RISK-FREE ASSETS: ARE THEY TRULY RISK-FREE? A COMPARATIVE STUDY OF SOUTH AFRICAN RATES AND INSTRUMENTS

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Abstract

Determining the price of a financial instrument is something that happens every day in the financial markets. Every price starts off with a spot price adjusted for interest until maturity of the particular instrument. The interest is usually described as risk-free interest. The price so determined is the most basic price that an investor is willing to pay if not risk is involved.
Risk-free assets, then, are securities of which the future rates of return are known with certainty. An exceptional degree of confidence in the issuer of the security brings about this certainty. Risk-free assets are normally in the fixed income securities (capital markets) investment category or in the liquid money market instruments such as treasury bills, category.
This study attempts to determine whether the risk-free rates used by treasury managers and traders in South Africa to formulate their bond yield curves and which are used in valuation models, may be deemed risk-free. The study specifies certain criteria that an asset must satisfy in order to be used as a risk-free asset. Short term and long term South African instruments are compared to the US counterpart instruments, to gain an understanding of the South African instruments relative to the US ones. The behaviour of the risk-free instruments used in South Africa is also compared to the FTSE/JSE All Share Index and gold spot prices, which are perceived to be a risky asset classes.
To gain some understanding of the behaviour of these instruments, analyses were done from different angles. The standard deviations of the daily percentage changes of the R157 were significantly lower than that of the ALSI and the gold spot price change. Compared to the ALSI and gold spot price, therefore, the R157 may be deemed a "low risk" instrument. The JIBAR was even less volatile that the R157. Interestingly, the US instruments were substantially more risky than the SA instruments over the analysis period. Also the JIBAR may be labelled "low risk" in this context. To improve on the comparisons especially where the magnitudes of change and the bases were very different, indices were used to compare the different instruments. Based on the index change, the JIBAR was now more risky than the R157. The ALSI and the gold spot was sill substantially more volatile than the JIBAR and R157. On this basis, the US instruments appeared less volatile but still more volatile than the SA instruments. It may be noted that the volatility of the US instruments were greatly influenced by the recent financial crisis.

Keywords: Risk-Free, Risky, Low Risk Assets, Volatility, Correlation.

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Introduction

Every financial instrument for which a price is determined (in its most basic form) in the financial markets, is based on a spot price, including interest to maturity, calculated using a risk-free interest rate. For instance, when we price a futures contract, the spot price of the underlying asset including risk-free interest to maturity makes up the price. The reasonable or fair price at which this instrument should trade, is based on this price. If the price quoted by a dealer to an investor is in fact fair, no opportunity for arbitrage exists. Most of our decisions in the financial environment starts off from a no-risk situation or price and then progresses into a price that will take risk into consideration. Investors, wanting to take risk want to be compensated for that risk, or, can expect to pay a higher price for an asset that is deemed risky.

Risk-free assets are securities of which the future rates of return are known with certainty. An exceptional degree of confidence in the issuer of the security brings about this certainty. Risk-free assets normally fall in the fixed income securities (capital markets) investment category or the liquid money market instruments such as treasury bills, category. Bills are short term fixed income securities (with maturities up to one year), notes are medium term

(between one and ten years) instruments and bonds are longer term (between ten an thirty years). The owner of a fixed income security receives fixed periodical interest payments (coupons) and the principal amount (the amount that was borrowed) is returned at maturity (when the contract expires). In the United States, Treasury securities are considered risk-free as they carry the full faith and credit of the US government (Fidelity 2011:1). Therefore government bonds are generally assumed to be the most risk-free option. The rate of return or yield to maturity on risk-free assets is the risk-free interest rate. In South Africa, Government bonds are some of the safest fixed income producing instruments.

South African Government Bonds has traditionally yielded much higher returns than that of the United States or the United Kingdom. The higher perceived risk of South Africa has held yields at a premium to that of more developed countries. At times the higher yields have also been an attraction for foreign capital seeking a safe place with high return. The South African financial system is sophisticated and has earned this status due to its diversity that is supported by an elaborate legal and financial infrastructure and general effective regulatory framework (IMF Country Report, 2008:6).

This study attempts to determine whether the risk-free rates used by treasury managers and traders in South Africa to formulate their bond yield curves and for use in valuation models, may be deemed risk-free. A number of analyses are performed on selected assets with the aim of answering the questions mentioned above. The study specifies certain criteria that an asset must satisfy in order to be used as a risk-free asset. Short term and long term South African instruments are compared to their matching US instruments, to gain a relative understanding of the South African instruments. The behaviour of the risk-free instruments used in South Africa is also compared to the FTSE/JSE All Share Index, which is perceived to be a risky asset class.

Statement of the problem

Since 2008 the risk-free nature of traditionally assumed risk-free instruments (US Treasuries/Government Bonds), have been questioned. Standard & Poor's (S&P) and Moody's are credit rating agencies that rate bonds and issuers of bonds on a default scale. In 2010 a number of countries - Spain, Ireland, Greece and Portugal- were downgraded from AAA, the highest credit rating. At the start of 2011 S&P suggested that bonds issued by AAA rated countries, such as the United States (US) and the United Kingdom (UK), are not free of risk. In August 2011, S&P lowered their long-term sovereign credit rating on the US to AA+ from AAA. S&P also said that the outlook on the long-term rating is negative (Standard & Poor`s: 2011:1). Before this it was assumed that governments are default free, and rates government securities may be used as risk-free rates. One can expect that the risk-free rate already contains some risk spread. "As a result, the amount that can be earned on these assets is often used as a short-cut in valuation and pricing exercises that specify a risk-free rate as the starting point - a fundamental element whether valuing a company, an option or a future obligation." (Wood, 2009:25)

Risk-free rates form the basis of most valuations and are thus an extremely important variable in this process of valuation. Even when valuing property, a risk premium is added to the risk-free rate to calculate a discount rate. This discount rate is then used to calculate the intrinsic value of the property. Aswath Damodaran was quoted saying:" If u don`t know the risk-free rate u don't know anything else." The process of determining the price for most financial instruments starts with choosing a risk-free asset and using the expected return on that asset as the risk-free rate (Damodaran, 2008:4).

The loss of confidence in financial markets following the financial crisis of 2008 and the European debt crisis raised a number of questions regarding the risk-free status of risk-free assets:

– When exactly may an asset be deemed risk-free?

– Are there truly risk-free interest rates?

– What rate should be used as the risk-free interest rate?

– What rates are currently used as the risk-free rates in South Africa?

– How does the behaviour of risk-free assets differ from that of a risky asset?

– How does South African risk-free assets compare to that of a developed economy such as the United States of America?

Primary objectives

The primary objective of this study is to determine which assets may be classified and used as risk-free assets in SA. These assets are analysed to determine if they satisfy the two conditions that were mentioned above. The analysis attempts to establish whether risk-free assets differ materially from risky assets in terms of the certainty of their outcomes or realized returns.

Methodology

To achieve the objective of the study, use was made of descriptive statistics. Standard deviations and correlation coefficients were calculated in order to make the comparisons.

Data Analysis

Daily yields for the past ten years were obtained from I-Net Bridge and were used in the relevant analyses.

Firstly, the risk-free instruments used in South Africa were compared to equivalent US risk-free instruments. Standard deviations as well as correlation coefficients were determined to gain a relative understanding of the South African and US risk-free rates. Secondly, the daily percentage change was calculated for each instruments being analysed. Two risky instruments were introduced in order to compare their behaviour to that of the risk-free instruments. Next, the returns on each of the instruments were converted to an index value. This simplifies comparisons as an index is ideal methodology that may be used to measure change over time between magnitudes at different levels. The standard deviations based on the index values were generally lower. The behaviour of the risk-free instruments relative to that of the risky instruments were once again measured using correlation coefficients.

Brief literature review

The Oxford Advanced Learner`s Dictionary (2008) defines the verb 'to risk' as follows: "to put something valuable or important in a dangerous situation, in which it could be lost or damaged". Risk is perceived almost entirely in negative terms. The precise definition of risk depends on the context and application. In finance and investments, risk is the possibility that one will receive a (positive or negative) return on an investment that is different from the return that one expects (hopes) to receive on the particular investment. Thus, in finance, the definition of risk is broader because it includes not only a return that is lower than the expected return but also good outcomes where the return is higher than expected ("risk", 2008). This is contrary to pure risk or insurance risk where a positive outcome should not be possible. If a building burns down, the owner, from an insurance perspective, will be placed in the situation that he/she was in before the incident occurred.

In investments and valuations, one assumes that there is an investment with a guaranteed return that offers investors a 'risk-free' choice. This is a critical assumption in the valuation of nearly every asset, from property to options on futures contracts, as well as in many important company decisions (Damodaran, 2010:1). An asset with a guaranteed return is a risk-free asset and the return on it is the risk-free rate of return. With the complexity and volatility of modern financial markets, one cannot help but question the existence of a truly risk-free asset.

Prior to the banking crisis of 2008, no one questioned the credit worthiness of United States of America treasuries, United Kingdom gilts and German bonds. But during the crises, the fear that even these governments could fail came to the fore (Damodaran, 2010:1). Previously, the United States, United Kingdom and Germany were perceived to be free of default, and therefore their debt would also be default free. Today they are still some of the most creditworthy countries in the world. There have been a number of cases where sovereign entities have defaulted on their debt obligations. Credit rating agencies rate countries on a default scale, which helps to assess the credit worthiness of a country.

In South Africa, zero-coupon government bonds/bills are used as risk-free assets. They are issued by the National Treasury and are considered to be the most risk-free investments in the country. The rates on these bonds and the Johannesburg Interbank Agreed Rate (JIBAR) are used as risk-free rates. Risk-free rates in South Africa are much higher than in most of the developed economies. This is because of the higher growth potential in the economy and higher levels of perceived risk and also inflation.

Definition of a risk-free asset

As far as could be established, little research has been done on risk-free rates/assets. Before the debt crises in 2008, no one doubted the existence of a risk-free asset. Everyone took the risk-free rate as a given. Aswath Damodaran, a finance professor from the Stern School of Business at New York University has written extensively on what a risk-free rate is. This study makes use of his definition of a risk-free rate. He explains the basic building blocks needed for a risk-free asset and then tries to establish a real risk-free rate that can be used in any country, even where there are no risk-free assets.

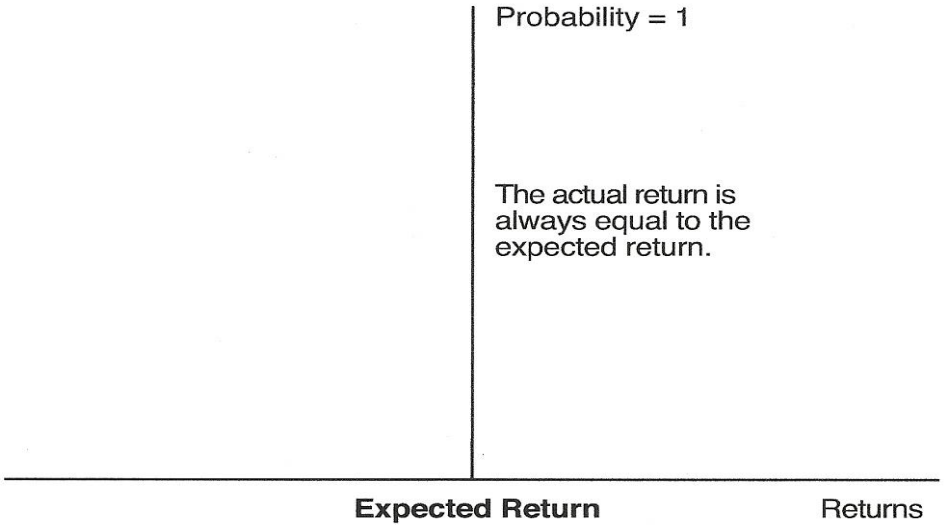
To understand what makes an asset or an investment risk-free, one must first look at how risk is measured in finance. An investor who buys a security expects to receive a certain return at the end of his/her holding period. The degree to which the actual returns deviate from this expected return is the source of risk.

"Risk in finance is viewed in terms of the variance in actual returns around the expected return. For an investment to be risk-free in this environment, then, the actual returns should always be equal to the expected return". (Damodaran, 2008:3)

To gain a better understanding of this concept, consider an investor who has a one-year investment horizon. The investor has two investment options: He/she can buy a SASOL stock now and sell it in a year's time at the prevailing market price. Alternatively, the investor could buy the share today and short a one one-year JIBAR future to sell the share at a fixed price. In case of alternative one, the investor does not know what the share price will be in one year: it could be worth more or less than the purchase price. Thus, the probability that the expected return will be equal to the actual return is, depending on the specific share probably quite low. On the other hand, with the JIBAR future, the return one will receive at expiration is fixed on the day that the future

is acquired which is the difference between the purchase price and the futures price. In this case the expected return will be equal to the actual return (ignoring any arbitrage). Thus, the JIBAR future can be referred to as instrument that can be used to remove risk (and uncertainty). The net outcome of alternative two is riskless. Figure 1 plots the distribution of returns of a risk-free asset. This indicates that there should be no variance or standard deviation around the expected or mean return.

Figure 1. Distribution of returns on a risk-free asset



Source: Damodaran, 2010:82

Another way to think about risk-free assets is by comparing their behaviour to that of risky assets. The variability in the returns of a risky asset should be much wider than that of a risk-free asset. Also, there should be no or little correlation (how one asset behaves relative to another) between the two (Damodaran, 2008:4). The return on risky assets correlates (positively or negatively) with the economic cycle. A risk-free asset should deliver the same return no matter what the scenario or economic cycle.

There are two types of assets. The first type has no promised future cash flows (income) from the asset (e.g. equities) but has only expected cash flows which may be paid as dividend or may be held back for reinvestment. The second type has promised future cash flows (e.g. fixed-income securities or bonds). A risk-free asset will always fall in the second category because the expected future returns should be known for an asset to be risk-free.

Two basic conditions have to be met for an asset to be risk-free: There can be no default risk and there can be no reinvestment risk. "Default risk" refers to an entity's ability to make the required payments on his/her debt obligations. This essentially rules out any asset sold by private organisations because even the largest institutions have some degree of default risk. Therefore, the only investments that can be considered risk-free are government securities. This is due to governments' ability to control the printing of currency (Damodaran, 2002). For the moment one can assume that governments are free of default risk, although there have been cases where governments have defaulted on their debt payments (this will be discussed later in the text).

"Reinvestment risk" is the risk that future proceeds (coupons and/or principals) may have to be reinvested at a lower (or higher) rate than the expected rate of return, thereby realising a lower (higher) overall return than expected. Reinvestment risk is of concern to bond (fixed income) investors who receive periodic coupon payments (Characterising Risk, 2006:1). When pricing bonds, the assumption is that coupons will be reinvested at the yield-to-maturity. To gain a better understanding, consider a five year government bond that pays semi-annual coupons. When attempting to estimate the expected return over your five year investment horizon because a five year risk-free rate is needed. A six month government bond rate is known today, but the rate for the next six month rate unknown. Every six months you will have to reinvest your coupons at the unknown six month rate. Thus the five year government coupon bond is not risk-free. The risk-free rate for a five year time horizon will have to be the expected return on a default free government five year zero coupon bond. Zero coupon bonds pay no coupons during the life of the bond, thereby eliminating any reinvestment risk. Instead they sell at a discount to their face value, and the interest is recorded each year but not paid to the investor until the bond matures or when the bond is sold. Because the interest accrues before expiry, it is reinvested at

the bond's stated rate of return (the investor's expected return) (CollegeBoard, 2007:1).

The importance of risk-free assets in the financial/investment environment

Obtaining the risk-free rate is the starting point in the pricing and valuation process of almost any investable asset. Risk premia are added to the risk-free rate to determine the applicable borrowing rate for an institution, or the return required by investors. The risk-free rate is also used to make decisions in corporate finance and portfolio management. This section will illustrate the importance of risk-free assets by looking at a variety of theories, models and functional areas where it is essential to understand the risk-free rate.

(1) Discounted cash flow (DCF)

DCF is method of valuation where the projected future cash flows from an investment opportunity is discounted to get a present value. If the present value is higher than the cost of the investment then the opportunity may be a good one. The present value (PV) is the sum of all the discounted cash flows ("Discounted cash flows", 2006:1). The equation used in the DCF model is shown below:

$$= \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_n}{(1+r)^n} \qquad (1)$$

Where:
r = discount rate
CF = cash flows
n = number of periods/cash flows

The discount rate used is usually the cost of capital (the required rate of return). The cost of capital (where risk is involved) is estimated by adding a default spread to the risk-free rate. The magnitude of the default spread will depend on the credit risk of the entity (Damodaran, 2008:4). From the equation it can be seen that a higher risk-free rate, *ceteris paribus*, will increase the discount rate and then reduce the present value of a DCF valuation. An inaccurate risk-free rate could lead to mispricing and consequently making the wrong investment decisions.

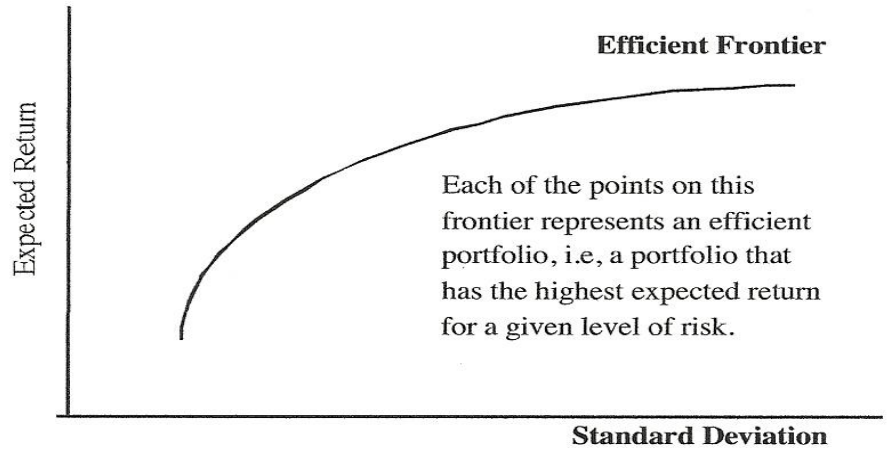
(2) Firm value

Discount rates increase and decrease with the risk-free rate. "If we categorise companies, based upon assets in place and growth assets, growth companies should be affected much more adversely when the risk-free rate increases than mature companies, holding all else constant." (Damodaran, 2008:5) Because growth companies focus on growth, cash flows are only delivered further into the future. The value of growth assets will decrease with a rise in the risk-free rate and the value of existing assets will increase (because cash flows are in the near term). Thus the value of growth companies will decrease relative to mature companies when risk-free rates rise.

(3) Portfolio theory

Nobel Laureate, Harry Markowitz, developed a method called mean-variance analysis. He tried to reduce the risk (the standard deviation) in a portfolio of risky assets, by combining risky assets with very different risk profiles and correlations. Consider two risky assets, one that pays off when it rains and the other when it does not rain. By combining the two in a portfolio, the assets will always pay off. This was the start to modern portfolio theory (3 Pioneers, 2010:1). The portfolios that emerged were called efficient portfolios, and the entire set of portfolios lie on the efficient frontier, as illustrated in Figure 2.

Figure 2. Markowitz Portfolios



Source: Damodaran, 2010:3

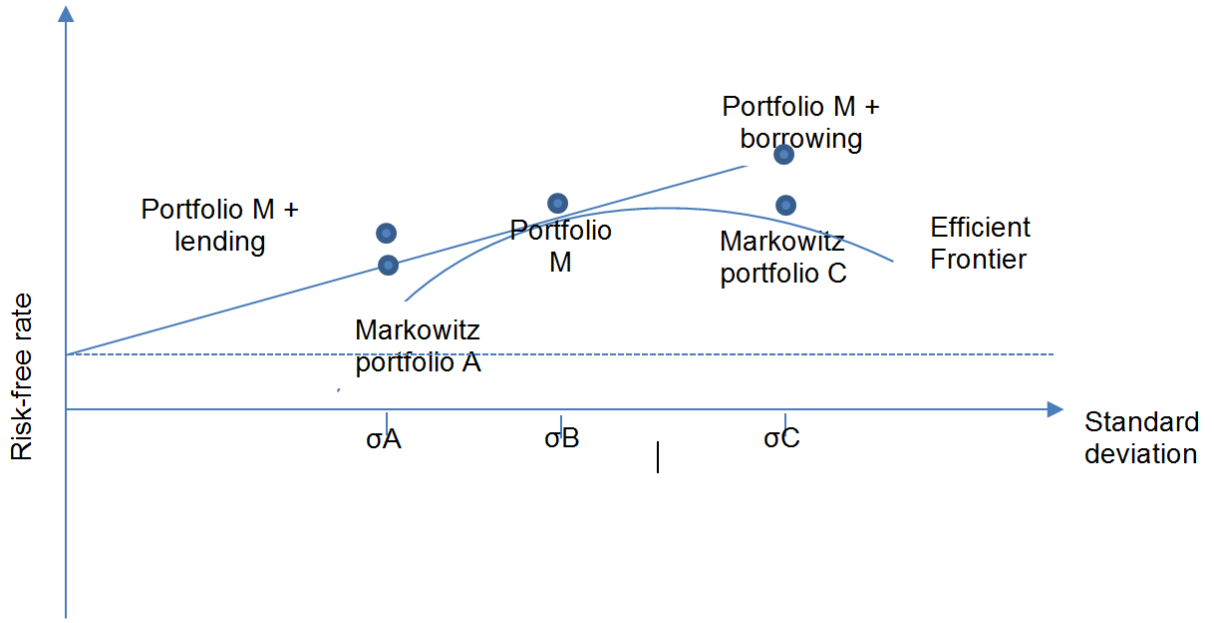
Among others, this approach suffered from two main problems: It required a large number of inputs and could not generate a portfolio with less risk than the least risky efficient portfolio. Sharpe (1964) and Linter (1965) developed the Capital Asset Pricing model (CAPM), by introducing a risk-free asset into the portfolio mix which improved the risk-expected return combinations. The risk-free rate is an important input to the CAPM, because it determines the intercept (representing the risk-free rate), and also affects the slope of the linear equation (Mukherji, 2011:75) (see Figure 3 below). The sloped line gives different portfolio combinations of risk-free and risky assets. Every point on this line represents a portfolio combination giving a return greater than the risk-free rate.

$$K = R_f + (R_m - R_f) \quad (2)$$

Where: R_f = risk-free rate
R_m = the return on the market

The risk-free asset has zero variance thereby reducing the portfolio variance (risk). The investor could now choose his/her desired level of risk and balance his/her portfolio accordingly. Diversification could now be done to the fullest extent possible across risky assets and then use the risk-free asset to reduce the portfolio risk. Thus, introducing the risk-free asset vastly simplifies the investment decision (Damodaran, 2010:8).

Figure 3. CAPM - Introducing a riskless asset



Source: Damodaran, 2010:8

In Figure 3, investor A has a desired risk level of σA. The Morkowitz portfolio A contains only risky assets. By introducing the risk-free rate, investor A can now invest in Portfolio M+, consisting of a combination of the riskless asset and a much riskier assets which may realise a higher return for the same level of risk (σA). As the slope of the line drawn from the riskless rate increases, the expected return increases (so does the standard deviation). The slope is maximised when the line is tangent to the efficient frontier line at the portfolio M point.

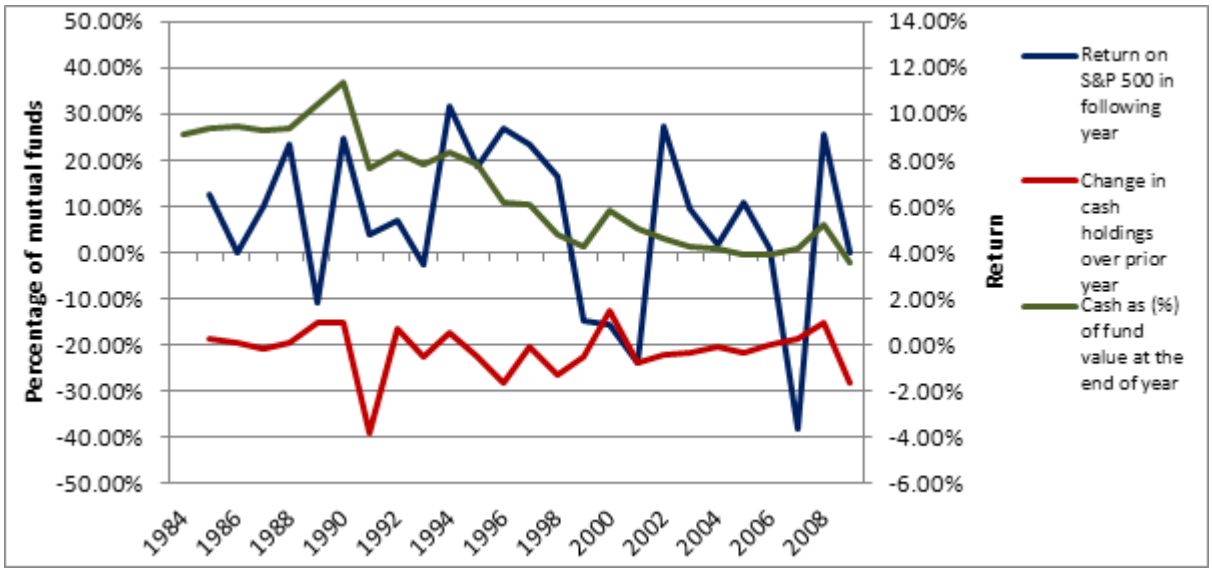
In efficient portfolios such as mutual funds, an amount of the overall fund value is always held in cash. The cash is invested at the risk-free rate. The extent to which equity mutual fund managers use treasury bills (risk-free assets or cash) as a diversification tool is shown in Table 1 and Figure 4. The table lists equity mutual fund cash holdings as a percentage of overall portfolio value and the returns on the Standard and Poor's 500 (Damodaran, 2010:13) for every year from 1985 to 2009. Note that cash holdings increased during market contractions and decreased during market expansions. Figure 4 is a graphical illustration of Table 1.

Table 1. Cash as a percentage of mutual fund assets and stock returns: 1985-2009

Date	Cash as (%) of fund value at the end of year	Change in cash holdings over prior year	Return on S&P 500 in following year
1984	9.10%		
1985	9.40%	0.30%	12.46%
1986	9.50%	0.10%	0.09%
1987	9.30%	-0.20%	10.09%
1988	9.40%	0.10%	23.37%
1989	10.40%	1.00%	-10.61%
1990	11.40%	1.00%	24.62%
1991	7.60%	-3.80%	4.09%
1992	8.30%	0.70%	6.98%
1993	7.80%	-0.50%	-2.66%
1994	8.30%	0.50%	31.68%
1995	7.80%	-0.50%	18.79%
1996	6.20%	-1.60%	26.81%
1997	6.10%	-0.10%	23.61%
1998	4.80%	-1.30%	16.38%
1999	4.30%	-0.50%	-14.79%
2000	5.80%	1.50%	-15.52%
2001	5.00%	-0.80%	-23.62%
2002	4.60%	-0.40%	27.33%
2003	4.30%	-0.30%	9.52%
2004	4.20%	-0.10%	1.82%
2005	3.90%	-0.30%	10.94%
2006	3.90%	0.00%	0.84%
2007	4.20%	0.30%	-38.16%
2008	5.20%	1.00%	25.79%
2009	3.60%	-1.60%	?

Source: Damodaran, 2010:13

Figure 4. Cash as a percentage of mutual fund assets and stock returns: 1985-2009

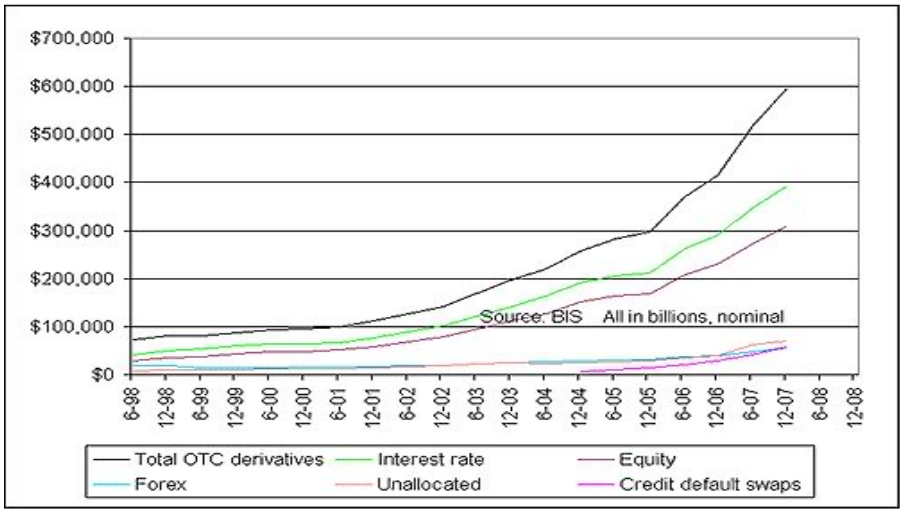


(4) Pricing of derivative assets

Since the late 1970s there has been a widespread process of removal of restrictions on international trade and investment. This, together with money being electronically held, lead to an expansion in financial markets, especially the derivatives market. Derivatives markets grew to meet the needs of managing and speculating on volatility (Bryan, 2009:6).

In 2008 the global derivatives market was valued at $1.14 quadrillion (Murphy, 2011:1). Figure 5 shows the exponential growth of the global derivatives market. The South African (SA) derivatives market has also exploded in the recent years. In 2007, SA accounted for 9.91 percent of the over the counter (OTC) derivatives positions in emerging markets. In 2008, futures contracts accounted for 49 percent of the volume of transactions surpassing equities that accounted for 46 percent. Between 2001 and 2008 the average annual growth rate in the number of futures contracts was 82.7 percent, while the underlying value grew by 28.4 percent per year on average during the same period (Adelegan, 2009:7).

Figure 5. Global derivatives market



Source: Murphy, 2011:1

As options and futures markets expanded, the models used to price and value them also became more complicated. The risk-free rate is the basic building block in most of these models, because they are based on the arbitrage principle and Arbitrage Pricing Theory (APT) (Damodaran, 2010:9). Arbitrage is an investment strategy that provides an opportunity for a positive profit with no investment outlay. It can be viewed as making something out of nothing with no probability of loss and some probability of gain. It is therefore a riskless strategy, also referred to as a "free lunch". The arbitrage pricing theory (APT) is built on the assumption that a necessary condition for market equilibrium is that no arbitrage opportunities should exist. In some cases, the price of an asset can be determined by the no-arbitrage condition and in others a wide range of prices exists. The APT has been extensively researched. It was introduced by Ross (1976, 1978), while the underlying assumption that the no-arbitrage condition is a necessity for market equilibrium comes from the general equilibrium model by Arrow (see Debreu, 1959) (Kallio & Ziemba, 2007:2282).

When a trading strategy produces the same cash flow stream as a given asset, the asset can be replicated. This replication will only work when markets are complete. In a complete/perfect market, assuming no-arbitrage, if an asset can be replicated then the price of the asset is equal to the initial investment of the replication strategy (Kallio & Ziemba, 2007:2283). This replicating argument in arbitrage pricing was introduced by Black and Scholes (1973) for option pricing and by Merton (1973) for the valuation of contingent claims. Harrison and Kreps generalised the APT, and later extensive literature appeared; see Merton (1992), Duffie (2001), Karatzas (1996), Pliska (1997), Luenberger (1998) and Bjork (1998). These earlier studies deal with perfect markets. Market imperfections include transaction costs, interest rate spreads between borrowing and lending, charges or restrictions on short selling and taxation. These imperfections were later introduced into APT models by e.g., Magill and Constantinides (1976), Garman and Ohlson (1981), Leland (1985), Jouini and Kallal (1995a), Bensaid et al., (1992), Boyle and Vorst (1992), Dermody and Prisman (1993), Naik (1995) and Cvitanic´ and Karatzas (1996), Edirisinghe et al. (1993), Bergman (1995), Jouini and Kallal (1995b) and Karatzas and Kou (1996) (Kallio & Ziemba, 2007:2283). All of these studies have seen the risk-free rate as a given, thus not a market imperfection. Since the recent debt crisis there is a need to examine the effect of variability in the risk-free rate on the pricing of derivative instruments and the arbitrage free condition.

To illustrate this arbitrage process with options, consider a normal American call option. When a call option is bought, the holder gets the right to acquire the underlying asset at a fixed price (the exercise

price) at any time before the options expiration date in the case of an American option. A replicating portfolio (an alternate investment) can be created to generate exactly the same cash flows as the call option. This is done by borrowing money at the risk-free rate, buying the underlying security and locking in the future price. Because this replicating portfolio and the call option has identical cash flows they should trade at the same price to prevent riskless or arbitrage profits. The cost of putting together the replicating portfolio should yield the value for the option. When buying a put option the process is exactly the opposite. The alternate portfolio is created by selling the underlying and investing the proceeds at the risk-free rate (Damodaran, 2010:9).

With forward and futures contracts, the same arbitrage argument is at work. An investor who wants to acquire a futures contract (long future) in silver intends to acquire say 500 ounces of silver in 6 months at the agreed upon futures price. The same can be achieved by borrowing money at the risk-free rate today and buying the 500 ounces of silver. Therefore the futures price of silver can be written as a function of the current spot price of silver, the risk-free interest rate and any costs associated with storing the silver for the next six months (Damodaran, 2010:9).

(5) Corporate finance

Corporate finance provides a framework for determining how firms invest their resources. It is the field in finance that deals with financing decisions that businesses have to make and the tools and analyses used in making these decisions. A selection of cases where the risk-free rate contributes to making these decisions are discussed in the following sections.

(6) The Investment Decision

Firms should only invest in a project if the project`s internal rate of return (IRR) exceeds a hurdle rate that reflects its risk. Having a risk-free rate puts a baseline on the hurdle rate. The hurdle rate is the risk-free rate and a premium for the risk of the anticipated project (Lambrechts, 2010:95).

Another method firms use to evaluate different investments/projects has to do with the calculation of the project's net present value (NPV). A positive NPV indicates that the project earns higher returns than other assets with similar risk can deliver. When investing in the risk-free asset the NPV should equal zero. It means therefore that no one would invest in a risky asset with a NPV lower than zero meaning that the project will yield a return of less than the risk-free rate (Lambrechts, 2010:91). To calculate the NPV, future cash flows are discounted to the present value using a discount rate. The risk-free rate is used in computing the discount rate.

(7) The Financing Policy

If a company/firm has accumulated cash in riskless assets lenders will be less concerned about their ability to repay their loans. For this reason it is common practise to compute debt ratios and financial leverage ratios using net debt. Net debt is the gross debt less cash and marketable securities. If R100 million is owed and the investor has R100 million in T-bills then the net debt is zero. Ratings agencies look for the presence of cash and their risk-free assets in a firm's balance sheet when assigning bond credit ratings. When a larger portion of a firm's assets are invested in risk-free assets, the cost of debt will be lower (Damodaran, 2010:11).

(8) The Dividend Policy

When profits are made by a firm, cash dividends can be paid to its shareholders or the cash built up can be held back for future expansion or whatever reason. Miller and Modigliani (1961) argued that the firm's dividend policy (whether they pay out dividends or retains it) does not influence the value of the firm. Their argument was based on the existence of a risk-free asset. "A firm that pays too little in dividends, relative to cash available for payouts, can always invest the cash in the risk-free asset and thus leave investors unaffected in terms of overall returns, by substituting price appreciation for dividends." (Damodaran, 2010:11).

Some of the most important uses of the risk-free asset in finance and investments were touched on. Yet there are numerous other uses of the risk-free rate for pricing and valuation of assets in the financial markets and in finance and economics otherwise. However these fall outside of the scope of this research. The aim of the previous section was to illustrate that the risk-free rate is a fundamental and critical component in investment management, corporate finance and investment valuation.

Default risk

Risk-free assets should have known cash flows, otherwise the expected return would not be known. The risk that the borrower does not fulfil his/her promises is called default risk. Default risk is measured by the likelihood that the promised payments might not be delivered. Investments with higher default risk should have higher interest rates. The premium demanded above the risk-free rate is the default spread (Damodaran, 2002:82). The only entities that stand a chance to be default free are governments. Governments control the right to print currency to pay their debt. The printing of currency has several consequences (e.g. reputation loss, capital market turmoil, decreases in real output and political instability), therefore it is not always a viable option. s.

History of sovereign defaults

Although governments are the only entities that can print money and therefore stand a chance to be default free, there has been numerous cases where governments have defaulted. The first recorded government default was in the fourth century B.C, when ten of the thirteen Greek municipalities defaulted on loans from the Delos Temple (Winkler in Strutzenegger & Zettelmeyer, 2006:3). Defaults between the sixteenth and eighteenth century are covered by Reinhardt, Rogoff and Savastano (2003). In the book "*Debt Defaults and Lessons from a Decade of Crises*", by Federico Strutzenegger and Jeromin Zettelmeyer they give an in depth historical overview on sovereign debt and debt restructurings. They found that the majority of defaults and debt restructurings occurred since the early nineteenth century, with most of them since the late 1970`s. An interesting fact about these defaults is that they are bunched in temporal and regional clusters that correspond to boom and bust cycles. Also the great majority of defaults in the last two centuries led to some form of settlement between creditor and debtor countries. Table 2 lists sovereign defaults from 2000 to 2010 with some detail on each:

Table 2. Sovereign defaults: 2000 – 2010

Default Date	Country	$ Value of Defaulted Debt (millions)	Details
January 2000	Ukraine	$1 064	Defaults on DM and US Dollar denominated bonds. Offered exchange for longer term, lower coupon bonds to lenders.
September 2000	Peru	$4 870	Missed payment on Brady bonds.
November 2001	Argentina	$82 268	Missed payment on foreign currency debt in November 2001. Debt was restructured.
January 2002	Moldova	$145	Missed payment on bond but bought back 50% of bonds before defaulting.
May 2003	Uruguay	$5 744	Contagion effect from Argentina led to currency crisis and default.
April 2005	Dominic Republic	$1 622	Defaulted on debt and exchanged for new bonds with longer maturity.
December 2006	Belize	$242	Defaulted on bonds and exchanged for new bonds with step-up coupons.

Source: Damodaran, 2008:16

Over the period 1824 till 2004, several defaults and restructurings took place. Several countries and regions have never defaulted. They include the United States (at federal level), Canada, Australia, South Africa (except for an episode related to sanctions in 1985), and most Asian and Arab countries. Defaults were normally associated with downturns (or busts) in economic cycles. All lending booms have so far ended in busts. (Strutzenegger & Zettelmeyer, 2006:7)

Sovereign ratings

There are many economies where governments in these markets are able to default on even their local borrowing. The rating agencies capture this potential by providing two sovereign ratings for most countries, one for local currency borrowing and the other for foreign currency borrowing. Moody, Standard and Poor and Fitch rate bonds and issuing entities on the basis of their credit worthiness. The primary factor they consider is default risk, because it includes both the capacity and the willingness to pay. They rate government debt on local and international borrowing. AAA is the highest rating and C the lowest. According to Standard and Poor`s rating an issuer rated AAA has an extremely strong capacity to meet debt obligations. On the other side of the spectrum, an issuer rated C is currently highly vulnerable to non-payment and might already have payments in arrears (Standard & Poor`s, 2009:9). In Table 3 Standard and Poor`s provide their estimates of default rates for different rating classes for both sovereign and corporate ratings:

Table 3. S&P Sovereign ratings and default probabilities

Fitch Sovereign Ratings Average Cumulative Default Rates: 1995–2008

(%)

	One-Year	Two-Year	Three-Year	Four-Year	Five-Year
AAA	0.00	0.00	0.00	0.00	0.00
AA	0.00	0.00	0.00	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00
BBB	0.00	0.75	1.68	2.83	4.21
BB	1.60	3.05	4.20	5.69	6.36
B	0.75	3.51	5.26	7.50	7.94
CCC to C	21.43	15.38	16.67	18.18	25.00
Investment Grade	0.00	0.18	0.39	0.66	1.00
Speculative Grade	2.09	3.78	5.20	7.01	7.73
All	0.72	1.39	1.97	2.69	3.10

Source: Fitch.

Source: Damodaran, 2010:31

In Moody`s publication on country default ratings, South Africa is rated Baa1 (compared to Aaa for the US and UK) on foreign debt and A2 (compared to Aaa for the US and UK) on local debt. At Baa, the government has the capacity to sustain a coherent economic policy framework and avoid any near term debt repayment problems if confronted with a severe shock to public finances. The A2 rating on local debt means that South Africa has high economic, financial or institutional strength and no material medium-term concern regarding repayment (Moody`s, 2008:4). Over the past year several emerging market economies investment ratings have been downgraded based on their sovereign risk. South Africa has maintained its ratings having been upgraded by one rating agency, and placed on a negative outlook rating watch by two others. This reflects the market`s confidence in our macroeconomic and fiscal policy framework (National Treasury, 2010:84).

Default spread

In many economies, like South Africa, the risk-free rate already includes a spread for the degree of default risk perceived by investors (measured by the rating agencies). This is called the default spread, the part of the spread rewarding investors for the expected default loss. Table 4 summarises the typical default spreads for sovereign and corporate bonds in different ratings classes in September 2008. According to the table South Africa has a 1.7% default spread on foreign debt and 1.3% on local debt. Corporate bond default spreads in September 2008 were larger than the default spreads on sovereign bonds. This confirms that the only entity that stands a chance to be risk-free are governments.

Table 4. Default spreads by sovereign ratings class - September 2008

Moody's Rating	Sovereign Bonds/CDS (%)	Corporate Bonds (%)
Aaa	0.25	0.50
Aa1	0.35	0.55
Aa2	0.60	0.65
Aa3	0.70	0.70
A1	0.80	0.85
A2	0.90	0.90
A3	1,00	1.05
Baa1	1,50	1.65
Baa2	1.75	1.80
Baa3	2.00	2.25
Ba1	3.00	3.50
Ba2	3.55	3.85
Ba3	3.75	4.00
B1	4.00	4.25
B2	5.00	5.25
B3	5.25	5.50
Caa1	7.00	7.25
Caa2	8.00	8,50
Caa3	10.00	10.50

Source: Damodaran, 2008:25

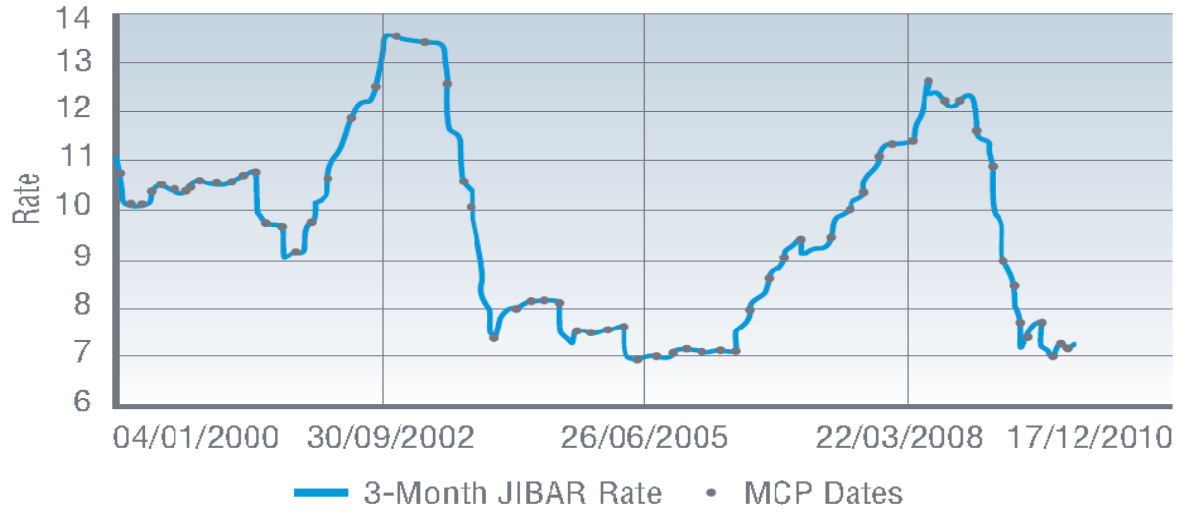
South African Government Securities

Since the only organisations that stand a chance to issue risk-free securities are governments, the next section will give a brief description of various South African government securities. The government of South Africa issues bonds/bills through the asset and liability management division of the National Treasury to raise money to fund the total budget deficit during a fiscal year. The bonds/bills discussed are issued in the domestic currency and are deemed to be the most secure investment in that currency. The bonds are listed on the Bond Exchange of South Africa. The National Treasury issues various types of bonds, e.g. Vanilla bonds, Variable bonds, CPI bonds and Zero coupon bonds. The most liquid bonds that are referred to as benchmark bonds are: R150, R194, R153, R157, R186 (National Treasury, n.d.:1).

JIBAR rates

The acronym JIBAR stands for the Johannesburg Interbank Agreed Rate and is the money market rate used in South Africa. It is an average of the rates indicated by local and local international banks. Every day at 10h30 each of the participating fourteen South African and South African based foreign banks are asked to provide the midpoint between their Bid and Offer prices of their 1, 3, 6, 9 and 12 month National Certificate of Deposit (NCD) rates. These rates are quoted as yields and then they are converted into a discount rate. In each category the fourteen rates are arranged in an order. The two top and bottom rates are eliminated and the remaining 10 are averaged and rounded to 3 decimal places. The JIBAR rate is the wholesale rate at which banks buy and sell short term money (in the money market) among each other. The JIBAR is calculated daily by the South African Futures Exchange (SAFEX) (Gumbo, 2001:81). The JIBAR is seen as a short term risk-free rate in South Africa. It is used as a benchmark and is considered to be an indication of the mark to market yield on NCD`s. Figure 6 illustrates the volatility of the 3-month JIBAR rate over the past decade with the Monetary Policy Committee dates shown as points on the graph.

Figure 6. 3- Month JIBAR rates from 1 Jan 2000 to 31 Dec 2009



Source: Johannesburg Stock Exchange, 2010:2

Treasury bills

Treasury Bills (TB`s) are short term debt instruments denominated in South African Rands (ZAR). They are sold at a discount to par and carry no coupon interest. TB`s are issued in the market at maturities ranging from 1 day to 12 months and are redeemable at par on maturity. Governments use TB`s as a short term funding instrument to manage the government`s liquidity. As mentioned earlier, Zero coupon bonds (bonds/bills that pay no coupon interest and are redeemable at par on maturity) are risk-free assets as they do not have reinvestment risk (National Treasury, 2008:1). A survey done by PriceWaterhouseCoopers Corporate Finance Division in 2000 of 34 South African corporate finance and asset management firms revealed that the R153 and R150 government bills were the most popular bonds used in determining the (long-term) risk-free rate (Cilliers, n.d.:1).

Comparing the SA and the US

The two South African instruments that will form the basis of the analysis in this research is the three month JIBAR for the short end, and the R157 Government Bond maturing in September 2015 for the medium to long term risk-free rate. The following part of the analysis uses only secondary data obtained from I-Net Bridge and BFA McGregor, for the period from 1 January 2001 until 31 August 2011. It was important for the analysis to be done over a period of

ten years. Since there was a recession in the US in 2001, the whole year of 2001 was included until the most recent data that could be gathered.

(1) Comparison of the South African and US Risk-free Instruments

Daily yields for the relevant instruments, for the time period specified above, were gathered from I-Net Bridge. In South Africa and the United States (US) these rates are regarded to be the most free of risk in the short term and medium to long term. Moody`s credit rating agency has rated the US Government as Aaa (which was changed in 2011 by S&P rating agency to AA+) credit quality on their local and foreign borrowing. A Aaa rating is the best/highest rating that can be achieved, and a government with such a rating should be able to repay their debts with ease. The South African Government was given a Baa1 on foreign borrowing and an A2 on local borrowing, also by Moody`s. Thus Moody`s expects the South African Government's risk-free securities to be more risky than their US counterparts. The two short term instruments are the most liquid in each of the countries.

Daily Yields of the 3-Month JIBAR and the 3-Month US Treasury Bills

In Figure 7 and Table 5 it is obvious that the JIBAR yields are much higher (average 9%) than the US Treasury Bills (TB`s) (average 2%), to compensate for the extra perceived risk of the South African economy. The JIBAR ranged from a minimum of 5.53% to 13.6% over the period, whereas the TB`s ranged from -0.01% to 5.67%. The Standard Deviation of the JIBAR is 58 basis points more than that of the US TB`s. Thus, the South African JIBAR deviates more from its mean return and can be considered more risky than the US TB`s, which is consistent with the higher credit rating given by Moody`s. The green line is the spread between the two instruments, which ranges from 2,26% to 12.35%, with the average spread over the period being 7,01%. The spread seems to widen after a recession, as can be seen towards the end of 2001 and 2008. Since 2009 the US Treasury Bills paid a rate of close to zero, to stimulate the economy. The President of the US Federal Reserve said in 2012 that he will keep those rates close to zero until 2013 if necessary. In 2011 global interest rates have been the lowest that they have been in the last ten years, because of policy makers trying to kick-start the economy after the crisis. Figure 8 shows the correlation between the two instruments, with the overall correlation over the period being 0.1, ranging from -0.94 to 0.81. This indicates that there is an extremely small positive relationship between the two instruments. From the graph it can be seen that at times the correlation is close to 1 when they move in tandem and other times when they move in different directions, the correlation is close to -1.

Figure 7. Comparison of Daily 3-Month JIBAR and 3-Month US Treasury Bills Yields

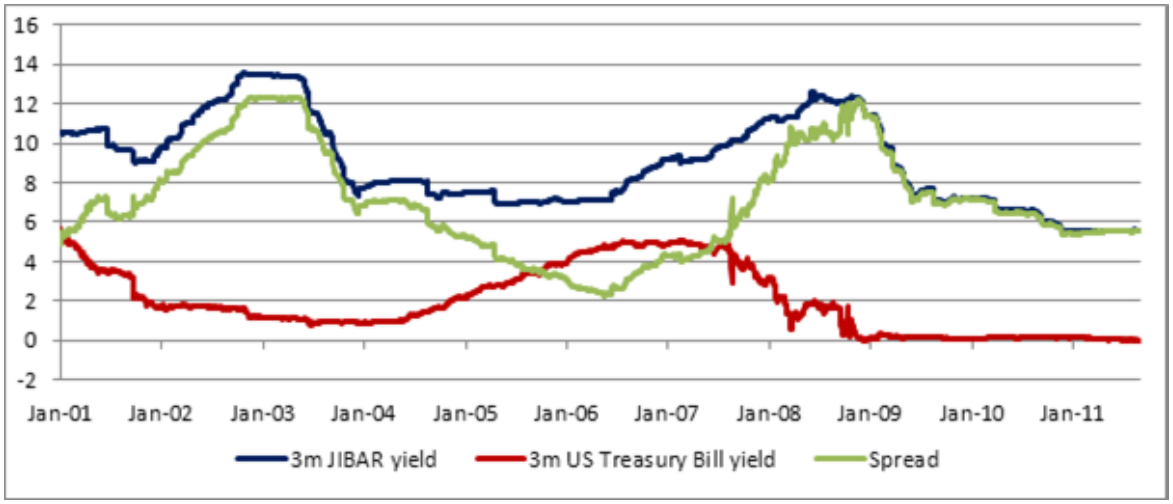


Figure 8. Correlation between 3-month JIBAR and 3-month US Treasury Yields

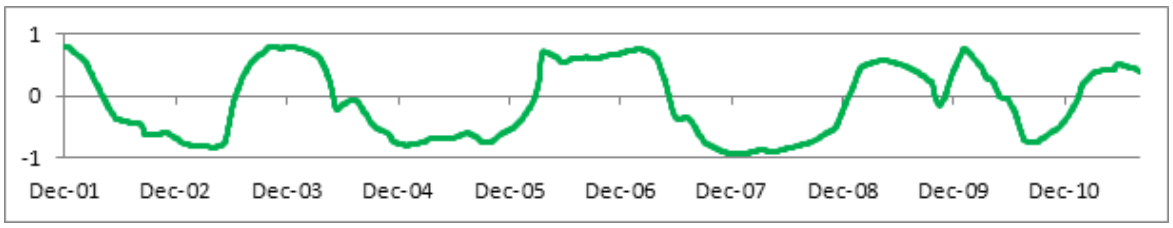


Table 5. 3-month JIBAR compared to the 3-month US Treasury Bills

	3m JIBAR (%)	*3m US Treasury Bill (%)*	*Spread (%)*	*Correlation*
Mean	9.0020	1.9930	7.0090	0.1017
Standard Deviation	2.2698	1.6878	2.6873	-
Minimum	5.5300	-0.0050	2.2630	-0.9408
Maximum	13.5980	5.6700	12.3500	0.8081

(2) Daily yields of the R157 and the 10 Year US Government Bond

Figure 9 shows the difference between the long-term risk-free rates in South Africa and the US rates. The two particular instruments compared here is the South African R157 and the US 10 year Government Bond (USGB). Over the longer term the R157 average yield is 9,02% which is more than double that of the USGB average of 4,1% for the relevant period. The R157 paid a maximum rate of 13.6% in 2001 and a minimum of 6.5% in 2011, compared to the maximum of the USGB of 5.51% and a minimum of 2.02%. The average spread between the two instruments was 4,92% over the period. This is significantly smaller than for the 3-month rates, but still makes sense due to South Africa`s lower credit rating. The correlation between the two instruments for the period can be seen in Figure 10. The average correlation was 0.53 which indicates, on average, some relationship in the same direction. They don't move perfectly in tandem, but as can be seen from the graph, there are extended periods where they do move in the same direction. These longer term rates are more correlated than short-term rates. For the periods following the two recent recessions of 2001 and 2008, the longer term rates tend to move in the same direction, whereas the short term rates tend to move in opposite directions. The yields on both the R157 and USGB instruments decreased significantly over the 10 year period, forming a bearish trend.

Over the entire period, the South African risk-free instruments tended to trade at almost double the yield of the American instruments. The standard deviation of South African risk-free instruments is also roughly double that of their US counterparts (see Table 6). Based on yield volatility, this implies higher risk in case of the South African instruments compared to that of the US instruments. The correlation between the instruments of the two countries increased with maturity (especially since 2008).

Figure 9. Daily Yields of R157 compared to 10yr US Government Bonds

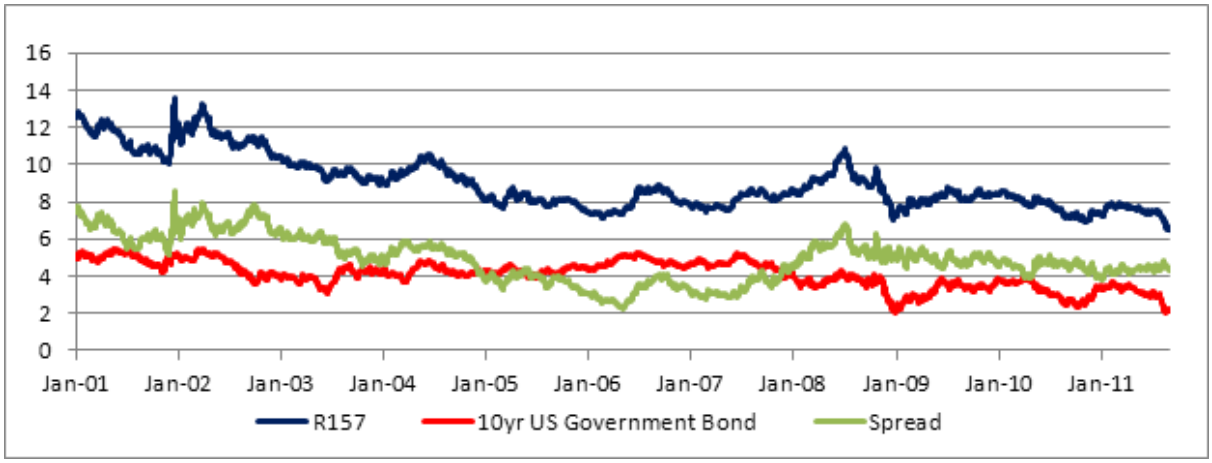


Figure 10. Correlation between R157 and 10yr US Government Bonds

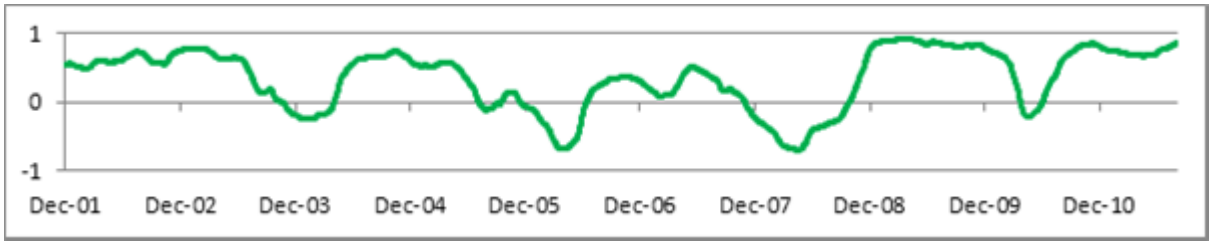


Table 6. R157 compared to 10yr US Government Bonds

	R157	*10yr US Government Bond*	*Spread (%)*	*Correlation*
Mean	9.0217	4.0991	4.9226	0.5284
Standard Deviation	1.4427	0.7294	1.2253	
Minimum	6.5000	2.0200	2.2820	-0.6906
Maximum	13.6000	5.5100	8.5600	0.9118

Risk-free and Risky Instrument Analysis

In the following section the risk of the South African risk-free instruments are compared to the FTSE/JSE All Share Index (ALSI). The ALSI is a market value weighted index of all the stocks of the main board on the Johannesburg Stock Exchange (JSE). The stocks that form part of the index are all perceived to be risky, because the expected return is not known with certainty. Since gold has been seen as a reserve currency and recently increased tremendously in price, it will be included in the risk analysis.

Comparison of Daily Percentage Change

In order to compare the risk of the JIBAR and R157 with the ALSI and the spot price of gold, as a start, the percentage daily change for each of the relevant instruments were calculated. Table 7 shows the specific statistics for all the relevant instruments calculated on the percentage daily change.

Table 7. Percentage Daily Change Statistics over the Research Period

Stats	***3m JIBAR***	***3m US Treasury Bill***	***R157***	***10yr US Government Bond***	***JSE Allshare Index***	***$ Gold Spot***
Mean	-0.0213%	0.8313%	-0.0200%	-0.0132%	0.0567%	0.0757%
Standard Deviation	0.5509%	20.8480%	0.8869%	1.7687%	1.3069%	1.1700%
Minimum	-8.4647%	-150.0000%	-8.0882%	-15.2926%	-7.3005%	-6.9565%
Maximum	5.6505%	600.0000%	13.9645%	11.0193%	7.0729%	10.8792%

The mean return and standard deviation of the two South African risk-free instruments are well below that of the ALSI and the dollar gold spot price. According to the percentage daily change, the South African risk-free instruments are much more stable, than the ALSI and gold, thus far less risky. The USTB had by far the largest mean daily change. It also had a standard deviation of 20,84% over the period, which is almost sixteen times that of the ALSI. Its minimum (150%) and maximum (600%) percentage change is enormous for a risk-free instrument, but even for a risky instrument. The ALSI had a minimum of -7.3% and a maximum of 7.07%. The 10 year USGB has the second largest daily changes, also showing larger percentage daily changes than the perceived risky ALSI.

Figure 11 to 13 is a graphical illustration of the change in daily yields for the different instruments. The only extreme and unexpected result that stands out is the US Treasury Bills with its large deviations from the mean for the period. One would also expect the change in the USGB to be less than the ALSI. The ALSI and Gold were very similar in terms of their standard deviation and mean daily changes. The analysis confirms that the JIBAR and Bond rates are less volatile than the ALSI and the gold spot price. It may also be noted that the JIBAR is substantially more volatile than the USTB except from 2008 onwards. This is due to the effect of the financial crisis.

Figure 11. Change in Daily Yields - 3-m JIBAR & 3-m USTB

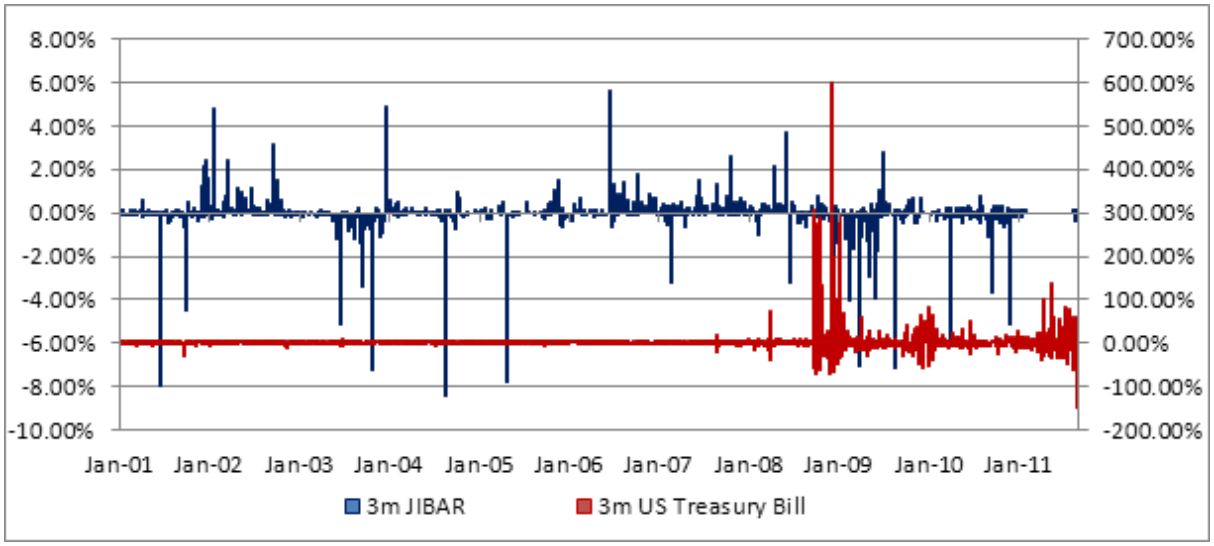


Figure 12. Change in Daily Yields - R157 and USGB

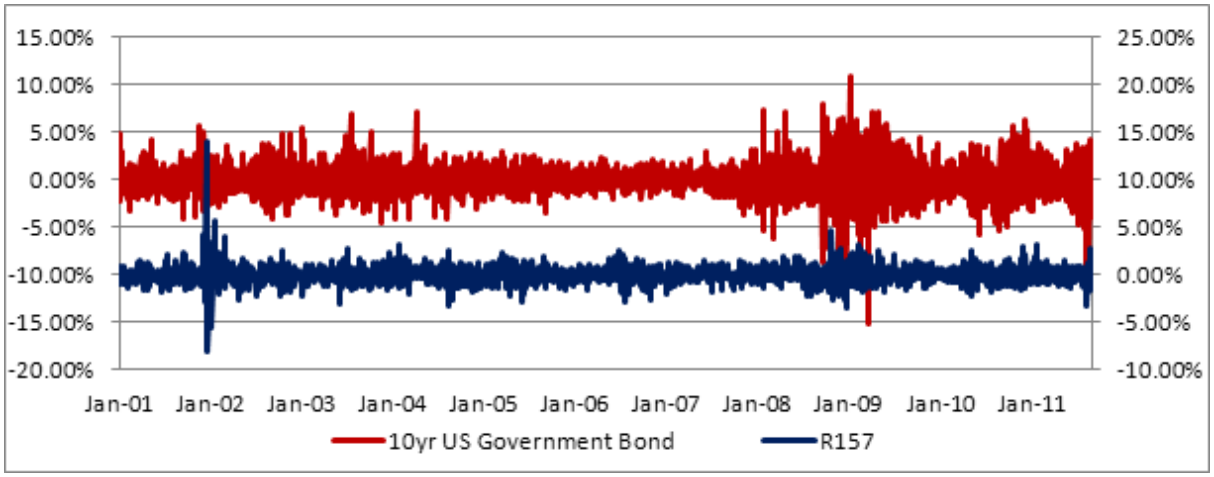
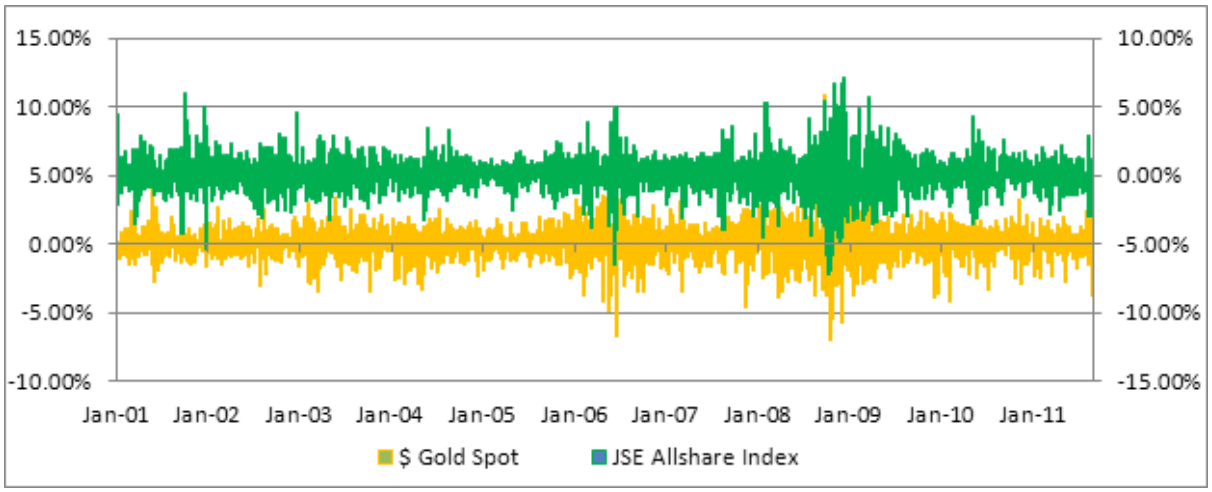


Figure 13. Change in Daily Yields - ALSI and Gold Spot



Standard Deviation of the Daily Percentage Change

Figure 14 is a graphical illustration of the annual moving standard deviation calculated from the percentage daily change for each of the instruments. The 3-month US Treasury Bills had such a large standard deviation calculated on the percentage daily change, that the other lines on the graph are virtually flat. This is unusual for one of the world's most risk-free rates with an Aaa (at that stage) credit rating. It reached a peak of close to 60% just before 2008, and stayed there for close to a year. Figure 15 is based on the same data as Figure 14, but the 3-month Treasury Bill was removed in order to eliminate the dramatic effect it has on the scale values in the graph. Over the last ten years the USTB`s as well as the USGB's showed the biggest percentage daily moves and the biggest standard deviation of the percentage daily changes. It reached an extreme during the 2008 recession, which was to be expected, and worsened again with the European Debt Crises and the US reaching its debt ceiling. Measured against the ALSI and gold spot, the US instruments, both percentage daily moves had higher standard deviations than the SA instruments. The two South African instruments performed well measured against the ALSI and gold. From the analysis is certainly seems as though the JIBAR and R157 rates are less volatile and may be termed "riskless", for the sake of this research at least.

Figure 14. Standard Deviation of the Percentage Daily Change

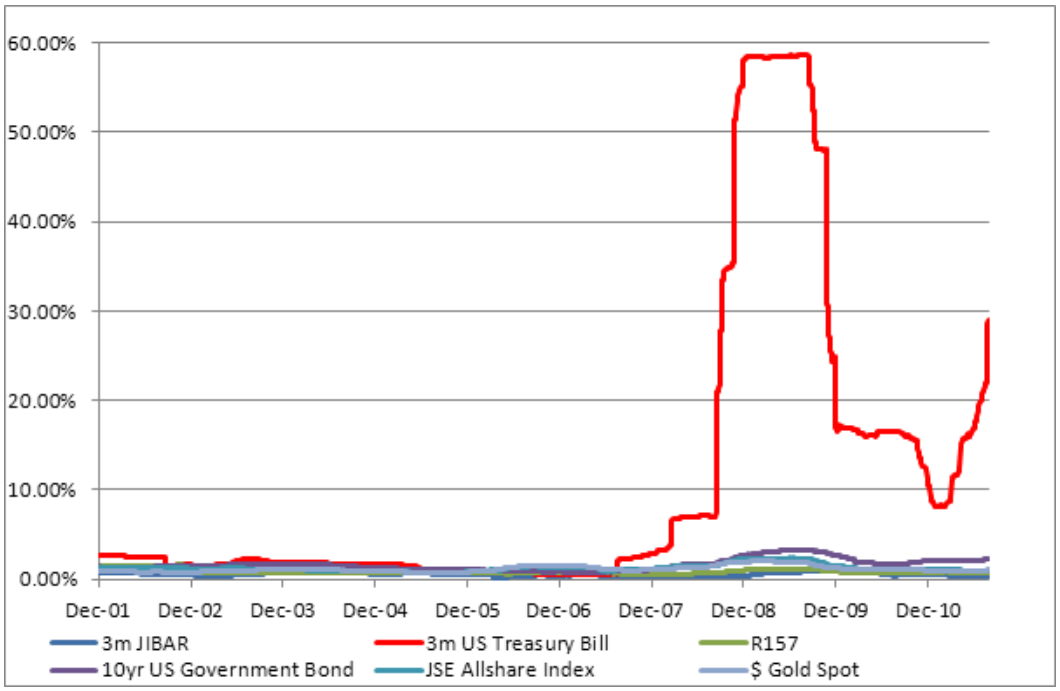
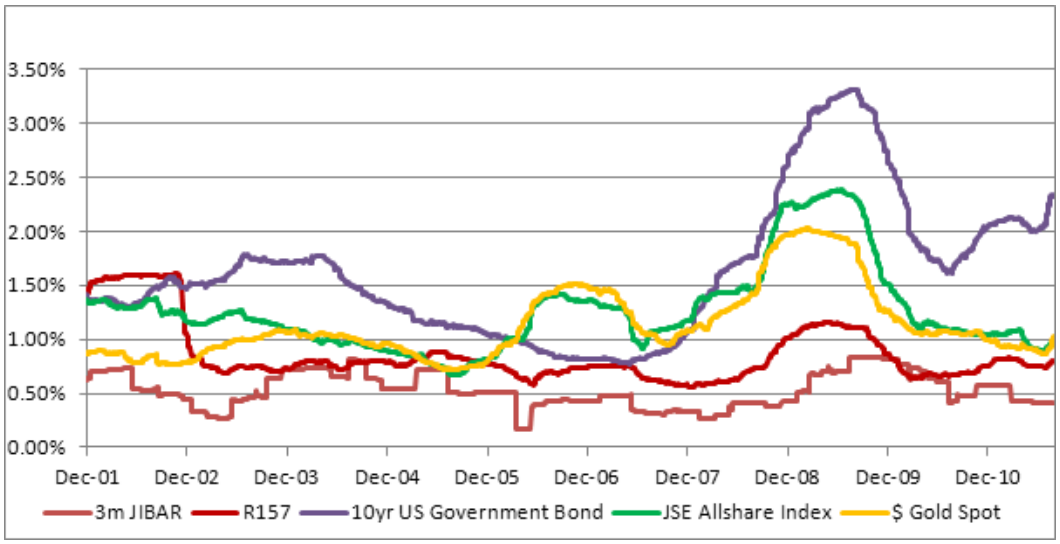


Figure 15. Standard Deviation of the Percentage Daily Change Excluding USTB



Only the R157 had a standard deviation larger than 1% on two occasions during the last ten years. The standard deviation of the JIBAR is the smallest of all the instruments being compared, reaching a maximum of 0.83%. According to the standard deviation of the percentage daily returns the JIBAR had the smallest variation in change followed by the R157. Even during the crisis in 2008 till the present day they remained in their range of change, whereas the US instruments breached their range. These two instruments deviated much less from their mean change than the ALSI and gold. They can therefore be regarded as the most stable instruments/rates available for the instruments compared and in all likeliness, also compared to other instruments in the SA financial markets.

The large percentage daily changes from the two US instruments were unexpected. However, it must be stressed that the extreme percentage daily changes are a result of small changes based on rates that are at a low level - close to zero. For example, if a rate is 0.1% and increases with 20 basis points to 0.3%, this indicates a 200% increase. That said, these changes must be seen within context. They were experienced only after the financial crisis in 2008 (see Figure 14).

Risk Analysis Based on Daily Index Changes

In the following part of the analysis all the instruments are converted to an index value starting with 100. The percentage daily change is then multiplied with the index number of the previous day. By using this method it is possible to plot all the instruments on the same graph, thus giving a more realistic comparative view. It also overcomes the problem of the comparison including extreme movements. The standard deviation of the index values is then calculated for each instrument.

Table 7 displays all the relevant statistics for the instruments being analysed. By using the index values for each instrument, a much more comparable result is obtained. Figure 16 plots the index values for each instrument. The index values for the four rates (JIBAR, USTB, R157, USGB) were calculated using the percentage change in daily yields, where the index values for the ALSI and gold were calculated using the percentage change in their daily closing prices. The four indices for the four rates are plotted on the primary axis and the ALSI and gold are plotted on the secondary axis. Of the two risky instruments, gold had the highest value over the period. There is a clear upward trend in the ALSI and gold and a downward trend in the in the other four rates. The end values on 30 August 2011 is shown in the last row in Table 7. The most extreme index value was the 3-month TB that ended on 0.31.

Table 7. Index value statistics

Stats	***3m JIBAR***	***3m US Treasury Bill***	***R157***	***10yr US Government Bond***	***JSE All Share Index***	***$ Gold Spot***
Mean	85.48	35.13	71.08	83.31	234.19	250.29
Standard Deviation	21.56	29.75	11.36	14.82	104.56	137.23
Range	76.61	100.09	55.95	70.93	320.38	610.85
Minimum	52.51	-0.09	51.22	41.06	88.45	95.05
Maximum	129.12	100.00	107.17	111.99	408.83	705.91
End Value (8/30/2011)	52.94	0.31	51.38	44.72	381.43	679.08

Figure 16. Index values

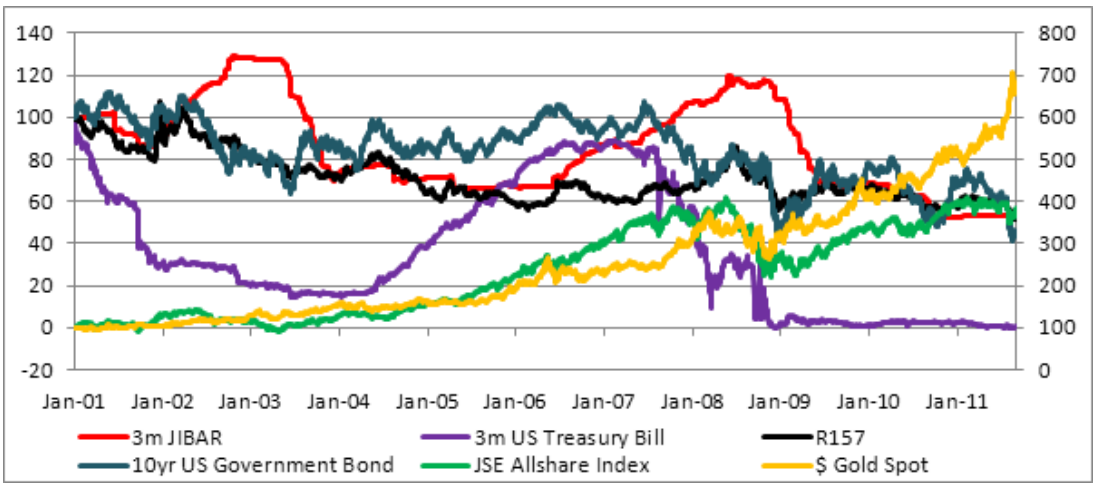


Figure 17 plots the standard deviation of each instrument calculated from the index values. From Table 7 and Figure 17 it is clear that all four of the risk free rates has significantly smaller standard deviations and smaller ranges than the two risky assets (ALSI and gold). Gold had the highest standard deviation of all the instruments over the period, which is consistent with its high return. The two longer term rates (R157 and USGB) has standard deviations and range that are almost half that of the two short term rates (JIBAR and USTB). On the short end of the yield curve the JIBAR has a tighter range and standard deviation than the USTB. Since December 2009 the USTB has been close to 0%, with minimum volatility over the period till present day. At the Medium to long end of the yield curve the R157 also has a tighter range and standard deviation than the 10 year USGB.

Figure 17. Standard deviation of Indices

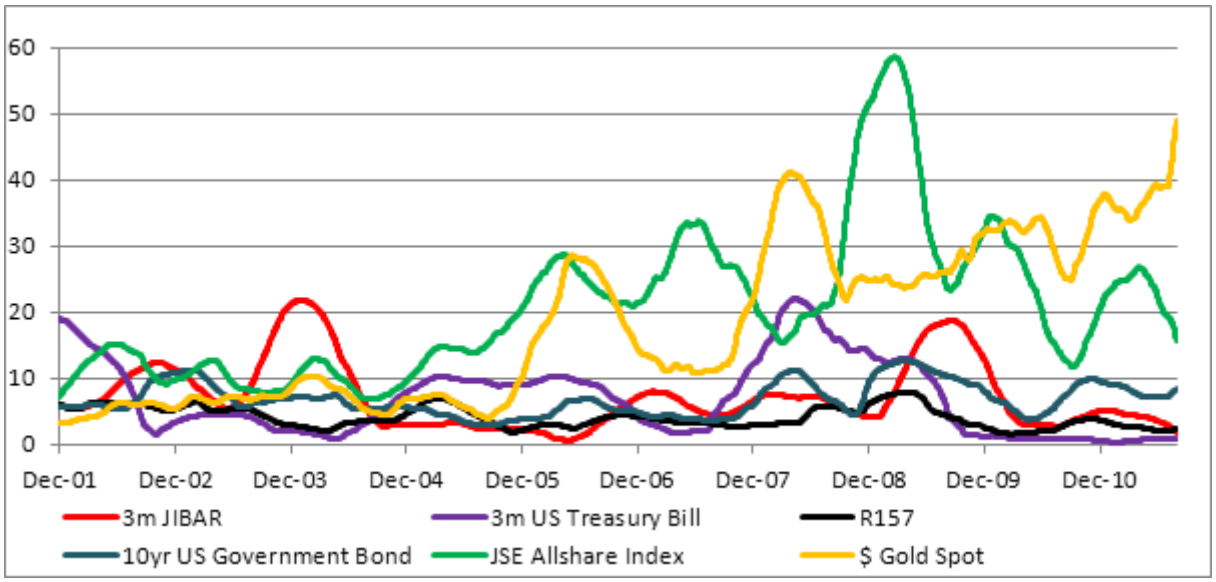
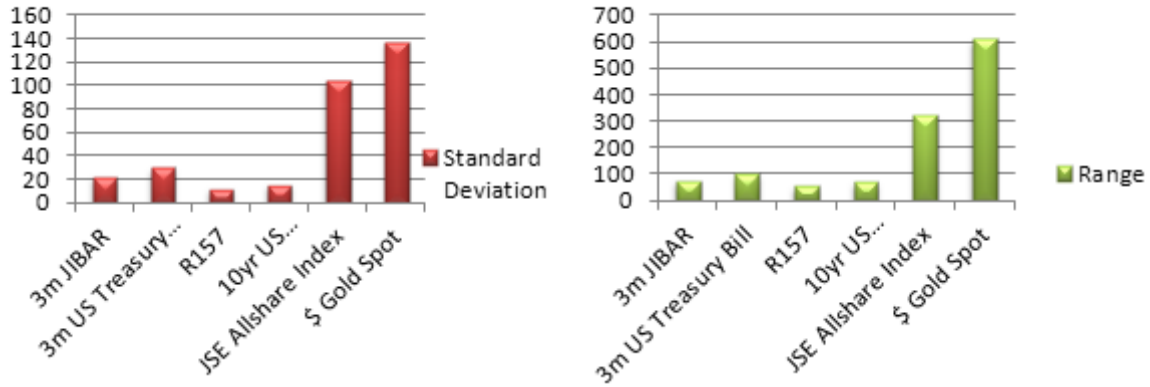


Figure 18. Standard deviation and the range of change of different instruments



According to the standard deviation over the last ten years, it can be concluded that the two South African risk-free rates are less risky than that of the US. The two South African risk-free rates are also significantly less risky than the ALSI and gold spot. The return on the R157 was more stable and had a smaller standard deviation than the JIBAR over the research period. From this analysis it may be concluded that these two instruments are "risk-free".

Correlation analysis

The correlation of the risk-free rates and the risky assets is now considered. The second condition for a risk-free rate is that it should not correlate with a risky asset in any way. Here the actual daily yields for the JIBAR and the R157 and the actual daily closing prices for the ALSI and gold spot is used to calculate the correlations.

The correlation coefficients between the relevant instruments are shown in Table 8, calculated over the full time period of the analysis. The

correlation of the JIBAR and the ALSI for the period is -0.355, which indicates a small negative correlation. The correlation between the R157 and the ALSI was -0.675, which is a relatively strong negative correlation. Over the period the JIBAR was the least correlated to the ALSI. This makes sense as the JIBAR is a money market rate which should reflect mostly short term money market movement but also liquidity problems which may occur.

Table 8. Correlation coefficients

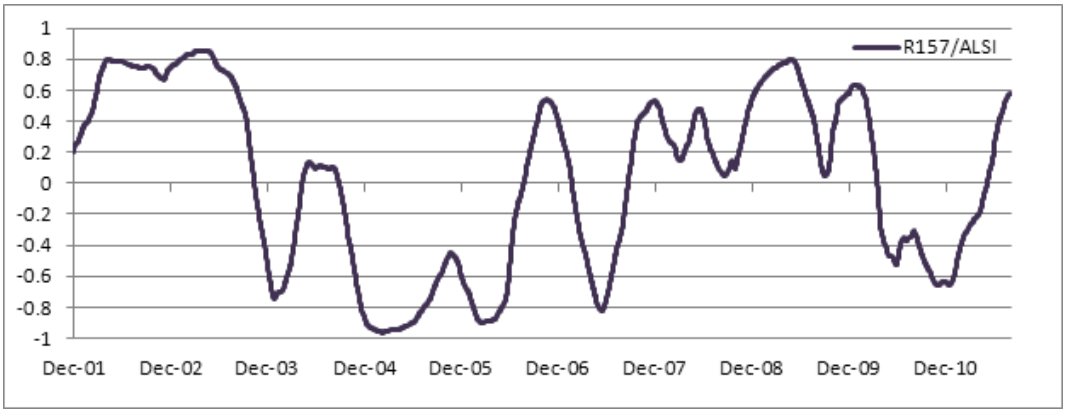
	3-month JIBAR	*R157 bond rate*	*JSE All Share Index*
3-m JIBAR	1.000		
R157	0.610	1.000	
JSE All Share Index (ALSI)	-0.355	-0.675	1.000
$ Gold Spot	-0.492	-0.658	0.876

Figure 19 is the annual running correlation between the JIBAR and ALSI. The average annual running correlation was -0.163, and much smaller than the correlation calculated for the whole 10 years as in Table 8. Considering the small average correlation coefficient, the JIBAR may be considered "risk-free" in this context.

Figure 19. Correlation between the JIBAR and ALSI

Figure 20 is the annual running correlation between the R157 and the ALSI. The average annual running correlation was 0.0315. This is an extremely small positive correlation that is closer to zero than that of the JIBAR with the ALSI. Also this makes sense as the R157 rate is considered a proxy rate for long term investment financial assets. The R157 is the cost of borrowing from the government and should therefore be free of risk. However, the risk of reinvestment of coupons (reinvestment risk) is not removed as in the case of zero-coupon bonds. From this perspective, although they are low risk instruments, they are certainly not the lowest risk instruments.

Figure 20. Correlation between the R157 and ALSI



From the comparison above it is clear that Both the South African risk-free rates yielded much higher than the US rates with matching maturities over the period. The average spread decreased with maturity of the instruments. The correlation between the yields of the relevant instruments increased with maturity. At the short end of the yield curve there was a slight positive correlation, and towards the long end the positive correlation increased.

The USTB clearly had the largest percentage daily changes over the period, followed by the 10 year USGB. The JIBAR had the smallest percentage daily change, followed by the R157. The ALSI and gold had much larger percentage daily changes than the two South Africa risk-free instruments, however, smaller than the two US instruments. The large percentage changes in the US instruments are due to the extremely low basis. A small change in their rates would represent a large percentage change.

Converting the rates to indices helped achieve better comparisons. The JIBAR had a smaller standard deviation than the USTB, and the standard deviation of the R157 was smaller than the USGB. The R157 had the lowest standard deviation of all the instruments. The two SA risk-free instruments had a significantly smaller standard deviation than the two SA risky assets. They may therefore be labelled "risk-free" in this context.

The correlation of returns between the JIBAR and the ALSI was slightly negative, but close enough to zero to say there is not any significant relationship between their behaviours. The correlation of the R157 and the JIBAR was closer to zero than that of the ALSI and the JIBAR. According to the correlation both the instruments are free of risk, with the R157 rate again being the most stable.

Conclusion

The risk-free rate concept rests on an extremely bold assumption, but it is one that modern finance cannot do without. The risk-free rate is the starting point for all expected return models. There can be no reinvestment risk and default risk on an asset that is considered risk-free. By applying these criteria, the only securities that can be considered more risk-free are zero coupon government securities as the re-investment risk is excluded (stripped out).

Risk-free rates are used in the pricing and valuation of all investable assets. The global financial derivatives market has exploded in recent years, reaching $1.15 quadrillion in 2008. The same kind of explosion happened in South Africa. All the other inputs in the pricing formulas of derivatives have been extensively researched, while the risk-free rate has always been seen as a given.

Governments are deemed the least prone to default, at least on local debt, because they control the printing of money. However, governments still have some degree of default risk. It was pointed out before that a number of governments have defaulted in the past. It recently became clear the even large economies were not as free of risk as was always believed by financial markets.

From this research it is clear that the definition of risk may need renewed attention, especially after the recent financial crisis. What the scope of risk is and what the scope of risk may be, should receive more attention. Risk-free is not truly risk-free. There is no entity that is truly default free. Even large governments and large banks were affected negatively by financial turmoil. The change in the financial environment and how instruments are priced are all affected by the structure of financial markets and the participants. People's perception about risk has a lot to do with how it affects financial markets. If people engage in more risk than is justified or may be deemed reasonable, the boundaries of risk-free are moved and the meaning of risk-free is changed.

References

1. Adelegan, O.J. 2009. *The Derivatives Market in South Africa: Lessons for sub-Saharan African Countries*. [Online]. Available: http://www.imf.org/external/pubs/ft/wp/2009/wp09196.pdf. [2011, 28 March].
2. Bergman, Y., 1995. Option pricing with differential interest rates. *Review of Financial Studies*, 8:475–500.
3. Bryan, D. 2009. Globalisation And The World Financial Markets. *Ecodate*, 23(1):6-8.
4. Bjork, T., 1998. *Arbitrage Theory in Continuous Time*. Oxford : Oxford.
5. Cilliers, A.J. *Investing in the JSE- How Much Return for How Much Risk?*. Sharenet. [Online]. Available: file:///H:/thesis/research/SA/Sharenetp1.htm. [2011, 3 April].
6. Characterising Risk. 2006. *Bank Investment Consultant*, March, Vol. 14, p36-37.
7. CollegeBoard. 2007. *Zero Coupon Treasuries (also known as Strips, TIGRS, and CATS)*. [Online]. Available: http://www.collegeboard.com/prod_downloads/highered/res/cc_tips/ZeroCoup05.pdf. [2011, 1 April].
8. Damodaran, A. 2002. *Investment Valuation: Tools and Techniques for Determining the Value of Any Asset*. 2nd edition. Wiley.
9. Damodaran, A. 2008. *What is the riskfree rate? A Search for the Basic Building Block*. [Online]. Available: http://pages.stern.nyu.edu/~adamodar/. [2011, 22 February].
10. Damodaran, A. 2010. *Into the Abyss: What if nothing is risk free?*. [Online]. Available: http://pages.stern.nyu.edu/~adamodar/. 2010, 20 March].
11. "Discounted cash flow". (2006). In *Collins Dictionary of Economics*. Retrieved from http://www.credoreference.com.ez.sun.ac.za/entry/collinsecon/discounted_cash_flow. [2011, 26 March].
12. Edirisinghe, C., Naik, V., Uppal, R., 1993. Optimal replication of options with transaction costs and trading restrictions. *Journal of Financial and Quantitative Analysis*, 28:117–138.

13. Fidelity. 2011. *US Treasury Bonds*. [Online]. Avaliable: https://www.fidelity.com/bonds/us-treasury-bonds. [2011, 9 May].
14. Garman, M.B., Ohlson, J.A., 1981. Valuation of risky assets in arbitrage free economies with transaction costs. *Journal of Financial Economics*, 9:271–280.
15. IMF Country Report No. 08/349. 2008. *South Africa: Financial System Stability Assessment, Including Report on the Observance of Standards and Codes on the following topic: Securities Regulation.* [Online]. Available: http://www.imf.org/external/pubs/ft/scr/2008/cr08349.pdf. [2011, 2 April].
16. Johannesburg Stock Exchange. 2010. *Jibar Futures Trading Strategies*. [Online].
17. Johannesburg Stock Exchange. 2009. *The new South-African Volatility Index* [Online]. Available: http://www.jse.co.za/Libraries/SAFEX_ED_-_Products_-_South_African_volatility_Indices_SAVI/New_SAVI.sflb.ashx. [2009, 8 December] Available: http://www.jse.co.za/Products/Interest-Rate-Market/Jibar-Futures_Trading_Strategies.aspx. [2011, 1 April].
18. Jouini, E., Kallal, H., 1995a. Martingales and arbitrage in securities markets with transaction costs. *Journal of Economic Theory*, 66:178–197.
19. Jouini, E., Kallal, H., 1995b. Arbitrage in securities markets with short-sales constraints. *Mathematical Finance*, 5:197–232.
20. Kallio, M & Ziemba, W.T. 2007. Using Tucker's theorem of the alternative to simplify, review and expand discrete arbitrage theory. *Journal of Banking & Finance*. 31:2281-2302.
21. Karatzas, I., 1996. Lectures on the Mathematics of Finance. American Mathematical Society, Providence.
22. Karatzas, I., Kou, S.G., 1996. On the pricing of contingent claims under constraints. *The Annals of Applied Probability*, 6:321–369.
23. Lambrechts (Ed.). 2010. The investment Decision. Adapted from Financial Management. SUN Media. Stellenbosch.
24. Luenberger, D.G., 1998. *Investment Science*. Oxford : New York.
25. Magill, M., Constantinides, G., 1976. Portfolio selection with transaction costs. *Journal of Economic Theory*, 13:264–271.
26. Merton, R., 1973. Theory of rational option pricing. *Bell Journal of Economics and Management Science*, 4:141–183.
27. Merton, R., 1992. *Continuous Time Finance*, 2nd ed. Basil Blackwell, Oxford and Cambridge.
28. Mukherji, S. 2011. The Capital Asset Pricing Model`s Risk-free Rate. *The International Journal of Business and Finance Research*, 5(2):75-83.
29. Murphy, E. 2011. *Global Derivatives Market now valued at $1.14 Quadrillion!* [Online]. JUTIA GROUP. Available: file:///H:/thesis/research/derivatives%20market/Global%20Derivatives%20Market%20now%20valued%20at%20$1.14%20Quadrillion!.htm. [2011, 24 March].
30. National Treasury. 2010. *Asset and Liability Management - National Treasury*. [Online]. Available: http://www.treasury.gov.za/documents/national%20budget/2010/review/chapter6.pdf. [2011, 28 March].
31. National Treasury. 2008. Treasury Bill Information Memorandum. [Online]. Available: http://www.treasury.gov.za/divisions/alm/Treasury%20Bills%20Information%20Memorandum.pdf. [2011, 1 April].
32. National Treasury. *What are RSA Bonds*. [Online]. Available: http://www.treasury.gov.za/divisions/alm/2004/What%20are%20RSA%20Bonds.pdf. [2011, 2 April].
33. W.T. (Eds.), Finance, Handbooks in Operations research and management Science, 9:31–64.
34. Pliska, S.R., 1997. *Introduction to Mathematical Finance: Discrete Time Models*. Blackwell Publishers, Oxford.
35. *The Oxford Advanced Learners Dictionary*. 2006. 7th edition. New York: Oxford Univ. Press.
36. "Variance". *Investopedia*. [Online]. Available: http://www.investopedia.com/terms/v/variance.asp. [2011, 18 May].
37. "Risk." *International Encyclopedia of the Social Sciences*. Ed. William A. Darity, Jr. 2nd ed. Vol. 7. Detroit: Macmillan Reference USA, 2008. 251-253. *Gale Virtual Reference Library*. Web. 4 Apr. 2011.
38. Standard & Poor`s. 2011. *United States of America Long-Term Rating Lowered To 'AA+' Due To Political Risks, Rising Debt Burden; Outlook Negative.* [Online]. Available: http://www.standardandpoors.com/ratings/articles/en/us/?assetID=1245316529563. [2011, September 2].
39. Strutzenegger, F & Zettelmeyer, J. 2006. Sovereign Defaults and Debt Restructurings: Historical Overview. *Debt Default and Lessons from a Decade of Crises*. Massachusetts Institute of Technology. 3-30.
40. Reinhardt, C.; Rogoff, K.; and Savastano, M. (2003). Debt Intolerance. *Brookings Papers on Economic Activity*, 1:1–74