the economy. This has involved the use of interest rates to stabilize the local currency rate against the major currencies as well as other variables such as inflation. In 2011, Marcus Gill, Governor of Reserve Bank of South Africa announced that the country spent around 50 billion Rands in 2010 in its attempt to stabilise the appreciation of the Rand⁵ while at the same time it cut its interest rates to record low in over 3 decades⁶. This in itself begs the question on whether real relationships exist between interest rates and exchange rates for the Reserve Bank to find this as a possible policy tool.

The South African Economy is now considered among the best⁷ in the emerging markets, and the results from this research paper will also help investors as well as investment managers to understand other emerging markets as they consider investing in those foreign markets.

Despite the importance of the South African Interest rate as well as the currency markets, not much research has been done in these areas. This research therefore, will add to the understanding of the behaviour of the variables in the event that one of them moves in a particular manner and whether the other variable can be used to explain future values of the other.

2.2 Theories of Interest Rates and Exchange Rate

The theories on the relationship between interest rates and exchange rates are well documented among scholars in Finance and Economics. This relationship has had the support of many theories from many scholars and as expected no one answer has been settled on. According to

Sjolander (2007); Staudinger (2002); and Arize et al. (2003), some of the most famous and popular theories explaining the interrelation between interest rates and exchange rates include the following:-

- Purchasing Power Parity (PPP)

⁵ <http://www.iol.co.za/business/business-news/marcus-economic-recovery-fragile-1.1049264>

⁶ <http://www.resbank.co.za/Publications/Detail-Item-View/Pages/Publications.aspx?sarbweb=3b6aa07d-92ab-441f-b7bf-bb7dfb1bedb4&sarblast=21b5222e-7125-4e55-bb65-56fd3333371e&sarbitem=3566>

⁷ In January 2011, South Africa was officially endorsed as a full member of BRIC.

- Uncovered Interest parity
- the interest rate parity theorem

2.2.1 Purchasing Power Parity (PPP)

Purchasing power parity (PPP) is a theory of long-term equilibrium exchange rates based on relative price levels of two countries. The theory was originally propounded by the sixteenth-century scholars of the University of Salamanca in Spain⁸. The modern theory and definition, however, is credited to Gustav Cassel (1918). According to Cassel (1918), exchange rates will, in the long run, adjust to eliminate the arbitrage opportunity of buying a product or service in one country and selling it in another. He stated that the exchange rate changes between two currencies over any period of time are determined by the change in the two countries' relative price levels. Further, Krugman and Obstfeld (2009) state that 'the exchange rate between two countries' currencies equals the ratio of the countries' price levels and compares average prices across countries'. In this regard, taking financial assets, for instance bonds, as goods whose price should be the same, it can be claimed that in the long run the prices and hence returns on bonds in two different countries should be the same taking into account the exchange rate. It asserts that monetary policies that seek to raise interest rates would bring about a (transitory) real appreciation of the local currency. In the same vein, it asserts that increasing interest rates in a local economy will attract investors from other countries, who will move their cash in search of the high yields and will lead to a high demand in the country with high rates. The increase in demand will result in the yields to be lowered and this will cause the prices of bonds to go up which will result in a fall in the interest yields and equilibrium will be attained in the end. Applying this theory further, it can be taken that a high interest rate on bonds in the local economy relative to another country will lead to a high demand on the country's bonds by foreign investors, and hence a high volume in foreign capital injection in the local economy leading to a demand for more of the local currency, and hence an appreciation of the local currency. Looked at in this way, a conclusion can be drawn that the changes in the interest rates had an effect on the exchange rate. However, one thing that the theory fails to explain or elaborate is by how much or at what stage does the effect of this difference in rates be able to induce a change in the rate. It also does not state whether

⁸ *The Princeton Encyclopedia of the World Economy*. I. Princeton: Princeton University Press. p. 942. [ISBN 978-0-691-12812-2](https://doi.org/10.1215/9780691128122). Retrieved 2 October 2011
<http://books.google.com/books?id=BnEDno1hTegC&pg=PA942#v=onepage&q&f=false>

appreciation of the local currency due to other factors can cause a change in the interest rates yields.

2.2.2 Uncovered Interest Parity (UIP)

The Expectations Theory or Uncovered Interest Parity (UIP) states that the difference in interest rates between two countries is equal to the expected change in exchange rates between the countries' currencies. According to Isard (2006) the hypothesis of uncovered interest rate parity, expected changes in the nominal exchange rate should be positively related to the difference in the nominal interest rate across countries. In particular, this hypothesis implies that the slope coefficient from the regression of the change in exchange rate on the interest rate difference should be one. If this parity does not exist, there is an opportunity to make a profit. The theory received much attention from Keynes (1923:pp.115-39). It predicts that the currency of the country with the higher interest rate tends to depreciate. Accordingly, high interest rate currencies should lose value in future and this is the more reason why these currencies offer high rates; to compensate investors in equilibrium. This theory implies that investors would essentially achieve the same return from holding the high-interest-rate currency as from holding the low-interest-rate currency. Sjolander (2007) puts that the hypothesis is that the forward or futures rates represents the unbiased estimates of the expected future spot rates and therefore, the futures-spot spread, or interest rate difference from covered interest parity, can be used to predict changes in future exchange rates .

Under the floating exchange rate policy, capital inflows attracted by interest rate differentials will cause a surplus in the balance of payments. This should lead to a temporary appreciation of the local currency, which according to Fama et al. (1984) is "less than 1 month", but in overall equilibrium, the currency should depreciate. Using this theory, it is expected that the resultant coefficient will be one when the change in the exchange rate is regressed on the domestic and foreign interest rate difference. Inci (2004) posits that the uncovered interest parity does link the exchange rate changes to interest rate but it is too simplistic in itself as it fails to take into account the complementary and substitution effects between short- and long-term interest rates and hence, more complex models are needed to do this.

However, UIP as a theory has failed to explain other behaviours observed between interest rates and exchange rates. Closely related with the failure of the UIP is the forward premium

puzzle. The forward premium puzzle refers to the empirical findings that the slope coefficient from the regression of the changes in exchange rate on the interest rate differential is significantly negative. The puzzle is the finding that the forward premium usually points in the wrong direction for the ex post movement in the spot exchange rate. Uncovered interest parity states that, if covered interest parity holds, then the forward discount and hence the interest differential, should be an unbiased predictor of the ex post change in the spot rate, assuming rational expectations. The forward rate bias puzzle is given by the fact that the forward rate does not provide an unbiased forecast of the future spot rate. According to Bansel (1997), this empirical finding can be interpreted as evidence of time-varying forward risk premia. This has been supported by empirical work done by various scholars such as Bilson (1981), Cumby and Obstfeld (1984), Fama (1984), Hansen and Hodrick (1983), Hodrick and Srivastava (1986), and Hsieh (1984)].

2.2.3 Interest rate parity Theorem

This theory states that differences in the interest rate between two countries are accounted for by the differences in the forward exchange rate and the spot exchange rate. According to Aliber (1973), “the analyses of the behaviour in the foreign exchange market frequently rely on the interest rate parity theorem as the theorem relates the forward exchange rate to the money-market interest differential”. These analyses are based on the differential between the observed forward rate and the forward rate predicted from the interest agio, for example, on observed departures from interest parity. According to Lien (2006) Interest Parity theory has one weakness in that it has shown little proof of working due to activities of “manual” intervention by Central Banks who try to align their currencies.

2.3 Review of Empirical Research

A number of scholars using a variety of statistical techniques have carried out empirical work on the link between real exchange rates and interest rates. Most of this work has been on the premise of the theories reviewed above in the preceding paragraphs. The results of the relationship however, have not been conclusive as many scholars have had different results and different interpretations. These differences have arisen primarily in the methods and models that have been applied in investigating the relationship. While old scholars (among them Campbell and Clarida (1987), Engel (1986), Loopesko (1984), Bilson (1981), Meese and Rogoff (1988), Sachs (1985) and Frankel (1985) and Campbell and Clarida (1987)) have used methods such as simple linear regression, the more recent scholars (Inci (2005), Meese and Rogoff (1998), Calvo and Reinhart (2002), Alexius (2001), Chinn and Meredith (2005), Alexius (2001), Chinn and Meredith (2005) and Bekaert et al. (2002)) have gone a step ahead and incorporated the use of advanced techniques such as co-integration to control for the time series factors such as non Stationarity of the data used. Moving averages models in regression analysis has also been applied as a way to deal with the non stationarity of the variables that have been investigated. Other differences in the approach have been the forecast period, i.e. long term versus short term.

With differences in models and results, so have different interpretations been used to analyse the effects of interest rates and exchange rates on each other. However, studies show that most models used have been geared towards either approving or criticising the 3 theories explaining the relationship between interest rates and exchange rates (the PPP, UIP and EH) as set out in the “review of theories” in the section above.

2.3.1 Non-Existence of Relationship between Interest Rate and Exchange Rates

As recent as 2006, some empirical research has shown that no relationship can be said to exist between interest rates and exchange rates. Inci (2005) states that using more sophisticated co-integrating regression analysis have resulted in even more mixed results as shown by Meese and Rogoff (1988) ,who found no evidence of a significant relationship between exchange rates and long-term interest rate differentials using the real interest and exchange rates variables. Edison and Pauls (1993), using co-integration techniques and error-correction models, state that while real exchange rates and real interest rates are non-stationary, they are not co-integrated with each other. On the other hand, the dynamic models indicate that there

might be a long-run relationship between these variables, but this assertion lacks any verifiable evidence and hence not accepted. Using an approach called ‘state-space’ approach and long term interest and exchange rate, Campbell and Clarida (1987), examined whether the dollar’s exchange rate movements can be explained by shifts in the U.S interest rates and found that expected interest rates changes have simply not been persistent enough, and their innovation variance is not large enough, to account for much of the fluctuation in the dollar’s real exchange rate. In their exact words:

The Dollar exchange rate has been dominated by unanticipated shifts in the expected long-run real exchange rate. Ex ante real interest differentials have not been persistent or variable enough to account for a major part of exchange rate variation. (Campbell and Clarida 1987:)

In another research study, using proxies for ex ante real interest difference on long term bonds to make inferences about the expected cumulative real appreciation of the dollar, Sachs (1985) and Frankel (1985) showed that there is enough evidence that the real appreciation of the U.S Dollar between the period of 1980 and 1985 had little or nothing to do with changes in the expected long run real exchange rate at the time.

Meese and Rogoff (1998) contend that little evidence of a stable relationship between real interest rates and real exchange rate exist. According to them, the data investigated (dollar/mark, dollar/yen, and dollar/pound rate) did not indicate a strong correspondence between real interest rate differentials (short-term/long-term) and real exchange rates. They allude to two findings; firstly, that the fact that in many cases, the sign of the estimated exchange rate-interest rate differential relationship is consistent with the possible predominance of financial market disturbances, but the relationship is not stable enough to be statistically significant. Secondly, that although one does find some evidence of a unit root in both real exchange rates and long-term real interest differentials, these two series do not appear to be linearly co-integrated and hence, the non-Stationarity (or near non-Stationarity) in the two series cannot be attributed to the same factor.

Other studies carried out also indicate that the relationship between interest rates and exchange rates have typically been found to be mixed or conflicting. Eichenbaum and Evans (1995), in their study of the effect of monetary effects shocks on the U.S economy found that

interest rate innovations resulting from contractionary shocks tend to appreciate the local currency while studies carried out by Calvo and Reinhart (2002) found that for developing countries, there is no systematic relationship between these two variables. Eichenbaum and Evans (1995), concluded that the U.S dollar appreciated slowly after the Federal Reserve Bank engaged in the use of instruments to reduce the money supply in circulation in the Economy, through the use of bonds and TBs, which also resulted in the rise of the U.S. interest rate relative to foreign interest rates. This, according to them was in line with the literature on the Forward Premium Puzzle which finds that future changes in the exchange rate tend to be negatively related to the forward premium.

2.3.2 Existence of Relationship between Interest Rate and Exchange Rates

Over the years, researchers and practitioners have carried out studies on that claim to have results that show a positive relationship between these two economic variables. This school of thought has argued that reasonable evidence exists to fully conclude that the interest yields and exchange rates are really related. Alexius (2001), Chinn and Meredith (2005) in testing the theory of Uncovered Interest Parity (UIP) based on investments in long-term bonds from a number of different currencies whilst taking into account the interest coupon payments and Bond's differences in maturity concluded that the coefficients of the relationship between currencies and yields are typically positive, but at the same time much significantly smaller than one. According to this research, whilst the relationship is smaller than one, it points to the fact that a reasonable relationship does exist which with further improvement in the techniques of analysis would move the value close to 1. The above findings seem to be based on the early findings of Flood and Taylor (1996) who together concluded that a relationship exists between the exchange rate and other fundamental economic factors (interest rate being one of them). However, according to Flood and Taylor (1996), for this relationship to be evident, the duration of the investment is important. They state that while the short term movements in exchange rates seem to suffer from a low explanatory due to 'noise', the use of techniques such as co integration still shows that it is a long term investment that seems to show much of a relationship. Testing the theory of uncovered interest rate parity, Bekaert et al. (2002) reported a negative slope coefficient for both short-term interest rates and long-term interest rates and suggested that the downwardness of the slope for the long term interest rates than it is for short term.

Investigating the determinants of the long term exchange rate, Coughlin and Koedijk (1990), found a relationship between the real exchange rate and the long-term real interest differential for the United States and West Germany. In so doing, they categorically disputed the findings laid out by Campbell and Clarida (1987) and Meese and Rogoff (1988) who failed to find any relationship between these variables. Their results however, are not conclusive as they show that the relationship only existed between Germany and U.S. and no relationship was seen between UK/West Germany and West Germany/Japan. Further, analysis of co-integration results among these tests all showed that the residuals were non-stationary and hence not related in the long term. Brown (1990), Blundell-Wignall and Browne (1991), however, find that exchange rates and interest rates may be related. The ability of Blundell-Wignall and Browne to find a relationship is due to the inclusion of the difference in the share of the cumulated current account relative to GNP in the relevant countries and the fact that they use real interest and exchange rates and not the nominal rates. Their results are also only limited for the mark/dollar exchange rate and resulted from an extended sample period with more recent data.

Inci (2004) states that empirical results depend on the forecasting horizons and terms of interest rates, and studies that have focused on horizons of less than one year using short-term interest rates have found that not only the slope coefficient is statistically different from one, but also it is negative for most of the major currencies. Further, Chaboud and Wright, (2005), state that UIP only holds for extremely short investment periods while Flood and Rose, (2002), argues that it holds better for countries with flexible exchange rates during periods of crises.

Chow et al (1997), posits that bonds are positively exposed to exchange-rate changes across all horizons due to a negative correlation between exchange rate and the domestic interest-rate changes and that the magnitude of the contemporaneous exchange-rate correlation coefficient appears to peak at the 24-month horizon (2 years). Thus, according to their research, a negative correlation between the exchange rates and interest rate exist. This result however is not consistent with that of Baxter (1994), who despite finding a relationship between the variables indicates that this relationship is a positive. Using real exchange rates and real interest differentials, he argues that the relationship is positive and the strongest link is at trend and business cycle frequencies. According to him, the reasons why prior research failed to find a relationship is that, there does not appear to be an important short-term (high-

frequency) link between these variables. In other words, he concludes that the relationship of exchange rates is more likely to be on the long-term interest rates than on the short term, a finding that is in line with that set out by Chow (1997).

With a caution, Hnatkovska et al (2007), using optimizing model of a small open economy, states that a relationship between interest rates and the exchange rate is non-monotonic. And that the exchange rate response depends on the size of the interest rate increase and on the initial level of the interest rate. They argue that this relationship is non-monotonic, in that it is a formal logic and can be explained by adding more information to the already existing theories on the relationship between the variables. They state that an increase in the interest rate up to 35% both appreciate the local currency and induce a fall in the rate of currency depreciation (hence a positive relationship) while a more aggressive increase in the domestic interest rate will result in both a depreciation in the currency as well as an increase the rate of currency depreciation (and hence a negative correlation).

Using a macroeconomic model, Engel (1986) demonstrated that a correlation between a country's currency value and its nominal interest rate need not indicate real interest rate movements. This, he states, should correct the misimpression that a negative correlation between the price of foreign currency and nominal interest rates is necessarily evidence of a change in the real interest rate. Engel employed a monetarist macro-model in which nominal foreign prices and interest rates were fixed.

2.3.3 Interest Yield Rates and Exchange Rates Risk

Exchange rate volatility thus plays an important role in determining the country's profile risk. This volatility is called the exchange rate risk (this arises from the change in prices of one currency against another). In business finance and economics, it's a general view that any investor will require more return for more risks. In this regard, it is true to claim that a relationship does really exist between this two variables. Foreign investors tend to require much more yields on investments made in a currency that is expected to be volatile over the life of the investment. A higher volatile exchange rate will usually have a high interest rate.

Hauser and Levy (1991) states that "it is widely recognized that interest rates are correlated with exchange rates and play a special role in their pricing". This indicates that whenever foreign investors are pricing bonds of another country, exchange rates prevailing at the time will be taken into consideration. This linkage between the two economic variables stem from many ways but one of the facts is that of risk that is brought about by movements in the exchange rate. Using the interest rate yield as a measure of the returns for investors who invest in international bonds, Hauser and Levy (1991) noted that:

The correlations between returns of bonds and foreign exchange rates are significantly lower for longer-maturity bonds than for shorter ones; the rates of change of exchange rates are more volatile than those of bond prices; and the variance of return of non-Dollar-denominated bonds are primarily due to exchange-rate risk.

(Hauser and Levy, 1991: 376).

The above observations are also supported by Dym (1992), who relates the effect of exchange rates on the country's foreign bond risk profile. According to Dym, the exchange rate effect will be two fold; first, the coupon and face value of the bond are paid in units of the foreign currency. Obviously, then, a foreign investor will be directly affected by changes in the currency's exchange rate with respect to the currency. Secondly, changes in the exchange rate will lead to associated movements in the bond's yield as the coupon amounts and price of the bond depend on the exchange rates. Thus, logically, a high-risk investment should have high returns otherwise the investor will be losing out. Chow et al (1997) states that the impact of exchange rates on an asset's return is negatively correlated, which means that an increase in the risk results in a low return on an asset and vice versa. This, according to Adjasi and Biekpe (2008), is caused by the fact that a depreciating currency will result in the investors getting money that is worthless than when invested.

This currency risk brought about by Bonds issued in local currencies has resulted in the market for these bonds to be limited, mostly noted among emerging markets as well as developing countries whose foreign currency profiles seem to be highly volatile. The market for local currency bonds, though growing, is still small as Ebner (2009) notes and the use of well denominated currencies like the Euro gives countries easy access to international markets.

The Economist (2005) noted that previous falls in the dollar's exchange rate had pushed American bond yields up, as foreign investors have demanded a bigger reward to compensate for the increased exchange-rate risk. Thus, depending on the exchange rate, the demand for any issued local currency bond by foreign investors will be either low or high partially based on the exchange rate. Ebner (2009), states that currency risks affects the bondholders who purchases the bond and receives returns, measured in terms of interest rates yields, in the bond's local currency which faces uncertainty due to volatilities, e.g. loses its value due to depreciation, as well as the fact that the depreciation of the currency may cause the government to default on the payments.

Dym (1992), however, notes that the risk posed by the exchange rates on the required return is somehow not consistent and will depend on how much the volatility sources can be traced as either a 'global source' or 'local source'. Different countries will respond differently to these two sources of interest rates volatility with regard to exchange rates. Countries differ with respect to the correlations between the two interest rate volatility sources and their exchange rate movements. Considering the correlations between the exchange rate and the local interest rate volatility factors, he states that countries such as Australia and the United Kingdom, showed falling currency values as the local components of their respective interest rate levels went up. Currencies of Belgium and New Zealand on the other hand, moved positively with local interest rate factor movements over the same period. The conclusion from this is that countries with high local sources as a reason for volatilities in their rates, showed a high correlation between interest rates and exchange rates. These countries with low exposures to local risks are thus expected to see less change because of changes in the local interest rates even though their total risks are high. Countries with high local risks sources on the other hand are expected to show high effects of changes in the interest rates.

The risk profile caused by the exchange rate on the bond yields is also seen in the differences of the yields that are offered by different countries. This is despite the fact that certain countries have the same credit ratings or exposure to the same default risk by virtue of being in the same development region. A good example of this has been noted in the European Union (EU) member countries. Codogno et al (2004) notes that one of the causes of large spreads on the bonds issued by member countries from the EU before the start of a single currency was the exchange rate movements and exchange rate risks. Their research showed that though the spreads on yields had not vanished completely, by January 1999, the spreads had largely decreased with the remaining small differences attributed to liquidity and default risks of the issuing member countries. In this instance, not only did the study reveal that a relationship really exist, but also that this relationship should be positive as an increase in the exchange rate risk movements caused a rise in volatility in risk which caused a rise in the rates.

The risk factor of currencies on interest yields is also seen when depreciation of the local currencies due to global risk leads to increase in rates. According to the financial stability and local currency bond markets (2007, No 28), during the increased global risk aversion of May and June 2006, which triggered a sudden reversal of large “carry” positions on Turkish bonds, a sharp decline in local currency bond prices and the exchange rate lead to withdrawal, by foreign investors, from lira-denominated bonds. This was estimated to have reached \$4 billion in two months. The resultant effect was an increase in the domestic yields so as to compensate for the low value of the currency. This again shows of a real world example of a likelihood relationship between the two variables.

The exchange risk also affects the prices of the assets in the interest rate markets. Empirical studies carried out to this effect show that stabilising the exchange rate reduces the volatility of asset prices. According to Flood and Rose (1995) and Rose (1995), there is a marked linkage between the patterns of volatilities on the bond market and the foreign exchange market which confirms the presumption that the uncertainty surrounding the conduct of domestic monetary policy is a crucial determinant of the volatility of bond prices. According to Hauser et al (2002), this explains Central Banks tendencies to conduct monetary policy using monetary tools such as the Repo rate. For example, an appreciation of the US\$/ZAR exchange rate induced the Reserve Bank of South Africa in 2010 to conduct a restrictive monetary policy which resulted in the country’s Repo rate being lowered to its lowest in 30 years (5.5%). This

is in direct contradiction with the findings of other scholars who regard the fact that changes in currency rates will more likely affect long term interest rates rather than the short term rates.

The relationship between interest rate and the exchange rates has also being explained with reference to stock models. According to the 'Stock Oriented' model, (Branson 1983 and Frankel, 1983) expectations of relative currency movements have a significant impact on price movements of financially held assets which include government securities such as Bonds and Treasury bills. In this model, the exchange rate equates demand and supply for assets (bonds and stocks) and thus, the bond price movements may influence or be influenced by exchange rate movements. In other words, the value and prices of these supplied assets is largely influenced by the exchange rates. In the case of bonds, the change in the prices will affect the interest yields realised on the bonds and hence it's clear that a relationship should exist between interest rates and exchange rates.

2.4 Central Banks Sterilisation

Sloman (2004) defines sterilisation as those actions that are normally undertaken by the country's central bank to counter the effects on the money supply caused by a balance of payments which may be brought about through either a surplus or deficit. This can be achieved by the normal central bank's operations such as issuing of more or less treasury bills. The relationship between interest rates and exchange rates is apparent from the use of this technique by the Central Banks to insulate the local currency from changes caused by capital mobility. Capital mobility in this case is defined as the movement of large amounts of cash in and out of the country caused by among other things capital flight as well as changes in the global economic conditions. This type of capital movement is in most cases beyond the control of local authorities and may result in either the appreciation or depreciation of the local currency, depending on the direction of the capital flows. In this regard, countries may be seen to intervene in the foreign exchange markets either through bulk selling of the currency or vice versa. For instance, during the 2008/09 economic recession which started with the fall of major financial companies in the United States and spread across the globe, investors withdrawal much capital from emerging markets while others suspended any new investments in projects and most countries in this region had their local currencies lose value against major world currencies. Benita and Lauterbach (2004) states that the importance of using either exchange

rates or interest rates to control the other has been well practiced by various Central Banks in the financial history of the world. During the 20th century, many countries attempted to moderate the impact of the exchange rate volatility on their domestic economics by coming up with exchange controls measures through changing the interest rates as well as by imposing restrictions on capital flows. According to Dornbush et al (1998), Central government sets the short term interest rates based on the deviation of the exchange rate, inflation rate and output growth from their respective targets, with a lagged variable to allow for instrument smoothing. According to Calvo et al (1993), sterilisation may lead to an increase in domestic nominal and real interest rates, lower aggregate demand, and mitigate the appreciation of the real exchange rate. From this, it is clear that the increase in the interest rates will result in the depreciation of the local currency. According to Calvo et al (1993), a relationship is posited, though in this case it's negative rather than positive.

However, the use of interest rates to curb exchange rates is not always clear cut. For instance, many commentators attributed the exit of the United Kingdom (UK) from the exchange rate mechanism of the European Monetary System (EMS) for the purpose of allowing the Bank of England to cut its interest rates. This cut led to a fall in the Pound Sterling against the Deutschmark (DM) instead of the expected rise in the value of the Pound (i.e. a positive correlation was seen). According to Loopesko (1984), using the Portfolio-balance channel, sterilised intervention operations will have no influence on the exchange rates through a Portfolio-balance channel if investors view securities denominated in different currencies as perfect substitutes. However, if investors view these securities as imperfect substitutes, the intervention operation may affect the exchange rate through a Portfolio-balance channel. Imperfect substitutability, as defined by Loopesko (1984), implies that investors care about the currency denomination of the securities in their portfolios. This imbalance, resulting from the incipient excess demand for the securities purchased by the authorities and incipient excess supply of the securities sold, will necessitate movements in either the exchange rate or interest rates, or both, to restore equilibrium. Other examples include European exchange market crises in past years, also showed that investors' assessed on whether interest rate increases are durable and credible for economies experiencing financial problems and not just trying to defend or stimulate recovery.

2.4.1 Yield Curve and Future Exchange Rate

The relationship between interest rates and exchange rates is also apparent from the use of yield curves in predicting the future exchange rates. Chen and Tsang (2009) and Koiv, Nyholm and Stromberg (2007) explore the use of the yield curve to predict the foreign exchange rate between any two given currencies. A yield curve, defined as the relation between the interest rate (or cost of borrowing) and the time of maturity of the debt for a given borrower in a given currency, can predict bilateral exchange rate movements and explain excess currency returns from one month to two years ahead. When the home yield curve becomes steeper relative to the foreign one, over the subsequent months, the home currency tends to depreciate and its excess return - currency returns net of interest differentials - declines. When the domestic yield curve shifts up or its curvature increases relative to the foreign one, the home currency appreciates subsequently, though the curvature response is not as robust. This implies a relationship between the interest rate and the exchange rates.

2.4.2 Currency Crashes, Interest Rate and Exchange Rates

The behaviour of inflation with regard to interest rates and exchange rates also show a possible relationship between these variables. Philippe Jorion (1991) states that while the exchange rate variable is positively correlated with the stock market, it is significantly related to other factors as well, among them inflation. The observations of the resultant effects on interest rates and exchange rates during a currency crash or crisis also show that a relationship is prone to exist between the exchange rate and the interest rates. A currency crash is defined as a sharp fall or depreciation of the local currency in comparisons to the other currencies, and can result in the increase in the interest rates of the depreciating currency. Sudden and large depreciations sometimes referred to as currency crashes, have on occasion led to sharp rises in bond yields. The results of a currency crash or crisis however is mixed as the balance favour the view that higher interest rates were associated with appreciations in emerging countries such as Indonesia, Korea, Malaysia, the Philippines, and Thailand (Goldfajn and Baig, 1998). Cho and West (2000) concluded that interest rate increases led to exchange rate appreciation in Korea during the crisis. A further review of these results however, reveal that while an exogenous increase in interest rates caused exchange rate appreciation in Korea and the Philippines, it resulted in a currency depreciation in Thailand and hence shows a form of mixed results between a positive correlation and a negative one that can result between the variables. Dekle et al (2001),) found sharp evidence that interest rate changes were reduced

form predictors of subsequent exchange rate appreciations in Korea, Malaysia, and Thailand, though with long and variable lags. Gould and Kamin (2000) were unable to find a reliable relationship between interest rates and exchange rates in the five countries. Cho and West (2001) found that interest rates and exchange rates are positively correlated, and this correlation is a result of monetary authorities' actively raising the interest rates. They found that an increase in interest rates caused exchange rate appreciation in Korea and the Philippines, and depreciation in Thailand. Similar studies have been done in a number of emerging market crises, including Mexico in 1995. These instances of rising bond yields are closely related to high and rising inflation rates.

Gagnon (2007) has noted that the effect of the currency crashes on the interest rates or yields is due to three reasons; i) the Fisher effect ii) "monetary reaction and; iii) risk premium effects. According to the Fisher effect, exchange rate depreciation may be expected to push up domestic inflation through higher prices for imported goods and services. Investors are likely to demand a higher nominal rate of returns to compensate for this expected inflation. According to this model, inflation has a positive effect on the bond yields and hence the name 'Inflation Channel'. The Monetary reaction channel is when investors expect the Central Bank to prevent the expected increase in inflation by raising the short-term interest rates. This increase may be expected to be more than the expected increase in the inflation rate in order to prevent the inflation from becoming entrenched. The third and final channel, the risk premium, arises when investors resorts to demand a higher risk premium on bonds because of heightened uncertainty about future inflation, future real interest rates, or even the possibility of a future default. In Australia for instance, foreign as well as domestic buyers are known to have purchased more bonds in anticipation of making capital gains as the Australian long-term bond rates had appeared high in relation to inflation. This provided considerable support for the Australian Dollar while bond yields fell from around 13.5 per cent in 1990 to 7.5 per cent in 1993.

On the other hand, Gagnon (2007) concludes that the currency crashes tend to only affect the emerging markets as far as yields are concerned. This is caused by anti-inflationary credibility earned by Central Banks in industrialised countries. Industrial countries especially since the mid-1980s have more stable monetary frameworks with greater anti-inflationary credibility.

This relationship is negatively correlated with changes in expected inflation, which are primarily driven by changes in short-term interest rates as explained by the “temporariness hypothesis” (Calvo, 1986; Calvo and Vwgh, 1993), which focuses on the effects of lack of credibility during inflationary period. This hypothesis considers the case in which agents expect the inflation stabilization program to be re-versed in the future. If money is needed to carry out transactions, a temporary reduction in nominal interest rates lowers the effective price of consumption today relative to the future and induces an initial consumption and output boom accompanied by an appreciated real exchange rate.

2.5 Review of Empirical Research in South Africa

While the exchange rates and the interest rates in any country are important economic variables, there is little research or publications that have been done on South Africa concerning these variables.

Empirical research done has shown how the behaviour of the exchange rate affects other economic variables such as interest rates but does not really show which direction this is. For instance in 1998, the Rand depreciation of 28% was followed by the increase in interest rates for short and long term bonds of 700 basis points while the spreads on the sovereign U.S dollar denominated bonds increased to about 400 basis points (Bhundia,2001; RICCI, 2001). However, the subsequent depreciation of the Rand in 2001 showed interest rates not to behave in the same way as in 1998 as this time around, while the Rand depreciated by 26%, interest rates remained fairly stable and sovereign U.S dollar denominated bond spreads narrowed by 40 basis points.

In 1998, increasing interest rates proved to be of limited effectiveness in fighting depreciation pressures, and proved to be costly for investment and growth. According to the Financial Stability Forum (FSF) report (2000) this was largely caused by some highly leveraged institutions (HLIs), who were selling the Rand short. This drove up the domestic interest rates. At the time these investors were also selling short government securities and making a profit when bond prices due to the increase in the interest rates went down. The short sellers hoped to make profits from a decline in the price of the Rand between the sale and the repurchase

period, as the seller would have paid less to buy the assets than the seller received on selling them.

Intervention in the foreign exchange market was also ineffective in stemming heavy pressure on the exchange rate, both because it was sterilized and because it entailed a large build-up of foreign obligations that limited the credibility of the policy choice. The South African authorities have acknowledged that the intervention policy in 1998 was inappropriate. They avoided adopting the same intervention policy in 2001, which proved to be a very successful strategy as the macroeconomic repercussions of the crisis were limited and the Rand strengthened over the next few years.

In its annual report of 1998, the Reserve Bank of South Africa also attributed the movement of bond yields during 1996 as strongly influenced by the sharp depreciation in the external value of the Rand from February of that year. This was caused by the fact that most international investors classified South Africa as an emerging market and as such the country is invariably affected when financial stability appears to be under threat in any of the other economies included in the emerging-markets category. The bank supported the FSF's observation that the Rand came under speculative attack, and hence monetary policy had to be tightened from the middle of May 1998. The resultant effect of the Rand depreciation thus led to the net sale of bonds by non-resident investors in the domestic bond market causing the yields on long-term government bonds to rise sharply from an average level of 12.67 per cent on 17 April 1998 to 16.44 per cent on 6 July 1998 (South Africa Reserve Bank Annual report; 2008). As per the South Africa Reserve Bank Annual report (2008) the Rand only started to stabilise again in the last quarter of 1996 when it became clear that macroeconomic balance had been largely restored and so did the bond yields.

3.0 METHODOLOGY

Methodology is structured into three sections: The first section describes the design of the study and discusses the sample and data. The second section is concerned with the empirical response (statistics) to the research questions set out in the beginning of this research while the third section sets out the test to answer the Hypotheses set out in the introduction part.

3.1 Research Design

This is a descriptive quantitative study, with a deductive approach. From the theory, hypotheses were created that were tested in the South African context. Actual quantitative observations were tested using a statistical approach. Regression analysis was the statistical tool used to test the hypotheses regarding the relationship between interest rates and Exchange rates. In order to ensure a high quality of the results, the data was controlled for certain factors that are susceptible to time series analysis. Using data generated from time series without controlling for such factors such as non Stationarity can lead to what is known as ‘spurious regression,’ which basically results from analysing data where the magnitude of the observations of each variable tends to increase (decrease) over time (Watsham & Parramore P 201, 1997).

Meanwhile, Statistical software, Eviews 7⁹ was used to analyse the statistical properties of the variables so as to reach the conclusion.

3.1.1 Data

The set of variables included in this research consisted of one dependent variable and four (4) explanatory variables. The dependent variable was the Dollar/Rand Exchange rate. The explanatory variables consisted of the following yields on government bonds:-

1. Interest yields on the 0-3 years South African Bonds
2. Interest yields on the 3-5 years South African Bonds
3. Interest yields on the 5-10 years South African Bonds
4. Interest yields on 10 years and above

⁹ EIEWS® is an econometrics & Time Series Analysis software package by Quantitative Micro Software.
<http://www.eviews.com/index.html>

The bond interest yields were an average of government bonds outstanding, and therefore do not have a constant maturity.

The interest rates used in this research are that of nominal rates instead of real rates. The notion is that the research is aimed at the international investor's point of view who is not so much concerned about the local inflation rate. Further, it is taken that both the interest rates and exchange rates pricing already factor in the rate of inflation at any time. The use of real rates also causes the issue of which inflation index should be used as many indexes are used in calculating inflation rates. Further, even if the rate is decided, should the average rate, current or future rate be used? The use of nominal rates thus reduces the subjectivity arising from the choice of the rate used in arriving at real rates.

The sample data was the monthly data collected for both the exchange rate and interest yield on the long term bonds. The period covered was from January 1998-October 2010 representing 156 data points.

Data was collected from the South Africa Reserve Bank (SARB) online financial research data-bases¹⁰ which offer historical online economic data. The SARB is the Central Bank of South Africa entrusted with monitoring and regulating both financial and currency markets in South Africa and hence the data is said to be reliable and complete. This was deemed as the source to have the most reliable source of data considering the variables that were being investigated. The Interest rate yields were those based on the government bonds that are issued by the government of South Africa and traded on the Johannesburg Stock Exchange (JSE), while the Rand/Dollar exchange rate is also closely monitored by the Central Bank and freely traded on both the JSE as well as through Commercial Banks and bureau de changes in the country.

3.2 Hypotheses:

Relationship between Interest Yields and Exchange Rate

The objective of this study is to investigate whether or not a relationship exists between the Interest rates and the exchange rates in South Africa. This was tested using regression analy-

¹⁰ <http://www.resbank.co.za/Research/Statistics/Pages/OnlineDownloadFacility.aspx>

sis incorporating co-integration analysis and. The resultant equation of the regression analysis followed the model:-

$$Y = \alpha + \beta X$$

Y is the dependent variable in this case the Exchange Rate

X is the independent variable in this case the Interest Rate

α is the constant term or Alpha

β is the coefficient of correlation

The Hypothesis is as below;

Ho: $\beta=0$: the coefficient is not statistically different from zero and hence a relationship doesn't exist

H1: $\beta \neq 0$: The coefficient is statistically different from Zero and a relationship does exist

3.3 Data Manipulation

Data manipulation was conducted to ensure the data was common and in comparable form.

This ensured that the start and end days were the same for the two time series.

Analysis of Data

Stationarity of Sample Data:

The majority of the economic time series exhibit a consistent upward or downward trend purely caused by the fact that the data is not stationary. The regression of non-stationary time series on one another often yields significant regression results even though there is actually no meaningful relationship between the two variables and are actually only correlated through a third variable that is not included in the model. This is essentially the problem known as spurious correlations. Thus, in this research, the data was controlled for the difference in time series as well as the fact that time series may not be stationary.

Stationarity implies a variable mean and variance are constant over time. The covariance between two time series should be solely dependent on the distance between the two time periods and not on the actual time period at which the covariance is measured. Unit root testing, tests whether the data is stationary or not.

Testing for Unit Roots:

The test for unit roots used the test developed by Dickey and Fuller (1979) for testing for unit roots. In this report, the tests involved regression of the Rand/Dollar exchange rate against the Bond interest yield separate for each type of yield according to its term horizon.

Secondly, the test involved regression of the first difference of the variables under consideration on their own lagged level, at a constant to control for autocorrelation.

The Hypothesis for this test was as follows:

$H_0: \delta = 0$ (Unit Root)

$H_1: \delta \neq 0$

Decision rule:

If $t^* >$ ADF critical value, \implies not reject null hypothesis, i.e., unit root exists.

If $t^* <$ ADF critical value, \implies reject null hypothesis, i.e., unit root does not exist

Unit root testing Using Eviews 7

The following assumptions were made for the tests using Eviews v7:

The following assumptions were taken into account in Eviews when running the Augmented Dickey Fuller (ADF) Test Hypothesis noted above;

- Test Type: ADF
- Test for Unit Root in: Level
- Included in Test Equation: Intercept (no trend)
- Critical Value: 1%, 5% and 10%

Testing for Unit roots after differencing

Unit root test after Differencing:

To test whether there is a long-run relationship between variables that contain unit roots, the residuals from an ordinary-least-squares regression between the variables were examined. In other words, a Dickey-Fuller test was performed on the residuals resulting from differencing the Dollar/Rand exchange rate on a potential determinant - the long term Interest rate. This is known as the Difference-Stationary Process (DSP). The first difference of the residual series was regressed on its lagged level, a constant and an appropriate number of lagged first differences.

The procedure for testing the differenced data was the same as the one performed on the original variables except for changing the level of test from “level” to “1st difference” in Eviews v7 as the data used was differenced once. If the null hypothesis of a co-efficient of zero can be rejected, then the residuals are stationary. If the residuals are stationary, then the variables will not drift away from each other, such variables are said to be co integrated

Co integration:

The concept of co integration was first introduced by Granger (1983) and later expanded upon by Engle and Granger (1987). Since then co integration has emerged as a powerful tool for investigating common trends in both multi and univariate time series and provides a sound methodology for modelling both long and short-term run dynamics in a system (Alexander et al, Gibin & Weddington, 2002).

A vector time series is co integrated of order (d, b) if each element needs to be differenced d times to achieve Stationarity but yet there exists a (not necessarily unique) linear combination of the two vectors that only needs to be differenced (d-b) times to achieve Stationarity. Two methods are available for testing of co integration:

- The Johansson's test
- The Engel-Granger test.

According to Hye (2009), the Johansen method has an advantage over the Engel-Granger method in that it fully captures the time series properties of the data. In this regard, this test was used in testing for co integration.

The hypothesis for Co integration was as below;

Ho: No Co integration Exist (hence no relationship)

H1: Co integration exists (Relationship exists)

Analysis

Ordinary Least Squares Regression Analysis:

Having established that the variables are co integrated and hence related, the Ordinary Least Squares was run. Thereafter, the F-statistic, R squared, the correlation of coefficient, and the sum of squares were analysed so as to determine the significance of the relationship between the variables.

The estimated equation from the above results was:

$$Y = \alpha + \beta X$$

4.0 RESULTS AND ANALYSIS

4.1 Unit Root in the Original Data Sets

TABLE 1.1: TESTING FOR THE PRESENCE OF UNIT ROOTS IN THE ORIGINAL TIME SERIES

Data Type	t-statistic	ADF critical Value @1%	ADF critical Value @5%	ADF critical Value @10%	Comment	Unit root Exist (Y/N)
Foreign exchange rate :Rand per Dollar	-2.528985	-3.473096	-2.880211	-2.576805	t* > ADF critical value, therefore the null hypothesis is not rejected.	Yes
KBP2000M Yield : 0-3 yrs	-1.817826	-3.473096	-2.880211	-2.576805	t* > ADF critical value, therefore the null hypothesis is not rejected.	Yes
KBP2001M Yield : 3-5yrs	-1.3998	-3.473382	-2.880336	-2.576871	t* > ADF critical value, therefore the null hypothesis is not rejected.	Yes
KBP2002M Yield: 5-10yrs	-1.413856	-3.473096	-2.880211	-2.576805	t* > ADF critical value, therefore the null hypothesis is not rejected.	Yes
KBP2003M Yield: 10 yrs and above	-1.494743	-3.473096	-2.880211	-2.576805	t* > ADF critical value, therefore the null hypothesis is not rejected.	Yes

From the analysis of the results above (Table 1.1), the ADF test clearly shows that the original time series, at the critical values of 1%, 5% & 10%, have unit roots in them and hence the null hypothesis for the test is rejected. This means that the data is non-stationary.

(See Appendix I for the E-views 7 actual output results schedule)

Even though the exchange rate and the Interest rate have a unit root, it is still possible that a long-run relationship between them may exist. For an equilibrium relationship to exist between these variables, the disturbances that cause non-stationary behaviour in both of the variables must also cause non-stationary in the other variables. Thus, both variables should be non-stationary and integrated to the same level. As discussed in the methodology section, the variables were differenced and tested for Stationarity.

4.2 Unit root test after Differencing

TABLE 1.2: TESTING FOR UNIT ROOTS IN EXCHANGE RATES AFTER DIFFERENCING

Yield Type	t statistic	ADF critical Value @1%	ADF critical Value @5%	ADF critical Value @10%	Comment	Unit root Exist (Y/N)
KBP5339M: Foreign exchange rate :Rand per Dollar	-8.849071	-3.475184	-2.881123	-2.577291	t* < ADF critical value, therefore the null hypothesis is rejected.	No
KBP2000M Yield : 0-3 yrs.	-11.56177	-3.473967	-2.880591	-2.577008	t* < ADF critical value, therefore the null hypothesis is rejected.	No
KBP2001M Yield : 3-5yrs	-14.61897	-3.473672	-2.880463	-2.576939	t* < ADF critical value, therefore the null hypothesis is rejected.	No
KBP2002M Yield: 5-10yrs	-14.11328	-3.473672	-2.880463	-2.576939	t* < ADF critical value, therefore the null hypothesis is rejected.	No
KBP2003M Yield: 10 yrs. and above	-9.046787	-3.475184	-2.881123	-2.577291	t* < ADF critical value, therefore the null hypothesis is rejected.	No

From the tests above, it's clear that with both variables differenced, the resultant t-statistic is less than the calculated ADF values as illustrated in Table 1.2. This indicates that the null hypothesis should be rejected and concludes that the time series is now stationary. It is also clear that the two time series are integrated to the same level i.e. the order 1 and hence satisfied the requirements for co integration to be performed. An actual Eviews graphical output for this test is illustrated in the Appendix and shows that the series drift about the mean (mean of Zero).

4.3 Co integration Results

CO INTEGRATION RESULTS BETWEEN DOLLAR/RAND EXCHANGE RATE AND THE 0-3 YEARS BOND INTEREST YIELDS

Date: 04/08/11 Time: 11:16				
Sample (adjusted): 1998M07 2010M12				
Included observations: 150 after adjustments				
Trend assumption: Linear deterministic trend				
Series: DIFFERENCED_YIELDS DIFFERENCED_EXCH_RATE				
Lags interval (in first differences): 1 to 4				
Unrestricted Co integration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.200108	60.93139	15.49471	0.0000
At most 1 *	0.167174	27.43953	3.841466	0.0000
Trace test indicates 2 co integrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co integration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.200108	33.49186	14.26460	0.0000
At most 1 *	0.167174	27.43953	3.841466	0.0000
Max-eigenvalue test indicates 2 co integrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

**CO INTEGRATION RESULTS BETWEEN DOLLAR/RAND EXCHANGE RATE AND THE 3-5
YEARS BOND INTEREST YIELDS**

Date: 04/08/11 Time: 10:59				
Sample (adjusted): 1998M07 2010M12				
Included observations: 150 after adjustments				
Trend assumption: Linear deterministic trend				
Series: DIFFERENCED_YIELDS DIFFERENCED_EXCH_RATE				
Lags interval (in first differences): 1 to 4				
Unrestricted Co integration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.222771	63.45944	15.49471	0.0000
At most 1 *	0.157214	25.65640	3.841466	0.0000
Trace test indicates 2 co integrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.222771	37.80304	14.26460	0.0000
At most 1 *	0.157214	25.65640	3.841466	0.0000
Max-eigenvalue test indicates 2 co integrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

**CO INTEGRATION RESULTS BETWEEN DOLLAR/RAND EXCHANGE RATE AND THE 5-10
YEARS
BOND INTEREST YIELDS**

Date: 04/08/11 Time: 11:28				
Sample (adjusted): 1998M07 2010M12				
Included observations: 150 after adjustments				
Trend assumption: Linear deterministic trend				
Series: DIFFERENCED_EXCH_RATE DIFFERENCED_YIELDS				
Lags interval (in first differences): 1 to 4				
Unrestricted Co integration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.230269	65.44321	15.49471	0.0000
At most 1 *	0.160185	26.18609	3.841466	0.0000
Trace test indicates 2 co integrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.230269	39.25712	14.26460	0.0000
At most 1 *	0.160185	26.18609	3.841466	0.0000
Max-eigenvalue test indicates 2 co integrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				

CO INTEGRATION RESULTS BETWEEN DOLLAR/RAND EXCHANGE RATE AND THE 10 YEARS AND ABOVE BOND INTEREST YIELDS

Date: 04/08/11 Time: 11:47				
Sample (adjusted): 1998M07 2010M12				
Included observations: 150 after adjustments				
Trend assumption: Linear deterministic trend				
Series: DIFFERENCED_EXCH_RATE DIFFERENCED_YIELDS				
Lags interval (in first differences): 1 to 4				
Unrestricted Co integration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.243348	67.46419	15.49471	0.0000
At most 1 *	0.157102	25.63646	3.841466	0.0000
Trace test indicates 2 co integrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co integration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.243348	41.82772	14.26460	0.0000
At most 1 *	0.157102	25.63646	3.841466	0.0000
Max-eigenvalue test indicates 2 co integrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

The extracts of the results from E-views' tests for co integration among the variables indicate that the variables are co integrated and hence related, at least in the long term. Both the trace tests and the maximum eigenvalue tests of Johansen's procedure have detected the presence of co integration in exchange rates and interest rates at level of significance 5%. Thus the null hypothesis that there was no co integration between the variables was rejected and the alternative accepted i.e. co integration existed (the variables are related).

4.4 Statistical Analysis of Results

These results are as a result of running an Ordinary Least Squares (OLS) regression on the resultant time series after testing for co integration. The summary of the important regression analysis statistics based on the equation is:

$$\text{Exch_Rate_2} = C(1) + C(2) * \text{INTER_RATE_2}$$

Where C (1) represents the Intercept or Constant and C (2) is the equation beta

Yield Type	Correlation Co efficient	R squared (%)	Durbin-Watson test	F-Statistic
KBP2000M Yield : 0-3 yrs.	0.270	7.3	1.231	12.043
KBP2001M Yield : 3-5yrs	0.296	8.8	1.192	14.722
KBP2002M Yield: 5-10yrs	0.353	12.5	1.179	21.824
KBP2003M Yield: 10 yrs. and above	0.343	11.8	1.171	20.437

From the table above, it's clear that while co integration results shows that each of the interest terms have a relationship with the Dollar/Rand exchange rate, the value of this relationship is not the same for all the bond yields.

Depending on the period of the interest yield, this relationship is different and in all is not statistically significant as explained below;

R-Squared

A review of the R-squared, which states the percentage of the dependent variable that is explained by the explanatory variable, established that as one moves from the short-term to long-term interest rates, the explanatory power of interest rates on exchange rate actually increases from a mere 7.3% to about 12.5%. Based on this analysis, the 5-10 years yields seem to be the best fit as it represents the analysis with the highest R-squared while the 0-3 years is the worse fit. This indicates that the long-term exchange rates in future are more likely to get

affected by changes in the 5-10 years, 10 years, 3-5 years and 0-3years in that order. However, it's also important to note the low R-squared in all the results. Due to this factor, any person wishing to forecast the movement of rates should not use the yields as a forecast of the future exchange rates. In summary, movements in yields have little resultant effect on the movements in the exchange rates, at least statistically.

Correlation coefficient

The correlation indicates the level of movements in the dependent variable as a result in variations in the explanatory variable. Through observation of the resultant correlation, it can be seen that the level of relationship among the variables while positive is not statistically significant as in all instances, this is below 50%. From the results above, a 1% rise in the interest rates yields would result in a 0.27, 0.296, 0.353 and 0.343 in the Dollar/ Rand exchange for the periods 0-3 years, 3-5 years, 5-10 years & above 10 years respectively. Generally, as the yield horizon increases from short term to long term yields so does the coefficient. The results show that the 5-10 year bond yield is where the relationship is most strong followed by the above 10 years yields with the 0-3 year's yields having the weakest link in the relationship. These results clearly show a bias for long term yields rather than the short to medium term yields in the bonds.

Durbin Watson Test

The Durbin Watson stat for auto correlation indicates that it's above 1. A test result of 0 to 4 is usually held as a sign of no auto correlation with 2 as a perfect (Baddely and Barrow-clough, (2009:168). This shows that the variables are free from autocorrelation and hence Stationarity is also at significantly low. This clearly shows that the observed relationship is not statistically caused by some other unknown variable but the related movements in the two variables.

F-statistic

F-statistic is 20.43 which is quite high (i.e. above 0.05) and therefore can conclude that the exchange rate does follow the long term interest rates.

CONCLUSION

The purpose of this study was to determine whether any relationship exists between the Dollar/Rand Exchange rate and the Interest Rate Yields in South Africa. A sample of interest yields and exchange rates were tested for co integration through an application of the Johansen (1988) method using the statistical software E-views 7. The results showed a positive correlation between the Dollar/Rand exchange rate and the interest rates of different periods with the highest correlation recorded on the 5-10 years rates and lowest rates noted on the 0-3 year rates. Although the trace and rank tests showed that the variables were co integrated and hence related, further analysis of the estimated equation using the OLS method indicated this relationship not to be significant as indicated by the low explanatory power of the in R-squared and correlation of co-efficient. However, one result stands out of the rests: The relationship between Dollar/Rand exchange rate and the different yields on different term structure is clearly positive. The results on this study are in line with many other empirical studies (Alexius (2001), Chinn and Meredith (2005), Blundell-Wignall and Browne (1991), Flood and Taylor (1996), Coughlin and Koedijk (1990) among others found that the relationship between interest rates and Exchange rates is not significant.

To some extent, the results are in line with the fact that the South African Economy is diverse and international and therefore the Dollar/Rand exchange rate is unlikely to be explained by only the variations in the interest. On the contrary, the interest rate is only one of the factors on which the rate can be explained.

RECOMMENDATIONS

In general, although the results of this study have shown that interest rates have a positive relationship with the Rand/exchange rate, this relationship is not very significant and hence an investors, Investment managers and policy makers should be careful in the way they make their decisions that involve evaluating the correlation on these two variables. A specific recommendation for users of this information is as follows:-

Having noted the results of this research, Investors wishing to invest in South Africa should be wary of the dangers of making their investment decisions solely based on the Rand's exchange rate volatility as it may not be significantly determinants of the future outlook for the interest yields on the respective bond yield based on the term structure/horizon of that bond. However, it may be used as an indicator of other tests that may need to be performed with regard to the future expected bond yield.

Further, foreign investors who may want to hedge the value of their expected yields in Rand value should be careful to do so, as the relationship between the variables is not significant. Other hedging options should be investigated rather than just the currency hedge. It may be that hedging of either interest rate or exchange rate against exposure of either should be taken with precaution as the exposure will not be that much.

The use of interest rates by policy makers as a tool for stabilising the movements in the exchange rate should be taken with due care as the relationship between these two variables is not that significant. It should also be taken as a sign that what may work in one economy/market may not be the solution in another economy/market as economic fundamentals are different. Policy makers should thus try to customise their models according to the specific market. A one size fits all policy should not be the answer.

For local investment fund managers, the result of this study should be a motivation to try and include both the interest rates and exchange rates in their structural risk models. The resultant co efficient calculated here together with the coefficient of these variables in the structural risk model should provide an adequate risk management tool in their portfolio management.

Further, future studies of this nature could be based on a similar procedure as carried out in this research but include the following variables:-

1. A set of South African stock market variables as well as the interest rates and treasury bills. The construction of this model would help to gauge the effect of the other variables in the financial markets on the exchange rate and the degree of co integration of the variables.
2. The inclusion of the Inflation rate which would help in explaining foreign investors' view of the target inflation that the investors in bonds are comfortable with, and hence their willingness to trade in bonds and currency.
3. There is need for inclusion of the price movements in oil, platinum and gold. This model would explain the impact on South Africa of the movements on international trade which is its source of foreign exchange through exports of minerals as well as imports of oil.

It is hoped that this study will set a back drop of the many research studies in this subject taking into account the above modifications.

Bibliography

- Adjasi, C., Harvey, K.S., Agyapong, D. 2008. *Effect of Exchange rate volatility on the Ghana stock exchange*; African Journal of Accounting, Economics, Finance and Banking Research Vol. 3. No. 3. 2008. [Http://www.globip.com/africanjournal.htm](http://www.globip.com/africanjournal.htm)
- Alexius, A. (2001) *Uncovered interest parity revisited*, Review of International Economics volume 9, p505-517.
- Alexiusy, A., Sellinz, P. 2006. *Exchange rates and long-term bonds*. Term paper. Available at: http://www.nek.uu.se/Pdf/wp2002_7%20revised%20version.pdf
- Aliber, Z. R. 1973. The Interest Rate Parity Theorem A Reinterpretation. *Journal of Political Economy* Vol 81, no 6 Nov 1973
- Arize, A.C., Malindretos, J., Christoffersen, S. 2003. Monetary dynamics, exchange rates and parameter instability: an empirical investigation: *Journal of Economic Studies*, Vol. 30 No. 5, pp. 493-513. Accessed at: <http://www.imf.org/external/pubs/ft/wp/2006/wp0696.pdf>
- Baddely, M.C., Barrowclough, D.V. 2009. *Running Regressions: A partial Guide to quantitative Research in Economics, Finance and Development Studies*, New York: Cambridge University Press
- Baxter, M. 1994. Real exchange rates and real interest differentials: Have we missed the business-cycle relationship? University of Virginia, Charlottesville, VA 22901, USA. *Journal of Monetary Economics*. 33 (1994) 5537. North-Holland
- Bekeart, G., Wei, M., Xing, Y. 2002, *Uncovered Interest rate Parity and the Term Structure*, NBER Working Paper 8795.
- Benita, G., Lauterbach, B. 2004. *Policy factors and exchange rate volatility: Panel Data versus a country specific country analysis* February 2004
- Bilson, J. F. O. 1981. *The 'Speculative Efficiency' Hypothesis*, *Journal of Business*, 54, p435-452.
- Blundell-Wignall, A., Fahrer, J and Heath, A. 1993. *Major Influences on the Australian Dollar Exchange Rate* Adrian Blundell- Conference Paper for *Economic Group Reserve Bank of Australia*. Available at: <http://www.rba.gov.au/publications/confs/1993/blundell-wignall-fahrer-heath.pdf>
- Bodarta, V., Reding, P. 1975. Exchange rate regime, volatility and international correlations on bond and stock markets: *Journal of International Money and Finance*. 18 (1999) 133-151 Vol. 110, No. 4, pages 1975 - 1010
- Bonnie, E., Loopesko, H. 1984. Relationships among Exchange Rates Intervention and Interest Rates: An Empirical Investigation: *Journal of International Money and Finance* (1984), 3, 257-277

- Boyle, W.G. 1990. International Interest Rates, Exchange Rates, and the Stochastic Structure of Supply. *The Journal of Finance*. vol. xlv, no. 2 June 1990.
- Burnside. C., Eichenbaum, M and Rebelo.S. 1998. "Prospective Deficits and the Asian Currency Crisis," *Journal of Political Economy* 109 (6), 1155-1197.
- Calverley, J. 2002. *Investor's Guide to Economic Fundamentals*; Wiley Finance Publications
- Calvo, A.G., Leiderman, L., Reinhart,M.C. 1993. Capital Inflows and Real Exchange Rate Appreciation in Latin America: The Role of External Factors. Source: *Staff Papers - International Monetary Fund*, Vol. 40, No. 1 (Mar., 1993), pp. 108-151 Published by: Palgrave Macmillan Journals on behalf of the International Monetary Fund Stable URL: <http://www.jstor.org/stable/3867379> Accessed: 25/01/2011 08:43
- Calvo, A.G., Reinhart, C. 2000, "Fixing for Your Life," NBER Working Paper No. 8006.
- Calvo, G., Végh, C. 1995, Fighting Inflation with High Interest Rates: The Small Open Economy Case under Flexible Prices, *Journal of Money, Credit, and Banking* 27, 49-66.
- Campbell, J.Y., Clarida, R.H. 1987. *The dollar and real interest rates*, Carnegie-Rochester Conference Series on Public Policy 27, 103-140.
- Charles M., E 1986. On the correlation of exchange rates and interest rates. *Journal of International Money and Finance* 5, 125-128.
- Chinn, M., Meredith, G. 2005. *Testing Uncovered Interest Parity at Short and Long Horizons during the Post-Bretton Woods Era*, Working Paper. This is a revised version of Long-horizon uncovered interest rate parity. NBER Working Paper 6797.
- Cho, D., Kenneth, D. 2003. West Interest Rates and Exchange Rates in the Korean, Philippine, and Thai Exchange Rate Crises; January 2003 National Bureau University of Chicago Press <http://www.nber.org/chapters/c9645> Effects of Shocks to Monetary Policy on Exchange Rates,' *Quarterly Journal of Economics*.
- Chow, H. E., Lee, Y. W., Solt, E. M. 1997. The Exchange-Rate Risk Exposure of Asset Returns in *The Journal of Business* Vol. 70, No. 1 (Jan., 1997), pp. 105-123 Published by: The University of Chicago Press Stable URL: <http://www.jstor.org/stable/2353483>
- Codogno, L., Favero, C., Missale, A., Portes, R., Thum, M. 2003. Source: *Economic Policy*. Vol. 18, No. 37, EMU Assessment (Oct., 2003), pp. 503-532Published by: Blackwell Publishing on behalf of the Centre for Economic Policy Research, Centre for Economic Studies, and the Maison des Sciences de l'Homme Stable URL: <http://www.jstor.org/stable/1344743> .Accessed: 19/01/2011 05:54
- Coughtin, C.C., Koedijk, K. 1990. *What Do We Know About the Long-Run Real Exchange Rate*; Term Paper. Available at: <http://arno.uvt.nl/show.cgi?fid=80531>
- Cumby. E.R., Obstfeld. M. 1981. A Note on Exchange-Rate Expectations and Nominal Interest Differentials: A Test of the Fisher Hypothesis. *The Journal of Finance*. Vol. 36,

- No. 3 (Jun., 1981), pp. 697-703. <http://www.jstor.org/stable/2327528>. Accessed: 02/02/2011 08:21
- Dekle, R., Hsiao, C., Wang, S. 1999. *Interest rate stabilization of exchange rates and contagion in the Asian crisis countries*. University of Southern California Unpublished Manuscript.
- Dym, S.1992. Global and Local Components of Foreign Bond Risk Author(s): Financial Analysts Journal, Vol. 48, No. 2 (Mar. - Apr., 1992), pp. 83-91Published by: CFA Institute Stable URL: <http://www.jstor.org/stable/4479529> .Accessed: 19/01/2011 05:55Your
- Ebner, G. 2009. *An empirical analysis on the determinants of CEE government bond spreads*, *Emerging Markets Review* 10 (2009) p.97–121 Available at: www.elsevier.com/locate/emr [Accessed on 3rd March 2011]
- Edison, H., Pauls, B. D. (1993). A re-assessment of the relationship between real exchange rates and real interest rate 1974–1990. *Journal of Monetary Economics*, 31, 165–187. EViews 7 User's Guide I Copyright © 1994–2009 Quantitative Micro Software, LLC
- Fama, E. (1984). Forward and spot exchange rates. *Journal of Monetary Economics*, 14, 319–338.
- Fan, L., Anders C., Johansson, B.2010. China's official rates and bond yields. *Journal of Banking & Finance* 34 (2010) 996–1007
- Financial stability and local currency bond markets report. 2007. *Committee on the Global Financial System*; Bank of International Settlements, Number 28 2007.
- Flood, R., Taylor, M. 1996. Exchange Rate Economics: What wrong with the Conventional Macro Approach? in J.A. Frankel et. al. eds. *The microstructure of foreign exchange markets*. National Bureau of Economic Research Conference Report series. Chicago and London: University of Chicago Press, pp. 261-294.
- Flood, R.P., Rose, A.K. 1995. *Fixing Exchange Rates: A Virtual Quest for Fundamentals*. *J. Monet. Econ.* 36, 337.
- Frankel, J. (1979). On the mark: A theory of floating exchange rates based on real interest differentials. *American Economic Review*, 69.4, 610–622.
- Frankel, J. 2007. On the Rand: Determinants of the South African exchange rate working paper 13050. <http://www.nber.org/papers/w13050> *National Bureau of Economic Research* 1050 Massachusetts avenue Cambridge, ma 02138 April 2007
- Frankel, J., *The Dazzling Dollar*; *Brookings Papers on Economic Activity*, 1:199-217, 1985.
- Fuller, Wayne A. 1996; *Introduction to Statistical Time Series 2nd Edition*; New York : J. Wiley, c1996.
- Goldfajn, I., Baig, T. 1998. Monetary policy in the aftermath of currency crisis: The case of Asia. *IMF Working Paper no. WP/98/170*. Washington, D.C.: International Monetary Fund

- Goldfajn, I., Gupta, P. 1999. Does monetary policy stabilize the exchange rate following a currency crisis? *IMF Working Paper no. WP/99/42*. Washington D.C.: International Monetary Fund, March
- Gould, D. M., Kamin, S. 2000. The impact of monetary policy on exchange rates during financial crisis. *International Finance Discussion Paper no. 699* Washington, D.C.: Board of Governors of the Federal Reserve System.
- Granger, C. W. J. 1983. Co-Integrated Variables and Error-Correcting Models." Unpublished U.C.San Diego Discussion Paper No. 83-13, 1983.
- Gustava, C. 1918, Abnormal Deviations in International Exchanges. *The Economic Journal*, Vol. 28, No. 112 (Dec., 1918), pp. 413-415. Published by: Blackwell Publishing for the Royal Economic Society. Accessed: 23/11/2011 05:35
- Hansen, L. P., Hodrick, R. J. 1980. Forward exchange rates as optimal predictors of future spot rates: An econometric analysis. *Journal of Political Economy*, 88, 829–853.
- Hansen, L. P., Hodrick, R. J. 1983. Risk-Averse Speculation in the Forward Foreign Exchange Market: An Econometric Analysis of Linear Models. In J. A. Frenkel (ed.), *Exchange Rates and International Macroeconomics*, University of Chicago Press, Chicago
- Hauser, S., Levy, A. 1991. Effect of exchange rate and Interest rate Risk on International Fixed-Income Portfolios: *Journal of Economics and Business* 1991
- Hnatkovska, V., Lahiri, A., Vegh, A. C 2007. *The Non-Monotonic Relationship between Interest Rates and Exchange Rates*. Available at: <http://econweb.umd.edu/~vegh/papers/viktoria-lahiri-vegh.pdf>
- Hodrick, R. J., and Srivastava, S. 1986. The Covariation of Risk Premiums and Expected Future Spot Exchange Rates: *Journal of International Money and Finance*. 5, 5–22.
- Hsieh, D. A. 1993. Using non-linear methods to search for risk premia in currency futures. <http://faculty.biu.ac.il/~lauteb/wp/4.pdf>. Accessed 14/01/11
- Ibbotson, G.R., Carr, C.R., Robinson, W.A. 1982. Institute International Equity and Bond Returns Author(s): Source: *Financial Analysts Journal*, Vol. 38, No. 4 (Jul. - Aug., 1982), pp. 61-83 Published by: CFA Institute Stable URL: <http://www.jstor.org/stable/4478566> .Accessed: 04/01/2011 06:08
- Inci, A.C. 2006. *Co-integrating currencies and yield differentials*, *Review of Financial Economics* 15 (2006) p159–175. Available at: <http://www.elsevier.com/locate/econbase>. [Accessed on 24th March, 2011]
- Inci, A.C., Lu, B. 2004. Exchange rates and interest rates: Can term structure models explain currency movements. *Journal of Economic Dynamics & Control*. 28, 1595–1624.
- John Y.C., Clarida, H, R. 1987. *The Dollar and Real Interest Rates*: Carnegie-Rochester Conference Series on Public Policy (Autumn 1987), pp. 103-40.

- Jorion, P. 1991. The Pricing of Exchange Rate Risk in the Stock Market: *Journal of Financial and Quantitative Analysis* Vol.26, No 3, September 1991
Journal of International Economics. 35, 113–132.
- Keynes, J.M., 1923. *A Treatise on Money* (London: Macmillan).
- Koivu, M., Nyholm, K., Stromberg, J. 2007. *The Yield Curve And Macro Fundamentals In Forecasting Exchange Rates* October 3, 2007
- Krugman, P., Obstfeld, M. 2009. *International Economics: Theory and Policy*, Seventh Edition. Pearson – Addison Wesley. Accessed online at <http://yangkiimadesuara.com/2008/11/17/international-economics->
- Lien, K. 2006. *Day trading the currency market: Technical and Fundamental Strategies to Profit from market swings*. John Wiley and Sons, 2006
- Mayes, D. G., Virén, M. 2000. The Exchange Rate and Monetary Conditions in the Euro Area. *Review of World Economics* published by Springer Copyright © 2000, Institut für Weltwirtschaft an der Universität Kiel; Available at: <http://www.jstor.org/stable/pdfplus/40440776.pdf?acceptTC=true>
- Meese, R. 1990. Currency fluctuations in the post-Bretton Woods era: *Journal of Economic Perspectives* 4, 117-134.
- Meese, R., Rogoff, K. 1988. Was it real? The exchange rate–interest differential relation over the modern floating-rate period. *Journal of Finance*. 43, 933–948
- Meese, R., Rogoff, K. 1988. Was It Real? The Exchange Rate-Interest Differential Relation over the Modern Floating-Rate Period: *Journal of Finance* (September 1988), pp. 933-48
- Meredith, G., Chinn, M. D., 1998. Long-horizon uncovered interest rate parity: National Bureau of Economic Research (NBER) *Working Paper Series*. No. 6797.
- Peter, I. 2006. Uncovered Interest Parity. IMF Working Papers. IMF institute.
- Rebelo, S., Végh, A.C. 1995. Real Effects of Exchange-Rate-Based Stabilization: An Analysis of Competing Theories Source: *NBER Macroeconomics Annual*, Vol. 10 (1995), pp. 125-274 <http://www.jstor.org/stable/3585108> Accessed: 02/02/2011 08:17
- Rose, A.K., 1995. *After the deluge: do fixed exchange rates allow inter-temporal volatility tradeoffs?* *International Journal of Finance and Economics*.
- Sachs, J. 1985. The Dollar and the Policy Mix: *Brookings Papers on Economic Activity*, 1:117-197, 1985.
- Sjolander, P. 2007. Unreal exchange rates: a simulation-based approach to adjust misleading, PPP estimates: *Journal of Economic Studies*, Vol. 34 No. 3, pp. 256-88.
- Sloman, J (2004). *Economics*. Penguin. pp. 969
- Staudinger, S. 2002. Optimal monetary policy and the term structure of interest rates: a note. *Journal of Economic Studies*, Vol. 29 No. 2, pp. 98-108.

The Economist-Business and Finance.2005, *Title: Competitive sport in Boca Raton*. Vol. 376
Issue 8439, p14-14, 3/4p. Available at: <http://www.economist.com/node/2404725>
theory-and-policy-krugman-and-obstfeld/

Throop, A. W. 1993. A generalized uncovered interest parity model of exchange rates. *Federal Reserve Bank of San Francisco (FRBSF) Economic Review*, 2, 3–16.4.

Watsham, T.J., Parramore, K.1997. *Quantitative Methods in Finance* First Edition. Boston.
International Thomson Business Press

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APPENDIX

Eviews v 7 output tests

Testing for Unit Roots in the Exchange rate

Null Hypothesis: KBP5339M_FOREIGN_EXCHANGE has a unit root				
Exogenous: Constant				
Lag Length: 1 (Automatic - based on SIC, maxlag=13)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-2.528985	0.1106
Test critical values:	1% level		-3.473096	
	5% level		-2.880211	
	10% level		-2.576805	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(KBP5339M_FOREIGN_EXCHANG)				
Method: Least Squares				
Date: 04/08/11 Time: 11:14				
Sample (adjusted): 1998M03 2010M12				
Included observations: 154 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
KBP5339M_FOREIGN_EXCHANG(-1)	-0.045325	0.017922	-2.528985	0.0125
D(KBP5339M_FOREIGN_EXCHANG(-1))	0.371563	0.074770	4.969392	0.0000
C	0.342663	0.134862	2.540848	0.0121
R-squared	0.162357	Mean dependent var		0.012297
Adjusted R-squared	0.151262	S.D. dependent var		0.338752
S.E. of regression	0.312082	Akaike info criterion		0.528188
Sum squared resid	14.70670	Schwarz criterion		0.587350
Log likelihood	-37.67051	Hannan-Quinn criter.		0.552220
F-statistic	14.63385	Durbin-Watson stat		1.955106
Prob(F-statistic)	0.000002			

Testing for Unit Roots in Exchange rates after differencing

Null Hypothesis: D(DIFFERENCED_EXCH_RATE) has a unit root			
Exogenous: Constant			
Lag Length: 6 (Automatic - based on SIC, maxlag=13)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.849071	0.0000
Test critical values:	1% level	-3.475184	
	5% level	-2.881123	
	10% level	-2.577291	
*MacKinnon (1996) one-sided p-values.			
Augmented Dickey-Fuller Test Equation			

Dependent Variable: D(DIFFERENCED_EXCH_RATE,2)
Method: Least Squares
Date: 04/08/11 Time: 11:14
Sample (adjusted): 1998M10 2010M12
Included observations: 147 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DIFFERENCED_EXCH_RATE(-1))	-3.683993	0.416314	-8.849071	0.0000
D(DIFFERENCED_EXCH_RATE(-1),2)	2.163792	0.376711	5.743904	0.0000
D(DIFFERENCED_EXCH_RATE(-2),2)	1.650109	0.328405	5.024614	0.0000
D(DIFFERENCED_EXCH_RATE(-3),2)	1.245104	0.271310	4.589235	0.0000
D(DIFFERENCED_EXCH_RATE(-4),2)	0.936455	0.206605	4.532589	0.0000
D(DIFFERENCED_EXCH_RATE(-5),2)	0.609030	0.140598	4.331727	0.0000
D(DIFFERENCED_EXCH_RATE(-6),2)	0.281777	0.079954	3.524217	0.0006
C	-0.005221	0.027015	-0.193268	0.8470
R-squared	0.727175	Mean dependent var		0.000600
Adjusted R-squared	0.713436	S.D. dependent var		0.611457
S.E. of regression	0.327323	Akaike info criterion		0.657148
Sum squared resid	14.89253	Schwarz criterion		0.819892
Log likelihood	-40.30034	Hannan-Quinn criter.		0.723272
F-statistic	52.92641	Durbin-Watson stat		2.044419
Prob(F-statistic)	0.000000			

Testing for Unit roots in the 0-3 years bond yields

Null Hypothesis: KBP2000M__YIELDS_ON_0_3_ has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.817826	0.3708
Test critical values:		
1% level	-3.473096	
5% level	-2.880211	
10% level	-2.576805	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(KBP2000M__YIELDS_ON_0_3_)
Method: Least Squares
Date: 04/08/11 Time: 12:37
Sample (adjusted): 1998M03 2010M12
Included observations: 154 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
KBP2000M__YIELDS_ON_0_3_(-1)	-0.028755	0.015818	-1.817826	0.0711
D(KBP2000M__YIELDS_ON_0_3_(-1))	0.372606	0.075668	4.924248	0.0000
C	0.258832	0.165277	1.566055	0.1194
R-squared	0.146234	Mean dependent var		-0.049286
Adjusted R-squared	0.134926	S.D. dependent var		0.571409
S.E. of regression	0.531464	Akaike info criterion		1.592926
Sum squared resid	42.65058	Schwarz criterion		1.652088
Log likelihood	-119.6553	Hannan-Quinn criter.		1.616957
F-statistic	12.93174	Durbin-Watson stat		1.872376
Prob(F-statistic)	0.000007			

Testing for Unit roots in the 0-3 years bond yields after differencing

Null Hypothesis: D(DIFFERENCED_YIELDS) has a unit root				
Exogenous: Constant				
Lag Length: 2 (Automatic - based on SIC, maxlag=13)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-11.56177	0.0000
Test critical values:		1% level	-3.473967	
		5% level	-2.880591	
		10% level	-2.577008	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(DIFFERENCED_YIELDS,2)				
Method: Least Squares				
Date: 04/08/11 Time: 11:15				
Sample (adjusted): 1998M06 2010M12				
Included observations: 151 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DIFFERENCED_YIELDS(-1))	-1.983708	0.171575	-11.56177	0.0000
D(DIFFERENCED_YIELDS(-1),2)	0.642345	0.124482	5.160136	0.0000
D(DIFFERENCED_YIELDS(-2),2)	0.237814	0.079198	3.002769	0.0031
C	-0.001927	0.047479	-0.040578	0.9677
R-squared	0.669516	Mean dependent var		-0.006755
Adjusted R-squared	0.662771	S.D. dependent var		1.004650
S.E. of regression	0.583414	Akaike info criterion		1.786293
Sum squared resid	50.03466	Schwarz criterion		1.866221
Log likelihood	-130.8651	Hannan-Quinn criter.		1.818764
F-statistic	99.26737	Durbin-Watson stat		2.071750
Prob(F-statistic)	0.000000			

Testing for Co integration between the 0-3 years yields and the exchange rate

Date: 04/08/11 Time: 11:16
Sample (adjusted): 1998M07 2010M12
Included observations: 150 after adjustments
Trend assumption: Linear deterministic trend
Series: DIFFERENCED_YIELDS DIFFERENCED_EXCH_RATE
Lags interval (in first differences): 1 to 4
Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.200108	60.93139	15.49471	0.0000
At most 1 *	0.167174	27.43953	3.841466	0.0000
Trace test indicates 2 co integrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.200108	33.49186	14.26460	0.0000
At most 1 *	0.167174	27.43953	3.841466	0.0000
Max-eigenvalue test indicates 2 co integrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co integrating Coefficients (normalized by b'*S11*b=I):				
	DIFFER- DIFFER- ENCED_YIELDS	DIFFER- ENCED_EXCH_R ATE		
	-2.942997	2.905952		
	-1.404717	-4.291701		
Unrestricted Adjustment Coefficients (alpha):				
D(DIFFERENCE D_YIELDS)	0.194202	0.141571		
D(DIFFERENCE D_EXCH_RATE)	-0.054407	0.130473		
1 Co integrating Equation(s):		Log likelihood	-152.2544	
Normalized co integrating coefficients (standard error in parentheses)				
	DIFFER- DIFFER- ENCED_YIELDS	DIFFER- ENCED_EXCH_R ATE		
	1.000000	-0.987412 (0.29425)		
Adjustment coefficients (standard error in parentheses)				
D(DIFFERENCE D_YIELDS)	-0.571536 (0.12940)			
D(DIFFERENCE D_EXCH_RATE)	0.160119 (0.08386)			

OLS Equation: 0-3 years yields and Dollar Exchange rate

Dependent Variable: DIFFERENCED_EXCH_RATE
Method: Least Squares
Date: 04/08/11 Time: 11:18

Sample (adjusted): 1998M02 2010M12
 Included observations: 155 after adjustments
 DIFFERENCED_EXCH_RATE=C(1)+C(2)*DIFFERENCED_YIELDS

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.020212	0.026300	0.768517	0.4434
C(2)	0.160117	0.046140	3.470251	0.0007
R-squared	0.072967	Mean dependent var		0.012195
Adjusted R-squared	0.066908	S.D. dependent var		0.337653
S.E. of regression	0.326162	Akaike info criterion		0.609972
Sum squared resid	16.27636	Schwarz criterion		0.649242
Log likelihood	-45.27286	Hannan-Quinn criter.		0.625923
F-statistic	12.04265	Durbin-Watson stat		1.231149
Prob(F-statistic)	0.000676			

Unit roots test results for 3-5 years bond yields

Null Hypothesis: KBP2001M_YIELDS_3_5_YRS has a unit root				
Exogenous: Constant				
Lag Length: 2 (Automatic - based on SIC, maxlag=13)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.399800	0.5811
Test critical values:		1% level	-3.473382	
		5% level	-2.880336	
		10% level	-2.576871	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(KBP2001M_YIELDS_3_5_YRS)				
Method: Least Squares				
Date: 04/08/11 Time: 10:55				
Sample (adjusted): 1998M04 2010M12				
Included observations: 153 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
KBP2001M_YIELDS_3_5_YRS(-1)	-0.021444	0.015320	-1.399800	0.1637
D(KBP2001M_YIELDS_3_5_YRS(-1))	0.379288	0.080423	4.716150	0.0000
D(KBP2001M_YIELDS_3_5_YRS(-2))	-0.151943	0.081075	-1.874104	0.0629
C	0.192614	0.163941	1.174902	0.2419
R-squared	0.138364	Mean dependent var		-0.038431
Adjusted R-squared	0.121015	S.D. dependent var		0.531060
S.E. of regression	0.497891	Akaike info criterion		1.468926
Sum squared resid	36.93647	Schwarz criterion		1.548153
Log likelihood	-108.3729	Hannan-Quinn criter.		1.501110
F-statistic	7.975600	Durbin-Watson stat		1.959510
Prob(F-statistic)	0.000058			

Unit root test results on 3-5 years after Differencing

Null Hypothesis: D(DIFFERENCED_YIELDS) has a unit root

Exogenous: Constant					
Lag Length: 1 (Automatic - based on SIC, maxlag=13)					
			t-Statistic	Prob.*	
Augmented Dickey-Fuller test statistic			-14.61897	0.0000	
Test critical values:					
	1% level		-3.473672		
	5% level		-2.880463		
	10% level		-2.576939		
*MacKinnon (1996) one-sided p-values.					
Augmented Dickey-Fuller Test Equation					
Dependent Variable: D(DIFFERENCED_YIELDS,2)					
Method: Least Squares					
Date: 04/08/11 Time: 10:57					
Sample (adjusted): 1998M05 2010M12					
Included observations: 152 after adjustments					
	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	D(DIFFERENCED_YIELDS(-1))	-1.722455	0.117823	-14.61897	0.0000
	D(DIFFERENCED_YIELDS(-1),2)	0.400806	0.075166	5.332253	0.0000
	C	0.005568	0.045276	0.122987	0.9023
	R-squared	0.676094	Mean dependent var		0.003816
	Adjusted R-squared	0.671747	S.D. dependent var		0.974271
	S.E. of regression	0.558193	Akaike info criterion		1.691316
	Sum squared resid	46.42534	Schwarz criterion		1.750998
	Log likelihood	-125.5400	Hannan-Quinn criter.		1.715561
	F-statistic	155.5052	Durbin-Watson stat		2.020852
	Prob(F-statistic)	0.000000			

Co integration test results between 3-5yrs yields and Exchange rate after differencing

Date: 04/08/11 Time: 10:59					
Sample (adjusted): 1998M07 2010M12					
Included observations: 150 after adjustments					
Trend assumption: Linear deterministic trend					
Series: DIFFERENCED_YIELDS DIFFERENCED_EXCH_RATE					
Lags interval (in first differences): 1 to 4					
Unrestricted Co integration Rank Test (Trace)					
	Hypothesized		Trace	0.05	
	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
	None *	0.222771	63.45944	15.49471	0.0000
	At most 1 *	0.157214	25.65640	3.841466	0.0000
Trace test indicates 2 co integrating eqn(s) at the 0.05 level					
* denotes rejection of the hypothesis at the 0.05 level					
**MacKinnon-Haug-Michelis (1999) p-values					
Unrestricted Co integration Rank Test (Maximum Eigenvalue)					

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.222771	37.80304	14.26460	0.0000
At most 1 *	0.157214	25.65640	3.841466	0.0000
Max-eigenvalue test indicates 2 co integrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co integrating Coefficients (normalized by b'*S11*b=I):				
	DIFFER- DIFFER- ENCED_YIELDS	DIFFER- ENCED_EXCH_R ATE		
	-3.532094	2.208739		
	-0.989954	-4.760810		
Unrestricted Adjustment Coefficients (alpha):				
	D(DIFFERENCE D_YIELDS)	0.224629	0.089856	
	D(DIFFERENCE D_EXCH_RATE)	-0.014013	0.131797	
1 Co integrating Equation(s):			Log likelihood	-136.4394
Normalized co integrating coefficients (standard error in parentheses)				
	DIFFER- DIFFER- ENCED_YIELDS	DIFFER- ENCED_EXCH_R ATE		
	1.000000	-0.625334 (0.23153)		
Adjustment coefficients (standard error in parentheses)				
	D(DIFFERENCE D_YIELDS)	-0.793411 (0.14235)		
	D(DIFFERENCE D_EXCH_RATE)	0.049495 (0.09953)		

Estimated Equation

Dependent Variable: DIFFERENCED_EXCH_RATE

Method: Least Squares

Date: 04/08/11 Time: 11:01

Sample (adjusted): 1998M02 2010M12

Included observations: 155 after adjustments

DIFFERENCED_EXCH_RATE=C(1)+C(2)*DIFFERENCED_YIELDS

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.020050	0.026068	0.769140	0.4430
C(2)	0.189344	0.049348	3.836925	0.0002
R-squared	0.087776	Mean dependent var		0.012195
Adjusted R-squared	0.081814	S.D. dependent var		0.337653
S.E. of regression	0.323546	Akaike info criterion		0.593869

Sum squared resid	16.01635	Schwarz criterion	0.633139
Log likelihood	-44.02481	Hannan-Quinn criter.	0.609819
F-statistic	14.72199	Durbin-Watson stat	1.191642
Prob(F-statistic)	0.000182		

Unit root Test results for 5-10 years bond yields

Null Hypothesis: KBP2002M_YIELD_ON_LOAN_S has a unit root				
Exogenous: Constant				
Lag Length: 1 (Automatic - based on SIC, maxlag=13)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.413856	0.5742
Test critical values:		1% level	-3.473096	
		5% level	-2.880211	
		10% level	-2.576805	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(KBP2002M_YIELD_ON_LOAN_S)				
Method: Least Squares				
Date: 04/08/11 Time: 11:27				
Sample (adjusted): 1998M03 2010M12				
Included observations: 154 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
KBP2002M_YIELD_ON_LOAN_S(-1)	-0.017877	0.012644	-1.413856	0.1595
D(KBP2002M_YIELD_ON_LOAN_S(-1))	0.313901	0.077400	4.055562	0.0001
C	0.159691	0.135539	1.178185	0.2406
R-squared	0.104441	Mean dependent var		-0.038506
Adjusted R-squared	0.092580	S.D. dependent var		0.440004
S.E. of regression	0.419142	Akaike info criterion		1.118073
Sum squared resid	26.52766	Schwarz criterion		1.177235
Log likelihood	-83.09165	Hannan-Quinn criter.		1.142105
F-statistic	8.804930	Durbin-Watson stat		1.895988
Prob(F-statistic)	0.000242			

Unit root Testing on 5-10 yrs yields after differencing

Null Hypothesis: D(DIFFERENCED_YIELDS) has a unit root			
Exogenous: Constant			
Lag Length: 1 (Automatic - based on SIC, maxlag=13)			
			t-Statistic
Augmented Dickey-Fuller test statistic			-14.11328
Test critical values:		1% level	-3.473672
		5% level	-2.880463
		10% level	-2.576939
*MacKinnon (1996) one-sided p-values.			

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(DIFFERENCED_YIELDS,2)
 Method: Least Squares
 Date: 04/08/11 Time: 11:27
 Sample (adjusted): 1998M05 2010M12
 Included observations: 152 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DIFFERENCED_YIELDS(-1))	-1.691270	0.119835	-14.11328	0.0000
D(DIFFERENCED_YIELDS(-1),2)	0.368820	0.076260	4.836369	0.0000
C	0.005489	0.038498	0.142572	0.8868
R-squared	0.669153	Mean dependent var		0.003684
Adjusted R-squared	0.664712	S.D. dependent var		0.819690
S.E. of regression	0.474634	Akaike info criterion		1.366995
Sum squared resid	33.56637	Schwarz criterion		1.426677
Log likelihood	-100.8916	Hannan-Quinn criter.		1.391240
F-statistic	150.6793	Durbin-Watson stat		2.084899
Prob(F-statistic)	0.000000			

Test results for Co integration between 5-10yrs yield and exchange rates

Date: 04/08/11 Time: 11:28
 Sample (adjusted): 1998M07 2010M12
 Included observations: 150 after adjustments
 Trend assumption: Linear deterministic trend
 Series: DIFFERENCED_EXCH_RATE DIFFERENCED_YIELDS
 Lags interval (in first differences): 1 to 4

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.230269	65.44321	15.49471	0.0000
At most 1 *	0.160185	26.18609	3.841466	0.0000

Trace test indicates 2 co integrating eqn(s) at the 0.05 level
 * denotes rejection of the hypothesis at the 0.05 level
 **MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.230269	39.25712	14.26460	0.0000
At most 1 *	0.160185	26.18609	3.841466	0.0000

Max-eigenvalue test indicates 2 co integrating eqn(s) at the 0.05 level
 * denotes rejection of the hypothesis at the 0.05 level
 **MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integrating Coefficients (normalized by b'*S11*b=I):

DIFFER- ENCED_EXCH_ RATE	DIFFER- ENCED_YIELDS
-1.137929	4.549358
5.190534	-0.075934

Unrestricted Adjustment Coefficients (alpha):		
D(DIFFERENCE D_EXCH_RATE)	-0.036056	-0.131877
D(DIFFERENCE D_YIELDS)	-0.210315	-0.036312
1 Co integrating Equation(s):	Log likelihood	-108.5399
Normalized co integrating coefficients (standard error in parentheses)		
DIFFER- ENCED_EXCH_ RATE	DIFFER- ENCED_YIELDS	
1.000000	-3.997929 (0.60123)	
Adjustment coefficients (standard error in parentheses)		
D(DIFFERENCE D_EXCH_RATE)	0.041029 (0.03232)	
D(DIFFERENCE D_YIELDS)	0.239324 (0.03800)	

OLS equation analysis

Dependent Variable: DIFFERENCED_EXCH_RATE
Method: Least Squares
Date: 04/08/11 Time: 11:30
Sample (adjusted): 1998M02 2010M12
Included observations: 155 after adjustments
DIFFERENCED_EXCH_RATE=C(1)+C(2)*DIFFERENCED_YIELDS

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.022915	0.025558	0.896579	0.3714
C(2)	0.271923	0.058208	4.671582	0.0000
R-squared	0.124833	Mean dependent var		0.012195
Adjusted R-squared	0.119112	S.D. dependent var		0.337653
S.E. of regression	0.316906	Akaike info criterion		0.552398
Sum squared resid	15.36573	Schwarz criterion		0.591668
Log likelihood	-40.81088	Hannan-Quinn criter.		0.568349
F-statistic	21.82368	Durbin-Watson stat		1.178639
Prob(F-statistic)	0.000006			

Unit root test results for 10 years and above bond yields

Null Hypothesis: KBP2003M_YIELD_ON_LOAN_S has a unit root		
Exogenous: Constant		
Lag Length: 1 (Automatic - based on SIC, maxlag=13)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.494743	0.5338
Test critical values:	1% level	-3.473096
	5% level	-2.880211

Variable	Coefficient	Std. Error	t-Statistic	Prob.
KBP2003M_YIELD_ON_LOAN_S(-1)	-0.018922	0.012659	-1.494743	0.1371
D(KBP2003M_YIELD_ON_LOAN_S(-1))	0.292556	0.077753	3.762616	0.0002
C	0.175465	0.136852	1.282154	0.2018

R-squared	0.094106	Mean dependent var	-0.033182
Adjusted R-squared	0.082107	S.D. dependent var	0.426528
S.E. of regression	0.408643	Akaike info criterion	1.067338
Sum squared resid	25.21533	Schwarz criterion	1.126499
Log likelihood	-79.18500	Hannan-Quinn criter.	1.091369
F-statistic	7.843065	Durbin-Watson stat	1.933209
Prob(F-statistic)	0.000575		

Unit root test on 10 yrs and above yields after differencing

Null Hypothesis: D(DIFFERENCED_YIELDS) has a unit root				
Exogenous: Constant				
Lag Length: 6 (Automatic - based on SIC, maxlag=13)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-9.046787	0.0000
Test critical values:				
	1% level		-3.475184	
	5% level		-2.881123	
	10% level		-2.577291	

*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(DIFFERENCED_YIELDS,2)				
Method: Least Squares				
Date: 04/08/11 Time: 11:46				
Sample (adjusted): 1998M10 2010M12				
Included observations: 147 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DIFFERENCED_YIELDS(-1))	-3.817757	0.422001	-9.046787	0.0000
D(DIFFERENCED_YIELDS(-1),2)	2.271006	0.383735	5.918170	0.0000
D(DIFFERENCED_YIELDS(-2),2)	1.647123	0.329681	4.996119	0.0000
D(DIFFERENCED_YIELDS(-3),2)	1.239692	0.269857	4.593878	0.0000
D(DIFFERENCED_YIELDS(-4),2)	0.914297	0.205370	4.451938	0.0000
D(DIFFERENCED_YIELDS(-5),2)	0.507178	0.138808	3.653802	0.0004
D(DIFFERENCED_YIELDS(-6),2)	0.292413	0.077888	3.754260	0.0003
C	-0.020936	0.034759	-0.602315	0.5479

R-squared	0.753088	Mean dependent var	-0.000816
Adjusted R-squared	0.740653	S.D. dependent var	0.825896
S.E. of regression	0.420597	Akaike info criterion	1.158601
Sum squared resid	24.58934	Schwarz criterion	1.321346
Log likelihood	-77.15719	Hannan-Quinn criter.	1.224726
F-statistic	60.56465	Durbin-Watson stat	1.661815
Prob(F-statistic)	0.000000		

Co integration Test between 10yrs above yields and the exchange rate

Date: 04/08/11 Time: 11:47				
Sample (adjusted): 1998M07 2010M12				
Included observations: 150 after adjustments				
Trend assumption: Linear deterministic trend				
Series: DIFFERENCED_EXCH_RATE DIFFERENCED_YIELDS				
Lags interval (in first differences): 1 to 4				
Unrestricted Co integration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.243348	67.46419	15.49471	0.0000
At most 1 *	0.157102	25.63646	3.841466	0.0000
Trace test indicates 2 co integrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.243348	41.82772	14.26460	0.0000
At most 1 *	0.157102	25.63646	3.841466	0.0000
Max-eigenvalue test indicates 2 co integrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co integrating Coefficients (normalized by b'*S11*b=I):				
DIFFER- ENCED_EXCH_ RATE	DIFFER- ENCED_YIELDS			
-0.872252	4.644114			
5.226131	-0.195158			
Unrestricted Adjustment Coefficients (alpha):				
D(DIFFERENCE D_EXCH_RATE)	-0.044822	-0.128684		
D(DIFFERENCE D_YIELDS)	-0.216141	-0.027909		
1 Co integrating Equation(s):		Log likelihood	-105.3418	

Normalized co integrating coefficients (standard error in parentheses)	
DIFFER- ENCED_EXCH_ RATE	DIFFER- ENCED_YIELDS
1.000000	-5.324279 (0.77716)
Adjustment coefficients (standard error in parentheses)	
D(DIFFERENCE D_EXCH_RATE)	0.039096 (0.02463)
D(DIFFERENCE D_YIELDS)	0.188530 (0.02857)

OLS Equation

Dependent Variable: DIFFERENCED_EXCH_RATE

Method: Least Squares

Date: 04/08/11 Time: 11:48

Sample (adjusted): 1998M02 2010M12

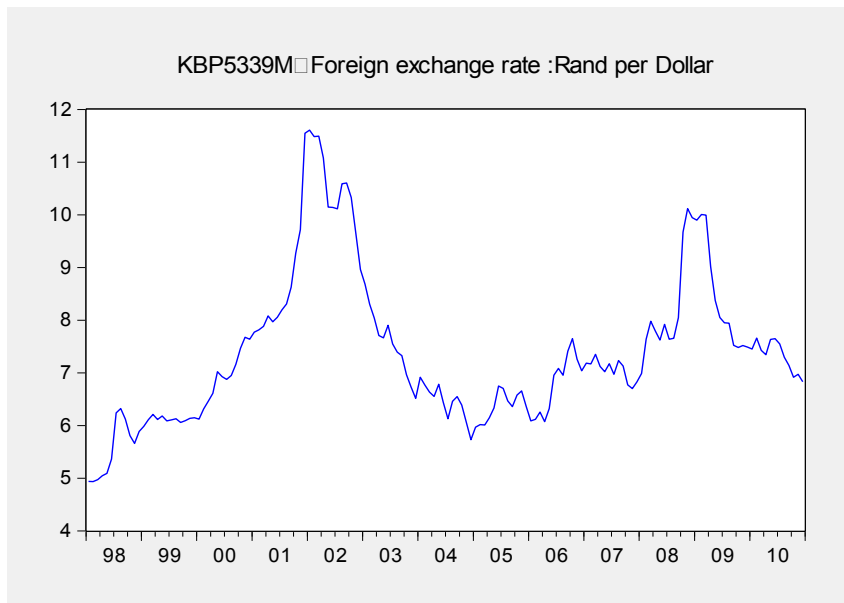
Included observations: 155 after adjustments

DIFFERENCED_EXCH_RATE=C(1)+C(2)*DIFFERENCED_YIELDS

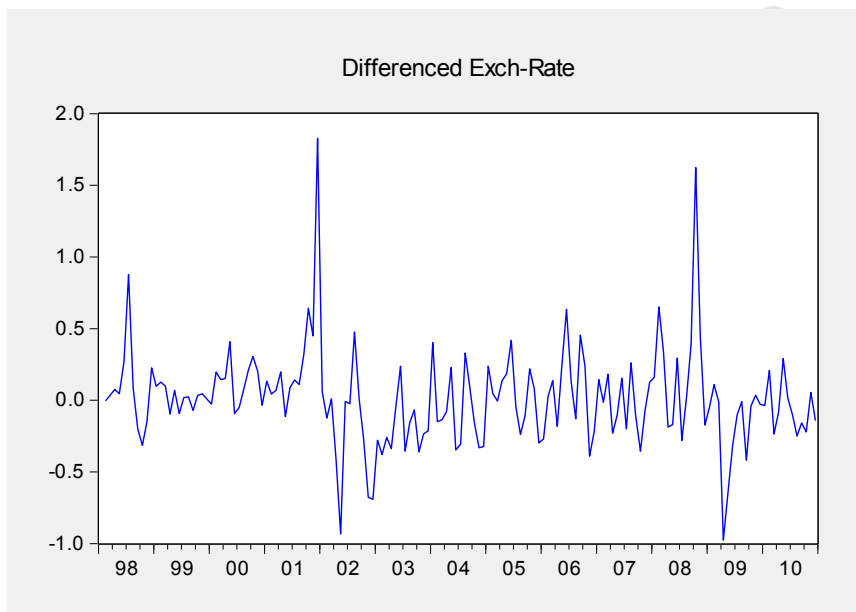
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.021393	0.025637	0.834473	0.4053
C(2)	0.272594	0.060299	4.520728	0.0000
R-squared	0.117835	Mean dependent var		0.012195
Adjusted R-squared	0.112069	S.D. dependent var		0.337653
S.E. of regression	0.318171	Akaike info criterion		0.560362
Sum squared resid	15.48859	Schwarz criterion		0.599632
Log likelihood	-41.42806	Hannan-Quinn criter.		0.576313
F-statistic	20.43698	Durbin-Watson stat		1.171377
Prob(F-statistic)	0.000012			

Graphical representation

Foreign Exchange: Rand/Dollar



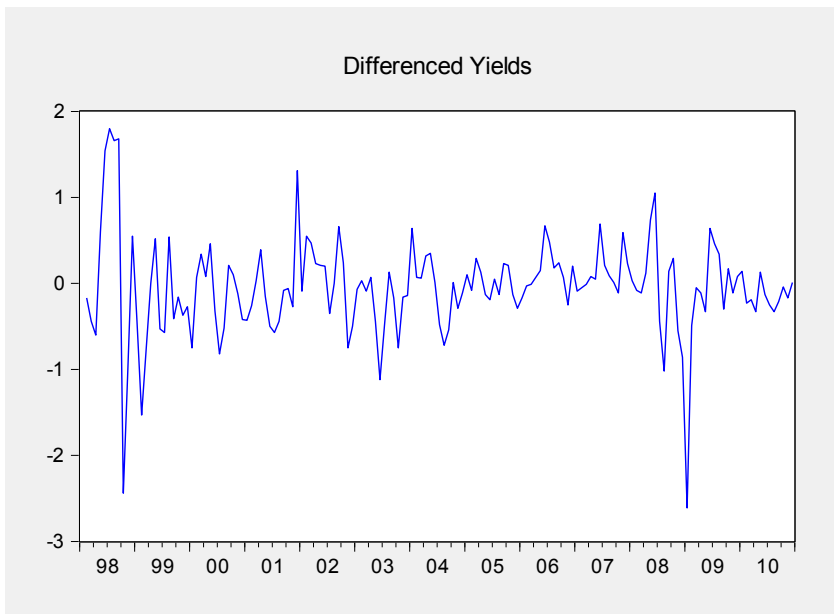
Exchange rate: Rand/Dollar after differencing



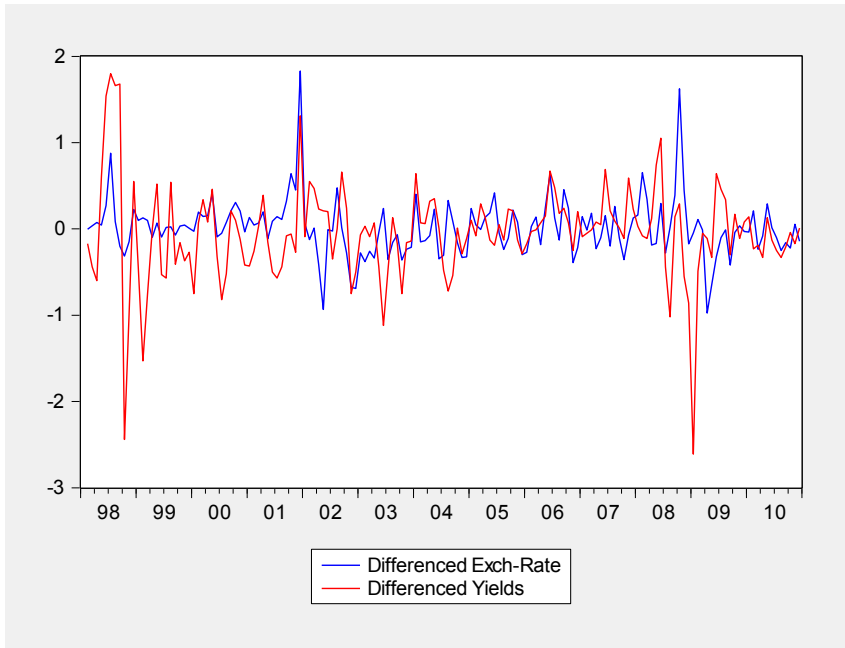
Bond Yields for 0-3 years



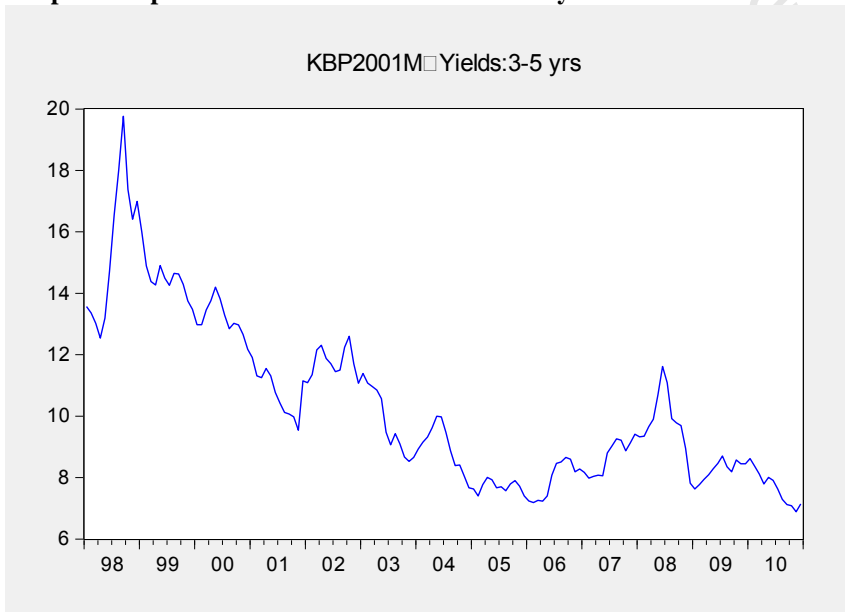
Bond Yields for 0-3 years after differencing



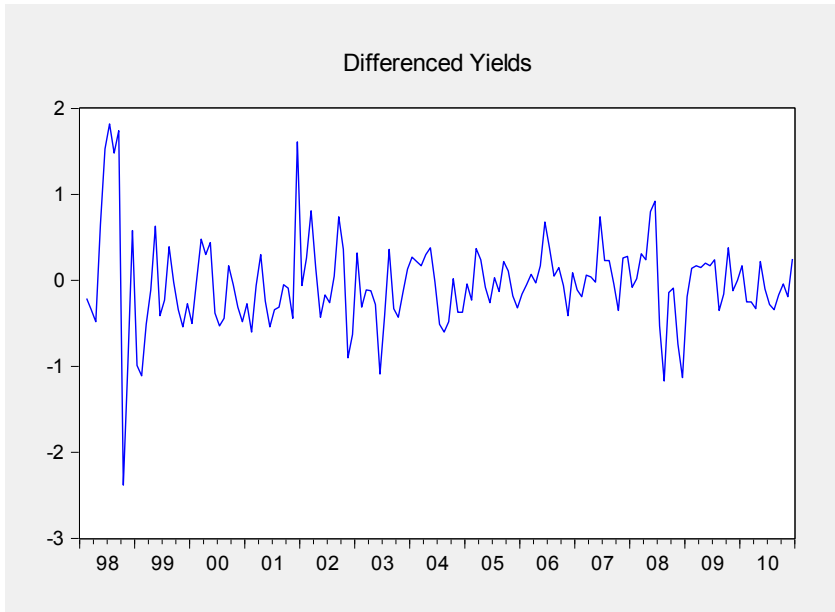
Graphical representation of Co integration between 0-3 years bond yields and Exchange rate (After differencing)



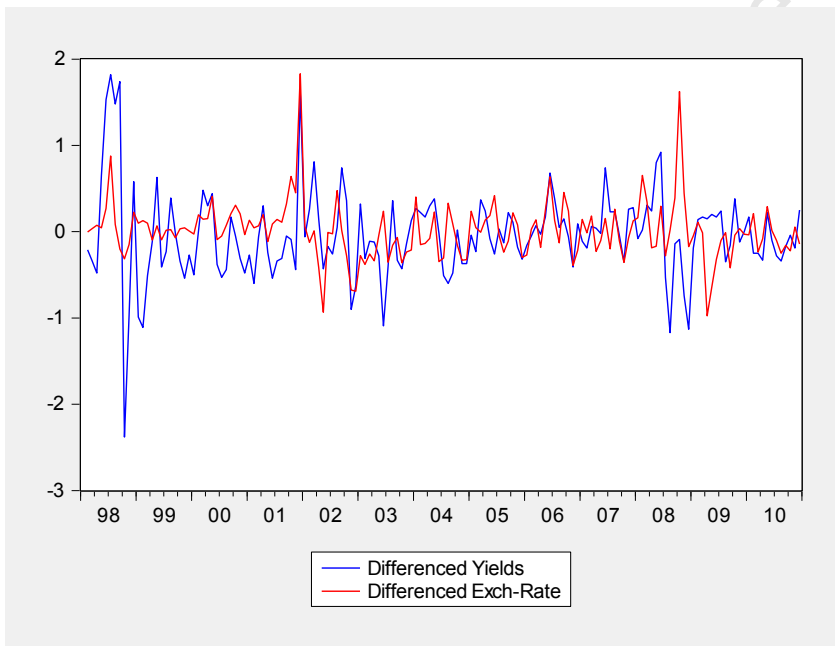
Graphical representation of Bond Yields for 3-5 years



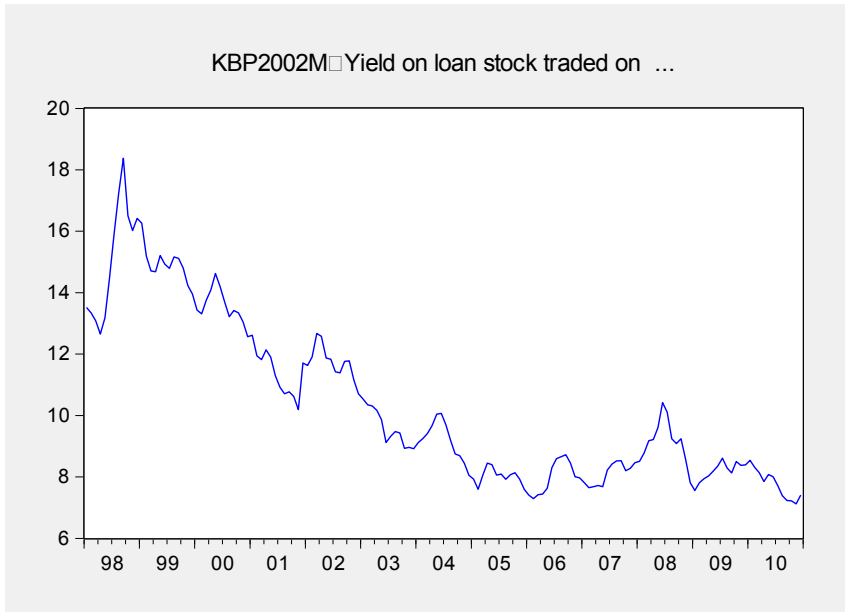
Graphical representation of Bond Yields for 3-5 years after differencing



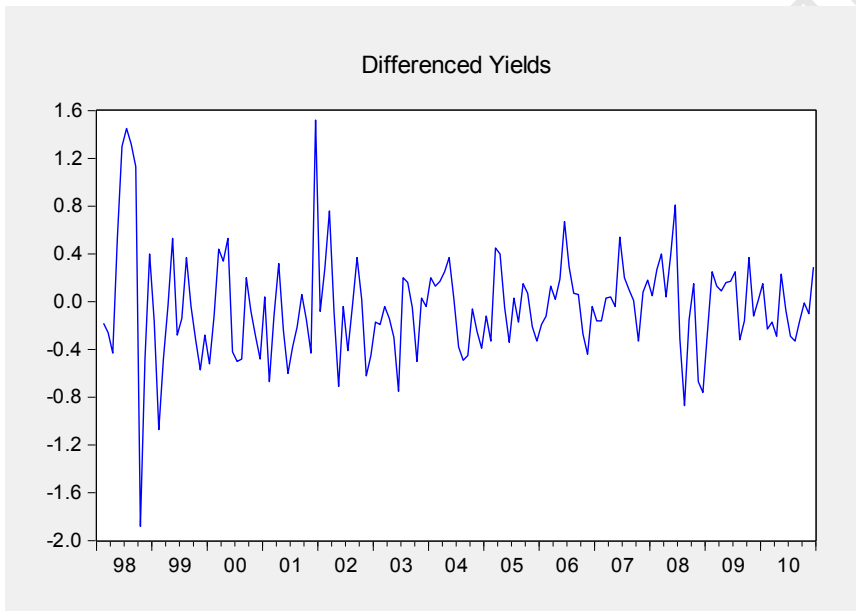
**Graphical representation of Co integration between 3-5 years yields and Exchange rate:
After differencing**



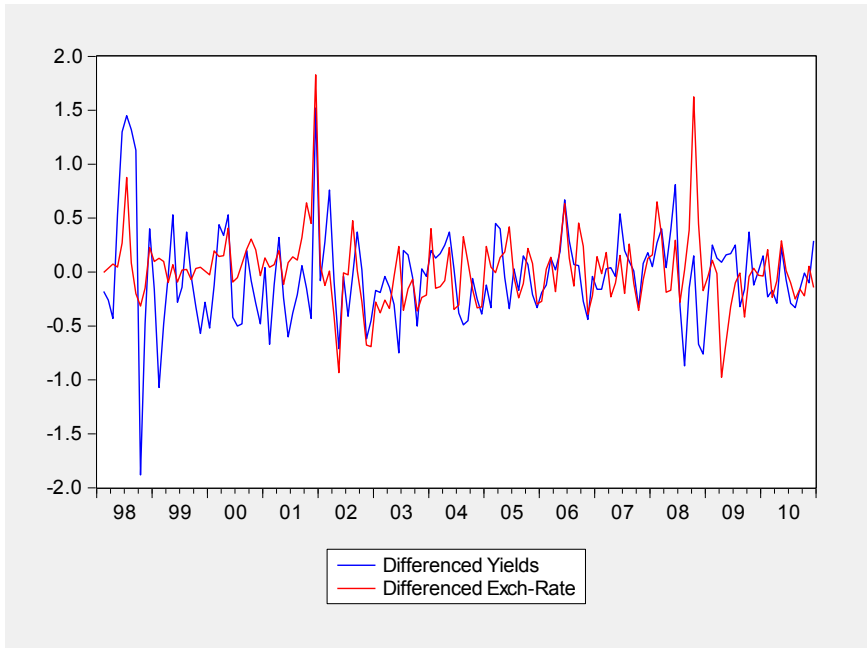
Graphical representation of Bond Yields for 5-10 years



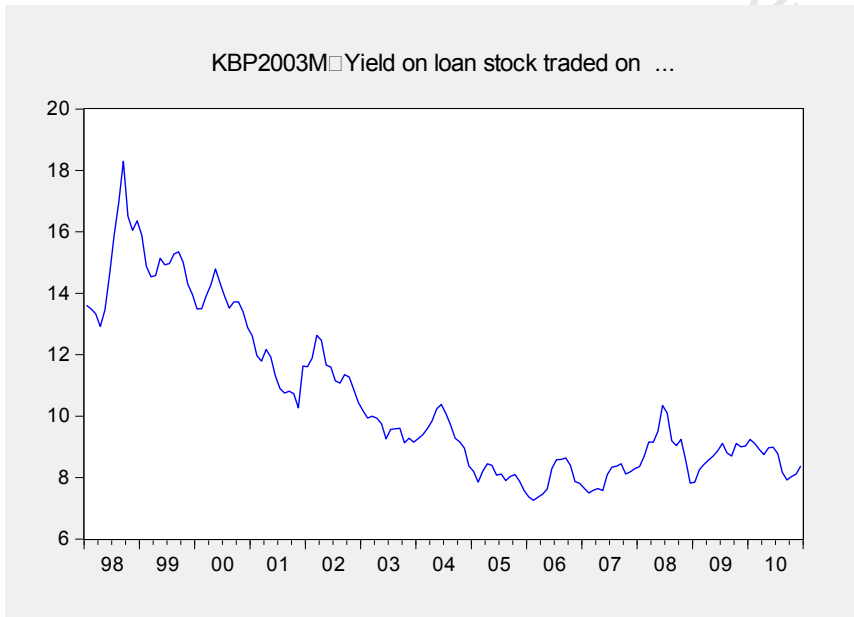
Graphical representation of Bond Yields for 5-10 years after differencing



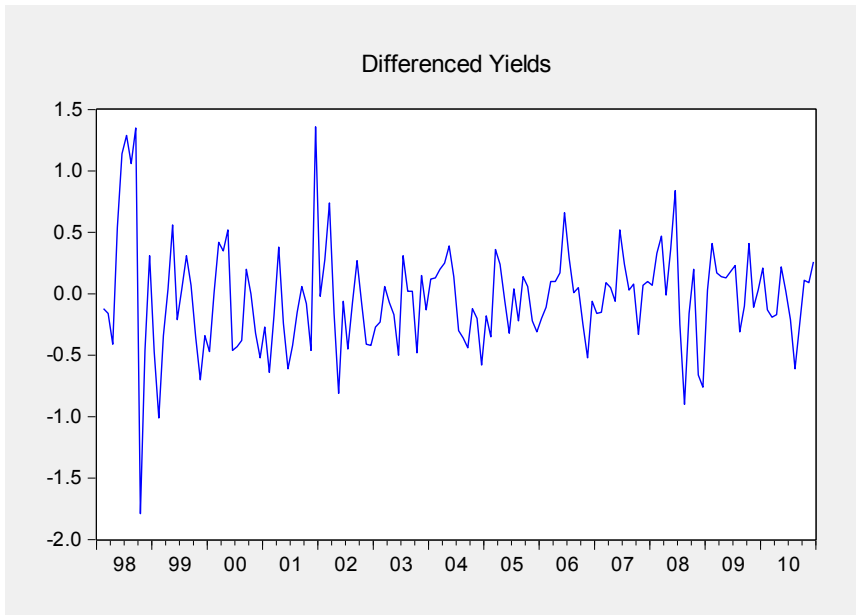
**Graphical representation of Co integration between 5-10 years yields and Exchange rate:
After differencing**



Graphical representation of Bond Yields for 10 years and above



Graphical representation of Bond Yields for 10 years and above after differencing



Graphical representation of co integration between Bond Yields for 10 years and the exchange rate: After differencing

