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The South African risk-free rate anomaly

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International tests of the suitability of the Capital Asset Pricing Model (CAPM) found that the minimum return required by investors implied by the model exceeded the risk-free proxy yield. In contrast, similar tests in South Africa found that the minimum required return was not significantly different from the risk-free proxy return. This study sought to resolve this apparent anomaly by employing direct and indirect approaches to estimate the minimum return required by investors. It found that, in keeping with international evidence, the minimum required rate of return exceeded that of the risk-free rate proxy; whilst the minimum-variance zero-beta portfolio return closely approximated the minimum required return. The implications of these findings for researchers and practitioners using the CAPM are discussed.

Key words: Capital Asset Pricing Model, zero-beta portfolio, risk-free rate, required rate of return.

INTRODUCTION

Since the development of the CAPM by Sharpe (1964) and Lintner (1965), it has been the subject of considerable debate and criticism, yet the model remains a fundamental tool in financial analysis in order to estimate the cost of equity for a firm (Graham and Harvey, 2001; Correia and Cramer, 2008). One of the difficulties in employing the model in practice is the correct identification of the parameters as they are all theoretical constructs that have to be estimated. When estimating the risk-free rate, short-term Treasury bills (T-Bills) and long-term Treasury bonds (T-Bonds) are generally used as proxies (Damodaran, 2008).

Some of the earliest tests of the validity of the CAPM tested the Sharpe-Lintner hypothesis that the minimum required return implied by the observed Security Market Line (SML) should equal the risk-free rate proxy. Black et al. (1972), Fama and MacBeth (1973) and Stambaugh (1982) however, find that the minimum rate of return required by investors significantly exceeds the return of commonly employed risk-free rate proxies such as the United States (U.S.) one-month T-Bill rate; which also leads to a flatter slope for the SML. This is demonstrated in Figure 1, which shows the theoretical SML based on the risk-free rate and observed market risk premium (blue line) compared to the implied SML (red line) with the higher intercept and flatter slope. Subsequent tests both in the U.S. (Fama and French, 2004) and internationally (Faff, 2001; Chou and Lin, 2002; Gao and Huang, 2004) also identify this relationship.

Only two South African studies have attempted a similar analysis; Bradfield et al. (1988) find no significant difference between the minimum required return and the risk-free rate proxy, while van Rhijn (1994) finds that the yield on the risk-free rate proxy *exceeds* the observed minimum required return, suggesting that the estimated relationship (given by the red line in Figure 2) actually lies below that of the theoretical relationship (the blue line). The existing, albeit limited, empirical evidence thus seems to point to a fundamental difference in the risk-return relationship for the South African market. This paper seeks to address this apparent anomaly by employing both indirect and direct tests of the suitability of the use of a proxy to measure the risk-free rate compared to the minimum-variance zero-beta portfolio

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returns.

LITERATURE REVIEW

While Sharpe (1964) and Lintner's (1965) CAPM assumed the existence of a risk-free asset, as early as 1972, Black demonstrated that this assumption was not necessary. In Black's version of the CAPM the return on a single risk-free security is replaced with the return on the minimum-variance zero-beta portfolio, if a suitable proxy for the risk-free rate does not exist; with the remainder of the model identical. To ascertain whether the zero-beta portfolio or the risk-free rate proxy is the best estimate of the riskless yield, an estimate of the minimum return required by investors is obtained, measured as the intercept of the regression of actual returns against beta, and this is compared to the chosen risk-free rate proxy. This test is known as the Sharpe-Lintner hypothesis, as it essentially examines the appropriateness of the traditional CAPM which postulates the use of a proxy for the risk-free rate in applying the model, assuming the model captures the remaining risk-return dynamics. If the null hypothesis is rejected, the alternative hypothesis is that the minimum-variance zero-beta portfolio of Black (1972) is a more appropriate measure of the risk-free rate. Morgan (1975) terms this an indirect test of the suitability of the zero-beta portfolio as the minimum-variance zero-beta portfolio return is not actually computed and compared to the historical estimate of the minimum return required by investors; but is assumed to be the best measure as the other inferences of the model are correct.

Black et al. (1972) and Fama and MacBeth (1973) were among the first to test the Sharpe-Lintner hypothesis. In both studies, the null hypothesis that the estimated intercept is equal to the risk-free proxy (one-month T-Bills) is rejected as the intercept of the SML is found to exceed the risk-free proxy yields. The conclusion of Black et al. (1972) and Fama and MacBeth (1973) therefore, is that the minimum-variance zero-beta portfolio provides a more accurate estimate of the minimum return required from investing, given that the other CAPM relationships held over the period examined.

Stambaugh (1982) follows a similar approach to these studies, but employs a different estimation procedure and broadens the sample to include preference shares and bonds. Despite these differences, Stambaugh (1982) reaches the same conclusion regarding the relationship between the risk-free rate proxy and the intercept of the SML. More recently, Fama and French (2004) update the analysis of Fama and MacBeth (1973) using data from 1928 to 2003. The results of their analysis confirm that the actual SML is characterised by a higher intercept and a flatter slope than the theoretical relationship based on the one-month T-Bill rate and the average market return.

Morgan (1975) conducted a direct test of the validity of the zero-beta portfolio to estimate the risk-free rate in the U.S. He directly computed the returns on the minimum-variance zero-beta portfolio whilst also estimating the implied minimum required return from the SML. He did not test the statistical equality of the two estimates, but rather compared the predictive power of the CAPM using the minimum rate of return and the zero-beta portfolio return. His results show that there is no statistical difference between the predictions using either the zero-beta portfolio return or the minimum required return and therefore concludes that the zero-beta portfolio approach is a suitable means to estimate the risk-free rate.

Indirect studies of the suitability of the minimum-variance zero-beta portfolio return as a measure of the risk-free rate have been conducted in other markets. The identical relationship to the U.S. is identified by Faff (2001) for Australia and Chou and Lin (2002) for the international market. In contrast, Fraser et al. (2004) in the United Kingdom (U.K), who find that although the minimum required return is greater than the one month T-Bill yield, the difference is not significant. This is confirmed by Nikolaos (2009) who finds that the monthly minimum return required by investors on the London Stock Exchange over the period 1980 to 1998 of 0.65% was not significantly different from the average monthly yield on the Equity Gilt over the period 1946 to 1995 of 0.87%. However, the choice of risk-free rate proxy in the study of Nikolaos (2009) is unusual and also does not exactly match the period under review.

The results of Gao and Huang (2004) dispute these two studies of the U.K. market, as they find that the intercept in the CAPM regression is significantly higher than the 91 day T-Bill, even after adjusting the standard error estimates to improve the accuracy. In contrast, they observe that in the Japanese market, the relationship appears to be reversed, when comparing the minimum return required by investors to the 30-day Gensaki rate, although the difference is not significant. Recently, Lazar and Yaseer (2010) find that in the Indian market the risk-free proxy yield (measured as the 91 day T-Bill) exceeds the minimum required return in all the sub-periods reviewed but the difference is only significant in some of the sub-periods.

Bradfield et al. (1988) and van Rhijn (1994) follow similar methodologies in studying the Sharpe-Lintner hypothesis in South Africa. Bradfield et al. (1988), using a sample of 100 shares, find that the fundamental relationship between risk and return postulated by the CAPM held for shares on the Johannesburg Securities Exchange (JSE). Although the intercept of the SML exceeds the twelve month fixed deposit rate, used as a proxy for the risk-free rate, in four of the five periods, the difference is not found to be significant. Accordingly, Bradfield et al. (1988) conclude that a proxy is more suitable than the zero-beta portfolio as the risk-free rate in the CAPM in South Africa. But, the choice of proxy by Bradfield et al. (1988) is unusual and although they do not provide any justification for their choice, it may be related to the deficiencies associated with some of the more traditional proxies in South Africa (Firer and McLeod, 1999). The fixed deposit rate, determined by a commercial bank, is likely to exceed the rate on more traditional government proxies and thus may have contributed to the differences observed between the South African and international studies. The average monthly estimate of the intercept of the SML obtained in the study of van Rhijn (1994), based on industrial shares only, was 0.92%, which is lower than the average monthly estimate of the three-year government bond of 1.08%, used as a proxy for the risk-free rate. No test however, is conducted to ascertain whether the difference is significant.

The fact that short-term T-Bills have been found to understate the minimum required return does appear to be counterintuitive as it would be expected that if these proxies are not suitable they would overstate rather than understate the true minimum return. A number of possible explanations have been proposed to account for this finding; for example, the historical-based tests of an expectational model may be incorrect, the form of the model tested may be inappropriate, the market-portfolio proxy may not be mean-variance efficient or the risk-free proxy may be unsuitable. However, a number of these explanations have been discarded on the basis of further studies, such as different forms of the model still signalling that the minimum return exceeds the T-Bill yield (Breeden et al., 1989), or that the use of a mean-variance efficient proxy for the market portfolio still results in the same observation (Stambaugh, 1982). Moreover, the fact that this relationship is consistent across the majority of markets, suggests that it is not a shortcoming associated with a particular market but rather a problem with the model or its application.

One argument, however, which has not been empirically disproven, is that the risk-free proxy does not truly measure what Sharpe (1964) defined as the risk-free rate. T-Bills only represent a proxy for the riskless investment rate, but by definition, the riskless return should represent the weighted average of the riskless borrowing and lending rates. The yield at which investors can borrow exceeds the proxy rate used and thus this may account for the disparity observed between the minimum return that investors require and the surrogates considered. It is precisely for this reason that Brennan (1971) advocates the use of the zero-beta portfolio rate as the measure of the risk-free rate given the difficulty in trying to determine the weighted average of the riskless borrowing and lending rates.

In light of this evidence, it appears that in more developed markets, like the U.K and U.S, the use of a proxy for the risk-free rate is not appropriate and the minimum-variance zero-beta portfolio return should be favoured; whilst in less developed markets, the proxy appears to be acceptable for applications of the CAPM. Damodaran (2008), Grandes et al. (2003) and Hearn and Piesse (2009) note that the yields on government securities tend to be higher in developing markets because of the greater risk associated with the issuing institution. Hence in developed markets, the return on government securities may be too low to reflect the minimum rate that investors require as compensation for being unable to use their funds for a given period of time, but in developed markets this may not be true.

The two South African tests of the Sharpe-Lintner hypothesis thus do not conform to the developed market evidence regarding the relationship between the minimum required return and the risk-free rate proxy. Given that the reintegration of South Africa into the global economy post 1994 has resulted in considerable development of the market, that the tests conducted used limited samples and short horizons, and that it is now possible to perform a more sophisticated direct test of the Sharpe-Lintner hypothesis, it is of value to revisit this apparent anomaly.

METHODOLOGY

Hypothesis tests

The preceding discussion has highlighted the existence of two alternative forms of the CAPM. Both assume a linear relationship between expected return and risk, as measured by beta, but the traditional Sharpe-Lintner version, as depicted in Equation 1, also requires the assumption of the existence of a risk-free rate at which investors can both borrow and lend. Black's zero-beta model, however, relaxes this assumption and instead employs the expected return on a zero-beta portfolio as the minimum return in the model, as shown in Equation 2. These equations represent the SML and in practice can be used to ascertain the return that a share should earn given its beta.

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] \quad (1)$$

$$E(R_i) = E(R_z) + \beta_i[E(R_m) - E(R_z)] \quad (2)$$

where $E(R_i)$ is the expected return on security i, R_f is the risk-free rate, β_i is the beta of security i, $E(R_m)$ is the expected return on the market and $E(R_z)$ is the expected return on the minimum-variance zero-beta portfolio (Black, 1972:447; Jensen, 1972:362)

To test the CAPM, studies have traditionally used the Fama and MacBeth (1973) two-step approach, which entails obtaining betas and realised returns for securities and then computing the SML implied by the risk-return relationship of the securities. The equation commonly used for this purpose is depicted in equation 3, where the slope of the SML provides an estimate of the actual market risk premium.

$$R_{it} = \gamma_0 + \gamma_1\hat{\beta}_{it} + \varepsilon_i \quad (3)$$

where: R_{it} are the realised returns on shares i = 1, 2 … 3 over period t, $\hat{\beta}_{it}$ are the estimated betas of the shares over period t, and ε_i are the residuals of the regression (Fama and MacBeth, 1973:609). Due to the fact that the CAPM assumes that investors have homogenous expectations, this means that all investors should have the same minimum required return from investing, which is captured in Equation 3 by the intercept estimate. If the traditional form of the model is most applicable, then the intercept should be equal to the risk-free proxy yield; whilst if the zero-beta model is more appropriate, the intercept should be equal to the minimum-variance zero-beta portfolio returns.

Empirical evidence internationally has shown that the actual minimum return identified by the SML exceeds the return on government securities typically used as proxies for the risk-free asset. South African research, while limited, has suggested that, contrary to international experience, the risk-free rate proxy is either not significantly different from the minimum required return or may even exceed it. To resolve this apparent anomaly it is therefore necessary to test the Sharpe-Lintner hypothesis for the South African market. As mentioned, Morgan (1975) terms this the indirect method to testing the suitability of using a proxy or the zero-beta portfolio returns for measuring the risk-free rate. The applicable null and alternative hypotheses for this relationship are displayed in Equation 4. If the null hypothesis is rejected, it can be concluded that the use of a proxy for the risk-free rate is inappropriate.

Hypothesis one - the Sharpe-Lintner hypothesis:

H_0: $\gamma_0 = R_f$ and H_1: $\gamma_0 \neq R_f$ (4)

where: γ_0 is the implied minimum required rate of return.
If the remaining CAPM relationships are found to hold in the empirical tests, then the rejection of the Sharpe-Lintner hypothesis is often taken as evidence that the zero-beta approach is preferable, however this conclusion is seldom tested empirically but it is possible to do so. For this purpose, the Black hypothesis, which is also known as the direct method shown in Equation 5, was tested in this study. If the null hypothesis is rejected in test 1 but is not rejected in test 2, this provides strong evidence against the use of a proxy for the risk-free rate and support for Black's (1972) minimum-variance zero-beta portfolio returns.

Hypothesis two – the Black hypothesis:

H_0: $\gamma_0 = R_z$ and H_1: $\gamma_0 \neq R_z$ (5)

where R_z is the return on the minimum-variance zero-beta portfolio.

Estimation of the Minimum Required Return

In order to estimate the SML, monthly prices and dividend yields were obtained from the JSE for all shares over the period 1990 to 2008. The number of shares was adjusted each year for any new listings or de-listings. The share returns were calculated as the sum of the capital gain and dividend yields. Portfolios rather than individual shares are commonly utilised to test Equation 3, as the betas of individual shares tend to be volatile. Traditionally shares have been allocated to portfolios based on historical beta estimates in order to achieve a wide dispersion in beta values (Fama and French, 2004). Sorting the shares based on industry classifications has been proposed as an alternative (Lewellen et al., 2010), as it achieves a similar distribution of betas but without relying on the inference that historical betas are good predictors of future values. Both of the South African studies have relied on the beta-sorting procedure and thus, it is possible that this method of sorting may have biased the results if the underlying assumption is in-appropriate. Consequently, shares were allocated to 20 industry-based portfolios.

The shares were equally-weighted within each portfolio to obtain the average monthly portfolio returns. Thereafter, the beta of each portfolio for each month in the sample was obtained by regressing the portfolio returns against the market portfolio returns using data from the immediately preceding 36 months (known as rolling beta estimates), as per Equation 6:

$$R_p = \alpha_0 + \beta_p R_m + \eta_t \quad (6)$$

where: R_p are the returns on portfolio p and R_m are the returns on the market portfolio proxy over the immediately preceding 36 months. Equation 3 was then estimated across the twenty portfolios for each month in the sample and time-series estimates of the intercept and slope coefficients were computed by averaging the estimates over the entire period (1993 to 2008; note the first three years of observations were used to compute the first beta for January 1993) and varying sub-periods.

To ensure the robustness of the results of this study, the analysis outlined above was extended to include two preference share and three bond portfolios. The Bond Exchange of South Africa indices for short-term (one- to three-years), medium-term (seven- to twelve-years), and long-term (twelve- to 30-years) bonds were used to represent the bond portfolios. As these bond indices were only formed in 2001, the estimates of the minimum required return including the additional asset classes were only obtained for the period 2001 to 2008.The preference shares were allocated to the portfolios based on historical betas as the industry affiliations of the securities were too broad to split the shares into two. The beta for each share was obtained for each year as the slope coefficient from a time-series regression of the returns of the share on the ALSI using the immediately preceding 36 months of data and the composition of the portfolios was adjusted each year to allow for changes in betas and any newly listed or delisted shares.

Estimation of the zero-beta portfolio returns

The minimum-variance zero-beta portfolio returns were computed over identical time horizons as the minimum required return, following the approach of Morgan (1975), and using the same 20-industry-sorted portfolios. The weightings of the asset portfolios in the zero-beta portfolio were determined by minimising the variance of the zero-beta portfolio subject to the constraints that the sum of the weightings of the individual portfolios must equal one and the weighted average of the portfolio betas must equal zero, as shown in Equations 7 to 9:

$$\sigma_z^2 = \sum_{q=1}^{N}\sum_{p=1}^{N} x_{zq} x_{zp} \sigma_{qp} \quad (7)$$

$$\sum_{p=1}^{N} x_{zp} = 1 \quad (8)$$

$$\sum_{p=1}^{N} x_{zp} \hat{\beta}_p = 0 \quad (9)$$

where: σ_z^2 is the variance of the zero-beta portfolio, x_{zq} and x_{zp} are the weightings of portfolios p and q in the zero-beta portfolio, σ_{qp} is the covariance of the returns of portfolios p and q, and p and q represent the individual portfolios. Once the portfolio weights were obtained, the minimum-variance zero-beta portfolio returns were computed as follows:

$$R_z = \sum_{p=1}^{N} x_{zp} R_p \quad (10)$$

The risk-free rate proxies

Both T-Bonds and T-Bills were selected as proxies for the risk-free rate to ensure that the results of these tests were robust to the choice of proxy. The three-month T-Bill and the R157 government bond were used for this purpose. The average monthly yield on the three-month T-Bill was computed by dividing the equivalent annual rates by twelve; whilst for the R157 government bond, the annual percentage rate was first determined (assuming semi-annual compounding) before dividing this value by twelve.

RESULTS AND ANALYSIS

The values of the intercept and slope coefficients from

Table 1. Coefficient estimates and zero-beta portfolio returns.

Period	γ_0	Standard error	γ_1	Standard error	R_z	Standard Deviation
A: Estimates using ordinary shares only						
1993-2008	1.7019***	0.6924	0.825*	0.4325	1.6133*	0.7544
1993-1997	1.6583***	0.4734	1.1619*	0.6069	1.6570***	0.5900
1998-2002	4.0301***	1.1789	-3.8047*	1.9367	5.3657***	0.8687
2003-2008	2.7085***	0.522	0.3673**	0.1524	2.7082***	0.6432
B: Estimates using ordinary shares, preference shares and bonds						
2001-2008	1.3550***	0.2166	1.3105***	0.3789	1.2499***	0.3704

***, **, * Statistically significant at the 1, 5 and 10% level respectively.

equation 3 (using only ordinary shares) are shown in panel A of Table 1, along with the direct estimates of the minimum-variance zero-beta portfolio returns. The estimates of γ_1 were found to be positive and significant for the entire period and for two of the three sub-periods. This confirms the existence of a positive risk premium implying that securities which have higher risk, as measured by beta, are rewarded with higher returns. Thus, the existence of a positive risk-return relationship not only confirms the fundamental premise of the CAPM but is also consistent with the early study of Bradfield et al. (1988). However, this does contrast with the more recent findings of van Rensburg and Robertson (2003), Strugnell et al. (2011) and Ward and Muller (2012), who find evidence against the CAPM in South Africa as there actually appears to be a negative relation between beta and returns. Although, a similar finding was observed for the 1998 to 2002 period in this study, this may reflect the market conditions (the period corresponds with three distinct contractions in the market, 1998, 2000 and 2002) rather than the failure of the model. That is, if the market return was always above the risk-free rate, then investors would not hold the latter. But shares are risky by nature and therefore there are likely to be periods where market downturns occur such that the market return is below the risk-free rate. This would suggest that shares with higher betas earned lower returns (or more negative returns) than shares with lower betas; a finding that is consistent with the CAPM provided realised rather than expected returns are considered (Pettengill et al., 1995).

In panel B of Table 1 the regression coefficients and the zero-beta portfolio returns are shown for the period where the bond and preference share portfolios were included in the sample. The inclusion of these asset classes results in a larger and more significant estimate of the market risk premium. This finding mirrors that of Stambaugh (1982) when he compares his results to earlier tests of the model by Black et al. (1972) and Fama and MacBeth (1973). The main reason for this observation is that the inclusion of the preference shares and bonds results in a lower estimate of the intercept and accordingly, this yields a larger value of the market risk premium.

All of the intercept estimates were significant and positive, whilst the inclusion of preference shares and bonds, in keeping with the results of Stambaugh (1982), reduced the value of the intercept estimate. In addition to this, the standard error associated with the intercept estimate using the expanded sample is lower than with ordinary shares only. Thus, the addition of preference shares and bonds increases the efficiency of the coefficient estimates because it increases the range of the betas as these two asset classes tend to exhibit lower risk and accordingly have lower betas than ordinary shares; therefore lying closer to the vertical axis.

Hypothesis one

The test statistics, shown in Table 2, for the test of hypothesis one, were significant at the one percent level for all periods using both the T-Bill and T-Bond; thereby indicating that the risk-free proxy yields differed significantly from the minimum return required by investors. The risk-free rate proxy returns understated the minimum required return as revealed by the positive test statistics. This is further supported by examining Figure 2, which depicts the actual SML based on the ordinary share portfolios, as well as the theoretical SML using both the T-Bill and T-Bond returns for the entire period. The difference between the values of the T-Bill and T-Bond returns were largely inconsequential, with the SML based on the T-Bond lying slightly above that of the SML with the T-Bill. The graph clearly indicates that the intercept implied by the risk-return relationships of the portfolios was significantly higher than either the T-Bill or T-Bond yields and consequently, the slope of the SML was flatter than predicted by theory. This figure closely resembles that shown in Figure 1, which also conforms to the diagrammatic evidence presented by Fama and French (2004).

Thus, the results from this analysis conform to some of

Table 2. Hypothesis test results.

Period	Hypothesis test one		Hypothesis test two
	T-Bills	T-Bonds	
Estimates with ordinary shares only			
1993-2008	4.9511***	4.4104***	0.3870
1993-1997	5.1670***	3.7231***	0.0077
1998-2002	11.3870***	11.0405***	-4.0788***
2003-2008	17.0929***	16.9735***	0.0016
Estimates with ordinary shares, preference shares and bonds			
2001-2008	12.8651***	12.6750***	1.0954

***, **, *Statistically significant at the 1, 5 and 10% level respectively.

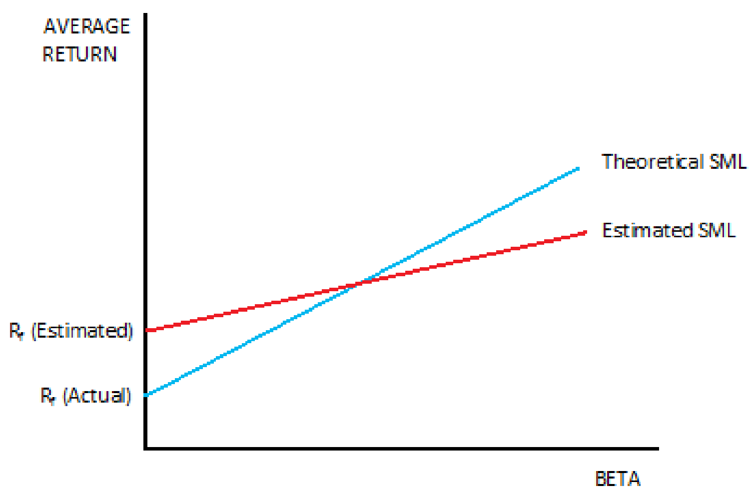

Figure 1. Observed relationship between the theoretical and actual SML.

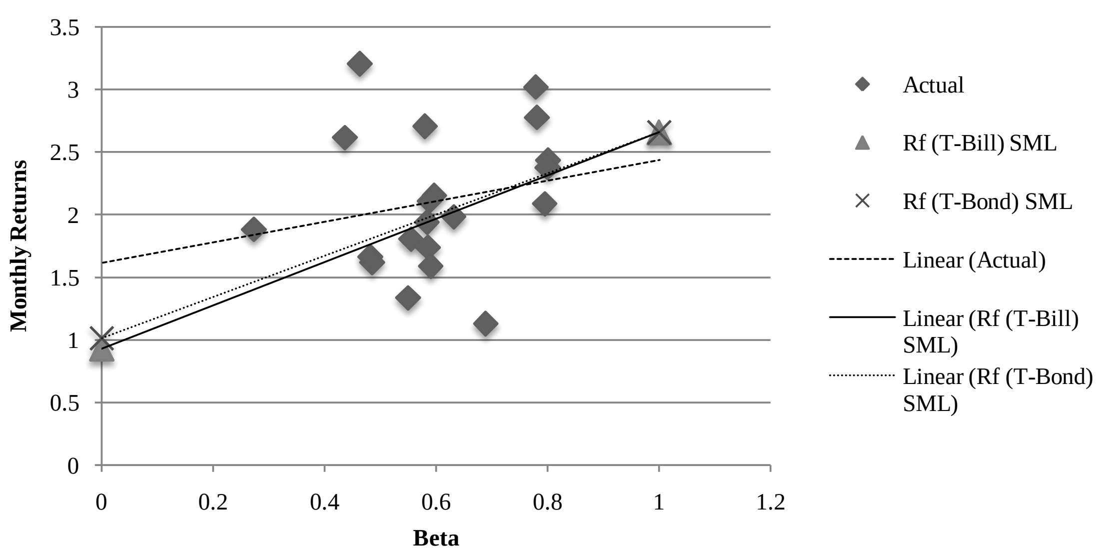

Figure 2. Actual versus theoretical SML (based on risk-free rate proxies) using ordinary shares, 1993-2008.

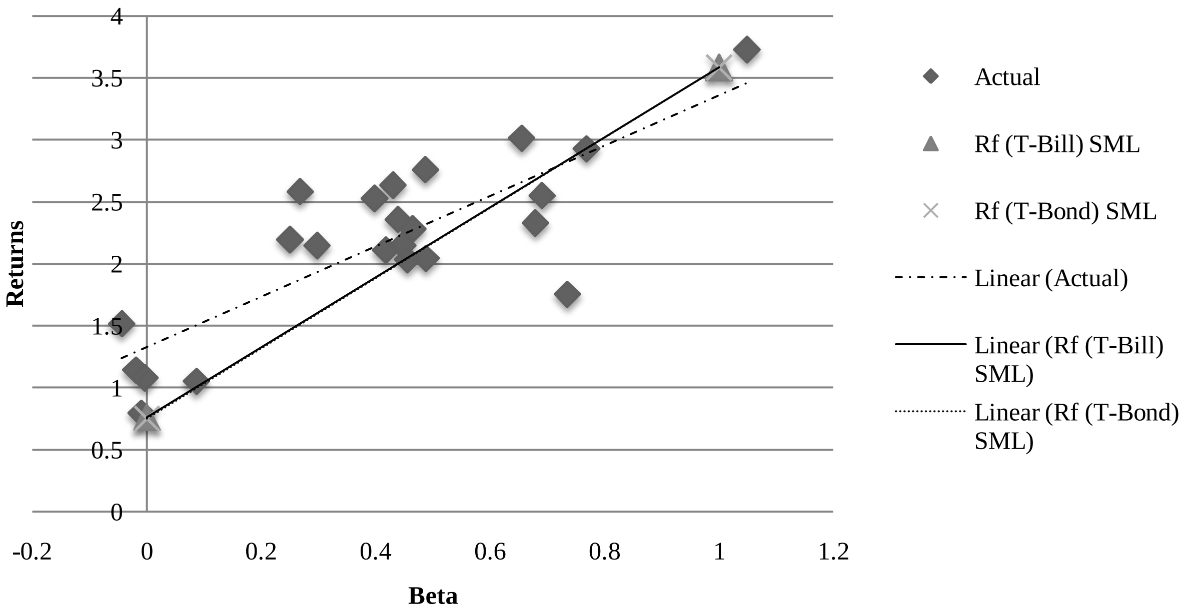

Figure 3. Actual versus theoretical SML (based on risk-free rate proxies) using all asset classes, 2001-2008.

the international studies discussed previously such as the early work of Black et al. (1972), Fama and MacBeth (1973) and Stambaugh (1982) and more recently Fama and French (2004)for the U.S. and Gao and Huang (2004) for the U.K. that the minimum required return exceeded the risk-free proxy yields. However, it does contrast with the previous South African studies of Bradfield et al. (1988) and van Rhijn (1994) and some empirical research on Japan (Gao and Huang, 2004) and a comparable developing market of India (Lazar and Yaseer 2010). The difference in the findings of this study compared to previous South African research could possibly be attributed to the limited samples used by Bradfield et al. (1988) and van Rhijn (1994) or the choice of risk-free rate proxy[1]; however, they may also reflect changes in the South African market over time.

In Figure 3, the actual and theoretical SMLs are plotted for the period 2001 to 2008 including the preference share and bond portfolios. The inclusion of these two additional asset classes had no impact on the relationship between the risk-free rate proxy yields and the minimum required return. Thus, the expansion of the analysis to include preference shares and bonds revealed that the results of this study were robust to the choice of asset class and sample. As mentioned previously, it is apparent from Figure 3 that the preference share and bond portfolios were clustered around the zero-beta mark on the horizontal axis; thereby contributing to the more efficient intercept estimates.

The direct implication of this finding is that the use of a proxy to measure the risk-free rate in the CAPM is inappropriate. As mentioned previously, one possible reason that is propagated for the finding that the minimum return actually exceeds the risk-free rate proxy is because the proxy used does not reflect the costs associated with borrowing and lending. Sharpe (1964:434) assumed that investors could borrow and lend without restrictions at the risk-free rate; an assumption he documents as “highly restrictive and undoubtedly unrealistic”. Lakonishok and Shapiro (1994) document that the finding that the intercept of the SML exceeds the risk-free rate is not consistent with the traditional CAPM. They argue that this finding may be consistent with the zero-beta version of the CAPM, but to obtain definitive evidence for the South African context it is necessary to examine the results of the second hypothesis of this study.

Hypothesis two

The statistics computed for the second hypothesis, also shown in Table 2, were insignificant for all periods, except 1998 to 2002[2]; thereby revealing that the minimum-variance zero-beta portfolio returns, in general, were not significantly different from the minimum required return. This result mirrors the findings of Morgan (1975) who found that the minimum variance zero-beta portfolio returns closely approximated the minimum return required by investors. Further to this, Grinold (1993:33) also finds that the zero-beta model does well at

[1]The different methods of sorting shares into portfolios cannot account for the different results, as the analysis in this study was repeated using the beta-sorting procedure and identical results were obtained.

[2]This discrepancy may be a result of the disruption to the risk-return relationship discussed previously.

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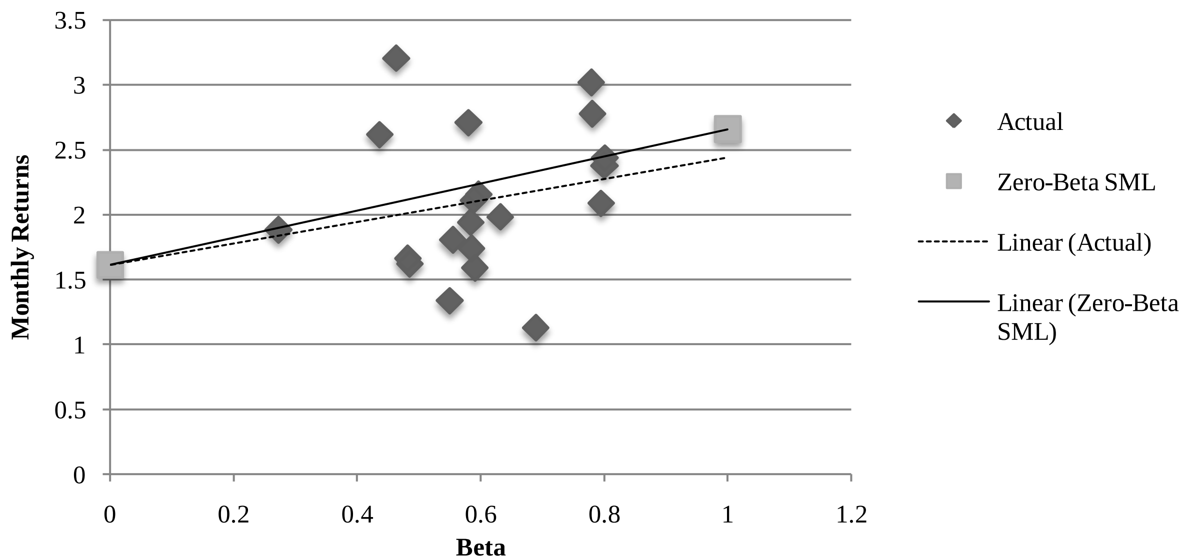

Figure 4. Actual versus theoretical SML (based on the zero-beta portfolio) using ordinary shares, 1993-2008.

explaining the return generating process of shares.

Figure 4 shows the same data points and implied SML as Figure 2; however, the theoretical SML is based on the minimum-variance zero-beta portfolio return. This graph confirms that it was not possible to distinguish between the estimated intercept and the zero-beta portfolio return; that is, the zero-beta portfolio return provided a good estimate of the minimum return. It was also evident that even with the use of the zero-beta portfolio return, the market risk premiums were not identical (the slopes of the SMLs differ), but these differences were not found to be significant. In addition to this, as can be seen from panel B of Table 2 and Figure 5, the results of hypothesis two were also robust to the inclusion of preference shares and bonds in the sample.

The results of hypothesis one and two thus infer that the use of a proxy for the risk-free rate was not appropriate in South Africa and that the minimum-variance zero-beta portfolio returns should be considered as a more appropriate measure of the risk-free rate. This conclusion certainly differs from previous work in this area in South Africa, most notably that of Bradfield et al. (1988), where they concluded that a proxy was an appropriate measure of the risk-free rate.

However, this finding does conform to several international studies. Accordingly, in international research the zero-beta rate is favoured over the use of a proxy to measure the risk-free rate (Sun and Yang, 2003), with He and Shi (2008) attributing this to the fact that the zero-beta rate provides a more realistic representation of the true riskless rate. Accordingly, the results of this study provide strong evidence to suggest that the return on the minimum-variance zero-beta portfolio should be employed as a measure of the risk-free rate in applications of the CAPM in South Africa rather than a T-Bill or T-Bond.

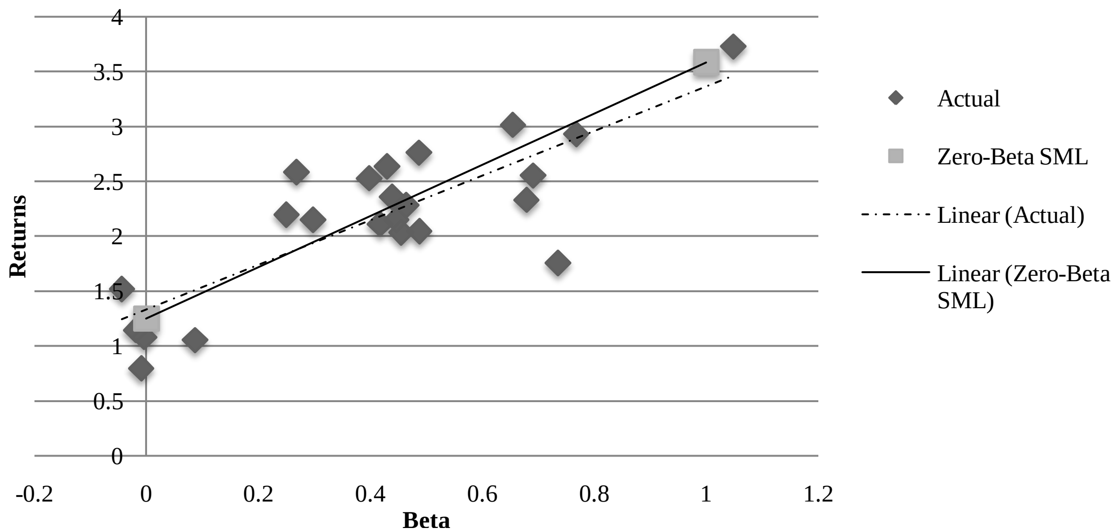

Figure 5. Actual versus theoretical SML (based on the zero-beta portfolio) using all asset classes, 2001-2008

Conclusions and Implications

In the majority of international studies, it has been documented that the short-term T-Bill understates the minimum required return. However, in two previous South Africa studies by Bradfield et al. (1988) and van Rhijn (1994) contrasting results were obtained, with the proxy not significantly understating the minimum return in the first and with the proxy overstating the minimum return in the second. This paper thus sought to resolve this South African risk-free rate anomaly by conducting an updated test of the relationship between the implied minimum return and the most commonly used proxies, as well as to provide a more direct test of the suitability of the minimum-variance zero-beta portfolio returns.

A more comprehensive sample and a longer time horizon were considered compared to the previous South African analyses and a different approach was also employed to allocate shares to portfolios. The CAPM was found to hold across the entire period and various sub-periods, confirming that this is a good tool for practitioners to estimate the cost of equity. The results also revealed that the risk-free proxy yields, similarly to international studies, understate the true minimum return required by investors whilst the minimum-variance zero-beta portfolio returns closely approximated the intercept of the SML over the period 1993 to 2008.

These findings thus reveal that the relationship between the risk-free proxies and the minimum required return does not differ in South Africa, contradicting previous research. The difference in findings may be as a result of limitations in the sample sizes used in previous studies, limitations in the methodology employed or simply the fact that the South African market has changed structurally since 1994. The fact that the minimum return exceeds the yields on T-Bills and the R157 government bond suggests that these instruments are not the best proxies for the risk-free rate. Further research, however, is required to quantify the impact of the incorrect specification of the risk-free rate in the CAPM on the reliability of the cost of equity estimates calculated. The finding that the minimum-variance zero-beta portfolio provides a better estimate of investors' actual minimum required rate of return has important implications for all practitioners and researchers who use the CAPM and indicates that Black's zero-beta approach may be more appropriate than the current practise of relying on government securities as proxies for the risk-free rate.

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