FMS

UNIVERSITY OF KWAZULU-NATAL

SCHOOL OF ECONOMICS & FINANCE

WORKING PAPERS IN FINANCE

A Theoretical And Empirical Analysis Of The Suitability Of South African Risk-Free Rate Proxies.

Barry Strydom*
And
Ailie Charteris

Working Paper No. 02-2009

* Corresponding author: Barry Strydom
School of Economics & Finance
University of KwaZulu-Natal
strydomb@ukzn.zc.za
Tel. (+27)33-2605794 Fax. (+27)33-2606051

A Theoretical And Empirical Analysis Of The Suitability Of South African Risk-Free Rate Proxies.

Barry Strydom[1] and & Ailie Charteris[2]

July 2009

Abstract

This study examines the theoretical requirements for a suitable risk-free rate proxy to use as a parameter in the Capital Asset Pricing Model (CAPM). Short-term Treasury bills and long-term Treasury bonds are identified to be the most popular proxies employed. We find that whilst neither of these securities in South Africa fully conforms to the theoretical requirements for the correct specification of a risk-free asset; the Treasury bill rate, in particular, is found to be subject to excessive volatility and to contain a significant volatility premium. We conclude that longer-term government bonds, matching the relevant investment horizon, are preferable as a proxy for the risk-free rate.

Keywords: Capital Asset Pricing Model; Risk-Free Rate; Risk-Free Proxy; Risk Premium, Treasury Bill, Treasury Bond.

JEL Codes: G11, G12, G31, E22, E43.

[1] Barry Strydom is Senior Lecturer in the School of Economics & Finance, University of Kwazulu-Natal, South Africa.

[2] Ailie Chateris is a post-graduate student in the School of Economics & Finance, University of Kwazulu-Natal, South Africa. This paper is based on work done as part of her Masters degree in Finance.

We would like to thank Andrew Christison for his invaluable comments and advice.

1. INTRODUCTION

The use of the Capital Asset Pricing Model (CAPM) in South Africa to estimate the cost of equity has increased considerably in recent years. Correia and Cramer (2008) established that 71 percent of firms surveyed used the model or a derivation thereof compared to the results of Pocock *et al* (1991), in which only 35 percent of the respondents employed the CAPM. This greater reliance of South African firms on the model for determining the cost of equity mirrors the changing practices observed in the United States of America (U.S.). Graham and Harvey (2001) found that 74 percent of respondents in the U.S. utilised the CAPM, in contrast to only 30 percent identified in the survey of Gitman and Mercurio (1982). The model has thus grown in popularity in the last two decades despite a substantial body of evidence (such as Fama and French, 1992; Fama and French, 2004) disputing its validity.

The CAPM parameters (beta, the risk-free rate and the return on the market) are all theoretical constructs that are not easily observable in the market, and consequently proxies are used for these variables in practice (Firer, 1993: 25). The accuracy of the CAPM in determining the cost of equity is therefore, at least partly, a function of the proxies employed. As Correia and Uliana (2004: 66) explained, it is the difficulty in selecting these surrogates that has hampered the implementation of the model.

Almost no explicit research has been conducted on the most suitable proxy to estimate the risk-free rate in South Africa. Firer (1993: 37), in concluding his discussion on the matter stated "…at this point it should be clear that the issue of estimating the risk-free rate … is by no means resolved, and CAPM users have not been given any firm and theoretically sound guidelines on which to base their estimates". This study thus seeks to address this gap in the literature by formulating a set of theoretical requirements that an asset must closely satisfy to be considered a suitable proxy for the risk-free rate. The most commonly used South African surrogates are then compared to these requirements to assess their appropriateness.

2. LITERATURE REVIEW

2.1. The Choice of Proxy

Most U.S. undergraduate finance textbooks advocate government securities as the most suitable proxies for the risk-free rate (see for example Harrington, 1987; Brigham and Ehrhardt, 2005; Reilly and Brown, 2006). These instruments have been utilised for this purpose in research for the past forty years (Black *et al*, 1972; Fama and French, 2004), and a study of corporate practices in the U.S. by Bruner *et al* (1998: 16) revealed that this method of estimating the risk-free rate is as prevalent in industry, as 85 percent of corporations and 90 percent of financial advisors surveyed used the yields on government securities as a proxy for the risk-free rate.

The difficulty with regards to the estimation of this parameter is the choice of the appropriate maturity of the instrument. Three month T-Bills have been favoured historically (Harrington, 1987: 149), but T-Bonds have become increasingly popular as evinced in the findings of the Bruner *et al* (1998: 19) survey, in which almost all of the corporations and financial advisors surveyed (77 percent and 80 percent respectively) favoured the use of securities with maturities greater than three years for the risk-free proxy.

T-Bonds usually have a higher yield than T-Bills to compensate investors for the inconvenience of being without their funds for a longer period of time. Thus the growing practice of employing these securities undoubtedly represents an attempt to reconcile theory with practice, as several empirical studies have indicated that the minimum return required by investors often exceeds the T-Bill yield (Black *et al*, 1972; Fama and MacBeth, 1973; Fama and French, 2004). However, a review of U.S. research revealed almost no evidence of longer-term securities being applied and, several texts continue to advocate T-Bills as the most suitable proxy (Reilly and Brown, 2006). It is therefore apparent that academics and practitioners in the U.S. appear to concur that a government security is the appropriate proxy to use, but that there is no agreement as to whether or not this proxy should be a short- or long-term government security.

Similar practices to the U.S. for the estimation of the risk-free rate have generally been observed in South Africa. Firer (1993: 29) conducted a review of research papers published in South Africa that required the estimation of the risk-free rate as part of the methodology. The articles examined all employed a proxy as the means to estimate this rate (Firer, 1993: 29). Affleck-Graves *et al* (1988), and Page and Palmer (1991) both estimated the rate as the three month T-Bill yield; whilst De Villiers *et al* (1988) used the one year equivalent (Firer, 1993: 29). In contrast, Bradfield *et al* (1988) employed the twelve month fixed deposit yield (Firer, 1993: 29).

In order to ascertain how practices have evolved in South Africa, a similar examination of published research was conducted over the period 2001 to 2008. Friis and Smit (2004), and Samouilhan (2007) chose simply to estimate the risk-free rate in their respective studies as the three month T-Bill yield. de Wet (2005), Moolman and du Toit (2005), de Wet (2006), de Wet and Hall (2006), and de Wet and du Toit (2007) all utilised the yield on government bonds. None of these authors provided any justification for their decision, but notably, shorter-term government bonds, such as the R150 and R153 (maturities of less than five years) were favoured in all of these studies except that of Moolman and du Toit (2005), who employed the R157 bond.

Several of the studies examined questioned the validity of government securities as proxies for the risk-free rate in the South African market, and consequently chose to estimate the parameter using short-term private sector securities which they deemed to be more appropriate. Graham and Uliana (2001), Cloete *et al* (2002), Oldham and Kroeger (2005), and Msweli-Mbanga and Mkhize (2007) employed the rate on Bankers' Acceptances (BAs), which are perceived to be the safest private sector short-term instrument. The other private sector security that has become increasingly popular is the three month Negotiable Certificate of Deposit (NCD), as this was used by Akonjolirie and Smit (2003), Correia and Uliana (2004) and Viviers *et al* (2008).

Corporations and financial advisors in South Africa, however, have not mirrored the evolving practices in research of using private sector securities rather than government instruments to estimate the risk-free rate. Correia and Cramer (2008: 42) found that the majority (55 percent) of those surveyed employed the R153 government bond yield, with 15 percent using the R157 bond. The other practitioners used the R186, R196, R201, or the All Bond Index (Correia and Cramer, 2008: 42).

It is certainly apparent that there is little or no clarity in South Africa as to the appropriate proxy to use for the risk-free rate in the CAPM and yet the choice can have a material impact on the cost of equity estimate. Therefore, to best assess which security provides the most suitable proxy for this parameter, a set of requirements that an asset must satisfy so that the risk-free rate is correctly specified are formulated.

2.2. Theoretical Criteria for the Correct Specification of the Risk-Free Rate

By definition a riskless asset should be devoid of risk. However, given the wide range of risks securities are exposed to, this requirement has a number of implications.

2.2.1 A Pure Interest Rate

The first requirement that Sharpe (1964: 431) identified for a security to be classified as a risk-free instrument was that the return on the security must be equal to the pure interest rate. Reilly and Brown (2006: 15) confirm this, suggesting that the real return should only depend on the time preference of individuals for the consumption of income and the investment opportunities available in the economy. This implies that the return earned should not be influenced by external factors, such as government policies or economic events (Harrington, 1987: 153).

2.2.2 Inflation Risk

Investors require a return which includes an inflation premium to provide compensation for the expected change in price levels over the investment horizon (Harrington, 1987: 40, 155; Reilly and Brown, 2006: 21). A risk-free asset should thus provide a yield greater than the real minimum return to compensate the holder for inflation (Firer, 1993: 28); that is, the return should comprise the pure interest rate plus a premium for inflation. However, a risk-free security must still satisfy the criterion that it is free of inflation risk, which arises when actual inflation differs from expectations and the premium included in the yield on the security does not accurately reflect the observed price level changes during the period of the investment (Blake, 2000: 86). Consequently, for an asset to be free of this risk, the expectations of inflation and the actual inflation level must be consistent.

2.2.3 Variance in Returns

For an asset to be risk-free in an uncertain environment the variance must equal zero for the duration of the investment, implying that the actual returns earned over the period are always equal to the expected return (Sharpe, 1964: 431).

2.2.4 Interest Rate Risk

Interest rate risk comprises both reinvestment and price risk (Reilly and Brown, 2006: 775), which are a function of volatility in interest rates. The yield on the risk-free rate proxy should not include compensation for the risk of interest rates fluctuating unfavourably during the life of the security. However, if the returns of the proxy instrument vary significantly over time, then the possibility exists that the return may include a premium for interest rate risk.

2.2.5 Covariance with the Market

A riskless asset, whose returns are always equal to the expected return, will have zero variation around its mean and thus it cannot be related to the movement of a risky asset's returns around its mean value (Reilly and Brown, 2006: 232). Hence the covariance of a risk-free security with any risky instrument, including the market portfolio consisting of all risky assets, must be zero (Sharpe, 1964: 431).

2.2.6 Default Risk

The security employed as the proxy for the risk-free rate must be devoid of default risk meaning that there is no possibility that the issuer of the security will default on the repayment of the investment to the holder (Damodaran, 2001: 3). Government securities are therefore identified as suitable proxies as a government can, under most circumstances, print money or raise taxes to avoid default on its commitments (Damodaran, 2001: 4; Reilly and Brown, 2006: 19).

2.2.7 Liquidity Risk

Liquidity refers to the ease with which an asset can be sold without a significant reduction in value; liquidity risk thus arises from the difficulty in selling an asset in the secondary market with respect to both the time taken to sell the security and the price to be received (Reilly and Brown, 2006: 22). The risk-free rate in the CAPM should only provide investors with compensation for the temporary illiquidity of being without their funds for a single investment horizon (Firer, 1993: 28), and thus as a consequence of the fact that a risk-free asset must not exhibit any liquidity risk, no liquidity premium should be included in the yield.

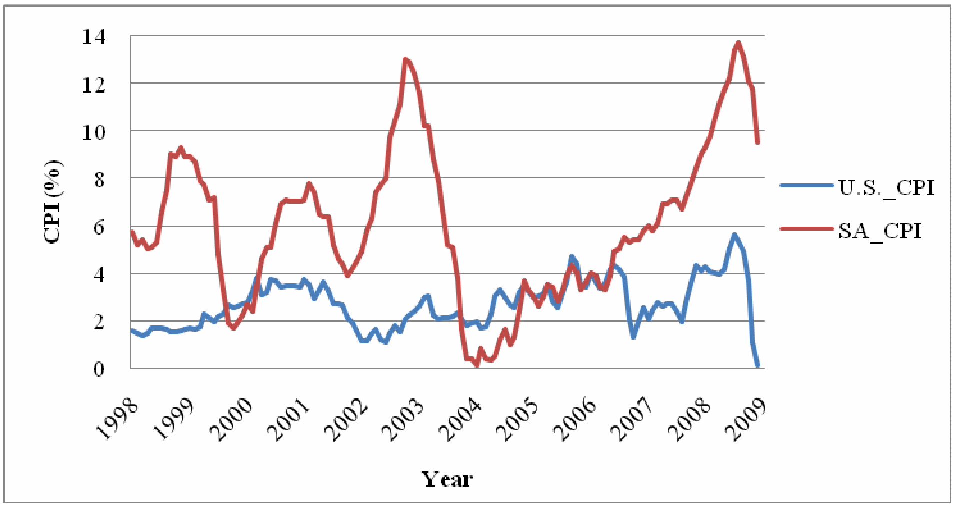
In order for a proxy to correctly specify the riskless rate in the CAPM, it must closely satisfy all of these conditions. Given the academic support for using government securities as the risk-free rate proxy, together with their extensive use in practise, this study will limit itself to examining the extent to which South African short- and long-term government securities (T-Bills and T-Bonds) conform to these requirements.

3. SOUTH AFRICAN PROXIES: ANALYSIS AND EVIDENCE

3.1 Inflation Risk

A comparison of the Consumer Price Index (CPI) for South Africa and the U.S. was conducted for the period 1998 to 2008 based on monthly data from the South African Reserve Bank (SARB) and Econstats. Figure 1 shows a graphical comparison of the two series, which suggests that inflation in South Africa exhibits greater volatility than in the U.S. Consequently, an F-test of the equality of the variances of the two series was performed (see Keller and Warrack, 2000:429). The test statistic obtained of 10.21 was considerably larger than the critical values based on 132 degrees of freedom (1.33, 1.41, and 1.57 at the ten, five and one percent significance levels respectively for a two-tailed test). It therefore follows that whilst inflation risk for U.S. securities is likely to be relatively low; South African securities are exposed to greater inflation risk, thereby reducing their suitability to act as a risk-free rate proxy.

Figure 1: U.S. and South African Consumer Price Index 1998-2008



In addition to this, it is also necessary to compare the inflation risk of longer-term T-Bonds and short-term T-Bills. In this regard, there is *no* debate in the literature that T-Bills minimise the impact of changes in price levels (Harrington, 1987: 156-157; Blake, 2000: 86; Reilly and Brown, 2006: 19; Pike and Neale, 2005: 250), as it is considerably harder for investors to anticipate long-term inflation movements with any accuracy and hence determine its likely impact on returns (Harrington, 1987: 155). Consequently, yields on T-Bonds include a greater inflation risk premium to compensate investors for the possibility that the promised return may be eroded by unexpected changes in purchasing power (Pike and Neale, 2006: 250).

3.2 Variance in Returns

To assess whether T-Bills or T-Bonds in South Africa and the U.S. adhere to the requirement of zero variation over the investment horizon, an analysis of historical fluctuations in the returns of these instruments was performed. Daily South Africa yield data was collected from the SARB for the three-month T-Bill and the R157 government bond. U.S. three-month T-Bill and 10-year T-Bond yields were obtained from the Federal Reserve for the period January 1996 to December 2008. The compounded returns on all four securities were computed as the difference in the natural log of the price of the assets across each day. The variance of the returns of each instrument was computed; the results of which are depicted in Table 1.

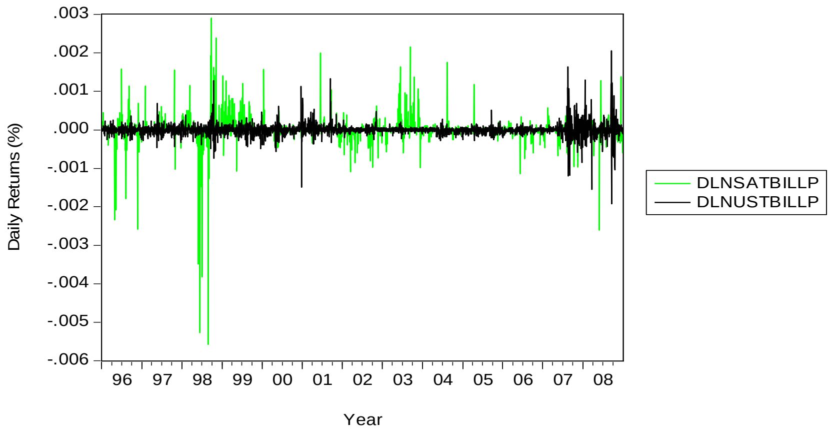
Table 1: Variance Analysis for U.S. and South African Risk-Free Proxies

	SA T-Bills	SA T-Bonds	U.S. T-Bills	U.S. T-Bonds
Variance (%^{2})	0.00069	0.587	0.00025	0.003
X^2 Statistic	2344*	1991449*	863	10870*

* Significant at the 1 percent level.

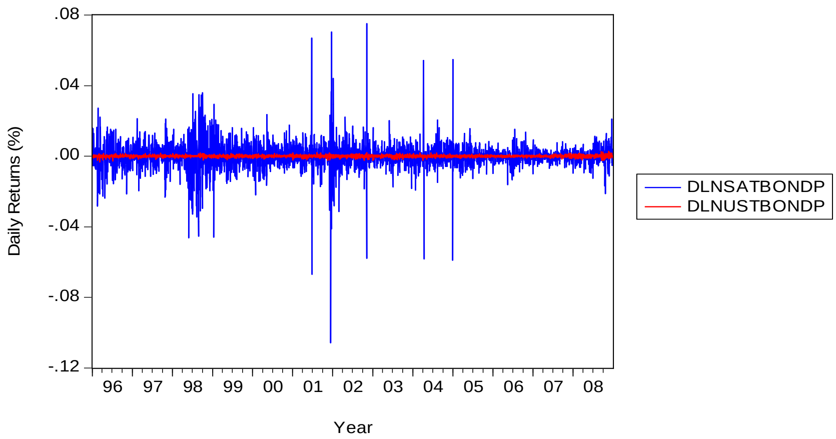
In order to accurately assess these values, a one-tailed chi-squared (X^2**)** test (see Keller and Warrack, 2000: 370-372) was performed to test whether the variance estimates were statistically significantly different from zero (a value of 0.001 was used as the hypothesised variance population value, σ^2. The test statistics, which are also shown in Table 1, indicate substantial disparity between the U.S. and South African securities. The greater volatility exhibited by the South African short-term security is confirmed graphically, as shown Figure 2, which depicts the stationary returns from the two instruments. U.S. T-Bills thus satisfy the condition of zero variance and can be applied as the proxy for the risk-free rate in the CAPM without introducing significant risk caused by variability in interest rates. South African T-Bills in contrast, do not fulfil this requirement.

Figure 2: The Volatility of U.S. and South African T-Bills 1996-2008



The test statistics for both U.S. and South African T-Bonds were greater than the critical values and therefore it can be concluded that the variances were statistically larger than zero. However, as is clearly demonstrated in Figure 3, the volatility of South African T-Bonds is still notably larger than that of the U.S. equivalents. This conclusion of greater volatility in longer-term instruments contradicts several texts which propose the use of T-Bonds as proxies for the risk-free rate because of their lower variation (Harrington, 1987; Brigham and Ehrhardt, 2005), but is in accordance with the findings of early studies of Ibbotson and Sinquefield (1979) and Carleton and Lakonishok (1985). The greater variation in T-Bond returns compared to T-Bills is however only pertinent if the investment horizon does not match the maturity of the project being assessed. That is, if the maturity of the T-Bond mirrors that of the investment being analysed in the CAPM, the movements in the yield have no influence on the returns of the T-Bond if held to maturity. In the event, however, that the security has to be rolled over or liquidated prior to maturity, the variance is a source of risk for the investor.

Figure 3: The Volatility of U.S. and South African T-Bonds 1996-2008



3.3 Interest Rate Risk

The evidence that both short- and long-term securities in South Africa exhibit variation in returns over the investment horizon raises the question of whether or not the return offered on the security includes compensation for this volatility; that is, whether a premium is included in the returns on T-Bills and T-Bonds for interest rate risk. The Generalised Autoregressive Conditional Heteroscedasticity in Mean (GARCH-M) model was employed to address this issue. The GARCH-M model expands the conditional mean equation of the GARCH model to include a lagged term of the conditional variance (Brooks, 2008: 409-410). By including this term it is thus possible to determine whether the returns on the particular financial asset are influenced by the volatility in the returns; hence the coefficient on the conditional variance term represents a volatility risk premium.

It is widely observed across financial literature that a GARCH (1,1) specification is sufficient to model the variability observed in the data (Bollerslev *et al*, 1992), and hence this order was applied for the examination of T-Bills and T-Bonds. The appropriate conditional mean and variance equations are:

$$y_t = \beta + \delta\sigma^2_{t-1} + u_t \quad (1)$$

$$\sigma_t^2 = \psi + \alpha u^2_{t-1} + \gamma\sigma^2_{t-1} \quad (2)$$

Where: δ is the volatility risk premium,

σ_t^2 is the conditional variance,

σ^2_{t-1} is the one period lagged conditional variance,

u_t are the residuals of the conditional mean regression

(Brooks, 2008:410)

Following the recommendation of Brooks (2008: 390) daily data was used for the same period as examined previously (1996-2008). All four asset prices were non-stationary and thus had to be transformed into first differences. The differenced natural log terms were then used to estimate the GARCH-M equations. The estimates of the volatility risk premia are shown in Table 2, with the Z-statistics for the test of significance of these coefficient estimates and the associated p-values also provided. For U.S. T-Bills, the risk premium was statistically insignificant (as reflected by the p-value of 89.70 percent) and thus this proxy not only conforms to the requirement of zero variance over the investment period, but also does not provide compensation to investors for any variation in returns that may be experienced. In contrast, for South African T-Bills, the coefficient on the lagged conditional variance term is highly statistically significant (p-value equal to zero); thereby indicating that the returns offered on this instrument include a premium to compensate investors for the risk inherent in South African T-Bills caused by volatility over time.

Table 2: Volatility Risk Premia of U.S. and South African Risk-Free Proxies

	U.S. T-Bills	U.S. T-Bonds	SA T-Bills	SA T-Bonds
δ (risk premium)	13.9683	-4.2764	282.3648	4.3567
Z-Statistic	0.1295	-0.0562	4.3687	1.4006
P-Value	0.8970	0.9552	0.0000	0.1613

The model estimated for U.S. T-Bonds also revealed a statistically insignificant coefficient for the risk premium; providing evidence that although these instruments do exhibit fluctuations in returns over time, no compensation for this volatility is provided to investors. For South African T-Bonds the evidence with regards to the presence of a volatility premium is less clear cut. The p-value of 16.13 percent lies above the conventional significance levels; however, it is close enough to the ten percent level to suggest that one should not completely reject the notion that the yield on the R157 bond includes a volatility risk premium.

The fact that the volatility premium is smaller in T-Bond than T-Bill returns in South Africa is somewhat at odds with the results obtained in the analysis of variance in the preceding section, which revealed the much greater volatility associated with the longer-term instrument. A possible explanation for this is the different perspectives of investors purchasing securities of varying maturities. If investors purchasing T-Bonds generally have a long-term investment horizon, then short-term fluctuations in returns are not likely to have an impact on their wealth position and consequently these investors will not demand compensation for the volatility in the returns earned on the instrument. Although the wealth position of short-term investors in T-Bills is guaranteed once the security is purchased, their ability to reinvest in the following period at the same rate depends on the movement in interest rates. In a volatile market these investors are thus exposed to substantial risk from this source, for which they require compensation in the form of a volatility risk premium.

3.4 Covariance

As explained in Section 2.2.5, the covariance of the risk-free asset with the market portfolio should be zero, and as with the preceding requirements, the extent to which South African securities satisfy this condition can be assessed empirically. The market portfolios used to represent the U.S. and South Africa for this analysis were chosen as the Standard and Poor's 500 Index and the All Share Index respectively. Monthly values were obtained for the period 1996 to 2008 from McGregor's Database and the holding period returns earned on each of these indices were computed. As with the variance values, it was deemed necessary to assess the statistical significance of the covariance estimates so as to determine the extent to which the proxies satisfy the zero covariance requirement. Rather than testing the covariance however, the correlation between the risk-free and market portfolio surrogates (denoted r) were examined because of the difficulty in determining the distribution for the covariance measurement (Freund and Perles, 2003: 455-457). The Z-test statistic computed for this purpose is:

$$\text{Z statistic} = ((n-3)^{0.5} / 2) * \ln \{(1+r)/ (1-r)\} \quad (3)$$

(Freund and Perles, 2003: 456)

The results of this analysis, which are presented in Table 3, show that the correlation of U.S. Treasury securities with the market is considerably smaller in absolute terms than for the comparable South African securities.

Table 3: Correlation Analysis for U.S. and South African Risk-Free Proxies

	U.S. T-Bills	**U.S. T-Bonds**	**SA T-Bills**	**SA T-Bonds**
Correlation	-0.14	-0.09	0.25	0.32
Z-Statistic	-1.77**	-1.10	3.20*	4.09*

* Significant at the 1 percent level. **Significant at the 10 percent level.

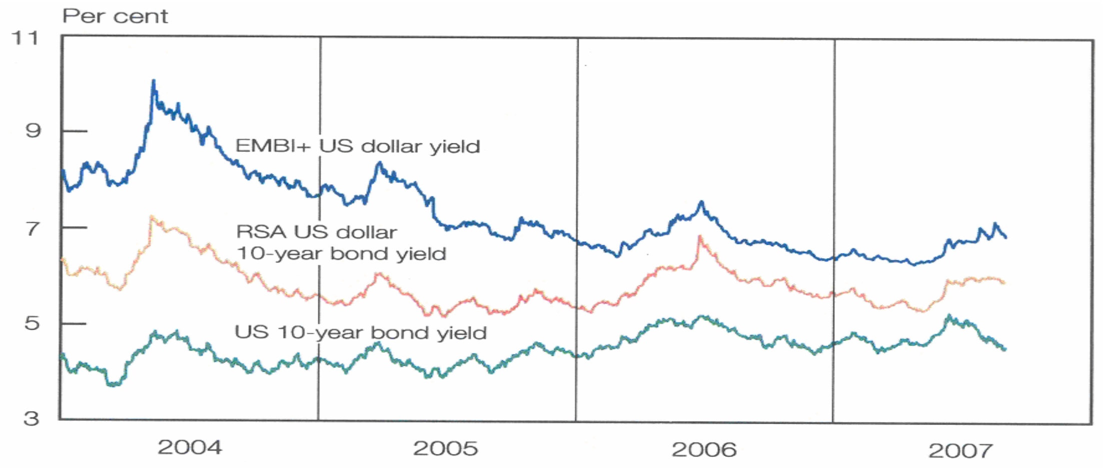
The co-movement of U.S. T-Bonds with the market was not significantly different from zero, whilst for U.S. T-Bills, there was some evidence that the returns do move in tandem with the returns on the market, but this relationship was only significant at the ten percent level. In contrast, both South African T-Bills and T-Bonds were identified to exhibit significant correlation with the market over the period analysed and thus neither of these two securities conforms to the risk-free asset requirement. However, contrary to the U.S., it is T-Bills that perform slightly better in this regard in South Africa than T-Bonds.

These statistical tests therefore suggest that in South Africa the correlation of T-Bills with the share market is potentially a source of risk for the investor as a consequence of the need to reinvest over the life of the project. For an investor who purchases a T-Bond, the statistically significant co-movement of this asset with the market is only of importance if the maturity of the security does not match the investment horizon and the security therefore has to be liquidated prior to maturity, or rolled over.

3.5 Default Risk

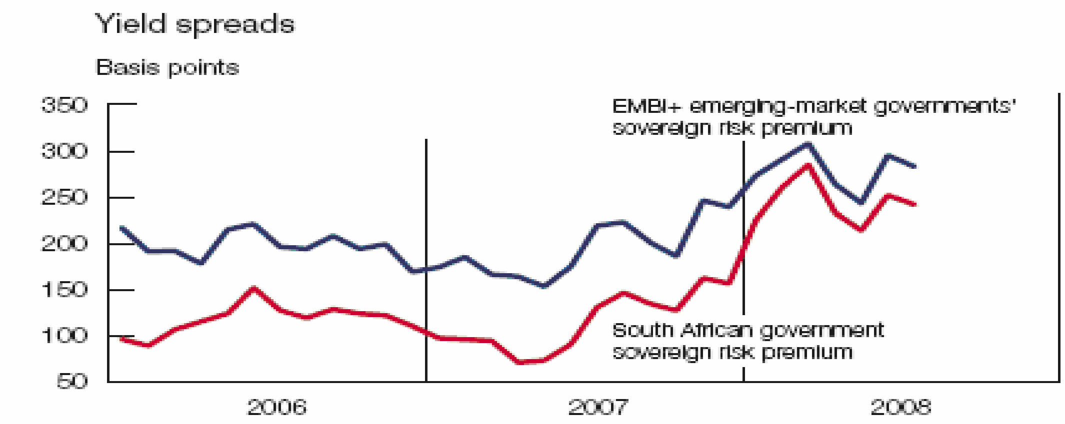
Theoretically, a risk-free asset should be free of default risk. Generally it is assumed that an asset backed by the government meets this requirement (Damodaran, 2001: 3), but there is some evidence that not even U.S. T-Bills are entirely devoid of default risk (Zivney and Marcus, 1989; Nippani *et al*, 2001;). In the case of emerging markets a sizable default risk premium usually exists, with the South African default risk premium (measured by the sovereign spread between South African and U.S. Treasury security yields) representing a significant portion of domestic long-term interest rates (Robinson; 2007: 5). As can be seen in Figure 4 the spread between U.S. and South African dollar denominated bonds has declined steadily from 2004. However, as is evident in Figure 5, where the red line shows the sovereign risk premium, this began increasing again in April 2007, from a low of 70 basis points to 285 basis points in March 2008 in response to declining yields in the U.S. and a ratings downgrade for South Africa from positive to stable (SARB, 2008: 60-61).

Figure 4: A Comparison of U.S. Dollar Denominated Bond Yields



(Source: SARB, 2007: 36)

Figure 5: South Africa's Sovereign Risk Premium

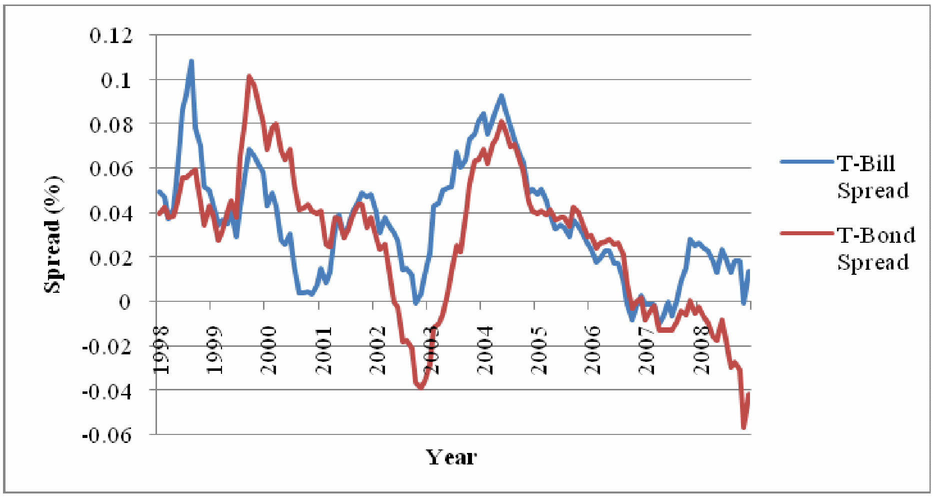


(Source: SARB, 2008: 61)

If the South African investment environment is inherently riskier than a market such as the U.S. then the inclusion of an appropriate risk premium in the minimum required rate of return for South African investments is arguably appropriate. However, the fluctuations in the premium are problematic as they imply that the appropriate return on investments in South Africa is subject to change. Less reliance can therefore be placed on CAPM valuations based on a proxy subject to such fluctuations.

In order to compare the sensitivity of South African T-Bills and T-Bonds to sovereign risk a simple comparison of the sovereign risk premia included in the yields of these two securities was conducted for the period 1998-2008. The short-term sovereign risk premium was estimated by subtracting the real return on U.S. T-Bills from the real return on South African T-Bills, while the long-term premium was estimated by calculating the difference between the real return on U.S. Treasury Bonds and the R157 bond. Figure 6 shows the result.

Figure 6: Sovereign Spread for T-Bills and T-Bonds 1998-2008



It can be seen that the sovereign spreads on T-Bills and T-Bonds have tended to move together, although short-run deviations do occur. It is also noticeable that in 2008 the long-term spread fell substantially below that of the short-term spread. A standard Z-test was conducted to determine whether or not there was a significant difference in the means of these two spreads (see Keller and Warrack, 2000: 397). Based on the null hypothesis that the mean T-Bill spread was equal to the mean T-Bond spread, a Z-statistic of 2.1208 was obtained, which was statistically significant at the five percent level. Therefore the T-Bill spread was statistically significantly larger than the T-Bond spread; hence South African T-Bills appear to incorporate a more substantial sovereign risk premium compared to longer-term instruments. This finding that the shorter the time to maturity, the greater the default risk is consistent with the maturity crisis hypothesis developed by Johnson (1967), in which he argued that short-term securities may be exposed to greater default risk than longer-term securities because investors believe that the Treasury's inability to pay may be resolved in the future.

3.6 Liquidity Risk

U.S. treasury securities are, in general, highly liquid instruments because of their perceived risk-free nature and are thus easily brought and sold in the secondary market at close to their true values (Reilly and Brown, 2006: 22). Short-term South African government securities are considered to be liquid instruments, but longer-term T-Bonds have only become reasonably liquid in the past few years, as the domestic bond market has expanded; however, it is now considered to be one of the most liquid emerging bond markets in the world (Botha, 2006: 303). Thus, with respect to liquidity risk, South African securities on average do not appear to deviate substantially from the theoretical requirement. The issue with respect to liquidity risk therefore is whether or not longer-term securities include a liquidity risk premium and if so, whether this premium is at odds with the theoretical criterion.

The liquidity preference hypothesis holds that investors require a premium to induce them to invest in volatile long-term bonds (Reilly and Brown; 2006: 637). Amira (2004: 809) demonstrates empirically using sovereign Eurobonds that longer maturity fixed-rate bonds display greater price volatility and that as a result there is a positive relationship between maturity and yield spread. It thus follows that longer-term government bonds will include a liquidity risk premium in their yields in contravention of the requirements for a risk-free asset. However, given that investors using the CAPM to make long-term investment decisions are likely to require compensation for the liquidity risk of tying up their funds for an extended period of time, it is arguable that incorporating an appropriate liquidity risk premium in the minimum return is justifiable. A further implication, however, is that it would then become essential to match the maturity of the risk-free asset with that of the proposed investment horizon in order to ensure the use of a suitable liquidity premium.

4. SUMMARY AND CONCLUSIONS

This study sought to assess the appropriateness of the use of T-Bills and T-Bonds as proxies for the risk-free rate in South Africa. A set of theoretical requirements that an asset must closely satisfy to be considered a suitable proxy were identifed, with the South African and U.S. short- and long-term proxies compared to these criteria. The analysis revealed that whilst the use of U.S. Treasury securities as proxies for the risk-free rate are not beyond reproach, the South African equivalents deviate substantially from the theoretical requirements; bringing into question their suitability.

Furthermore, it was found that short-term government securities are likely to be less appropriate than longer-term instruments because of the greater volatility of South African T-Bills, their greater correlation with the market proxy, the presence of a volatility premium in the pricing of T-Bill returns, and the more significant default premium compared to longer-term T-Bonds. This finding is in contrast to the suggestion of Firer (1993: 38) to use the T-Bill to estimate the risk-free rate in South Africa. Whilst the use of a longer-term T-Bond does introduce issues concerning inflation and liquidity risk it can be argued that their presence is not inappropriate in the assessment of long-term investments that are equally subject to inflation and liquidity risks. This argument would, however, require matching the maturity of the risk-free proxy with that of the investment horizon to ensure that appropriate premia are applied. It therefore appears that using a long-term government security with a maturity equivalent to the investment horizon as the risk-free rate proxy is preferable to the use of a short-term T-Bill.

These findings suggest areas for further research on the interaction between the choice of risk-free rate proxy and the forecasting ability of the CAPM. Specifically examining the interaction between the presence of volatility, liquidity and inflation in risk-free proxies and CAPM forecasts would be appropriate. The shortcomings of T-Bills and T-Bonds as risk-free rate proxies identified in this study also point to the need to investigate the suitability of alternative approaches such as the use of inflation-linked government bonds.

REFERENCES

Akonjolirie, A. and Smit, E (2003). South African unit trust performance and strategy in a changing climate (1989 – 2002). *Investment Analysts Journal*, 58: 41-50.

Amira, K. (2004). Determinants of sovereign Eurobonds yield spread. *Journal of Business Finance and Accounting*, 31(5) and (6): 795-821.

Black, F., Jensen, M. and Scholes, M. (1972). The capital asset pricing model: Some empirical tests. In Jensen, M. (Ed.) (1972) *Studies in the Theory of Capital Markets*, New York: Praeger.

Blake, (2000) *Financial Market Analysis*, 2nd Edition. United States of America: Wiley.

Bollerslev, T., Chou, T. and Kroner, K. (1992). ARCH modelling in finance: A review of the literature. *Review of Econometrics*, 52: 5-59.

Botha, Z. (2006). The money market. In: Van Zyl, C.; Botha, Z. and Skerrit, P. (Eds.) (2006). *Understanding South African Financial Markets*, 2nd Edition. Pretoria: Van Schaik: 229-283.

Brigham, E. and Ehrhardt, M. (2005). *Financial Management: Theory and Practice*, 12th Edition. United States of America: Thomson South-Western.

Brooks, C. (2008). *Introductory Econometrics for Finance*, 2nd Edition. United Kingdom: Cambridge University Press.

Bruner, R., Eades, K., Harris, R. and Higgins, R. (1998). Best practices in estimating the cost of capital: survey and synthesis. *Financial Practice and Education*, (8): 13-28.

Carleton, W., and Lakonishok, J. (1985). Risk and return on equity: The use and misuse of historical estimates. *Financial Analysts Journal*, 41(1): 38-47.

Cloete, G., de Jonah, P. and de Wet, T. (2002). Combining Vasicek and robust estimators for forecasting systematic risk. *Investment Analysts Journal*, 55(3)

Correia, C. and Uliana, E. (2004). Market segmentation and the cost of equity of companies listed on the Johannesburg Stock Exchange. *South African Journal of Accounting Research*, 18(1): 65-81.

Correia, C. and Cramer, P. (2008). An analysis of cost of capital, capital structure and capital budgeting practices: a survey of South African listed companies. *Meditari: Research Journal of the School of Accounting Science*, 16(2): 31-52.

Damodaran, A. (2001). Estimating Risk-Free Rates. *Stern School of Business*.

de Wet, J. (2005). EVA versus traditional accounting measures of performance as drivers of shareholders value – a comparative analysis. *Meditari: Research Journal of the School of Accounting Sciences*, 13(2): 1-16.

de Wet, J. (2006). Determining the optimal capital structure: A practical contemporary approach. *Meditari: Research Journal of the School of Accounting Sciences*, 14(2): 1-16.

de Wet, J. and du Toit, E. (2007). Return on equity: A popular, but flawed measure of corporate financial performance. *South African Journal of Business Management*, 38(1): 59-69.

de Wet, J. and Hall, J. (2006). An analysis of strategic performance measures of companies listed on the JSE securities exchange South Africa. *South African Journal of Economic and Management Sciences*, 9(1): 57-71.

Fama, E. and French, K. (1992). The cross section of expected stock returns. *Journal of Finance*, 52(1): 427-465.

Fama, E. and French, K. (2004). The capital asset pricing model: Theory and evidence. *Journal of Economic Perspectives*, 18(3): 25-46.

Fama, E. and MacBeth, J. (1973). Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy*, 81(3): 607-636.

Firer, C. (1993). Estimating the return parameters of the capital asset pricing model. *South African Journal of Accounting Research* (*De Ratione)*, 7(1): 23-39.

Freund, J. and Perles, B. (2003) *Statistics: A First Course*, 8th Edition. United States of America: Prentice-Hall.

Friis, L. and Smit, E. (2004). Are some fund managers better than others? Manager characteristics and fund performance. *South African Journal of Business Management*, 35(3): 31-40.

Graham, J.R. and Harvey, C.R. (2001). The theory and practice of corporate finance: evidence from the field. *Journal of Financial Economics*, 60: 187-243.

Graham, M. and Uliana, E. (2001). Evidence of a value-growth phenomenon on the Johannesburg Stock Exchange. *Investment Analysts Journal*, 53(1).

Gitman, L.J. and Mercurio, V. (1982). Cost of capital techniques used by major U.S. firms: survey and analysis of Fortune's 1000. *Financial Management*, 14: 21-29.

Harrington, D. (1987). *Modern Portfolio Theory, the Capital Asset Pricing Model, and Arbitrage Pricing Theory: A User's Guide*, 2nd Edition. New Jersey: Prentice Hall.

Ibbotson, R., and Sinquefield, R. (1979). Stocks, bonds, bills and inflation: Updates. *Financial Analysts Journal*, 35(4): 40-44.

Johnson, R. (1967). Term structure of corporate bond yields as a function of risk of default. *Journal of Finance*, 22 (2): 313-351.

Keller, G. and Warrack, B. (2000). *Statistics for Management and Economics*, 5th Edition. United States of America: Duxbury Thomson Learning.

Moolman, E. and du Toit, C. (2005). An econometric model of the South African stock market. *South African Journal of Economic and Management Sciences*, 8(1): 77-91.

Msweli-Mbanga, P. and Mkhize, H. (2007). The risk-adjusted performance of companies with female directors: A South African case. *South African Journal of Economic and Management Sciences*, 10(2): 207-213.

Nippani, S., Liu, P. and Schulman, C. (2001). Are Treasury securities free of default? *Journal of Financial and Quantitative Analysis*, 36 (2): 251-265.

Oldham, G. and Kroeger, J. (2005). Performance, persistence and benchmarks of selected South African unit trusts for the period 1998-2002. *South African Journal of Business Management*, 36(4): 81-90.

Pike, R. and Neale, B. (2006). *Corporate Finance and Investment*, 5th Edition. Essex: Prentice Hall.

Pocock, A.S., Correia, C. and Wormald, M. (1991). An analysis of the approaches used by industrial companies listed on the JSE to identify their cost of capital. *South African Journal of Accounting Research (De Ratione)*, 5(1): 27-40.

Reilly, F. and Brown, K. (2006). *Investment Analysis and Portfolio Management,* 8th Edition. United States of America: Thomson South-Western.

Robinson, Z. (2007). The sovereign risk premium in South Africa: An empirical approach [Online]. Available at: https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=IIPF63&paper_id=187. Accessed on: 10th April 2009.

Samouilhan, N. (2007). The price of risk in the South African equity market. *South African Journal of Economics*, 75(3): 442-458.

Sharpe, W. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance*, 19(3): 425-442.

South African Reserve Bank (SARB) (2007). *Quarterly bulletin: March*. Pretoria.

South African Reserve Bank (SARB) (2008). *Annual Report 2007/2008: March*. Pretoria.

Viviers, S., Bosch, J., Smit, E. and Buijs, A. (2008). The risk-adjusted performance of responsible investment funds in South Africa. *Investment Analysts Journal,* 68: 39-55.

Zivney, T. and Marcus, R. (1989). The day the United States defaulted on Treasury Bills. *Financial Review*, 24(3): 475-489.