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MARKET DERIVED CAPITAL ASSET PRICING MODEL – COST OF EQUITY CAPITAL IN A SOUTH AFRICAN CONTEXT

by

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DECLARATION

I, Samuel William Chivaura declare that the research work reported in this dissertation is my own, except where otherwise indicated and acknowledged. It is submitted for the degree of Master of Management in Finance and Investment at the University of the Witwatersrand, Johannesburg. This thesis has not, either in whole or in part, been submitted for a degree or diploma to any other universities.

_____ _____

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ABSTRACT

The Capital Asset Pricing Model (CAPM) is widely used in estimating cost of equity capital. CAPM relies on historical data to estimate beta which is subsequently used to calculate ex-ante returns. Several authors have highlighted anomalies with CAPM and have proposed various models that capture these anomalies. This study investigates the Market Derived Capital Asset Pricing Model (MCPM), an ex-ante model that uses traded option premium prices and implied volatility to determine ex-ante equity risk premium used in estimating cost of equity capital. The implied volatility captures future market risk expectation of a firm. This is of importance to corporate managers who need to establish appropriate hurdle rates when making capital budgeting decisions. Additionally, investors need to determine expected returns based on future risk outlook of an investment. Using data from the South African Johannesburg Stock Exchange (JSE) listed firms', a comparison of cost of equity capital estimates was done using CAPM, Fama and French Three-Factor Model and MCPM. The results show MCPM's yields higher estimates compared to CAPM and Three-Factor Model.

Table of Contents

List of Figures v
List of Tables v
1 Introduction 1
1.1 Background 1
1.2 Problem Statement 2
1.3 Research Objectives 3
1.4 Significance of Study 3
1.5 Overview of Methodology 4
1.6 Outline of Study 4
2 Literature Review 5
2.1 Capital Asset Pricing Model (CAPM) 5
2.1.1 Markowitz Modern Portfolio Theory 5
2.1.2 Capital Asset Line 8
2.1.3 Capital Asset Pricing Model (CAPM) 10
2.2 Three Factor Asset Pricing Model 16
2.2.1 Arbitrage Pricing Theory Model 16
2.2.2 Fama and French Three Factor Model 17
2.2.3 Three-Factor Model Criticism and Responses 19
2.3 D-CAPM – extension of CAPM to emerging markets 20
2.3.1 Significant Emerging Markets Asset Pricing Models 22
2.4 Market-Derived Capital Asset Pricing Model (MCPM) 24
2.4.1 Black-Scholes Options Pricing Formula 26
2.4.2 MCPM equity risk premium 28
2.5 Valuation based Equity Risk Premiums 30
2.5.1 Dividend Discount Model 30
2.5.2 Free Cashflow to Equity (FCFE) Model 31
2.6 Conclusion 32
3 Data and Research Methodology 33
3.1 Data 33

3.2 CAPM Research Methodology 34
3.3 Three Factor Model Methodology 36
3.4 MCPM Methodology 38
3.5 Research Limitations 39
4 Results 41
4.1 Introduction 41
4.2 CAPM 41
4.3 Three Factor Model 43
4.4 MCPM 46
5 Conclusion 50
6 References 52

List of Figures

Figure 2.1: Markowitz Efficient frontier and Indifference curves..... 7
Figure 2.2: Efficient Frontier and Capital Allocation Line 9
Figure 2.3 Security Market Line and Efficient Frontier 10
Figure 2.4: Zero Beta portfolio and efficient frontier curve 12
Figure 2.5: USA bond yield and General Electric credit spread on fixed coupon bonds.....25
Figure 2.6 Long call and long put payout profile 26
Figure 4.1: MCPM and CAPM cost of equity estimates 48
Figure 4.2: MCPM and 3F model cost of equity estimates 49

List of Tables

Table 3.1: Sources of Data.....33
Table 4.1: Descriptive Statistics of portfolio excess returns 41
Table 4.2: Estimated portfolio beta and alpha parameters 42
Table 4.3: Summary of second pass regression.....43
Table 4.4: Average raw returns for the S/L, S/M, S/H, B/L, B/M, B/H, SMB and HML.....44
Table 4.5: CAPM results on portfolios sorted on size and value 44
Table 4.6: Three factor model regression results 45
Table 4.7: List of corporate bonds used in the MCPM study.....46
Table 4.8: MPCM and CAPM cost of equity estimate 47
Table 4.9: MPCM and 3F model cost of equity estimate 49

1 INTRODUCTION

1.1 Background

Firms that embark on new capital projects or investments need to determine if these projects add value to the firm and ultimately to the shareholder as part of the capital budgeting process. To determine a project's worth, the discount cashflow (DCF) valuation methodology is applied, where the project's future cashflows are discounted by an appropriate discount rate. This approach is most widely used in South Africa by corporate financiers (PriceWaterHouse Coopers, 2010). The appropriate discount rate is the weighted average cost of capital (WACC) when a project's risk profile is similar to that of the firm (Firer, 1993). WACC is computed by applying appropriate weights to firm's after-tax cost of debt capital and cost of equity capital. Fink (2003) states that an incorrect WACC estimate can result in a firm not rejecting projects that could add value to shareholder's wealth if the cost of funds was lower. The cost of debt is the rate of return the firm's debt holders require and can be observed directly or indirectly in capital markets (Ross, Westerfield and Jordan, 2001, p424).

The focus of this study is on cost of equity capital which is the required rate of return by the equity investor and is not observable as it is future oriented (Firer, 1993). The Capital Asset Pricing Model (CAPM) derived by William Sharpe in 1964 is the most widely used model to estimate cost of equity capital by investment professionals in South Africa (PriceWaterHouse Coopers, 2010) given its intuitive way of measuring risk and expected returns.

One of the model inputs is beta, also known as systematic risk, computed as the co-variation of individual asset's return with market return (Sharpe, 1964). Hence, when presented with two stocks a high beta and a low beta stock, one expects a higher rate of return for the high beta stock as it is deemed riskier compared to the low beta stock.

Since an asset beta relies on correlations between itself and the market, this is useful when constructing a well diversified portfolio, however the downside is that this fails to measure the overall risk of the asset (Fink, 2003). McNulty, Yeh, Schulze and Lubatkin (2002) assert that corporate investors do not necessarily want to diversify risk, however they manage it appropriately through "sound management practices", consequently requiring a higher rate of return. Additionally, CAPM beta rely on historical data (ex post) that might not fully reflect future

risks of the firm that need to be incorporated when estimating an ex ante rate of return (Van der Berg, 2010).

In addition to corporate managers applying CAPM in capital budgeting decisions, researchers use this model in event studies to explain abnormal expected returns and test for market efficiency. CAPM is also used in analyzing investment portfolio managers' performance.

1.2 Problem Statement

Sharpe's classical CAPM has been shown to have a poor empirical record which may be linked to model's simplified assumptions (Fama and French, 2004). This model relies on historical data (ex post) in estimating beta. The estimated beta is subsequently extrapolated to calculate ex ante returns. The assumption one makes is that past performance is a good predictor of expected returns. This may not be necessarily true as there are periods in history when unreliable returns occur due to events such as changes in capital structure, merger and acquisition activity and secondary equity offerings (SEOs) (Christoffersen, Jacobs and Vainberg, 2007). Furthermore, Fink (2003) states that the predictive power of *ex post* beta has been shown to be poor with investment specialist as they regularly make adjustments to cost of equity capital that represents the investment risk. This poses a challenge to investment specialist as these adjustments may result in under/overestimation of risk which may not be proportional to the expected return. Therefore a forward looking equity risk premium is deemed to circumvent "gut feel" adjustments in estimating risk.

Another assumption of CAPM is that beta is a "catch-all" risk factor with no other priceable risk being able to explain excess equity returns. Several authors such as Basu (1977), Banz (1981), Rosenberg, Reid and Lanstein (1985), Fama and French (1992, 1993, 1996) have documented anomalies such as high price/earnings ratios, small stock capitalization (size premium), high book-to-market/value (value premium) that provide a better explanation of expected returns compared to beta. Fama and French (1992, 1993, 1996) further went on to develop a model that encapsulates the market, size and value premiums and has performed better empirically in explaining excess equity returns using US stock data. Van Rensburg and Robertson (2003) also document anomalies that are not captured by CAPM's beta when using South Africa stock market.

Given the unreliability in estimation of CAPM beta's, there is a need to explore the use of *ex ante* models in determining a more accurate estimate of cost of equity capital.

1.3 Research Objectives

The objective of this paper is to present an alternative way to estimating ex-ante equity returns. As already stated, CAPM's empirical record in estimating beta is not impeccable therefore cannot be fully relied upon to estimate ex-ante returns without making a "gut-feel" adjustment for risk that is not captured by beta.

1.4 Significance of Study

Given the recent economic turmoil of 2008 and the ensuing uncertainty in the world economy, this study is of importance to investment professionals who need to determine appropriate hurdle rates for investments that need to be undertaken. Since the majority of professionals use historical CAPM betas (PriceWaterHouse Coopers, 2010), these rates may not encapsulate the relevant risk factors which are of a forward looking nature. The current environment requires that capital be deployed in areas that maximize expected returns.

In addition, this study is of importance when measuring investment managers' performance. Several studies have shown that investment manager's alpha disappears when returns are controlled for size effect and value premium effect.

Finally, it is widely known that venture capitalists and private equity investors' require higher rates of return on equity investments compared to large stock capitalization firms. This is rational as these firms are usually smaller and deemed riskier. However Mnculty et al. (2002) show that when these investors exit these firms through listing on an exchange, the required rate of return using CAPM is lower compared to what the alternative investments investors required. Applying a Market Derived Capital Asset Pricing Model (MCPM) equity risk premium to estimate expected returns shows that investors should require a higher rate of return for the newly listed firms similar to that of alternative investment investors.

1.5 Overview of Methodology

This study's conclusions are inferred from cross sectional analysis of empirical tests done on the 160 largest JSE listed companies (determined by market capitalization). Firms that are listed on the JSE Alternative Exchange (Alt-X) are excluded from this study as they are thinly traded and relatively illiquid. The data used is from 1 January 1998 to 31 December 2010, with the data sourced from Bloomberg, McGregor BFA and Bond Exchange of South Africa (BESA) daily MTM files. Bloomberg is mainly used to source option volatility and share price data while McGregor BFA is used for accounting data. The BESA daily MTM files provide information of traded corporate bond yields.

Fama and Macbeth (1973) methodology of estimating portfolio betas and subsequently applying these to individual stocks is used in CAPM regression analysis. A further regression analysis is conducted using Fama and French (1993, 1996) three factor model. Mcnulty et al. (2002) methodology which is used to derive MCPM equity risk premiums for the listed shares, is applied in estimating ex-ante returns. These ex-ante returns are subsequently compared to CAPM and three factor model returns.

1.6 Outline of Study

In addition to the introductory chapter, the paper is structured as follows. Chapter 2 presents literature review on asset pricing models that have been developed to estimate equity required rate of returns. Furthermore, a review of the MCPM is provided. The proposed methodology and data used in the study to show if ex-ante MCPM's equity risk premium has superior predicting capabilities of ex-ante returns compared to the equity risk premium derived from ex-post asset pricing model is done in Chapter 3. Thereafter, Chapter 4 discusses the empirical results of the study and Chapter 5 provides a conclusion to the study.

2 LITERATURE REVIEW

2.1 Capital Asset Pricing Model (CAPM)

The equilibrium of exchange model, commonly known as the Capital Asset Pricing Model (CAPM) was derived by Sharpe (1964), Lintner (1965) and Mossin (1966). The model provides an elegant and insightful relationship between a financial asset's expected return and risk measure. This one factor model is based on the Markowitz (1952) and Tobin's (1958) seminal papers "*Portfolio Selection*" and "*Liquidity preference as behavior towards risk*", respectively.

Before providing CAPM's formulation and evidence of empirical work done on the model, a synopsis of Markowitz (1952) and Tobin's (1958) work will be presented.

2.1.1 Markowitz Modern Portfolio Theory

A rational investor's objective is to maximize expected returns and minimize the variability of future returns. Markowitz (1952), widely regarded as the father of modern portfolio theory, put forward a mean-variance single period model that aids an investor in achieving this objective. In deriving the model several assumptions were made and are summarized below (Schulmerich, 2012):

i. Investors are rational and seek to maximize their consumption utility function;
ii. Investors are risk averse, that is they maximize return and minimize risk;
iii. Investors are price takers;
iv. Asset returns are normally distributed and highly divisible;
v. Markets are efficient and absorb information quickly; and
vi. There are no transaction cost and taxes.

Suppose a portfolio *P* has *n* shares each with a historical return R_i, expected returns of μ_i and variance, σ_i^2. One can assume that returns are normally distributed. This is represented by the Normal distribution $R \sim N(\mu, \sigma^2)$.

The portfolio's expected return E_p is given in equation (2.1):

$$\boldsymbol{E_p = \sum_{i=1}^{n} \omega_i \mu_i} \tag{2.1}$$

and portfolio variance σ_p^2 is:

$$\boldsymbol{\sigma_p^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} \sigma_{ij} \omega_i \omega_j} \tag{2.2}$$

where

- σ_{ij} is the covariance between share *i* and share *j*.
- ω_i is the portfolio fraction held in asset *i* and ω_j is the portfolio fraction held in asset *j* subject to the condition of no short selling is allowed:

$$\boldsymbol{\sum_{i}^{n} \omega_i = 1 \quad 0 < \omega \leq 1} \tag{2.3}$$

The covariance σ_{ij} measures co-movement of shares *i* and *j*. This can be expressed in terms of returns or the correlation coefficient ρ_{ij} in equations (2.4) and (2.5):

$$\boldsymbol{\sigma_{ij} = E\{(R_i - \mu_i)(R_j - \mu_j)\}} \tag{2.4}$$

and can be also expressed in terms of correlation coefficient

$$\boldsymbol{\sigma_{ij} = \rho_{ij} \sigma_i \sigma_j} \tag{2.5}$$

As a result of correlations that occur among shares, an investor can minimize risk through diversification and maximize returns. Markowitz (1952) states that for obtainable combinations of expected returns and variance, a rational investor selects a portfolio that meets the expected-variance (E-V) rule:

i. maximize expected return for a given variance; and
ii. Minimize variance for a given expected return.

Portfolios that meet the E-V rule lie on the efficient frontier curve above point A as shown in Figure 2.1. Bodie, Kane and Marcus (1999) state that Point A on the efficient frontier curve is the global minimum variance portfolio.

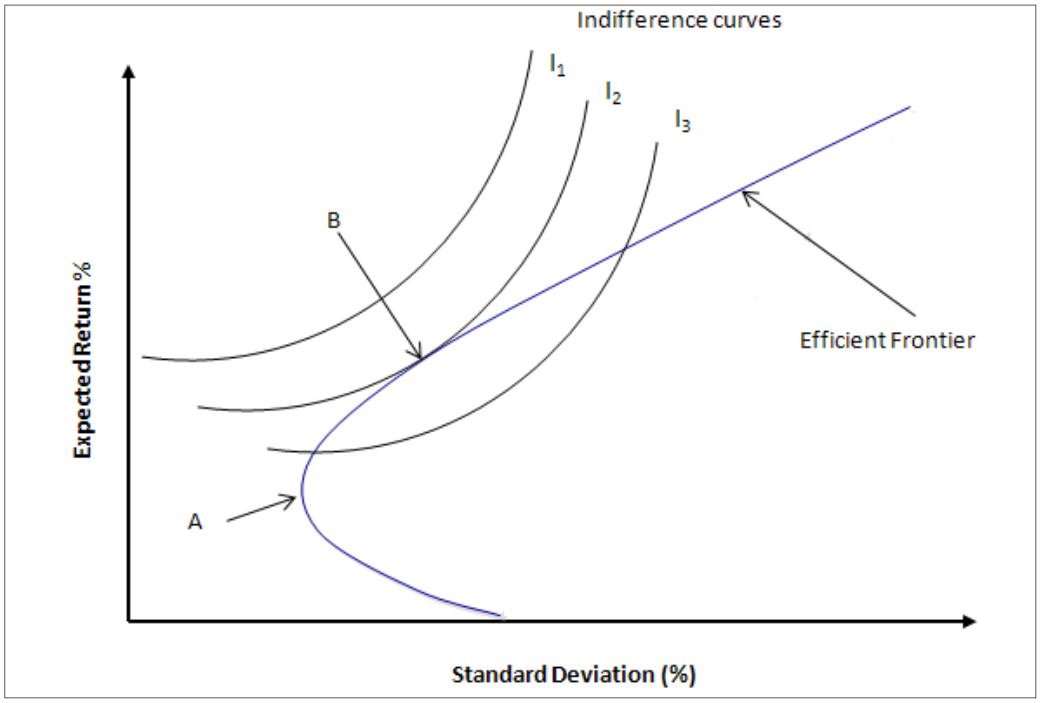


Figure 2.1: Markowitz Efficient frontier and Indifference curves

Investors have unique consumption utility functions depending on the risk appetite of the investor. These are denoted in Figure 2.1 as upward sloping curves I_1, I_2 and I_3. In addition, point B provides an optimal portfolio for an investor who seeks to maximize their utility function and invest in an efficient portfolio. This is the tangency point of the efficient frontier and indifference curves.

2.1.2 Capital Asset Line

Bodie et al. (1999) state that asset allocation between risky portfolio and risk-free asset is a technique used to control investment risk. Tobin (1958) proposed combining a risk-free asset and a risky optimal portfolio. In addition an assumption is made that the investor has unrestricted borrowing and lending at the risk free rate. The new combined portfolio's reward-variability ratio is higher than a portfolio that lies on the efficient frontier curve. Allocating of resources between the risk-free and risky asset is known as Tobin's separation theorem (Sharpe, 1964).

A portfolio C is created with a portion of wealth *y* invested in the risky portfolio and (*1-y)* in the risk-free asset. Portfolio C's expected return and variance is stated in equation (2.6) as:

$$\begin{aligned} \boldsymbol{E(R_c)} &= \boldsymbol{(1-y)R_f + y\left[E\left(R_p\right)\right]} \\ &= \boldsymbol{R_f + y\left[E\left(R_p\right) - R_f\right]} \\ \sigma_c &= y\sigma_p \end{aligned} \tag{2.6}$$

where

- R_f is the risk free-rate
- $E\left(R_p\right)$ is the expected return of the risky portfolio
- $E(R_c)$ is the expected return of the combined risky portfolio
- σ_p is the standard deviation of the combined risky portfolio
- σ_c is the standard deviation of the combined risk-free asset and risky portfolio

Substituting for *y* in equation (2.6) gives rise to equation (2.7) for which an investor expects to receive a risk free return plus the risk premium associated with investing in the risky portfolio:

$$\boldsymbol{E(R_c) = R_f + \frac{\sigma_c}{\sigma_p}\left[E\left(R_p\right) - R_f\right]} \tag{2.7}$$

This linear relationship is depicted in Figure 2.2 which graphs portfolios derived from possible combinations of the risky portfolio and risk-free asset by varying *y*. This relationship is called the Capital Allocation Line (CAL). The slope of CAL is a measure of excess return per unit of risk (also known as the Sharpe Ratio). The CAL that is tangent to the efficient frontier provides the

highest expected Sharpe ratio. The portfolio that resides at this tangency is called the optimal risky portfolio (point C).

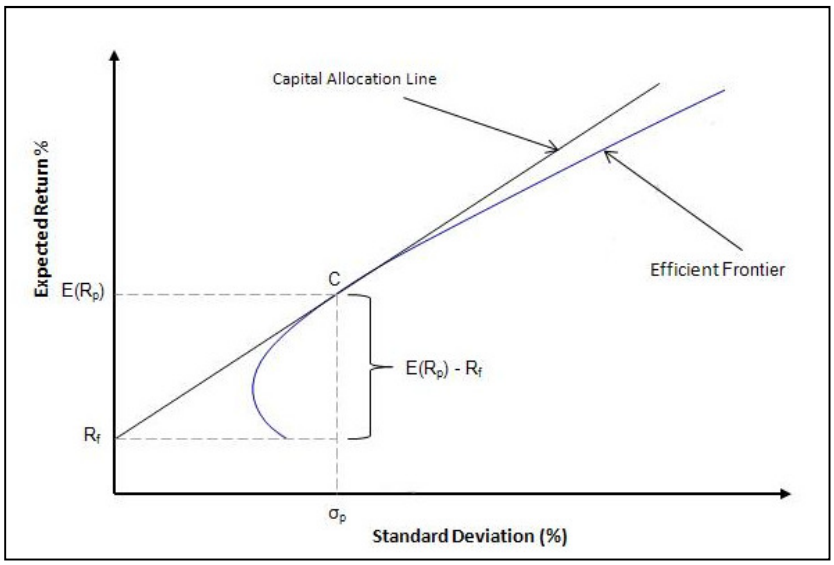


Figure 2.2: Efficient Frontier and Capital Allocation Line

At market equilibrium, investor's expectations are homogenous (Sharpe, 1964). This means all investors have the same expectation about asset returns, efficient frontier and CAL. As a result, an aggregation of all the investors' optimal risky portfolios represents the market portfolio. The CAL becomes the Capital Market Line (CML) and the expected return of the optimal risk portfolio becomes:

$$\boldsymbol{E(R_c) = R_f + \frac{\sigma_c}{\sigma_m}\left[E(R_m) - R_f\right]} \tag{2.8}$$

where

- $E(R_m)$ is the expected return of the market portfolio
- σ_m is the standard deviation of the market portfolio

2.1.3 Capital Asset Pricing Model (CAPM)

Sharpe-Lintner CAPM Model

Sharpe (1964), Lintner (1965) and Mossin (1966) enhanced the work on portfolio selection and the risk/return relationship framework that had been done by Markowtiz (1952) and Tobin (1958) to develop the one factor CAPM. The model provides a "*market equilibrium theory of asset prices under conditions of risk"* as stated by Sharpe (1964).

In deriving the model at equilibrium, Sharpe (1964) added more assumptions to those used in deriving the mean-variance Markowitz (1952) model. These assumptions were:

i. The pure rate of interest at which investors can borrow or lend is equal.
ii. Investor's expectations are homogenous.

Since the model is at equilibrium, a rational investor invests in the market portfolio that lies on the efficient frontier curve. The allocation of wealth between the risky asset and risk-free asset as described above also applies in formulation of the model. Figure 2.3 below shows the Security Market Line (SML) that provides the relationship of expected return of a single asset to its beta. The mathematical representation is given in equation (2.9).

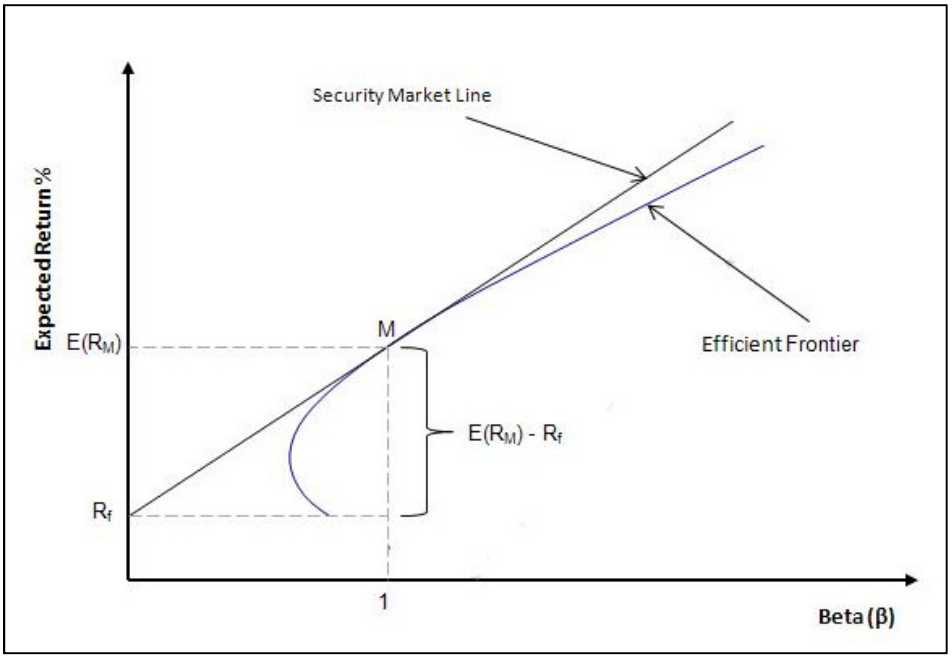


Figure 2.3 Security Market Line and Efficient Frontier

$$\boldsymbol{E(R_i) = R_f + \beta_i\left[E(R_m) - R_f\right]} \quad (2.9)$$

where

- $E(R_i)$ expected rate of return on i^{th} asset;
- R_f is the risk free rate of return;
- $E(R_m)$ is the expected rate of return on market portfolio;
- beta (β) is the measure of co-movement of security *i* and the market relative to risk of the market. This is also known as systematic risk. β is defined as follows:

$$\boldsymbol{\beta = \frac{cov(R_i, R_m)}{var\,(R_m)} = \frac{correl(R_i, R_m).stdev(R_i)}{stdev(R_m)}} \quad (2.10)$$

Equation (2.9) shows that expected return has a positive linear relationship to beta. Hence an investor is compensated for taking systematic risk that cannot be diversified. The slope of Figure 2.3 is the risk premium of the market portfolio with point M showing the market portfolio expected return when β = 1.

Black Model

The CAPM assumption of borrowing and lending at the risk free rate is an unrealistic assumption in the real economy. This assumption is necessary for all investors to be invested in the market portfolio on the CML. The proxy used for risk free rate is either the short term one month or three month government issued Treasury Bill (T-bill). Bodie et al. (1999) posit that T-bill real values are exposed price risk from inflation fluctuations, therefore the T-bill is not a risk-free instrument.

Black (1972) developed a model that assumes no risk free asset is available and unrestricted short selling is permissible. The assumption of unrestricted short selling is unrealistic in the real world as regulators have restrictions on short selling. Black (1972) recognizes this real-world constraint on short-selling; however he further claims that restrictions would not adversely impact the model. The model is also based on all the other assumptions of the Sharpe-Lintner CAPM.

Sharpe (1970) demonstrated that any mean-variance efficient portfolio can be derived from a combination of two basic portfolios by altering their weights. The basic portfolio satisfies the condition stated in equation 1.3, that the sum of the weights must equal one. Therefore one can create a minimum-variance efficient portfolio by combining an efficient portfolio with a minimum variance portfolio. The minimum variance portfolio lies below point A in Figure 2.1.

Black's (1972) CAPM is based on the following mean-variance efficient portfolios (Bodie, at. al 1999):

1. Portfolios created by combining efficient portfolio lies on the efficient frontier
2. There is a corresponding zero beta portfolio on the minimum variance frontier for every efficient portfolio. This is shown in Figure 2.4 where portfolio M has a corresponding uncorrelated portfolio Z.
3. The expected return of an asset can be stated as a linear function of expected returns on any two frontier portfolios.

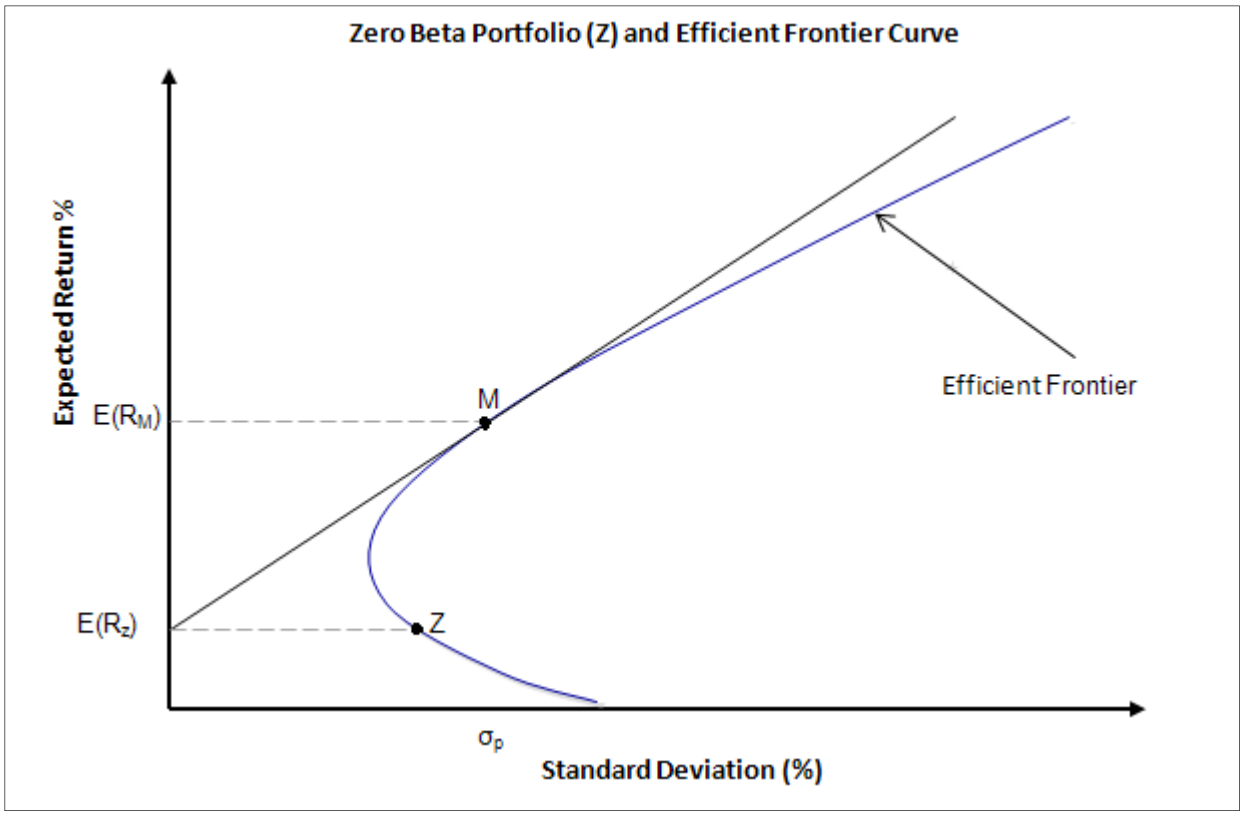


Figure 2.4: Zero Beta portfolio and efficient frontier curve

These properties allow for the Black model to be derived as shown below since the market portfolio M has a corresponding zero beta portfolio Z.

$$\boldsymbol{E(R_i) = E(R_z) + \beta_i[E(R_m) - E(R_z)]} \quad (2.11)$$

where

- $E(R_z)$ is the zero beta portfolio expected return.

Finally, Black (1972) further illustrated that when the assumption changed to unrestricted risk free lending and restricted risk free borrowing; the expected return remained as a linear function of beta albeit the new portfolio that included the risk-free asset had a lower expected return. Note that the Sharpe-Lintner model can be derived from the Black model by substituting $E(R_z)$ with the risk free rateR_f**.**

Empirical tests conducted on CAPM

Fama and Macbeth (1973) stated three testable implication of the CAPM equation (see equation (2.9)):

i. Expected returns of an asset is linearly related to its risk in the efficient portfolio M;
ii. β_i is a complete measure of risk of an asset in the efficient portfolio M; and
iii. In a universe of risk averse investors, higher risk should be associated with higher expected return; that is the beta premium is positive $E(R_m) – E(R_f) >0$.

These implications were tested using either time series or cross section regression. The regression model is defined as:

$$\boldsymbol{R_{it} - R_{ft} = \gamma_{0t} + \gamma_{1t}\beta_i + \sum_{i=2}^{n} \gamma_{it} Z_{it} + \epsilon_i} \quad (2.12)$$

where

- γ_{0t} is the zero beta rate;
- γ_{1t} is the market risk premium $R_{mt} - R_{ft}$
- Z_{it} is a vector of additional factors relevant to asset pricing, with load factor γ_{it}expected to be zero if beta is the only characteristic that holds; and
- ϵ_i is the error term.

Early researchers noticed that measurement errors arose when estimating single asset beta to explain average returns (Fama and French, 2004). To overcome this challenge, researchers estimated individual asset beta using portfolio betas[1]. This methodology has become standard practice for beta estimation in empirical analysis and is detailed in Chapter 3.

The early cross section tests by Blume and Friend (1973), Black Jensen and Scholes (1972) and Fama and Macbeth (1973) using US stock data showed that the intercept (γ_{0t}) was consistently greater than R_f (proxied by a 30 day US Treasury bill rate). In addition the β coefficient was "flat" even though there was a positive relation between beta and average returns. Furthermore, Fama and French (2004) updated the sample period from 1928 – 2003 on US stock data and documented results that were contradictory to the early empirical results. The authors showed that cross sectional average returns on low beta portfolios were higher than expected and the high beta portfolios had lower than expected returns.

Fama and Macbeth (1973) tested for linearity by adding a squared beta term to the regression model and results showed that the data supported CAPM. In the late 1970's a study on the relationship between stock returns and price-to-earnings (P/E) ratio by Basu (1977) indicated that stocks with low P/E ratio provided a higher than average stock return than stocks with high P/E ratio.

Banz (1981) reported a size effect anomaly that was not captured by CAPM beta. The size effect was notable when stocks were sorted in order of market capitalization (size); stocks with low market capitalization had higher than average return compared to large market capitalization stocks. Rosenberg, Reid and Lanstein's (1985) study of US stock data and Chan, Hamao and Lakonishok's (1991) study of Japanese data revealed that high book-to-market equity (BE/ME) stocks "distressed stocks" had higher average returns compared to stocks with low BE/ME. The high BE/ME stocks are generally deemed as value stocks with low BE/ME stocks as growth stocks. Several researchers have gone ahead to study value premium in stocks based on this ratio.

Debondt and Thaler (1985) documented stocks with poor returns over three to five years "losers" had higher returns in the next three to five years when compared to stocks that had high returns over past similar period "winners". This was supported by Chopra, Lakonishok and Ritter (1992) having controlled for size and beta. Jegadeesh's (1990) study of US stocks for the period

[1] Fama and Macbeth (1973) were not the first to use portfolio beta to estimate individual security beta. The authors state that Blume (1970) first recognized this technique followed by Black, Jensen and Scholes (1972).

1934 – 1987 revealed that stocks with high returns over past few months continue this during the next month. This is known as the momentum effect. Further empirical work by Jegadeesh and Titman (1993) showed that short term winners outperform short term losers after constructing portfolios of long winners and short losers in a three to twelve month periods. Subrahmanyam (2010) provides a summary of various authors who have documented evidence of momentum effect.

Bhandari (1998) found empirical evidence illustrating firms with high debt-to-equity ratio (leverage) had higher than expected stock returns in contrast to lower levered firms. This anomaly was still evident after controlling for size and beta.

Van Rensburg and Robertson (2003) using JSE data from 1990 to 2000 illustrated that several ratios such as price-to-profit, price-to-NAV, return-on-equity, return-on-asset, retention ratio and those mentioned above provided explanatory power in explaining expected returns. Fama and French (2004) concluded it was not surprising that ratios involving stock prices offer information on expected returns since each ratio numerator variable was a scaling factor of price. For high returns one would expect the stock to have low price and high discount rate applied to expected future cashflows.

Roll's Critique – Bad Market Proxy

Roll (1997) pointed out that CAPM was not testable because there was no true market portfolio. Market portfolios such as JSE ALSI and S&P 500 are proxies of the true portfolios. In addition, for CAPM to be tested the market portfolio must be mean-variant efficient. This condition has implication on the entire hypotheses testing of CAPM such as linearity. Since a true market portfolio does not exist, the author further argues that there is a likelihood of the proxy market portfolio being mean-variance efficient with the true market portfolio being inefficient.

2.2 Three Factor Asset Pricing Model

CAPM is a single factor model with beta being the only variable explaining expected returns. The short-comings of the single factor model led to the development of the multifactor models. This section provides a primer on Arbitrage Pricing Theory Model (APT) and thereafter the Fama and French three factor model which is linked to multi-factor asset pricing is discussed.

2.2.1 Arbitrage Pricing Theory Model

Ross (1976) proposed a multi-index pricing APT model based on the law of one price, which is less restrictive than CAPM's financial market equilibrium requirement and quadratic utility function. In addition APT does not require a market portfolio to derive the relationship between expected returns and beta. The APT model assumes that there are *n* systematic factors that affect asset returns. Since these factors are not correlated, all unsystematic risks related to the n factors are diversified away. The APT model is:

$$\boldsymbol{E(R_i) = R_f + \beta_{i1}\lambda_1 + \beta_{i2}\lambda_2 + \cdots + \beta_{in}\lambda_n + \varepsilon_i} \tag{2.13}$$

where

- $E(R_i)\ and\ R_f$ are defined as before;
- β_{in} is the sensitivity of asset *i* to the risk factor *k;*
- λ_n is the common factor with a zero mean that influences the returns on all assets; and
- ε_i is the error term with mean of zero.

When APT model has a one factor $\boldsymbol{\lambda_1}$ defined as the market risk premium, this becomes the single index CAPM.

APT model assumptions are:

i. asset returns can be described by a linear factor model;
ii. there are sufficient assets in the market to diversify idiosyncratic risk; and
iii. arbitrage opportunities do not exist.

Since no specific factors are defined for APT there is no consensus which factors are appropriate to use in explaining expected returns. For example, Chen, Ross and Roll (1986) use the APT model to test if macro-economic variables such as inflation, industrial production and spreads between long and short term interest rates explain stock returns. In contrast Van Rensburg and Slaney (1997) in pricing risk on the JSE propose a two factor APT model using market indices, the JSE Industrial and All-Gold indices.

2.2.2 Fama and French Three Factor Model

As stated in the prior section above, during the 1980's several authors performed empirical tests on CAPM that resulted in anomalies being identified, illustrating that average stock returns were not explained by the model. This work laid a platform for Fama and French (1992) to synthesize these results and perform a joint test of β, size, E/P, leverage and BE/ME to explain cross-section expected stock returns. Using US stock data[2] from 1963-1990 available on the COMPUSTAT and Centre of Research in Security Prices (CRSP) databases and applying Fama and Macbeth (1973) methodology in estimating single stock beta by calculating portfolio beta's. The joint test excluded financial firms as they are highly leveraged. The study revealed that

i. β had a poor relationship to average stock returns;
ii. leverage's relationship to average returns was captured by BE/ME; and
iii. E/P relation to average returns was explained by both size effect and BE/ME.

Using these results, Fama and French (1993) proposed a three-factor (3F) asset pricing model that captures the variation of these anomalies to average stock returns. The 3F model is stated in the equation that follows:

$$\boldsymbol{E(R_i) = R_f + \beta_i\left[E(R_m) - R_f\right] + \beta_{si}[SMB] + \beta_{hi}[HML]} \tag{2.14}$$

where

[2] US stock data used came from the New York Stock Exchange (NYSE), American Stock Exchange (Amex) and National Association of Securities Dealers Automated Quotations (NASDAQ).

- *SMB* is small minus big, that is the difference in portfolio returns of small stocks and portfolio returns of large stocks;
- *HML* is high minus low, that is the difference in portfolio returns of high BE/ME stocks and portfolio returns of low BE/ME stocks;
- β_{si} and β_{hi} are load factors (slopes) for SMB and HML respectively obtained using linear regression.

The 3F model was supported by strong empirical evidence. The regression model indicated an intercept of zero and an ability to capture the variation of average stock returns for portfolios formed on size and BE/ME (Fama and French, 1993 and 1996). In addition they demonstrated average return on portfolios constructed using price ratios which were captured by the model. Furthermore, there was evidence from the model that value stocks (stocks that tend to have high price ratios) have a positive HML slope with the converse being true for growth stocks implying lower average returns for growth stocks. Large market capitalization stocks have negative SMB slope and small market capitalization stock a positive value implying higher average returns for small sized stocks. Finally the model was able to capture the reversal of long term average returns as "losers" have positive SMB and HML slopes with "winners" having negative SMB and HML slopes. Unfortunately the model is not able to explain the momentum effect documented by Jegadeesh and Titman (1993). Fama and French (2004) state that momentum effect is short-lived therefore has relatively no impact on estimation of cost of equity.

The theoretical backing for the 3F model is not as well constituted as that CAPM. Fama and French (2004, p39) state the SMB and HML variables are:

"*brute force constructs meant to capture the patterns uncovered by previous work on how average stock returns vary with size and book-to-market equity*."

In light of 3F's model empirical backing, Fama and French (1996) suggest that the model is an equilibrium pricing model with SMB and HML being systematic risk variables that satisfy the APT model of Ross (1976) and inter-temporal CAPM (I-CAPM) model of Merton (1973).

2.2.3 Three-Factor Model Criticism and Responses

The work of Fama and French (1992 and 1993) resulted in ensuing debate from several researchers disputing the results of the 3F Model.

Data Mining

One of the initial challengers to the three factor model was Black (1993) who argued that the empirical results of the three factor model were due to data mining since the variables for size effect and value premium were based on prior studies to which there is lack of underlying theory. The data mining problem was also supported by Mackinlay (1995).

A solution to tackle the data mining problem is to use out-of-sample data in empirical research. An out-of-sample study was conducted by Davis (1994) using US stock data prior to 1963 and illustrated that the value premium provided an explanation to average stock returns. In addition, further out-of-sample tests done by Chan et al. (1991) and Capaul, Rowley, & Sharpe (1993) using Japanese and European stock data, respectively, supported the three factor model. Recently, Basiewicz and Auret (2010) using JSE data 1992 to 2005 revealed that the 3F model can be used to estimate expected returns.

Survivor Bias

Kothari, Shanken and Sloan (1995) argued survivor bias existed in COMPUSTAT database. The construct of the database is such that on the day a firm is added to the database the firm must be in existence. The firm's accounting history of prior years is also added to the database. Firms that no longer exist are not added to the database even if they have prior years' accounting history. This results in statistical selection bias as the COMPUSTAT database includes firms that have survived with a high book-to-market equity value; therefore, they have higher average stock returns. To overcome this challenge, Kothari et al. (1995) use Standard & Poor's industry level stock data for the period 1947 to 1987. Their results showed that book-to-market equity provides no significant explanatory power to average returns. The authors conclude by saying: "*A useful pricing model must be trusted to work under a wide variety of conditions and not just for a limited set of portfolios*."

In response to the survivorship bias criticism, Chan, Jegadeesh and Lakonishok (1995), using the COMPUSTAT and CRSP databases, concluded that there was not enough evidence to show survivorship bias impacted Fama and French (1992) results. Furthermore, Fama and

French (2006) used data free from survivor bias and confirmed that the value premium existed in US stock data.

In addition to the survivorship bias, Kothari et al. (1995) also dispute that using monthly data is appropriate in calculating beta since typical investors have long investment horizons. The authors estimate beta using one year data and their results reveal that the annually estimated betas provides a better explanation to average returns compared to monthly estimated betas. Additionally they do not contest the fact that size provides explanatory power to average returns. In contrast, Fama and French (1996) show that annual and monthly betas provide the same inferences about explaining expected returns.

Finally, anomalies in asset pricing are described by behaviouralist as real but irrational. The irrational behaviour of investors results in over/under-reaction, therefore high returns for values stocks and low returns for growth stocks (Fama and French, 2004). Lakonishok, Shleifer and Vishny (1994) argue that the negative relationship between stock returns and financial performance ratios that is evident in their study is a result of investor extrapolating past performances. Subrahmanyam (2010) summarizes research conducted by several behaviouralists who assert that investor irrationality causes the anomalies' observed in asset pricing.

2.3 D-CAPM – extension of CAPM to emerging markets

CAPM equilibrium is based on an investor's ability to maximize the utility function dependant on mean and variance of returns as described earlier. Estrada (2002) questions the validity of variance as a measure of risk since numerous researchers have shown that stock return distributions are asymmetric and not normally distributed. Researchers such as Fama (1965) using US stocks, Aparicio and Estrada (2001) using European stocks and more recently Mangani (2007) using South African stock provide evidence that stock returns distributions are asymmetric.

As a result of the asymmetry in returns Estrada (2002) proposed semivariance of returns as a measure of risk. The author justified semivariance as there is high correlation between mean-variance utility function and the mean-semivariance utility function. In addition he states "*investors do not dislike upside volatility only dislike downside volatility*" (Estrada, 2002; p. 366).

Semivariance as a measure of risk was originally proposed by Markowitz in his 1959 book "Portfolio Selection: Efficient Diversification of Investments". However this measurement was not used in earlier literature in modern finance theory because semivariance was relatively unknown compared to variance and computation of semivariance of optimal portfolio was costlier. With advances in technology it is relatively simple to calculate semivariance nowadays.

Estrada (2002) postulates the derivation of a downside beta based on CAPM's beta formula albeit using semivariance in the downside-CAPM (D-CAPM). The semideviation ($\sum_{\boldsymbol{i}}$) of an asset *i* and the cosemivariance ($\sum_{\boldsymbol{iM}}$) of the asset *i* to the market portfolio *M* equation is stated as:

$$\begin{aligned} \sum_{\boldsymbol{i}} &= \sqrt{\boldsymbol{E}\{\boldsymbol{MIN}[\boldsymbol{R_i} - \boldsymbol{\mu_i}, \boldsymbol{0}]^{\boldsymbol{2}}\}} \\ \sum_{\boldsymbol{iM}} &= \boldsymbol{E}\{\boldsymbol{MIN}[\boldsymbol{R_i} - \boldsymbol{\mu_i}, \boldsymbol{0}]\boldsymbol{MIN}[\boldsymbol{R_M} - \boldsymbol{\mu_M}, \boldsymbol{0}]\} \end{aligned} \tag{2.15}$$

With semidevaition and cosemivariance defined in equation (2.15), downside beta (β_i^D) is defined as:

$$\boldsymbol{\beta_i^D} = \frac{\sum_{\boldsymbol{iM}}}{\sum_{\boldsymbol{M}}{}^{\boldsymbol{2}}} = \frac{\boldsymbol{E}\{\boldsymbol{MIN}[\boldsymbol{R_i} - \boldsymbol{\mu_i}, \boldsymbol{0}]\boldsymbol{MIN}[\boldsymbol{R_M} - \boldsymbol{\mu_M}, \boldsymbol{0}]\}}{\sqrt{\boldsymbol{E}\{\boldsymbol{MIN}[\boldsymbol{R_M} - \boldsymbol{\mu_M}, \boldsymbol{0}]^{\boldsymbol{2}}\}}} \tag{2.16}$$

Equation (2.16) is analogous to CAPM's β in equation (2.10). Hence, D-CAPM is given by equation (2.17) and which is similar to CAPM equation (2.9).

$$\boldsymbol{E(R_i)} = \boldsymbol{R_f} + \boldsymbol{\beta_i^D}\left[\boldsymbol{E(R_m)} - \boldsymbol{R_f}\right] \tag{2.17}$$

Cross-sectional empirical tests conducted by the author using the Morgan Stanley Capital Indices (MSCI) monthly emerging markets data from 1988 to 2001 provides evidence in support of downside beta explaining 55% of variability in emerging market cross-section returns. Furthermore, D-CAPM expected returns were on average 2.5% higher than CAPM expected returns.

2.3.1 Significant Emerging Markets Asset Pricing Models

Estrada (2002) is not the only author to propose an asset pricing model that is relevant to emerging markets given the difference in financial markets development and depth between developed and emerging markets.

Global/International CAPM

Buckberg (1995) proposed a conditional international capital asset pricing model which is an extension of CAPM. The model is based on the premise that emerging markets have become more integrated with the global economy, therefore "emerging market returns should be proportional to the market's covariance with a world market portfolio" (Buckberg (1995); p. 56). The study conducted by the author revealed that emerging market economies were more integrated with developed economies in the late 1980's compared to the 1970's and early '80s. Pereiro (2006) summarizes the work of other authors who have the same view that markets are integrated and therefore develop a global CAPM model.

Local CAPM

This model is used for emerging markets that are segmented. This is an adaptation of CAPM with a county risk premium added to account for the specific economic, social and/or political risk for that country. The country risk premium R_C is usually computed as the difference between the country's sovereign dollar-denominated bond and the US Treasury bond with same duration (Pereiro, 2006).

$$\boldsymbol{E(R_{EM}) = R_{fG} + R_C + \beta_L\left[E(R_{ML}) - R_{fL}\right]} \tag{2.18}$$

where

- R_{EM} is the cost of equity capital for a firm in emerging markets country;
- R_{fG} is the global risk free rate;
- R_C is the country risk premium;
- β_L, R_{ML}, R_{fL} is the local firm beta, emerging market rate of return and emerging market risk free rate respectively.

Lessard Model

Lessard (1996) proposed an emerging market CAPM that combines the local emerging markets and global data to estimate the cost of equity capital of a firm in emerging markets. The model uses US data to proxy global data and pure-play methodology to estimate the local firm's cost of equity capital. Therefore there is no need for local data in estimating cost of equity capital particularly in frontier markets where data is not readily available.

$$\boldsymbol{E(R_{EM}) = R_{f,US} + R_C + \beta_{L,US} \times \beta_{US}\left[E\left(R_{M,US}\right) - R_{f,US}\right)]} \quad (2.19)$$

where

- $R_{f,US}$ and $R_{M,US}$ is risk free rate and stock market return in US market respectively;
- β_{US} is the covariance of returns for a US company that is in the same industry as the local emerging market firm to the US stock market;
- $\beta_{L,US}$ is the emerging markets country beta that is the sensitivity of emerging market stock returns to the US stock returns.

Pereiro (2006) further summarizes other asset pricing models that are an extension of CAPM. In essence, an analyst or corporate manager adjusts the CAPM model with various risk factors that need to be taken into account when making an investment or capital budgeting decision in an emerging market.

2.4 Market-Derived Capital Asset Pricing Model (MCPM)

The asset pricing models and beta estimation discussed up to this point use historical data. A central assumption in using *ex post* data to predict *ex-ante* returns is that patterns observed in history are likely to re-occur in the future. This assumption does not always hold regardless of what sophisticated model is used to forecast the expected returns.

In addition, a firm's beta is dependent on the correlation of the stock to the market and volatilities of the stock returns and the market (see equation (2.10)). A firm with low correlation with the market, results in low beta and cost of equity capital, and the converse is true for high beta stocks. This is desirable to the diversified investor who wants to reduce his portfolio's risk. However, Mcnulty et al (2002) argue that the hedge benefit derived from low correlation stocks in an investment portfolio diminishes for the focused corporate investor who assumes total risk on the investment they are undertaking. Furthermore the authors posit that the focused investor does not reduce risk by diversification; however he manages it by applying good quality management to the firm's operation, therefore expecting higher return proportional to higher risk assumed on the investment.

Mcnulty et al. (2002) propose the market derived capital asset pricing model (MCPM) that estimates equity risk premium from market traded option pricing to predict ex-ante stock returns. Implied volatility from option pricing is a forward looking metric that incorporates market expectations to a firm's ex-ante returns. Christoffersen, Jacobs and Vainburg (2007) point out that this provides improved estimation of ex-ante returns as compared to using historical data that may not include changes in a firm's operating environment even when using advanced volatility forecasting techniques such as GARCH. Other authors who have proposed the use of option prices in estimating ex-ante returns are Siegel (1995), Santa-Clara and Yang (2010), and Chang, Christoffersen, Jacobs and Vainberg (2009).

MCPM overcomes the challenge of using historical data in beta estimation. Several authors have shown that beta is sensitive to changes in time period, Jagannathan and Wang(1996) proposed a conditional CAPM that uses time varying estimates of beta. There are three types of risk an investor requires compensation for making an investment as stated by Mcnulty et al. (2002):

- The first type is national confiscation risk, measures the risk that an investor will lose the value of his or her investment because of national policy – expropriation, for instance, or confiscatory taxes or a loose monetary policy leading to runaway inflation.
- The second type, corporate default risk, reflects the additional risk that a company will default as a result of mismanagement independent of macroeconomic considerations.
- The third type, the equity returns risk, reflects the extra risk that an equity investor bears because his residual claim on the company's earnings is secondary to debt holders' claims in bankruptcy or otherwise (p. 8).

The government bond yield for a specific tenor to maturity represents compensation an investor expects for bearing national confiscation risk. Corporate credit risk premium is the spread on the government bond yield. Comparative analysis can be used to determine an appropriate yield for a firm that has not issued any corporate bonds or does not have outstanding bond issuances. GE term structure of bond yields is provided in the graph that follows.

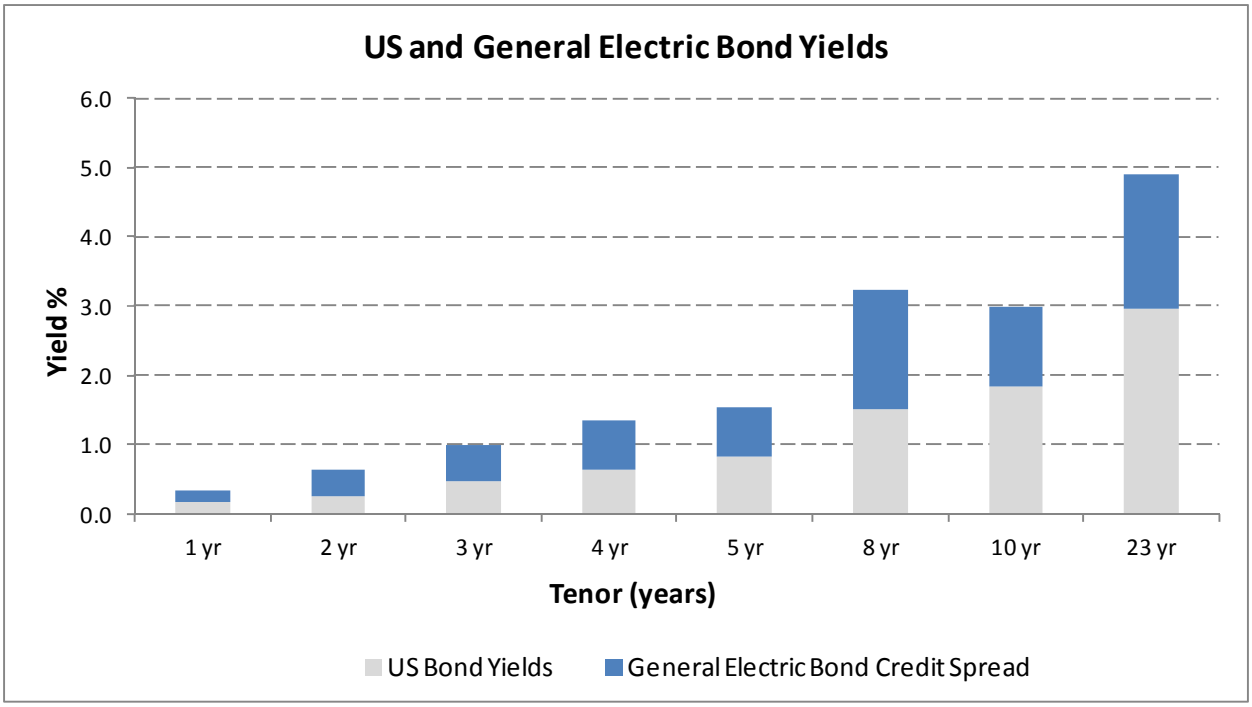


Figure 2.5: USA bond yield and General Electric credit spread on fixed coupon bonds.

Source: Bloomberg 5 February 2013

The equity returns risk represents the extra premium the shareholder requires for being the last to receive any cashflow in the event of a firm's liquidation. MCPM equity premium is derived from information in the options market. Black-Scholes options pricing formula is used to value

options and is provided in the following section. Thereafter the MCPM equity premium is presented.

2.4.1 Black-Scholes Options Pricing Formula

An option is a financial instrument that gives the holder the right and not the obligation to buy or sell the underlying asset at a pre-defined price (strike price) and a certain date (expiry date). A call option gives the holder the right to buy the underlying asset and a put option gives right to sell the underlying asset. The graph below shows the pay-off profile for a call and put options, with a strike of R50.

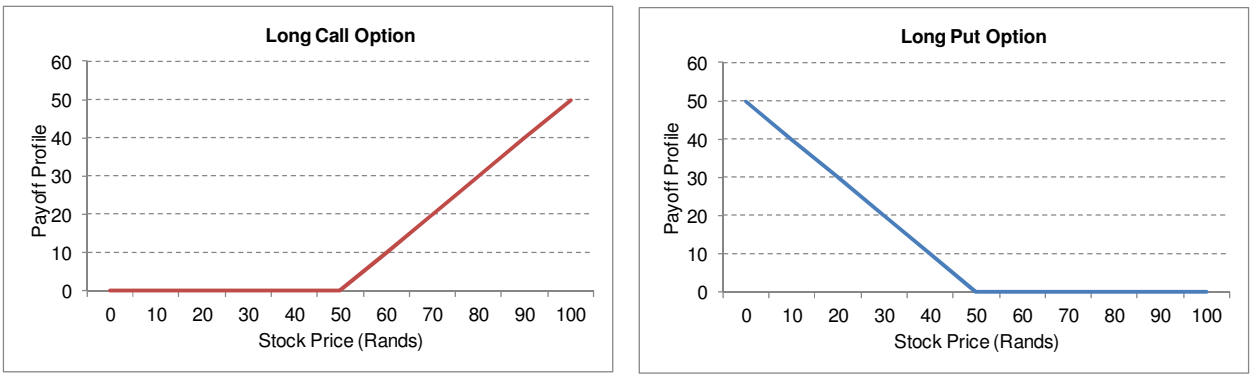


Figure 2.6 Long call and long put payout profile

Black and Scholes (1973) present the formula to value a stock option in the seminal paper "*The pricing of options and corporate liabilities".* The formula (now commonly known as Black-Scholes formula) was derived under certain "ideal" conditions (assumptions):

i. Interest rates are known and constant
ii. An investor can borrow at short term interest rate;
iii. Stock prices follow a random walk and have lognormal distribution;
iv. Stock pays no dividend and short selling is permissible; and
v. The option is European, that is, it can only be exercised at maturity.

Several studies have been done in relaxing some of these ideal conditions to reflect reality and changing market condition as presented by Hull (2010).

In order to value the price of an option, an investor can create a portfolio of a stock and zero coupon bond that replicates the payoff structure of the option. The valuation of the option is subject to risk neutral valuation where no extra return is required by an investor for bearing risk.

Hull (2010) further demonstrates that the valuation of options gives the correct price for an option in all worlds, not just the risk neutral world.

MCPM requires the price of a put option in calculating its equity risk premium. A portfolio of short stock and long zero coupon bond replicates the payoff structure of a put option. Black-Scholes formula for put option is given below as:

$$\boldsymbol{p = Ke^{-rT}N(-d_2) - S_0N(-d_1)} \tag{2.20}$$

where

$$\boldsymbol{d_1 = \frac{ln\left(S_o/X\right) + T\left(r + \sigma^2/2\right)}{\sigma\sqrt{T}}} \tag{2.21}$$

and

$$\boldsymbol{d_2 = d_1 - \sigma\sqrt{T}} \tag{2.22}$$

- p is European put option price;
- S is stock price and K is the strike price;
- r is continuously compounded risk-free interest rate;
- T is time to maturity of the option;
- σ is stock price volatility;
- *N(x)* is the cumulative probability distribution function for a standardized normal distribution.

2.4.2 MCPM equity risk premium

In order to calculate the equity risk premium the following four steps are applied:

1. Calculate the forward break-even price

Return on equity is the sum of capital gains from share price movement and dividend yield as stated in equation (2.23). Dividend yield is the firm's expected dividend divided by the current stock price. The equity investor expects a higher rate of equity return compared to the bond holder. Therefore the minimal equity capital gains return cannot be less than the difference between bond yield and dividend yield (equation (2.24).

$$\boldsymbol{r_{equity} = r_{capital\ gains} + r_{dividend}} \tag{2.23}$$

$$\boldsymbol{IR = r_{bond} - r_{dividend}} \tag{2.24}$$

where *IR* is the required minimal stock capital gain by an equity investor.

In order to realise the minimal capital gains, the equity investor expects the stock price to reach S_T for the time period T. S_T is the breakeven price.

$$\boldsymbol{S_T = S_0 \times (1 + IR)^T} \tag{2.25}$$

2. Estimate the stock future volatility

Since S_t is known, the likelihood of the current stock price not reaching the expected level needs to be esablished as the investor require compensation for the risk of underperformance. This information is available from market option prices and implied volatility. The higher the uncertainty of a firm to deliver expected cashflows in a given time period the higher the stock's volatility until the actual cashflow occurs. Volatility is estimated using the Black-Scholes equation.

3. Calculate the cost of downside insurance

The investor's target price at the end of the investment horizon is the break-even price. However there is likelihood that the target is not met, therefore the investor is willing to seek protection against the stock price falling below the break-even price. The premium paid for this protection is the value of a put option which gives the investor the right to sell the shares at the break-even (strike) price. The put option premium is calculated using the Black-Scholes equation and volatility derived in step 2. The authors (Mcnulty et al., 2002) state that this premium reflects the extra risk of equity over debt.

4. Derive the annualised excess equity returns

The put option price is expressed as an annualized premium as this represents the excess equity return.

$$\boldsymbol{E(R) = \frac{p/S_0}{\left[\frac{1}{r_{bond}} - \frac{1}{r_{bond} \times (1 + r_{bond})^T}\right]}} \quad (2.26)$$

where

- E(R) is the firm's expected return;
- p is the put option price;
- S_0 is the stock spot price; and
- r_{bond} represents the firm's bond yield for a tenor *T*.

Finally MCPM is derived by adding the excess equity return to the firm's bond rate.

MPCM Conclusion

The authors test MCPM on IBM and Apple based on the 1998 data and compared the results to those derived by using CAPM. During this time period Apple had higher stock volatility from lower earnings and market share compared to IBM whose outlook was more favourable at that time. Apple's return on cost of equity as estimated by CAPM was 8% compared to IBM's return on cost of equity of 12%. Apple's lower cost of equity was a result of the firm's lower correlation

to the market compared to IBM. Applying MCPM to Apple the return on cost of equity was 19.2% that was more consistent with the risk of firm during that time period.

Further studies done by authors on biotechnology (biotech) start-ups and established firms show that higher return on cost of equity were expected for start-up biotech firms in comparison to established biotech firms when using MCPM to estimate return on cost of equity. MCPM's estimated return on equity capital was similar to what venture capital firms expected when they were investing in these start-up firms.

Despite MPCM's relatively realistic ex-ante estimates of cost of equity capital when compared to CAPM, MCPM has its weaknesses. This model does not have the solid theoretical backing of CAPM. Also, little work has been done in further developing this model since it was proposed by its authors. Additionally applying MCPM to smaller firms is a challenge because (1) these firms do not have actively traded options on their stocks and (2) they do not have issued corporate bonds. The authors propose a "pure-play approach" by using options prices and bond yields of firms in the same industry. Despite these weaknesses MCPM remains an alternative model for estimating ex-ante returns on cost of equity capital.

2.5 Valuation based Equity Risk Premiums

An alternative approach to estimating a firm's cost of equity capital is to derive an implied expected return based on a firm's expected cashflows and current market equity value.

2.5.1 Dividend Discount Model

The equity value of a firm is the present value of expected dividends. Using the Gordon dividend discount model (DDM) where dividends are assumed to grow at a constant rate the equity value is:

$$\boldsymbol{Equity\ Value} = \frac{\boldsymbol{D_1}}{[\boldsymbol{R_e} - \boldsymbol{g}]} \tag{2.27}$$

where

- D_1 is the expected dividend to be paid per share in the next period;

- $\mathrm{R_e}$ is the required rate of equity return and g is the expected growth rate

Since the equity value, $D_1$and g are known variables one can solve for R_e . The implied equity risk premium is the difference between the required return on equity (R_e) and the risk free rate (R_f). Damodaran (2008) indicates that if one assumes dividends to grow constantly at the risk-free rate the dividend yield becomes a measure of equity risk premium. DDM is valid only for firms that pay dividends and with a constant growth in earning. Empirical tests done by Rozeff (1984), Fama and French (1988), Campbell and Shiller (1988 and 2008) on US data show that dividend yields can capture variability of expected returns. The results of these empirical tests are refuted by Goyal and Welch (2008) as they show that earlier results are spurious and unstable.

2.5.2 Free Cashflow to Equity (FCFE) Model

Given the constraint of DDM, Damodaran (2008) suggests using free cashflow to equity (that is the cashflow remaining after taxes, reinvestment needs and debt repayments) as a proxy to potential dividends. In addition the model can cater for varying growth rates. The equity value for the FCFE model is:

$$\boldsymbol{Equity\ Value} = \sum_{\boldsymbol{t=1}}^{\boldsymbol{N}} \frac{\boldsymbol{E(FCFE_t)}}{\boldsymbol{(1+k_e)^t}} + \frac{\boldsymbol{E(FCFE_{N+1})}}{\boldsymbol{(k_e - g_N)(1+k_e)^N}} \qquad (2.28)$$

where

- $FCFE_t$ is the potential dividend at time *t*;
- N is the number of high growth years;
- g_N is the constant growth rate after year N; and
- $\mathrm{k_e}$ is the required rate of equity return.

One can derive the required rate of equity return since all the other variables are known in (2.28). Finally as before, subtracting the risk free rate from the required rate of equity return gives the implied equity risk premium.

2.6 Conclusion

Valuation of risky cashflows and appropriate asset pricing models is one of the most researched topics in modern finance. One of the tenets to asset pricing is the CAPM model that has been widely tested with empirical results not completely backing its solid theoretical foundation. The Achilles heels of the model led to many researchers proposing models that capture anomalies' not captured by the CAPM's beta. *Ex post m*odels presented in this section such as the Fama and French three factor model and D-CAPM are a few of the many models researchers have proposed to estimate *ex ante* returns. However, *ex post* models based on historical data do not fully capture current market expectations. Therefore a review of *ex ante* models such as MCPM and valuation based models has been presented because these provide an alternative way to estimate expected returns.

One of these alternative MCPM is hereby proposed for consideration in this study. What follows is a description of the methodology that highlights the good points of MCAPM, particularly in comparison to CAPM-based equity returns determination.

3 DATA AND RESEARCH METHODOLOGY

This chapter provides a description of the data and methodology used in testing which model is a better predictor of cost of equity capital for publicly listed companies on the Johannesburg Securities Exchange (JSE). A study of several asset pricing models was presented in Chapter 2; however the study will be on the following models:

- CAPM;
- Fama and French Three Factor model (3F); and
- Market Derived Capital Pricing Model (MCPM).

The study focuses on these asset pricing models given that CAPM and 3F are the most widely used models when estimating cost of equity capital in South Africa (PriceWaterHouse Coopers, 2010). Hence a comparison of these two *ex-post* models to MCPM is done to determine which model provides superior estimation of cost of equity capital.

3.1 Data

The time period for the study is 2 January 1998 to 31 December 2010. Data prior to 1998 has not been considered for the study due to illiquidity on the JSE. In addition the top 160 listed JSE firms, by market capitalization, are used in this research as the smaller firms are thinly traded. Data for the purpose of this study is sourced from Bloomberg, McGregor BFA and Bond Exchange of South Africa (BESA) daily MTM files. Table 3.1 provides a summary of the data gathered from each data source.

Data Source	JSE Data Collection
Bloomberg	▪ Historical option prices and option volatility ▪ South Africa corporate bond yields
BMF McGregor	▪ Monthly Stock prices and dividends ▪ Accounting data
Bond Exchange South Africa (BESA) daily MTM files	▪ South Africa government bond yields ▪ South Africa corporate Bond yields

Table 3.1: Sources of Data

The frequency of data used is monthly similar to prior studies done by Fama and Macbeth (1973), Fama and French (1992 and 1993) and Van Rensburg and Robertson (2003). The monthly return for a stock *i is* calculated as:

$$\boldsymbol{R_i = \frac{S_{i,t} - S_{i,t-1} + D_{i,t}}{S_{i,t-1}}} \quad (3.1)$$

where *S* is the stock price and *D* is the dividend paid at time *t*.

The JSE All Share Index (ALSI) is used as the proxy for market portfolio as this index is the most comprehensive of the other JSE indices such as the JSE Top40 shares index or JSE Industrial index.

3.2 CAPM Research Methodology

The empirical form of CAPM is estimated using the cross-sectional regression for financial panel data as developed by Fama and Macbeth (1973) (hereafter, FM). The FM method estimates parameters in two steps. The first step uses ordinary least squares (OLS) method to estimate the β_i coefficient in (3.2) for each stock.

The first pass regression model for N stocks at time *t* is

$$\boldsymbol{R_{it} - R_{ft} = \alpha_{it} + \beta_i(R_{Mt} - R_{ft}) + \varepsilon_{it}} \quad (3.2)$$

where

- $R_{it} - R_{ft}$ is the excess return of stock *i* above the risk free rate;
- $R_{Mt} - R_{ft}$ is the market risk premium, the excess return of JSE ALSI above the risk free rate;
- $\alpha_{it}\ and\ \varepsilon_{it}$ are the intercept and error term, respectively.

Thereafter the estimates of β_i are used in the second pass cross-section regression with β_i being the independent variable

$$\overline{\mathbf{R}}_{\boldsymbol{i}} = \boldsymbol{\gamma_0} + \boldsymbol{\gamma_1}\boldsymbol{\beta_i} + \mathbf{u_i} \tag{3.3}$$

This cross-section regression is to test CAPM's null hypothesis H_0:

- $\gamma_0 = 0$
- $\gamma_1 = \left(R_{Mt} - R_{ft}\right) > 0$

The estimate $\hat{\beta}$ obtained from the regression analysis poses an errors-in-variables problem (Fama and Macbeth, 1973) since β_i is an estimate for the true β in equation (2.9), resulting in the OLS $\gamma_1$coefficient being downward biased and intercept γ_0 being upward biased. To mitigate this problem the authors created portfolios ranked on β_i. The next section details the creation of ranked β_i portfolios.

In conducting the two pass regression, 2 years of data are used to estimate betas since the data sample period of 12 year is relatively small. Fama and Macbeth (1973) estimated beta using five years of data as they had a large dataset 1926 - 1968.

The coefficients are aggregated for each stock to get an average regression coefficient of

$$\overline{\boldsymbol{\gamma}}_{\boldsymbol{i}} = \frac{\mathbf{1}}{\boldsymbol{T}}\sum_{\boldsymbol{t=1}}^{\boldsymbol{T}} \boldsymbol{\gamma}_{\boldsymbol{i,t}} \tag{3.4}$$

with a variance of

$$\widehat{\boldsymbol{\sigma}}^{\mathbf{2}}(\overline{\boldsymbol{\gamma}}_{\boldsymbol{i}}) = \frac{\mathbf{1}}{\boldsymbol{T}(\boldsymbol{T}-\mathbf{1})}\sum_{\boldsymbol{t=1}}^{\boldsymbol{T}} (\boldsymbol{\gamma}_{\boldsymbol{i,t}} - \overline{\boldsymbol{\gamma}}_{\boldsymbol{i}})^{\mathbf{2}} \tag{3.5}$$

The t-statistic for the coefficients is

$$\boldsymbol{t}(\overline{\boldsymbol{\gamma}}_{\boldsymbol{i}}) = \frac{\overline{\boldsymbol{\gamma}}_{\boldsymbol{i}}}{\boldsymbol{s_b}} \tag{3.6}$$

where $s_b$is the standard error of the coefficient.

Portfolio Creation

The following steps were taken in estimating portfolio beta's based on Fama and Macbeth's (1973) methodology:

1. Estimate stock beta's (β_i) for every two years, for example January 1998 – December 1999, January 1999 – December 2000, January 2000 – December 2001. The last β_i estimation will occur for the period January 2008 – December 2009.
2. Rank the β_i in descending order and group the stocks into 10 portfolios with the highest beta stock in the first portfolio for each estimation period. Since the JSE ALSI has 160 stocks each portfolio will contain 16 stocks;
3. Calculate portfolio returns for the following year based on ranked stocks for each year from year 2000 to 2010 therefore 11 portfolios returns are created.
4. Estimate portfolio beta using time series regression for each portfolio. The regression is similar to the first pass regression equation (3.2).
5. The estimated portfolio beta is allocated to stocks in each portfolio as it is assumed that the individual stocks have beta's equal to the portfolio beta.
6. Perform a second pass regression (similar to equation (3.3)) of the new stock beta (based on portfolio beta) against the stock return.
7. Test CAPM's null hypothesis H_0 :
   i. $\gamma_0 = 0$
   ii. $\gamma_1 = (R_{Mt} - R_{ft}) > 0$

3.3 Three Factor Model Methodology

Fama and French (1993, 1996) 3F regression model is expressed in equation (3.7) below as:

$$\boldsymbol{R_{it} - R_{ft} = \alpha_{it} + \beta_i(R_{Mt} - R_{ft}) + \beta_{is}SMB_t + \beta_{iv}HML_t + \varepsilon_{it}} \quad (3.7)$$

Where

- $R_{it} - R_{ft}$ is the excess return of stock *i* above the risk free rate;
- $R_{Mt} - R_{ft}$ is the market risk premium, the excess return of JSE ALSI above the risk free rate;
- SMB_t is small minus big, represents size premium;

- HML_t is high minus low, denotes value premium;
- $\beta_{is}\ and\ \beta_{iv}$ are load factors for SMB and HML respectively, that is slopes in the regression model; and
- $\alpha_{it}\ and\ \varepsilon_{it}$ are the intercept and error term, respectively.

In order to estimate the 3F load factors, I use the approach to classify and rank data into portfolios followed by the Fama and French (1993, 1996).The approach is detailed below.

For a firm to be included in the analysis the firm needs to be listed for at least 24 months. This is done to ensure that there is sufficient accounting data for analysis. This implies that firms listed on the JSE after 1 January 2008 are excluded.

The sample for each year is ranked by market capitalization in December of each year *t*. The data is split into two portfolios, that is stocks above the median size are classified as Big (B) and those below the median are classified as Small (S).

Furthermore, the sample is ranked using BE/ME. This ratio is calculated as the ordinary shareholder book-value divided by market capitalization six month prior to December. The data is classified into three groups of high, medium and low book to price ratio. The low (L) and high (H) groups have a firm's allocation of 30% each and the medium (M) group at 40%.

The resultant six portfolios are constructed based on intersections of the size and BE/ME portfolios. The six portfolios are S/L, S/M, S/H, B/L, B/M and B/H. The portfolio of S/L consists of small capitalization stocks with low BE/ME ratio and portfolio B/M consists of large capitalization stocks and medium BE/ME ratio with the other portfolios having similar explanations. Monthly value weighted returns are calculated for each portfolio with a new portfolio created every January.

The SMB portfolio returns are average returns of long small size group portfolios and short big size group portfolios as shown in equation (3.8).

$$\boldsymbol{SMB_t = \frac{1}{3}[(S/_L + S/_M + S/_H) - (B/_L + B/_M + B/_H)]} \quad (3.8)$$

Similarly the HML portfolio returns are average returns of long high BE/ME group portfolios and short low BE/ME group portfolios as shown in equation (3.9).

$$\boldsymbol{HML_t = \frac{1}{2}[(B/_H + S/_H) - (B/_L + S/_L)]} \quad (3.9)$$

3.4 MCPM Methodology

MCPM analysis is conducted for the period 2005 to 2010 as there were few listed firms that have issued public corporate debt before this time period. In 2011 there were 38 JSE listed bond issuers with 15 issuers being in the financial sector and 23 in the corporate sector[3].

The steps below were followed when deriving MCPM equity risk premium (a detailed account is provided in section 2.4):

1. **Calculate the forward break-even price**

$$\boldsymbol{S_T = S_0 \times (1 + IR)^T} \quad (3.10)$$
$$\boldsymbol{IR = r_{bond} - r_{dividend}}$$

where S_T is the breakeven price, S_0 is the spot price, r_{bond} is the corporate bond yield, $r_{dividend}$ is the dividend yield and IR is the required minimal stock capital gain by an equity investor

Monthly corporate bond yields are sourced from Bond Exchange of South Africa (BESA) daily MTM files. The BESA file comprises of all listed bonds that trade on the JSE.

Dividend yield is calculated using the last dividend paid and is used as a proxy for forecast dividend yield.

[3] Source: Standard Bank Credit Research Report 2012.

2. **Estimate the stock future volatility**

   Historical 30 day volatilities for each stock are sourced from Bloomberg. Mcnulty et, al.(2002) used implied volatilities in their study, however due to lack of historical implied volatilities for JSE stocks the historical volatilities are used as a proxy to price the put option.

3. **Calculate the cost of downside insurance**

   Black-Scholes pricing formula (see equation (2.18)) is used to calculate the premium paid for a put option with S_T as the strike. The put option is a protection against the stock price not reaching the break-even price.

4. **Derive the annualised excess equity returns**

The put option price is expressed as an annualized premium as this represents the excess equity return.

$$RP_{MCPMi} = \frac{p_i / S_{0i}}{\left[\frac{1}{r_{bondi}} - \frac{1}{r_{bondi} \times (1 + r_{bondi})^T}\right]} \tag{3.11}$$

where

- RP_{MCPMi} is the firm's MCPM equity risk premium;
- p_i is the put option price;

3.5 Research Limitations

- The study is limited to the 160 largest listed JSE companies ranked by market capitalization with stock returns based on monthly data. Companies listed on the JSE Alt-X have been excluded as they are thinly traded.
- The sample period of research is 12 years and this is relatively short compared to studies done in the US. For example Fama and French (1996) use 30 year data when performing empirical analysis on the 3F model. This limitation can have an impact on empirical analysis as there is a possibility of increased standard errors in the cross-sectional analysis.

- South Africa's corporate debt market is small compared to the US corporate debt market with large US firms having term structure of interest rates based on their corporate debt issuance. This has an impact when deriving MCPM as the assumption is that the firms being studied have listed corporate debt. This can result in bias as firms that have not issued debt will proxy bond rates from firms with similar ratings.
- The effects of market frictions such as trading costs and liquidity have not been included in this study.
- Lastly, the study does not apply time variation methodologies in estimating beta such as used by Jagannathan and Wang (1996).

4 RESULTS

4.1 Introduction

The estimation results of the asset pricing models discussed in Chapter 3 are presented in this section. The Ordinary Least Squares (OLS) technique is applied to estimate the asset pricing model parameters.

4.2 CAPM

Chapter 3 provided details of the portfolio formation. The ten value weighted portfolios were created for the period 2000-2010 based on ranking of stock betas. Portfolio-1 consists of 10% of stocks with the highest ranked stock betas while Portfolio-10 has 10% of stocks with the lowest ranked stocks. Table 4.1 provides descriptive statistics of the 10 portfolios. Each portfolio has 132 data points of excess monthly returns (that is 12 months x 11 years of data). Average excess returns for the majority of the portfolios are 1%, with the standard deviation ranging between 5% and 10%. Portfolio 10 has the widest spread of monthly excess returns ranging from -48% to 29% and highest standard deviation.

Value Weighted Portfolio	N	Minimum	Maximum	Mean	Std. Deviation
JSE MRP	132	-14.8%	13.1%	0.5%	6%
Portfolio 1	132	-29.2%	23.4%	0.6%	9%
Portfolio 2	132	-25.4%	38.7%	0.9%	8%
Portfolio 3	132	-18.7%	23.4%	0.6%	7%
Portfolio 4	132	-20.9%	12.6%	0.4%	6%
Portfolio 5	132	-25.5%	21.5%	0.2%	7%
Portfolio 6	132	-14.8%	13.8%	0.0%	5%
Portfolio 7	132	-35.0%	17.2%	0.3%	7%
Portfolio 8	132	-11.4%	14.4%	0.8%	5%
Portfolio 9	132	-16.6%	23.8%	0.8%	5%
Portfolio 10	132	-47.6%	28.8%	-0.1%	10%

Table 4.1: Descriptive Statistics of portfolio excess returns

10 portfolios beta's and alpha's were estimated for the value-weighted portfolios by performing the first pass linear regression of equation (3.2). Portfolio betas as shown in Table 4.2 range between 0.6 (portfolio 10) and 1.2 (portfolio 1). This is in line with expectation as the portfolio constituents were based on stock beta ranking. The hypothesis test of β=0 is rejected at both the 1% and 5% level of significance for all portfolios. However, α=0 is not rejected at the 1% and 5% level of significance.

	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Portfolio 5	Portfolio 6	Portfolio 7	Portfolio 8	Portfolio 9	Portfolio 10
alpha	0.00053	0.0033	0.0010	0.0003	(0.0026)	(0.0031)	(0.0013)	0.0048	0.0057	(0.0036)
t -Stat	0.11	0.78	0.35	0.09	(0.66)	(0.87)	(0.31)	1.29	1.51	(0.44)
Sig.	0.91	0.44	0.72	0.93	0.51	0.38	0.76	0.20	0.13	0.66
beta	1.1917	1.1371	1.0871	0.7742	0.9368	0.5857	0.9011	0.6230	0.5891	0.5609
t -Stat	14.36	15.29	20.92	11.42	13.66	9.30	11.99	9.43	8.72	3.76
Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4.2: Estimated portfolio beta and alpha parameters

The estimated portfolio betas in Table 4.2 are allocated to the stocks as described in Chapter 3 in order to perform the second pass linear regression (see equation (3.3)) of average returns against beta. In this regression beta is the independent variable.

Table 4.3 provides a summary of the second pass regression parameters. $\boldsymbol{\gamma_1}$ coefficient represents the market risk premium with the null hypothesis being $\boldsymbol{\gamma_1}$> 0. The results in the table show that the average market risk premium has a negative relationship with average stock returns. This is consistent with results of (Strugnell, Gilbert and Kruger, 2011), Ward and Muller (2012) and Fama and French (1992). Statistically, one cannot reject that $\boldsymbol{\gamma_1}$> 0 at a 5% level of significance since the t-statistic is 1.53. The intercept of the second pass regression is 2.0% and statistically significant at a 5% significance level therefore one can reject the null hypothesis of $\boldsymbol{\gamma_0}$ *= 0.* Hence, when measuring a portfolio manager's performance using CAPM the positive intercept (alpha) can imply that his investment skills are providing excess monthly returns of 2% above the benchmark. As a result the investor needs to compensate the portfolio manager for this superior performance. Furthermore, this result can implies that beta does not capture all priceable risks.

	$\overline{\gamma_1}$	$\overline{\gamma_0}$
Mean	(0.00952)	0.02019
Standard Error	0.00621	0.00562
Standard Deviation	0.07135	0.06458
Observations	132	132
t-stat	(1.53)	3.59
Decision	Do not reject H_0: $\overline{\gamma_1} > 0$	Reject H_0: $\overline{\gamma_0} = 0$

Table 4.3: Summary of second pass regression

4.3 Three Factor Model

Six portfolios S/L, S/M, S/H, B/L, B/M and B/H were created using the procedure detailed in Chapter 3. Table 4.4 provides the average raw returns for these portfolios and the SMB and HML portfolios. The S/H portfolio has the highest average monthly return of 1.6% implying that small distressed stocks offer a higher return due to the perceived higher risk profile of these firms. This is consistent with Gaunt's (2004) results when testing the 3F using Australian data. The average returns presented suggest that small stocks tend to have higher monthly returns on average compared to the larger market capitalization stocks. The 6 portfolios standard deviation is range bound between 5% and 7%.

When the SMB and HML portfolios are created (representing size and value effect), the SMB average returns are negative suggesting that higher capitalization stocks produce higher returns compared to smaller capitalization stocks. The S/L average returns are significantly lower than the B/L portfolio returns therefore having an impact on the SMB average returns. The remaining portfolios with small stocks produce higher returns compared to the large stocks. The HML average returns suggest a value premium effect over the sample period.

	Mean Returns		Standard Deviation	
	Small Size	Big Size	Small Size	Big Size
Low BE/ME	0.37%	1.02%	6.0%	7.3%
Medium BE/ME	1.37%	1.19%	4.9%	5.8%
High BE/ME	1.55%	1.23%	4.9%	5.9%

	Mean Returns	Standard Deviation
MRP	0.5%	5.6%
SMB	-0.1%	3.6%
HML	0.7%	4.5%

Table 4.4: Average raw returns for the S/L, S/M, S/H, B/L, B/M, B/H, SMB and HML

CAPM Regression results

Table 4.5 shows the regression results when using CAPM to explain average portfolio returns. The large capitalization stocks exhibit higher beta values compared to small capitalization stocks. This is in contradiction to CAPM theory as one expects small stocks to be riskier compared to the larger stocks. As expected the higher BE/ME firms have a higher beta values compared to the low BE/ME firms. All beta values are significant.

It is interesting to note that once firms were sorted according to size and value, the intercept coefficients are significantly smaller and statistically insignificant when compared to the CAPM intercept of 2% from the second pass regression CAPM results presented above.

		Book Equity to Market Equity Portfolio					
		Low	Medium	High	Low	Medium	High
Market Capitalization Portfolio		*intercept*			*p-value*		
	Small	-0.6%	0.4%	0.6%	0.16	0.31	0.08
	Big	-0.2%	0.0%	0.1%	-0.16	0.90	0.72
		beta coefficient			*p-value*		
	Small	0.596	0.605	0.608	0.000	0.000	0.000
	Big	1.002	0.988	0.892	0.000	0.000	0.000
		R squared			*F Statistic*		
	Small	31%	47%	47%	58.71	115.94	114.66
	Big	58%	90%	70%	178.91	1,214.44	308.08

Table 4.5: CAPM results on portfolios sorted on size and value

3F Regression Results

Table 4.6 presents the three factor model regression results on value-weighted portfolios. The market risk premium betas are less than 1 with all of them statistically significant. The small stocks tend to have marginally higher beta values as expected when compared to the larger stocks. The results of β_s for four of the six portfolios are statistically significantly. The small stocks have positive βs coefficients and large stocks have negative βs coefficients. This is in line with Fama and French (1993, 1996) results that imply small stocks having a higher average returns compared to large stocks. β_h load factor results show evidence of value effect premium for the sample period with all coefficients being statistically significant except the S/M portfolio. Furthermore, one can note that the low BE/ME portfolios have negative coefficients and positive coefficients for the high BE/ME portfolios implying that growth stocks tend to have lower average returns when compared to growth stocks. The size and value effect are also confirmed by Strugnell et al. (2011). The adjust R^2 ranges between 79% and 91% implying that the three factor model provides greater explanatory power in explaining average monthly stock returns compared to the CAPM R^2 reported in Table 4.5. This is supported by the *F-statistic* being significant for all portfolios.

		Book Equity to Market Equity Portfolio					
		Low	Medium	High	Low	Medium	High
Market Capitalization Portfolio		*intercept*			*p-value*		
	Small	-0.23%	0.27%	0.26%	0.365	0.263	0.220
	Big	0.42%	-0.05%	-0.07%	0.144	0.763	0.787
		βm coefficient			*p-value*		
	Small	0.925	0.889	0.899	0.000	0.000	0.000
	Big	0.859	0.970	0.884	0.000	0.000	0.000
		βs coefficient			*p-value*		
	Small	1.016	0.795	0.775	0.000	0.000	0.000
	Big	-0.296	-0.063	-0.055	0.002	0.234	0.548
		βh coefficient			*p-value*		
	Small	-0.701	0.013	0.291	0.000	0.809	0.000
	Big	-0.755	0.104	0.254	0.000	0.003	0.000
		Adjusted R squared			*F Statistic*		
	Small	77%	69%	77%	143.24	99.44	148.80
	Big	81%	73%	91%	186.56	431.86	120.61

Table 4.6: Three factor model regression results

Finally, the intercept of the three factor models has significantly decreased and closer to zero compared to the second pass CAPM intercept of 2%. At a 5% level of confidence we cannot reject the null hypothesis of the intercept α = 0. When measuring portfolio manager's performance using the three factor model the intercept can imply that there is no superior performance provided by the portfolio manager as measured by alpha. Therefore an investor can potentially achieve the same or superior returns when investing in a combination of indexed fund that can capture the size and value premium effect.

4.4 MCPM

The study of MCPM is limited to 18 JSE listed companies that have issued corporate bonds. The majority of firms that issue bonds in this study are Banks (37%) followed by the diversified industrial sector (21%). Banks issue corporate bonds most frequently in the South African market in order to meet capital requirements and enhance their intermediation role in the economy. The table that follows provide a list of the bonds used in the study.

Company Issuer	Sector	Bond Code	Issue Size (ZAR'm)	Issue Date	Maturity	Coupon Rate	SA Govt. Benchmark	Average Credit Spread
ABSA	Banks	AB03			26-Mar-10	11%	R153	125
African Bank	Banks	ABL4	500	31-Aug-05	31-Aug-10	9%	R153	151
Angolgold Ashanti	Mining	AG01	2,000		28-Aug-08	11%	R196	101
Barloworld	Diversified Industrials/Business	BAW01	1,500	29-Jul-04	29-Jul-11	11%	R153	146
Bidvest	Diversified Industrials/Business	BID01	1,500	06-Sep-07	06-Aug-14	10%	R201	198
Capitec	Banks	CBL01	110	06-May-08	06-May-11	15%	R153	363
First Rand	Banks	FRB01			31-Aug-10	13%	R153	130
Group 5	Heavy Construction	GFC2	550	27-Feb-07	27-Feb-12	9%	R153	187
Imperial Holdings	Diversified Industrials/Business	IPL3			30-Nov-10	10%	R153	128
Investec	Banks	IV01	180	17-Jul-00	31-Mar-12	16%	R153	110
MTN	Telecommunication	MTN01		31-Jul-06	13-Jul-10	10%	R153	147
Nedbank	Banks	NED5		28-Apr-06	24-Apr-11	8%	R153	145
SAB Millers	Beverage	BEER01	1,600	16-Jul-07	19-Jul-12	10%	R153	157
Sappi	Paper	SMF1	1,000	27-Jun-06	27-Jun-13	9%	R201	193
Standard Bank	Banks	SBS1			24-May-10	9%	R153	106
Steinhoff	Furnishing	UTR02	1,000	21-Nov-07	21-Nov-12	10%	R201	214
Supergroup	Diversified Industrials	SPG1	900	25-Jun-04	25-Jun-08	13%	R196	161
Telkom	Telecommunication	TL12	1,060	29-Apr-08	29-Apr-12	12%	R153	239

Table 4.7: List of corporate bonds used in the MCPM study[4]

[4] Corporate bond data sourced from Bloomberg, BESA Daily MTM files and Standard Bank Corporate Credit Handbook 2012.

Monthly corporate bond yields sourced from the BESA MTM files were used to derive r_{bond}. The dividend yield $r_{dividend}$ was calculated on a monthly basis based on the last dividend paid. The break-even interest rate was then calculated for each month. Chapter 3 MPCM steps 2 to 4 were then following to estimate the MCPM rate.

Table 4.8 provides the estimate cost of equity rates for MPCM and CAPM methodology. The cost of equity estimates using MCPM are higher compared to CAPM results. This result is similar to that of Mcnulty et al. (2002). The average difference in estimated cost of capital is 10%. This is less than differences of up to 25% that Mcnulty et al. (2002) reported when estimating cost of equity capital for Biotechnology companies. The narrower spread in the results in Table 4.8 may possibly be due to the fact that the firms in this study do not include recently listed shares. In addition, Mcnulty et al. (2002) used forecast dividend yields and implied volatilities to estimate MCPM rates, whereas due to lack of data historical volatilities and current dividend yields were used to estimate MCPM rates.

Company Issuer	MCPM Rate	CAPM Rate	Difference (%)
ABSA	23%	8%	14%
African Bank	22%	3%	19%
Angolgold Ashanti	24%	29%	-5%
Barloworld	18%	14%	3%
Bidvest	16%	1%	14%
Capitec	21%	0%	21%
First Rand	20%	8%	12%
Group 5	18%	4%	14%
Imperial Holdings	18%	8%	10%
Investec	17%	18%	-1%
MTN	25%	8%	17%
Nedbank	19%	8%	11%
SAB Millers	16%	12%	5%
Sappi	18%	12%	6%
Standard Bank	20%	6%	14%
Steinhoff	19%	6%	13%
Supergroup	23%	19%	4%
Telkom	19%	4%	15%

Table 4.8: MPCM and CAPM cost of equity estimate

Figure 4.1 is a graphical representation of the MPCM and CAPM cost of equity estimates.

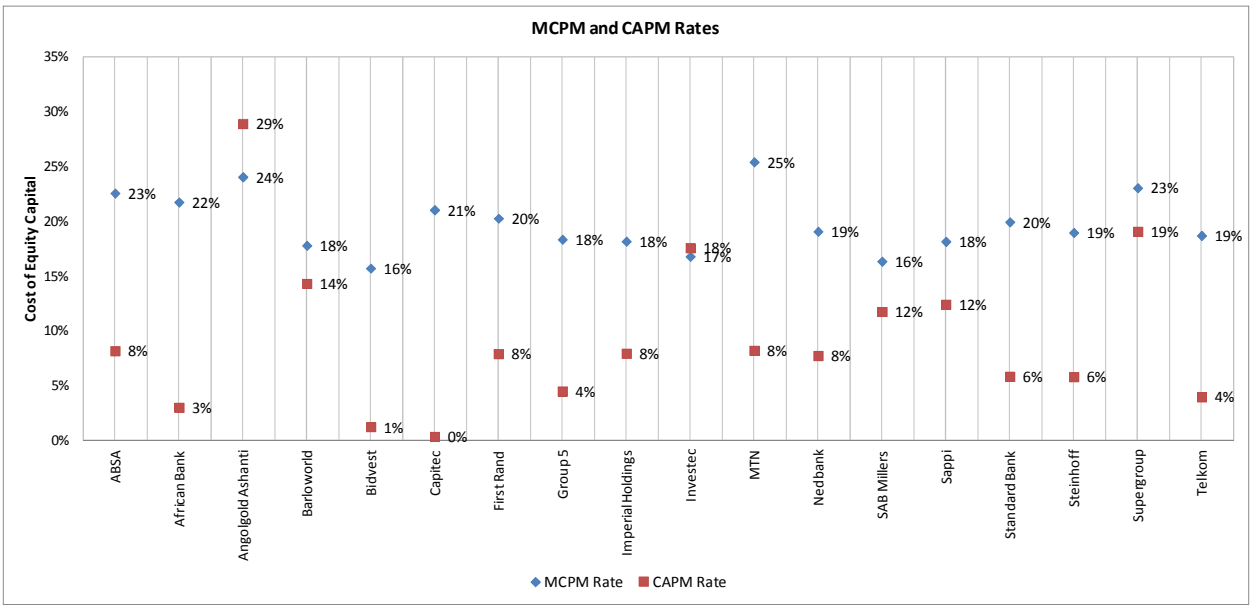


Figure 4.1: MCPM and CAPM cost of equity estimates

Further to the MCPM and CAPM comparison discussed above, a comparison of MCPM and 3F Model cost of equity capital are shown in Table 4.9 and Figure 4.2. 3F model betas in Table 4.6 were used to estimate 3F cost of equity capital. The results show that MPCM cost of equity capital is higher compared to 3F model cost of equity capital. However, the average difference in spread between the two methodologies is 8%. This is expected as the 3F model is empirically a better asset pricing model when compare to CAPM.

Company Issuer	MCPM Rate	3F Model Rate	Difference (bps)
ABSA	23%	19%	3%
African Bank	22%	12%	10%
Angolgold Ashanti	24%	23%	1%
Barloworld	18%	19%	-1%
Bidvest	16%	4%	12%
Capitec	21%	2%	19%
First Rand	20%	16%	5%
Group 5	18%	1%	17%
Imperial Holdings	18%	17%	1%
Investec	17%	17%	0%
MTN	25%	7%	19%
Nedbank	19%	11%	8%
SAB Millers	16%	4%	12%
Sappi	18%	15%	3%
Standard Bank	20%	17%	3%
Steinhoff	19%	4%	15%
Supergroup	23%	26%	-3%
Telkom	19%	6%	13%

Table 4.9: MPCM and 3F model cost of equity estimate

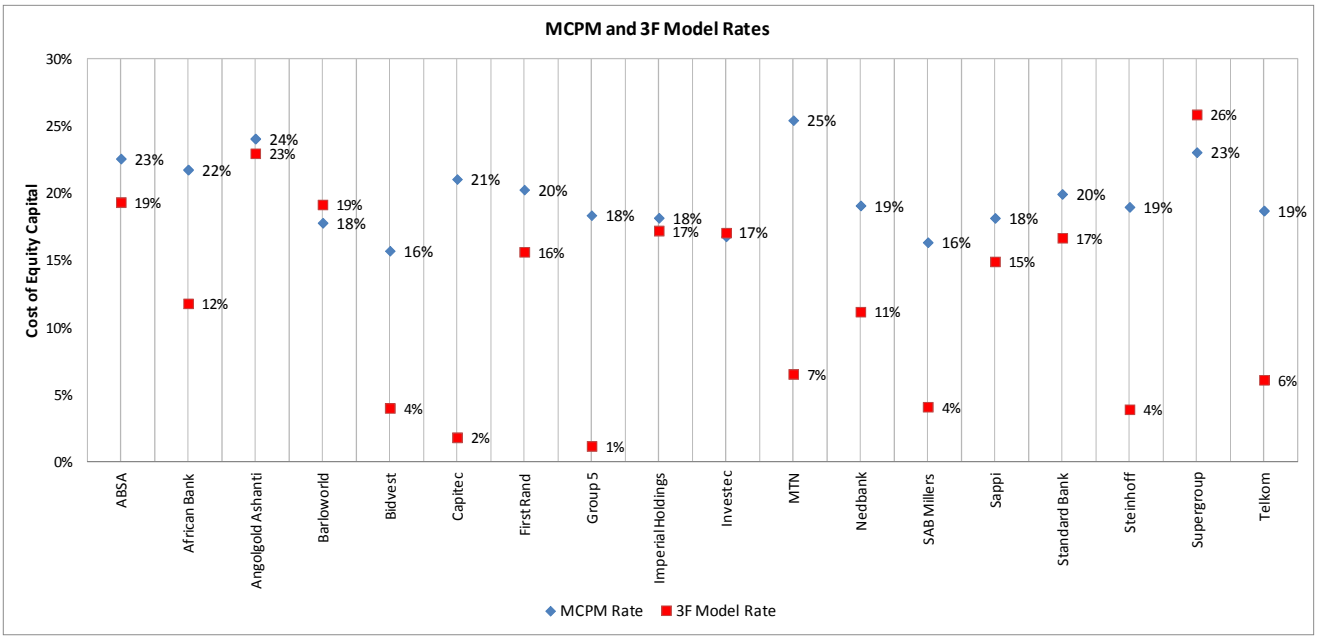


Figure 4.2: MCPM and 3F model cost of equity estimates

5 CONCLUSION

CAPM remains the most widely used asset pricing model in financial markets as its risk and return relation is intuitive to its users. In addition, the model has strong theoretical backing. Unfortunately several authors have shown that the empirical performance is weak, with various anomalies not captured by the model. Some of these have been discussed in the literature review. Fama and French (1992, 1993, 1996) synthesized these anomalies and proposed the three factor asset pricing model that sufficient captured anomalies in the by adding size and value effect premia to CAPM's market risk premium. Despite weak theoretical backing, the three factor model has strong empirical performance for both developed and emerging markets stock market data. Variants of these models have been developed by several researchers as the aim is to enhance the models' performance in predicting ex-ante returns. Unfortunately, one cannot always rely on ex-post data in predicting ex-ante returns as stock markets are dynamic and historic market events do not necessarily re-occur in the future.

As a result of the gap from using ex-post data to estimate ex-ante returns, researchers such as Mcnulty et al. (2002) propose the use of option prices to estimate cost of equity capital. The authors argue that option volatilities contain information on the market's expectation of future performance and therefore this information can be used to derive an appropriate equity risk premium. In addition they state that the minimum return an equity investor can expect is the return equivalent to the firm's debt holders. Hence, one can formulate the Market Derived Capital Asset Pricing Model (MCPM) to estimate cost of equity capital by combining the corporate bondholders return and the premium paid on a put option.

The aim of the study was to ascertain whether MCPM as an ex-ante model can yield superior results when estimating ex-ante returns as compared to CAPM and the three factor model using data for JSE listed companies. The top 160 listed JSE shares were used in the study of CAPM and the three factor model as these firms contribute 99% of JSE's market value. In addition, this aided in avoiding the thin trading problem of smaller market capitalization shares.

Empirical test of CAPM based on Fama and Macbeth's (1973) was done with the results showing an inverse relationship between average stock return and the average market returns. This result confirms earlier empirical tests done on CAPM by Strugnell et al (2011), Ward and Muller (2012) and Fama and French (1992).

In addition, the study provided empirical testing of the three factor model using the JSE data. The findings showed that there is a size and value effect premium on the JSE supported by earlier researchers who have tested this model on stock data.

Since the South Africa corporate debt market is not as developed as the USA market, few firms access the capital market by issuing corporate debt. As a result 18 firms with corporate debt were included in the MCPM study for the period 2005 to 2010. The MCPM methodology provided higher cost of equity capital estimates compared to the ex-post models of CAPM and Three Factor Model. The difference in spreads between MCPM and CAPM in the estimated cost of equity capital was 10% with difference to the Three Factor model being 8%. This was similar to the results Mcnulty et al. (2002) achieved when they tested the MCPM model using USA biotechnology firms and compared it to CAPM, albeit they had spreads of up to 25%.

From the findings in this report, it is recommended that investors and corporate manager consider using MCPM as an additional tool when determining the cost of equity capital given that this methodology uses ex-ante data to estimate ex-ante returns. The challenge with MCPM is to get the necessary inputs such as option implied volatility of JSE traded shares which is not readily accessible in the market. An investor can proxy the implied volatilities by using historical volatilities.

Further studies on MCPM will need to be conducted on the wider JSE population for inferences to be drawn on its full capability as an ex-ante asset pricing model though initial signs of the model seem to suggest that MCPM is a better pricing model.

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