Capital Asset Pricing Model Test on the Johannesburg Stock Exchange

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DECLARATION

I, Kabelo Keosi Mokgele, 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 Masters of Management in Finance and Investment at the University of Witwatersrand, Johannesburg, South Africa. 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), jointly accredited to Markowitz (1952), Treynor (1961), Sharpe (1964), Lintner (1965) and Mossin (1966), provides that, at equilibrium, the return on all risky assets is attributable to their covariance with the market portfolio. This paper studies whether the CAPM holds for the South African market (represented by the Johannesburg Stock Exchange), by using the methodology developed by Fama and Macbeth (1973).

Furthermore, the paper expands on other factors that influence asset returns and interrogates alternative asset pricing models.

The findings of the study on individual assets rejects CAPM in the context of South Africa. This is consistent with other empirical studies. CAPM is also rejected for the Industrial Index as well as the Top 40 index. What is interesting to note however, is that for the Resources index, CAPM is validated.

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1 INTRODUCTION

1.1 Background

Asset Pricing relates the prices of assets to the payments of those assets (which are uncertain with regard to timing and risk). The importance of this relation cannot be overstated, as it informs the decisions of which assets to add into a portfolio given their particular risk and return properties. This relation is captured by the required rate of return on an asset.

The rate of return of an asset is of crucial importance to financial officers. When a new project or business is under review, the prospective cash flows from that project or business are discounted at a certain rate of return, depending on the capital structure employed. The discount rate applied, incorporating the cost of debt and the cost of equity, is referred to as the Weighted Average Cost of Capital (WACC). The cost of debt is directly observable, while that is not the case with the cost of equity.

Perold (2004), posits that prior to the 1960's, there was scant knowledge or development, in terms of a theoretical framework that captured the relationship between the risks and the returns of assets, in the capital market. The work of Markowitz (1952) and Tobin (1958) served as a preamble for the development of arguably the most famous theory in asset pricing: Capital Asset Pricing Model (CAPM). This is the focus of this study.

CAPM is an elegant model that shows a linear relationship between the risk of an asset (captured by the sensitivity of that assets' returns to the returns of the market portfolio), and the expected return of that asset. Assets which provide for a higher return than that suggested by CAPM, are under-priced, and those which have a lower return are over-priced. At equilibrium, the prices of assets should correct, such that the returns observed for those assets are in accordance with the expected return as suggested by CAPM.

In the world of business, CAPM has numerous important implications. As mentioned above, the cost of equity is instrumental in the formulation of WACC, which is utilised in new project/business assessment to ascertain financial viability. Discounted Cash Flow (DCF) is the most commonly used valuation method, to determine the addition to shareholder wealth (Net Present Value or NPV), when undertaking a new project or business. CAPM is used to determine the cost of equity in DCF's.

Shahid (2007), indicates that risk-adjusted performance measurement tools, such as the Jensens Index, Sharpe Index and the Treynor index, are all based on CAPM. These are tools commonly used to assess the performance of funds and fund managers. Furthermore, Gordons Dividend Discount Model, which is used to obtain the fair value of dividend paying stocks, also utilises the cost of equity as a discount rate.

In academia, the importance of CAPM cannot be overstated. Multitudes of academics have spent considerable periods of time either proving or disproving CAPM, with varied results. This has led to the development of alternative models of calculating the cost of equity, with a few of these models covered in this paper.

1.2 Problem Statement

South Africans are invested in the capital markets either directly via the purchase of stocks of companies on the Johannesburg Stock Exchange (JSE), or indirectly through their pension/retirement funds. In addition, people also invest their surplus income with asset managers (e.g. mutual funds) who select investment opportunities on their behalf.

People and institutions alike, are faced with numerous decisions when making investments: how much to invest, how to apportion the allocated funds between different asset classes, which specific assets to invest in and lastly what is the appropriate price for purchasing an asset.

In order to assess the performance of their investment selections, the above-mentioned parties need criteria to rely on. Likewise, fund managers are continuously judged on their performance and suitable measures/criteria are needed in order to make sensible judgements. Companies, issuing equity or bonds, also need measures of how to price their assets prior to going to market. All of the afore-mentioned issues have one central theme: how to price assets.

While CAPM has been extensively tested in developed markets, the coverage is limited in developing markets like South Africa. Ward and Muller (2012) tested CAPM 's applicability in the South African context by constructing portfolios based on beta and their findings rejected CAPM. Van Rensburg and Robertson (2003) and Hoffman (2012) also tested CAPM and found that other factors influenced returns besides the market. There is a need for further empirical tests to be conducted on CAPM to further validate or reject its applicability as an asset pricing tool for the South African market.

While the shortcoming of CAPM are well established, the proposed alternative pricing models are not without issue. For one, the Fama and French Three Factor model has been criticised for not being premised on motivational grounding, whereas the Dividend Discount model, while intuitive, can only be applied to assets which pay dividends. These alternative asset pricing models are covered in this study, with both their advantages and drawbacks being discussed.

1.3 Research Objective

The primary objective of this paper is to test the validity of the original Capital Asset Pricing Model, in the context of the South African Market. In addition, there is due consideration of other factors influencing assets returns and how the CAPM should be adapted to take into account these factors. Lastly, alternative asset pricing models are presented and critiqued in turn.

1.4 Significance of Study

The South African economy is currently under duress. The World Bank, in its report in 2017, lowered its estimates for South Africa's economic growth between 2017 and 2019. The economy, according to the World Bank, is estimated to grow at 0.6% in 2017, 1.1% in 2018 and 2% in 2019, which is hardly encouraging and a slight improvement from the growth rate of 0.5%, achieved in 2016 (2017 Budget Review). The estimates by the South African Reserve Bank of 1.0% growth in 2017, followed by 1.5% in 2018 and then 1.7% in 2019 are marginally better, but still below the 5% targeted growth rate, as stipulated in the National Development Plan.

In the second and third quarters of 2017, South Africa underwent a technical recession because of two consecutive quarters of negative economic growth. Compounding this stark outlook on the economy of South Africa is the political instability (e.g. shifts within the ruling party) which has resulted in downgrades by credit agencies.

Given this dire outlook in the South African economic space, it is crucially important for financial officers and fund managers to select projects and portfolios that yield a real and appreciable return for their stakeholders. This would be much simpler if the economy was booming, but since that is not the case, greater care should be taken to identify and select assets that are priced correctly according to their risk properties. CAPM thus comes into prominence, lest value is eroded and not created. If CAPM holds for the South African market, then it may be relied upon to make correct investment decisions, but if not, then its usefulness should be confined to the realms of academia.

1.5 Methodology

For this study, a cross-sectional analysis will be conducted on the 100 largest JSE listed companies as determined by market capitalisation. The data used will cover a decade from 1 January 2005 to 31 December 2014, and will be sourced from Bloomberg, and the Bond Exchange of South Africa (BESA). Bloomberg is used for stock prices and company information, while BESA is used to retrieve bond yields.

The well-documented methodology of Fama and Macbeth (1973) for testing CAPM will be utilised.

1.6 Outline of Study

Following this introductory chapter, the paper is structured as follows: Chapter 2 covers the literature review on the CAPM model-its origins, criticism and evolution. Also presented in chapter 2 are the alternative asset pricing theories such as the Arbitrage Pricing and the Three-Factor Models. Chapter 3 deals with the proposed methodology and data utilised in the study. The empirical results of the study are captured in Chapter 4 and thereafter, Chapter 5 provides a conclusion to the study.

2 LITERATURE REVIEW

2.1 Capital Asset Pricing Model

Few theories in Finance and Economics are studied as much as the Capital Asset Pricing Model (CAPM). Derived by Sharpe (1964), Linter (1965) and Mossin (1966), it provides an elegant and intuitive model that computes the expected return of a security or portfolio in relation to its risk. CAPM is premised on the earlier papers of Markowitz (1952) and Tobin (1958). These precursory papers will be revisited, in order to form a holistic appreciation for the development of this widely used theory.

2.2 Markowitz Modern Portfolio Theory

Harry Markowitz, widely acclaimed in the field of finance, published a paper named "Portfolio Selection", for which he was awarded The Nobel Peace Prize in 1990 (Mangram, 2013). Markowitz provided the framework for how rational investors should make investment decisions.

The founding principle was that the return and risk of an individual asset should not be viewed in isolation, but rather in relation to how the addition of said asset, affects the risk-reward properties of the entire portfolio. The prevailing train of thought, prior to Markowitz' seminal paper, was that diversification is indeed beneficial. However, a well-known but frankly basic statement captured the form of diversification, much touted prior to the discovery of Markowitz,: "Do not keep all your eggs in one basket" (Perold, 2004, p.6). The idea was that selecting a sufficiently large number of assets into a portfolio, will erode the risk of that portfolio.

"Portfolio Selection" went a step further, by explaining the manner under which diversification should be applied, the benefit of such diversification and the limits to it. Before expanding on the workings and findings of "Portfolio Selection", the assumptions underpinning it, are presented below (Bofah; Wecker; Markowitz, 1952):

i) Investors are rational. They strive to maximise returns while simultaneously minimizing risk

ii) Investors will only accept higher risk, if they are compensated by higher returns

iii) Investors timeously receive all information pertaining to their investment

iv) Investors are unable to influence the price (i.e. they are price takers)

v) Markets are perfectly efficient

vi) Returns of assets are normally distributed

vii) There is an absence of transaction cost or taxes

To appreciate the workings of the model, a brief synopsis of the calculations of the expected return and the risk of a portfolio follows.

The expected return of a portfolio is simply the weighted average of the expected returns of the constituent assets. In a two-asset portfolio, the expected return of the portfolio E $[r_p]$ is:

$$E\,[r_p] = \sum_{i=1}^{2} W_i E[r_i], \text{ where:}$$

W_i is the weight of asset i in the portfolio, and E$[r_i]$ is the expected return of asset i

The computation of the variance of the portfolio is more complex. Markowitz (1952) argued, that there are certain macro-economic factors (e.g. GDP growth rate) that affect all or a significantly large group of assets. There is thus correlation (to a certain degree) amongst different assets' risk, thereby nullifying the notion that portfolio risk can be totally eliminated by diversification. The effect of diversification, on the variance of the portfolio, depends on the correlation of the additional assets risk and the risk of the rest of the portfolio.

Portfolio variance is calculated using the weighted standard deviations of each asset in the portfolio together with the correlation coefficient or covariance of the assets. The formula for portfolio variance is as follows:

$$\sigma_p^2 = \sum i \sum j \ W_i \, W_j \, \sigma_i \, \sigma_j \, \rho_{ij}, \text{ where:}$$

W_i and W_j are the weights of asset i and j in the portfolio, σ_i and σ_j are the standard deviations of asset i and j, and $\rho_{ij}$is the correlation coefficient between assets i and j

As long as the risk of the additional asset is not perfectly correlated with the portfolio, there will necessarily be a risk reduction that accrues from its inclusion. Markowitz, argues that a rational investor, given a particular risk appetite, strives to adhere to one of the following maxims:

i) Maximizing the expected return for a given level of risk

ii) Minimizing risk (measured by standard deviation) for a given level of return

In figure 1 that follows on the next page, portfolios that satisfy either one of the two conditions stated above, are referred to as efficient. An efficient frontier, depicted as the curve above point A, which is known as the global minimum variance portfolio (Bodie; Kane; Marcus, 1999), combines all the efficient portfolios. Portfolios to the right of this frontier are inefficient as they provide a higher level of risk at the same level of return, whereas those below, also inefficient, provide a lower level of return for the same level of risk

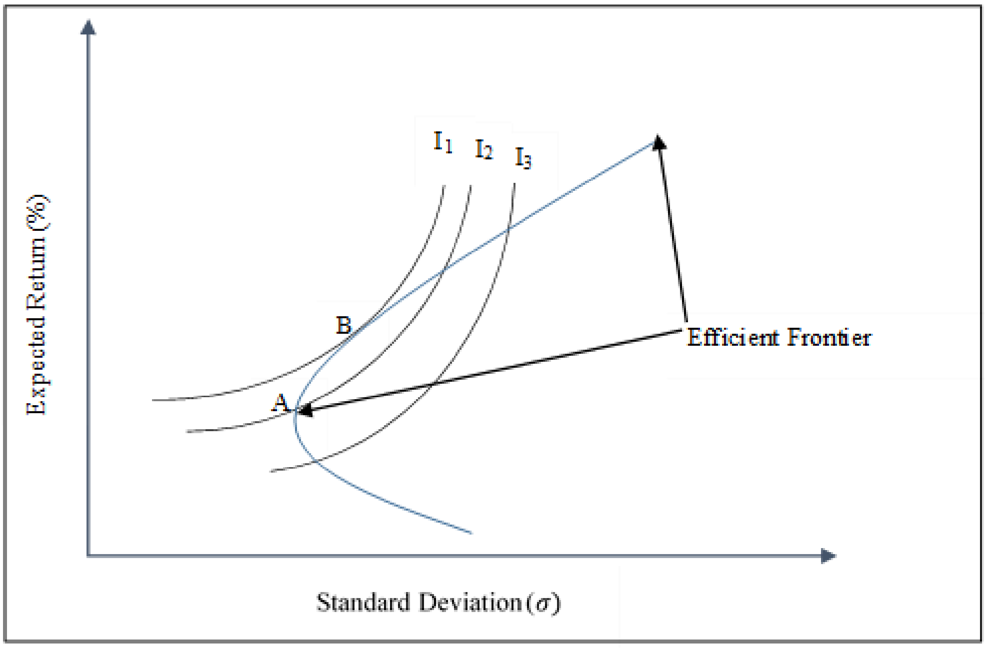

Figure 1: Markowitz Efficient Frontier

The choice of a specific portfolio, along the efficient frontier, depends on the consumption utility function of the individual investors, which is predicated on that investors risk appetite. The utility functions are presented by the indifference curves, labelled I_1, I_2 and I_3. The optimal choice of portfolio, for an investor, is the point of tangency between their utility function and the efficient frontier (Point B).

2.3 Tobins Separation Theorem

James Tobin's seminal paper, which later became known as "Tobin's Separation Theorem" introduced the concept of leverage into portfolio formation. Based on the assumption that investors can borrow and lend at the risk free rate, the theorem postulates that investors can control risk by either:

Borrowing at the risk-free rate, and investing the proceeds into the basket of risky assets (as determined by the Markowitz portfolio theory), or;

Lending at the risk-free rate and thus moderating the risk of the portfolio

Tobin (1958) proposed that portfolio formation should be a two-step process:

a) Investors should determine an efficient portfolio of risky assets as proposed by Markowitz

b) De-leverage the efficient portfolio to obtain the desired level of risk

This is known as The Separation Theorem, because the two above-mentioned decisions are independent of one another, and thus have no effect on each other.

Given that most investors are risk-averse, they will select a portfolio that combines the basket of risky assets with a risk free asset (e.g. Treasury bill).

A portfolio A, with a portion Y invested in basket of risky assets and a portion (1-Y) invested in the risk-free asset, is created. The portfolios expected return is the rate of return on the risky asset multiplied by the portion of funds invested in that risky asset added to the rate of return of the risk free rate multiplied by the portion of funds invested in that risk free asset. It takes the following form:

$$E(r_A) = Y\ [E(r_P)] + (1 - Y)r_f$$, where:

$E(r_A)$) is the expected return on the combined portfolio of the risk free asset and the risky basket of assets, r_f is the risk free rate of return,$E(r_P)$ is the expected return on the risky portfolio, and σ_A is the standard deviation of the combined risky basket of assets and the risk free rate

Combining the two equations above and then substituting for Y, gives rise to the equation below, which states that an investor expects to receive a risk free rate of return plus a premium due to investing in a risky portfolio.

$$E(r_A) = r_f + \frac{\sigma_A}{\sigma_P} [E(r_P) - r_f]$$

The line that shows possible combinations of the risk free asset and the risky portfolio by altering the Y (proportion allocated to the risky portfolio) is known as the Capital Allocation Line. This line, drawn from the risk free asset to the tangency point A (the optimal risky portfolio), is depicted below. The slope of the Capital Allocation line is a measure of the risk premium and is known as the Sharpe Ratio.

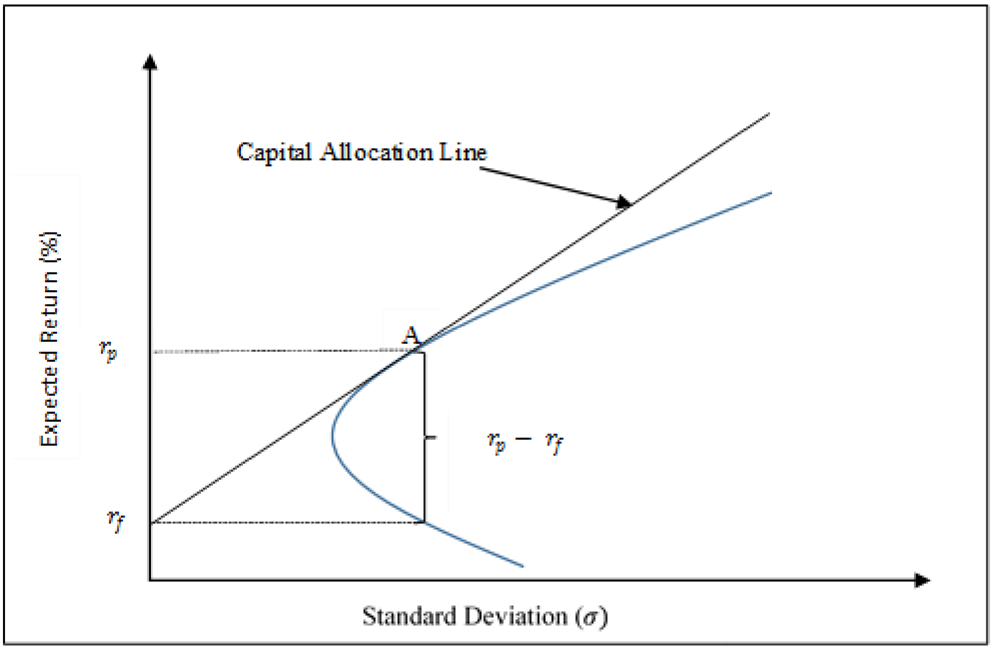

Figure 2: Capital Allocation Line

2.4 Sharpe-Lintner CAPM

Sharpe (1964), Linter (1965) and Mossin (1966) expanded on the earlier work of Markowitz (1952) and Tobin (1958), to develop The CAPM. With Tobin's Separation Theorem, it was shown that when there is riskless lending and borrowing, the risky portfolio that any investor would hold, could be identified without taking into account the investor's risk preferences (Elton, Gruber, Brown, Goetzmann; 2003). This portfolio lies tangent to the efficient frontier of risky assets and a line drawn from the risk-free rate of return. Investors will tailor their portfolio to suit their risk preferences, by combining this risky portfolio with lending or borrowing.

Investors' expectations are homogenous at market equilibrium (Sharpe, 1964). Consequently, the Capital Allocation Line thus becomes the Capital Market Line, as investors have uniform expectations about asset returns, efficient frontier and the Capital Allocation Line. The portfolio of risky assets held by all investors will be identical, and must then, in equilibrium, be the market portfolio (Elton et. al.; 2003). This market portfolio (M), comprises of all risky assets and each asset in that portfolio is held in proportion to its market value to the entire market value of all risky assets.

In figure 3 on the following page, the capital market line is captured by the following equation:

$$r_{p_e} = r_f + (\frac{r_{m-}\ r_f}{\sigma_m})\sigma_{e,} \text{ where:}$$

subscript $_e$ denotes an efficient portfolio

In the equation above, the first term (r_f) is the time value of money, and the term ($\frac{r_{m-}\ r_f}{\sigma_m}$) is known as the market price of risk and refers to the additional return that can be received by increasing the level of risk by one unit. Therefore, ($\frac{Rm-Rf}{\sigma_m}\sigma_e$) is the market price of risk multiplied by the amount of risk in a portfolio.

In "Modern Portfolio Theory and Investment Analysis," (Elton et. al; 2003) argued that for a well-diversified portfolio, non-systematic risk is negligible and the correct measurement of risk is sensitivity to the market. As explained above, due to uniform expectation, all investors will hold the market portfolio. The equation of the capital market line has the form: = $r_i = \alpha + b\beta i$ and is derived as follows:

The intercept is the risk free rate of return (r_f) and has a beta of zero. Therefore

$$r_f = \alpha$$

The market portfolio (M) has a beta of one, therefore

$$r_m = \alpha + b\ (1) \text{ or } (r_m\ \text{-}\alpha) = b$$

Putting these two equation above together, and substituting into the capital market line equation stated above, results in the CAPM equation:

$$r_i = r_f + \beta i \ (r_m - r_f)$$

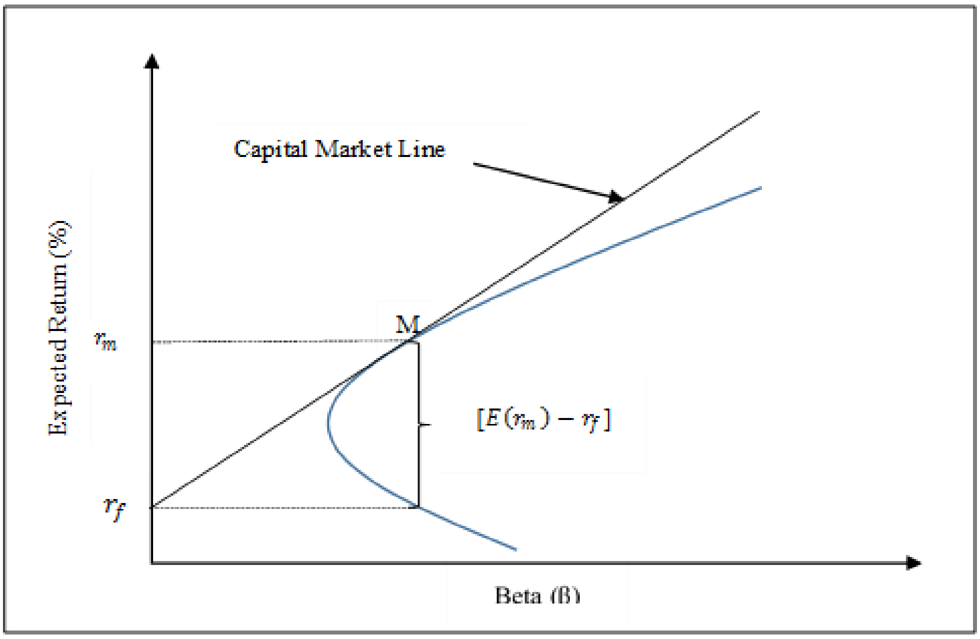

Figure 3: Capital Asset Pricing Model

2.5 Criticism of CAPM

2.5.1 Unrealistic Assumptions

The formulation of The Capital Asset Pricing Model, while important in the field of finance, has been heavily criticised, primarily due to its simplifying assumptions which do not mirror the real world. We present the common criticism labelled against each assumption below:

Investor rationality: This has been contradicted by the "strange" actions displayed by market participants (e.g. herd mentality) (Morien). These actions are now well studied and documented in a field called "Behavioural Finance."

Perfect Information: The assumption that all market participants have the same information has been dispelled due to the presence of insider trading (for example) (Bogar, n.d.)

Efficient Markets: The numerous observations of market “booms”, “busts” and “crises” contradict the assumption relied on by Markowitz, that markets are efficient (Mangram, 2013)

No Taxes or Transaction Costs: Assets are subject to taxes and a number of transaction costs (e.g. broker fees, administrative costs, etc.), which contradicts the assumption underpinning CAPM. Factoring these costs could change the portfolio selection (Mangram, 2013)

Higher Risk = Higher Return: The assumption that investors will only accept higher risk if compensated with higher return is not always true. In reality, investors may select perceived risky assets, such as derivatives, “in order to reduce risk without any discernible increase in the expected returns” (McClure, 2010).

Unlimited Access to capital: Investors have different credit profiles, which limits the amount and the rate at which they can borrow. Furthermore, Governments are the only persons/entities that can consistently borrow at the risk free rate (Morien, n.d)

2.5.2 Rolls Critique

Roll (1977) asserts that testing the CAPM is not only difficult but also impossible. Any test of the asset pricing theory is premised on absolute knowledge of the market portfolio’s composition. This implies that all assets, including bonds, real estate etc. should be included in the market portfolio. In practice, however, proxies that solely include stocks, such as The JSE ALSI and The S&P 500, are frequently used. For example, the inclusion of bonds, which have a beta close to zero, would dismantle the linearity condition of the asset pricing theory. Therefore, as long as there is no agreement on what constitutes a true market portfolio, then all past and future tests, which rely on a mean-variance efficient market portfolio, may be deemed invalid (Roll, 1977).

2.6 Empirical Evidence of CAPM

The CAPM provides for expected return given the systematic risk of a particular stock. Recall that the basic CAPM can be written as follows:

$$r_i = r_f + \beta i \ (r_m - r_f)$$

All variables in the equation above, including the Beta, are stated in terms of expectations/future values. However, a potential problem arises, due to the unavailability of data on expectations. As a result, ex-post or observed values are used to test the model. The use of ex-post values in testing an expectation model, is understandably disconcerting. According to Elton et.al (2003), one defence to this problem, is that, in general, expectations are correct and therefore in the long run, actual events can be said to be reflective of expectations.

In testing CAPM, certain hypothesis should hold. These are:

a) A higher level or systematic risk (as measured by beta) should translate into a higher level of return

b) Non-systematic risk has no bearing on the level of return

Below, is a brief synopsis of the most pertinent research that has been conducted on CAPM

<u>Tests of Sharpe and Cooper</u>

Sharpe and Cooper (1972) conducted a very simple test of CAPM, to determine whether higher betas have indeed corresponded with higher levels of returns. They found that, while the relationship is not perfect, in general-stocks with higher betas have performed better than stocks with lower betas. Their research thus corroborated the principle underpinning CAPM.

Tests of Lintner and Douglas

Lintner conducted a study on CAPM, using 301 stocks in his sample. Firstly, he estimated the beta of each stock by regressing the return of that stock against the market return. He then performed cross-section regressions on stocks and found the following:

i) The intercept (representing the risk free rate of return) was larger than any reasonable estimate,

ii) The market premium (r_m -r_f) was slightly lower than expected, and

iii) Residual/unsystematic risk affected stock returns.

Lintner's findings thus violate/reject CAPM

George Douglas (1968) performed the same test to Lintner and his findings also rejected CAPM

Tests of Black, Jensen and Scholes

The first in-depth time series test of The CAPM was conducted by Black, Jensen and Scholes (1972).They discovered that firstly: there is a positive linear relationship between return and beta and secondly: the intercept value in the regression is positive. Their findings are thus in support of CAPM.

Tests of Fama and Macbeth

Fama and Macbeth (1973) continued with the methodology used by Black et al. in testing CAPM. Their findings are explained below.

They found that residual (unsystematic) risk does not affect stock returns. This is contradictory to the findings of Lintner and Douglas. The difference in the results of Fama and Macbeth versus Lintner and Douglas, is explained by the use of portfolios by Fama and Macbeth, which was not the case with Lintner and Douglas.

Fama and Macbeth also found a positive linear relationship between returns and betas. This, together with the finding stated above, pertaining to the non-relationship between unsystematic risk and returns, gives credence to CAPM. The intercept point, was however, found to be larger than the risk-free rate of return, like in the studies of Lintner and Douglas.

Other studies

Michael Gibbons (1982) performed a test by using the methodology of seemingly unrelated regression and his findings rejected CAPM in all its forms. Robert Stambaugh (1984), followed a similar approach to Gibbons but used a different statistical test (Langrangian Multiplier versus Gibbons'Likelihood ratio) and found strong support for the zero-beta CAPM, while rejecting CAPM.

Tests in South Africa

Bradfield, Barr and Affleck-Graves (1988) found that CAPM holds for the JSE, except for gold stocks. Bradfield and Barr (1988) also found support for CAPM for the JSE. However, Bowie and Bradfield (1993) cautioned that the usefulness of CAPM is highly sensitive to the choice of a "correct" market proxy. This is an indication of the sensitivity of South African stocks to their particular industries.

Van Rensburg and Robertson (2003) found that CAPM does not wholly capture the variation of stock returns. More recently, Ward and Muller (2012) also rejected the CAPM within the South African market, as did Frazzini and Pederson (2014). These researchers found that lower beta stocks were actually performing better than high beta stocks, which is the antithesis of what CAPM states.

2.7 Responses to CAPM Criticism

The previous section documented a few of the most pertinent issues commonly raised against The CAPM. Not least of these, is that CAPM violates conditions in the real world, due to its overly simplistic assumptions. Elton, Gruber and others (2003), argue that this does not eradicate the usefulness of the model as “it may still have real-life explanatory power,” despite these concerns. They, however, proceed to argue that alternative CAPM models-that relax one or more of the assumptions, are beneficial. For example, while CAPM describes equilibrium returns at a macro-level, it does not do likewise at a micro level. The relaxation of particular assumptions may help us understand individual investor behaviour. To this end, a few of the most prominent alternative models, which incorporate these “real-world factors” are presented below.

2.7.1 Black-Scholes CAPM

One of the assumptions that The CAPM is built on, is that investors can short-sell assets without limitation. While this made the derivation of the model simpler, Black (1972), argued that this assumption was not necessary. In equilibrium, all investors hold the market portfolio, and in that state, no investor sells any security short. Therefore, disallowing short selling of securities would not alter the output of The CAPM (Elton et. al.; 2003).

Another assumption that CAPM is predicated on, is the presence of riskless lending and borrowing. This assumption clearly does not conform to the real world and the argument against it, which speaks to the differential rates between lending/borrowing as well as differential rates amongst entities, was presented earlier.

Black (1972) developed an “improved” version of the classic CAPM, which did not rely on the unrealistic assumption of riskless lending and borrowing. This model, called the Zero Beta CAPM, operated in the same fashion as the original CAPM, but the risk free rate of return is substituted with a portfolio whose return has no correlation with the market portfolio (i.e. the portfolio has a beta of zero).

The Zero Beta CAPM is captured by the equation below:

$$r_i = r_z + \beta_i(r_m - r_z), \text{ where:}$$

r_z is the zero portfolio beta which replaced the risk free rate

In figure 4 below, the depiction is similar to that of CAPM, with the difference being that the intercept of CAPM which is the risk free rate is now substituted with the risk-free portfolio (as measured by beta).

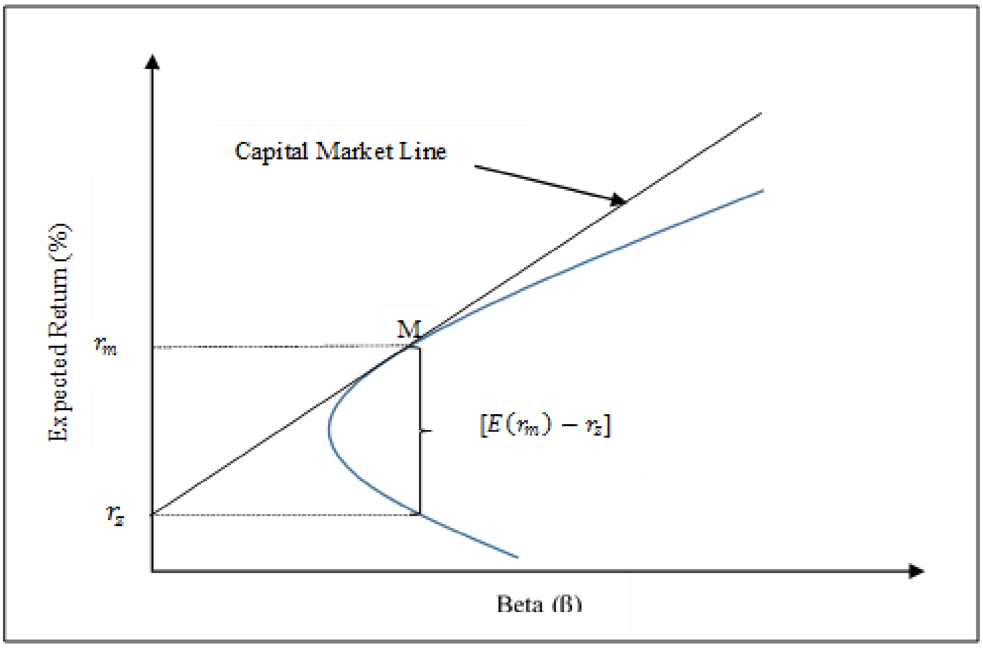

Figure 4: Zero Beta CAPM

2.7.2 Non-Marketable Assets CAPM

CAPM operates under the assumption that all assets are marketable. In reality, this is not true for many assets. Consideration is given to a few such assets below.

Elton et. al (2003) argue that: human capital is one case of a non-marketable asset. By law, people are disallowed from selling themselves into slavery and there is thus no way of marketing this "asset." Another example of a non-marketable asset is that of an investor's primary residence. While an investor may very well sell and therefore "market" their home, they will often not do so purely on the basis of "optimising their portfolio." This is due to the large transaction costs as well as other personal reasons.

Elton, Gruber et. al. (2003), proceeded to derive an equation for CAPM that includes non-marketable assets.

In a world of both marketable and non-marketable assets, there is an equation that captures the equilibrium return on all assets. Let:

r_h = the rate of return on non-marketable assets

P_h = the aggregate value of all non-marketable assets

P_m = the aggregate value of all marketable assets

All other terms in the equation below, are defined as before. It can then be shown that equation for the expected return on asset i is:

$$r_i = r_f + \frac{r_m - r_f}{\sigma_m^2 + \frac{P_h}{P_m} Cov\ (r_m, r_h)} \left[Cov\ (r_i, r_m) + \frac{P_h}{P_m} Cov\ (r_i, r_h)\right]$$

This can be juxtaposed with the simple CAPM, which can be written as:

$$(r_i) = r_f + \frac{r_m - r_f}{\sigma_m^2} \left[Cov\ (r_i, r_m)\right]$$

It is notable from the two equations above that the general equilibrium equation, with the inclusion of non-marketable assets carries the same form as the CAPM, which excluded the non-marketable assets. With CAPM, the relationship states that the expected return on asset i is the compensation for the time value of money (i.e. risk free rate) in addition to the market premium (adjusted for the covariance of that particular stock to the market). However, when non-marketable assets are included, the equilibrium return on asset i is again the addition of the compensation for the time value of money and the market premium (now adjusted not only for the covariance of asset i with the market, but also adjusted for the apportioned covariance of that particular asset to the non-marketable assets).

The risk-return trade-off of the simple CAPM is:

$$\frac{r_m - r_f}{\sigma_m^2}$$

The extension (which includes non-marketable assets) of the risk-return trade off is:

$$\frac{r_m - r_f}{\sigma_m^2 + \frac{P_h}{P_m}\ Cov\ (r_m, r_h)]}$$

Elton et al. (2003) conclude by stating that: the assumption is reasonable that the return on non-marketable assets has a positive correlation to the return on the market. Given the two relationships stated above, the suggestion is that the simple CAPM overstates the market risk-return trade off. The degree of this overstatement is premised on a) the covariance of the non-marketable assets and the marketable ones and b) the relative value of the non-marketable assets to the marketable assets. If the relative value of the non-marketable assets was meagre in comparison to the marketable assets or if there was little correlation between the returns of the two, then using the simple CAPM would be harmless.

2.7.3 Intertemporal CAPM

The Intertemporal Capital Asset Pricing Model (ICAPM) was developed by Robert Merton in 1973. It is a generalised model that seeks to price a number of sources of uncertainty. In this model, there is uncertainty about other influences such as labour income, future prices of goods to be consumed and future investment opportunities etc. This is in addition to the uncertainty surrounding the future value of securities.

ICAPM is thus premised on investors solving lifetime consumptions decisions when faced with numerous sources of uncertainty. This uncertainty (i.e. risk) is undesirable and investors will aim to hedge it away. If this risk is common to investors, then it will affect the expected returns of stocks.

For illustration, inflation is a risk that can be incorporated into asset pricing, and duly modelled by the ICAPM. The inflation adjusted ICAPM would thus be:

$$E(r_i) = r_f + \beta_i + (r_m - r_f) + \beta_{iI} (r_I - r_f)$$

The equation above is the simple CAPM with the addition of a new term ($\beta_{iI} (r_I - r_f)$. The new term is the product of a new beta (which is the sensitivity of any stock held to hedge away inflation risk) and the price of inflation risk.

The ICAPM (or multi-beta CAPM) thus informs us that the expected return on a stock is related to the market return as well as the set of influences/risks. It takes the following form:

$$E(r_i) = r_f + \beta_i + (r_m - r_f) + \beta_{iI1} (r_{I1} - r_f) + \beta_{iI2} (r_{I2} - r_f) + \ldots$$

In the above equation all the $r_{In}{}'s$ are the expected returns on particular portfolios that allow an investor to hedge the risk that they are concerned about.

2.8 Responses to CAPM Criticism

2.8.1 The Arbitrage Capital Asset Pricing Model

The linear relation underpinning the formulation of The CAPM is based on the mean-variance efficiency of the market portfolio. Ross (1976) points out that theoretically, the assumptions of a normal distribution of returns and of the quadratic preferences (utility functions), to guarantee such efficiency, are difficult to justify. Furthermore, empirical evidence has challenged both the conclusions as well as the assumptions of the CAPM. Ross (1976), as an alternative to The CAPM developed the Arbitrage Pricing Theory (APT). This theory of pricing risk preserves many of the principles of the original theory but is less restrictive. Its development and the argument for it, is presented below.

The APT, unlike the CAPM, does not require uniform investor behaviour or claim that the market portfolio will be the only risky asset held. It does however agree with the CAPM that systematic risk, and not total risk affects assets returns. With The APT, there are numerous other macro-economic factors that impact security returns. Investors, diversify risk (as recommended by Markowitz et al.), but “they may choose their own systematic profile of risk and return by selecting a portfolio with its own peculiar array of betas,” (Goetzmann, n.d.). The APT model is:

$$E\ (r_i) = r_f + \beta_{i1}\lambda_1 + \beta_{i2}\lambda_2 + \ldots + \beta_{in},\ \text{where:}$$

$E(r_i)$ and r_f are defined as before

β_{in} is the sensitivity of asset i to the macro-economic risk factor λ

In order to appreciate the model, particularly the concept of “arbitrage,” a descriptive example follows.

Figure 5 shows the difference between CAPM and APT. In CAPM, investors only care about the market portfolio and thus their choice of portfolio will lie on the Capital Allocation Line. With APT, the market portfolio is simply one of a number of possible macro-economic factors. Asset B cannot be an available choice of asset under CAPM, but depending on the particular systematic risk profile of individual investors, it very well can, under APT. This means that it is under-priced, given its beta. Investors who notice this, will buy B to take advantage of this arbitrage opportunity, thereby driving the price up, until the asset lies on the Capital Market Line.

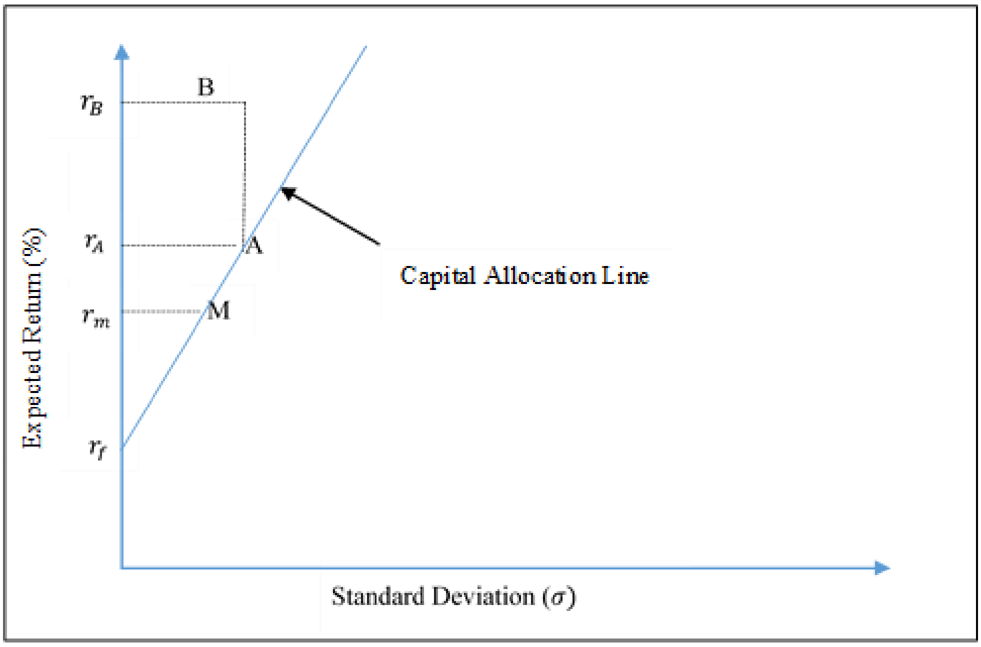

Figure 5: APT vs. CAPM

2.8.2 The Fama and French Three-Factor Model

In the 1970s, empirical evidence began mounting against the Black CAPM, which was the supposed improvement on the much criticised original CAPM. While much of the critique against the original CAPM was pitted against the simplifying theoretical assumptions and the testability of the model, the evidence against the Black CAPM laid bare to another failing of the CAPM. That is: "much of the variation in expected return is unrelated to the market beta," (Fama, French, 2004).

Several researchers found that the following factors also played a role in the variation of the expected asset returns: earnings-price ratios, stock sizes (in terms of market capitalisation), leverage, book-to-market ratios. Specifically, it was found that:

CAPM understates returns on high E/P stocks, small size stocks, highly leveraged stocks as well as stocks with high book-to-market ratios

Armoured with the discoveries of researchers before, Fama and French synthesised this previous work and found the following:

i) Sensitivity to the market portfolio did not completely capture the variation in stock returns

ii) The effect of E/P on stock returns was captured by both size and BE/ME

iii) The effect of leverage on stock returns was captured by BE/ME

This lead to the proposition of a Three-Factor (3F) asset pricing model that incorporates the factors above into the prediction of stock returns. The 3F model is stated below:

$$E(r_i) = r_f + \beta_i \left[E\left(r_m - r_f\right)\right] + \beta_{si}\,[SMB] + \beta_{hi}\,[HML] \text{ where:}$$

β_{si} and β_{hi} are the sensitivities to SMB and HML respectively

SMB (small minus big) is the difference between the returns on diversified portfolios of small stocks and diversified portfolios of big stocks

HML (high minus low) is the difference between the returns on high B/M stocks and low B/M stocks

Fama and French (1993, 1996) found the model explained the variation of returns of portfolios formed on size, B/E and other ratios that were problematic for the CAPM. They also found that the intercept in the regression analysis was zero for all assets. Again, according to Fama and French (1998), the 3F model performed better than the CAPM when assessing the prediction of stock returns internationally, as these tests were conducted across 13 major markets.

The 3F model, like the CAPM before it, is now used in a wide array of applications that require the prediction of stock returns. Along with determining the cost of equity, the model is used to determine how quickly a stock responds to new information (Loughran and Ritter, 1995) and is also used to measure information of portfolio managers (Carhart, 1997).

The 3F model is not without its shortcomings however. Theoretically, the model lacks empirical motivation, as the small-minus-big and high-minus-low explanatory variables are merely “brute force constructs meant to capture patterns uncovered by previous work," (Fama and French 2004). In addition, the model fails to capture the fact that stocks that do well in relation to the market, continue to do so for the next few months, and stocks that do not do well, continue likewise. Jegadeesh and Titman (1993) termed this phenomenon, "the momentum effect."

2.9 Implied Cost of Capital

The CAPM and its variants for estimating the cost of equity (e.g. Fama and French three-factor model), rely on historically available data (Echterling, Eierle, Ketterer, 2015). The usefulness of the estimates stemming from these models, is unfortunately limited. Fama and French (1997, 2004), along with others, go as far as to say that the empirical evidence against the CAPM "probably invalidates its use in applications." These drawbacks have lead to multiple methods of computing the cost of capital, premised on reverse engineering the accounting-based valuation methods. This is known as the "implied cost of capital" and three of its most prominent models are visited below.

The basic idea behind the implied cost of capital is equating the cash flow streams of an asset to its market value, in order to determine the rate of return.

2.9.1 Dividend Discount Model (DDM)

The Dividend Discount Model (DDM) obtains the equity value of a company by discounting the dividends paid out by that company. The formula for the DDM is:

$$V_0 = \sum_{t=1}^{T} \frac{D_t}{(1+r_e)^t} + \frac{D_{t+1}}{(1+r_e)^T\,(r_e-g)}, \text{ where:}$$

V_0 is the company's current value, D_t is the dividend at period t, r_e is the cost of equity capital, and g is the dividend growth rate at the terminal point.

2.9.2 The Residual Income Valuation Model (RIM)

Residual Income is the income that a firm generates after having taken into account its cost of capital. While the cost of debt is already imputed in the "net income" figure of a company, a further step is needed to account for the cost of equity. The cost of equity, otherwise known as the opportunity cost of shareholders, is deducted from net income, to find the residual income. The value of a company using RIM is:

$$V_0 = CSE_0 + \sum_{t=1}^{T} \frac{RIt}{(1+r_e)t} + \frac{RI_{t+1}}{(1+r_e)T\ (r_e - G_{RI})}, \text{ where:}$$

CSE_0 is the value of the ordinary shareholders equity at time 0,

RI_t is the future residual income in period t. It is calculated by deducting the cost of equity from the net income. In turn, the cost of equity is the shareholders equity multiplied by the required rate of return (R_e), r_e is the required rate of return, and

G_{RI} is the terminal growth rate of residual income

2.9.3 The Abnormal Earnings Growth Model (AEGM)

The AEGM, developed by Ohlson and Juettner-Nauroth in 2005, is centred on future earnings and earnings growth. The key feature of the AEGM is that the current price is dependent on the forward Earnings per Share (EPS) and their growth, but encapsulates measures that disregard dividend policies. This model is appealing because it dismisses management policy on wealth distribution and prioritises factors that actually encourage/promote wealth creation.

$$V_0 = \frac{E1}{Re} + \sum_{t=1}^{T} \frac{AEG\ t+1}{Re(1+Re)t} + \frac{AEG\ T+2}{Re(1+Re)T\ (Re - G\ AEG)}, \text{ where:}$$

E_1 is the earning in period 1,

AEG_{t+1} is the abnormal earnings growth in period t+1. AEG_{t+1} is calculated is calculated as follows: $(E_{t+1} + D_t R_e – (1+ R_e)E_t)$, and

G_{AEG} is the terminal growth rate of abnormal earnings

Theoretically, according to (F. Echterling, B. Eierle, S. Ketterer: 2015), the DDM, RIM and AEGM are the same and should therefore produce the same valuation for the company and the implied cost of capital. There are however, nuances that may lead to different results, depending on the model used. For example the RIM provides the same results only if the clean surplus relation applies. The clean surplus relation is when the shareholders equity at the beginning of the period, added to the earnings during the period, less the dividends paid during the period, equal the shareholders equity at the end of the period.

The implied cost of capital valuation models are not without issues. (Echterling et al.; 2015) have identified that the limitations of the models stem from either the model utilised, the inputs into the model, or both these factors. A few of these limitations are documented below.

i) A key input of the models, is the prospective earnings/dividends, which rely on forecasts. These forecasts may be based on analyst estimations, accounting conservatism or mechanical estimation. Optimistic bias of analysts as well as the historic focus of accounting based modelling, are but two of the problems, that misalign the model output with the market based valuation.

ii) DDM can only be applied to companies that pay out dividends

iii) These models provide that the cost of equity is constant and deterministic over time, but theory and empirical evidence have shown that returns are time-varying

2.10 Chapter conclusion

The CAPM remains an appealing asset pricing model, given its properties and parsimonious design. However, its theoretical underpinning is flawed, with many unrealistic assumptions informing its design. Also, CAPM has often failed to hold up when empirically tested, giving credence to the viewpoint that: beyond theoretical appeal, CAPM provides little value.

There are numerous adaptations to “correct” the shortcomings of CAPM, like the Black-Scholes CAPM, the non-marketable CAPM and the intertemporal CAPM, which improve upon an aspect or another of CAPM, but they too, are not without issue.

Lastly, several models have been formulated to counter the essential failings of CAPM. The Arbitrage Pricing Theory (APT) ,Model and the Fama Three Factor model are the ones presented in this literature review. While appealing, for different reasons, they also encounter problems when interrogated. AP, for one, is difficult to test, while Fama Three Factor model suffers from a lack of theoretical founding.

3 DATA AND RESEARCH METHODOLOGY

This chapter delves into the data and methodology used to answer the issues identified in chapter 1. Of the numerous asset pricing models presented in the previous chapter, there are two models in particular, which have received widespread attention and are said to be the most commonly used in practice (PriceWaterhouse Coopers, 2010). These models are: The classic CAPM and the Fama and French Three Factor Model. This study will focus on CAPM by testing whether CAPM can reliably predict the return on individual stocks as well as on indices.

3.1 Data selection

For testing CAPM on individual stocks, 100 companies listed on the Johannesburg Stock Exchange were used. These companies form part of the JSE’s All Share Index (ALSI)-which constitutes 99% of the market capitalisation of all stocks on the JSE main board. These are the most liquid stocks on the exchange. For testing CAPM on indices, the three most common indices were selected: RESI 20 (comprising of the 20 largest resources stocks by market capitalisation), INDI 25 (largest 25 industrial stocks by market capitalisation) and TOP 40 (largest 40 stocks by market capitalisation, irrespective of industry)

Covering the 10-year period from 1 January 2005 to 31 December 2014, the data is retrieved from the following sources: Bloomberg and Bond Exchange of South Africa (BESA). The 10 year chosen period caters to two requirements:

i) Sufficiently long - to remove noise associated with short-term data analysis

ii) Relatively recent- to capture the essence of the market at the time of the creation of this research report

Initially, the target was to use all 160 companies in the JSE ALSI but numerous companies had missing financial data. It was thus decided to select the top 100 companies (in terms of market capitalisation, of those remaining that have the requisite data).

Similar to the research conducted by Fama and Macbeth (1973) and Fama and French (1992 and 1993), monthly data will be used for this study. The monthly return for a stock is calculated as follows:

$$R_i = \ln\left(\frac{S_{i,t+1}}{S_{i,t}}\right) \text{where:}$$

R_i is the return on stock i

$S_{i,t+1}$ is the stock price at time t +1

$S_{i,t}$ is the stock price at time t

As stated above, the JSE ALSI represents 99% of the full market capital value of all equities listed on the Main Board of the JSE and will be used as a proxy for the market portfolio.

3.2 CAPM Research Methodology

The CAPM on individual stocks will be tested utilising the cross-sectional regression method as developed by Fama and Macbeth (1973). This is a two-stage method with the first step being: to use the ordinary least squares (OLS) method to determine the beta coefficient for each stock.

The regression model for the first stage (for N stocks at time t) is:

$$r_{it} - r_{ft} = \alpha_{it} + \beta_i\left(r_{mt} - r_{ft}\right) + \varepsilon_{it}, \text{ where:}$$

$(r_{it} - r_{ft})$ is the excess return on stock , $\left(r_{mt} - r_{ft}\right)$ is the market risk premium, α_{it} is the intercept and ε_{it} is the error term.

Once the beta is identified in the first step above, its values are used in the second pass regression with beta now the independent variable.

$$\overline{r_i} = \gamma_0 + \gamma_1 \beta_i + u_i$$

This cross regression above is then used to test CAPM. The null hypothesis is:

$$\gamma_0 = 0$$

$$\beta_i = 0$$

Miller and Scholes (1972) identified a number of statistical problems inherent in all empirical tests of CAPM. The most pertinent of these problems is using beta above as the true beta for a stock. While a true and stable beta may exist for a stock, all we have is an estimate, which may be subject to sampling error. Any sort of error in the estimated beta "will cause the coefficient of beta in the second pass regression to be downward biased and the intercept to be upward biased,"(Elton et. al, 2003).

To overcome this problem, Black, Jensen and Scholes (1972) ran the time series regression on portfolios instead of individual stocks. The reasoning for this is straightforward. Portfolios incorporate data from more than one stock and therefore, since the effect of any cross-sectional interdependencies is incorporated in the residual variance from the regressions, "the standard error of the intercept can be used to test the difference of alpha from zero," (Elton et. al, 2003). Fama and Macbeth also tested CAPM using portfolios constructed by ranking betas. This paper follows this process of running regressions based on portfolios and the next section details the creation behind said portfolios.

Fama and Macbeth (1973) used 5 years of data to estimate beta as their data set was large (1926-1968). This study will estimate beta using 2 years of data due to the limited time frame. This study (again due to limited data) limits the number of portfolios to be constructed to 5.

3.3 Portfolio Formation

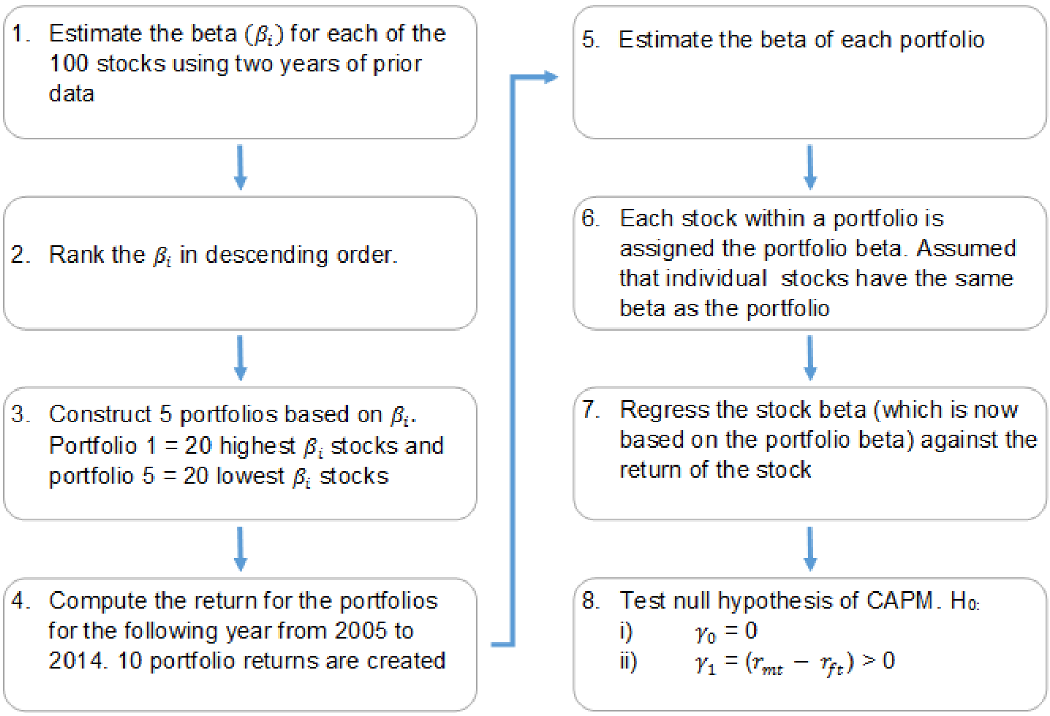

Figure 6: Portfolio Formation

3.4 Research Limitations

- The results of this study should be viewed in the context of the South African market, as other countries may have different regulations and market influences.
- CAPM is not solely applicable to listed companies. In this study however, due to data availability, only companies featuring on the Johannesburg Stock Exchange were used. The results should therefore not be extrapolated to assess other unlisted companies.
- With almost 400 companies listed on the JSE, this study used 100 of these in order to test CAPM. Furthermore, due to thin trading, companies listed in the JSE Alt-X have been omitted.
- The impact of transaction costs and frequency of trading was unaccounted for

- The time frame used for this study (10 years) is short. In comparison, Fama and Macbeth (1973) used 42 years of data when testing CAPM.

3.5 Chapter Conclusion

This chapter firstly explores the rationale behind the selection of the data and the sources of required data. The study covers a ten year period as it is felt that this period is sufficiently long to capture the essence of the market while being short enough to account for recent changes in the market.

Secondly, the method of testing the CAPM on the JSE is borrowed from Fama and Macbeth (1973). The basic tenet of this methodology, which is a cross sectional regression, is that portfolios of assets be used (ranked by beta), to remove the noise inherent in analysis individual assets. Since CAPM purports that higher risk assets (as measured by beta), should earn higher rewards, the expectation should be that higher beta portfolios should outperform their lower beat portfolio counterparts. In addition, three indices, namely; RESI 20, INDI 25 and TOP 40 are also tested to see if their performance is in line with the predictions of CAPM.

The research does suffer from limitations, the most important of which is the short-term horizon. Thus the research should be viewed and assessed within the parameters of its design.

4 RESULTS

4.1 Discussion

Chapter 3 presented the methodology used in assessing the validity of CAPM within the context of the South African market. Five portfolios were formed. As previously stated, Portfolio 1 contains the top 20% of stocks in terms of betas, while Portfolio 5 contains the lowest 20% of stocks by same construction. Table 1 below provides the statistics of these five portfolios. Each portfolio has 120 data points (being the 10 years of monthly data). The average excess returns for the portfolios are 0% and the average standard deviation is approximately 2%. This is telling as the portfolios are, on average, providing little extra return over and above the risk free rate. The range between the minimum and maximum values for excess is approximately 10%, with Portfolio 3 having the smallest range (9%) and Portfolio 1 having the largest range (14%). It is also worth noting that contrary to what is predicted by CAPM, the riskier portfolios (in terms of their covariance with the market returns, as measured by beta), are not necessarily performing better than the portfolios with less risk.

Portfolio 1 (containing the 20 highest beta stocks), and therefore the most “risky” had an average excess return of -0.10%. Portfolio 2 (containing the second highest beta stocks), also had an average excess return of -0.10%. These portfolios, along with Portfolio 4 (fourth highest beta stocks) have the lowest average excess returns. Portfolio 3 and Portfolio 5 (lowest beta stocks) provided the highest average excess returns of 0.00%. A few things are worth noting here. Firstly, the riskier portfolios (1 and 2) are not performing better than the lower risk portfolios (i.e. 4 and 5). This is contradictory to the essence of CAPM, which posits that higher risk assets/portfolios provide for a higher return than the lower risk assets/portfolios. Secondly, there is no discernable pattern in terms of the excess returns of the different portfolios. If anything, there seems to be little excess returns across all five portfolios. This may be due to monthly returns being used. Expanding the “window of assessment may result in more significant excess returns being observed.

	N	Minimum	Maximum	Mean	Std Deviation
Portfolio 1	120	-8%	6%	-0.10%	2.30%
Portfolio 2	120	-7%	4%	-0.10%	1.90%
Portfolio 3	120	-6%	3%	0.00%	1.70%
Portfolio 4	120	-6%	4%	-0.10%	1.70%
Portfolio 5	120	-7%	4%	0.00%	1.70%
JSE ALSI	120	-7%	4%	0.00%	2.00%

Table 1: Summary of Excess Portfolio Returns

The results of this study (i.e. rejection of CAPM), is consistent with the findings of Lintner and Douglas (1968) and Gibbons (1972). However, the results are not consistent with those of Sharpe and Cooper who find a relationship (albeit not perfect), between assets' risk (beta) and returns. More interesting however, is that these results are contradictory to the findings of Fama & Macbeth (1973), whose methodology was used in conducting this study.

In the context of South Africa, these results contradict those of Bradfield, Barr amd Affleck-Graves (1988) who found that CAPM holds for South Africa, aside from gold stocks. The results confirm the findings of Van Rensburg and Robertson (2003) and Ward and Muller (2012). Their findings that that lower beta stocks were performing better than higher beta stocks is what was found in this study, with Portfolio 1 and 2 being outperformed by Portfolio 3 and 5.

The five portfolio betas and alphas were computed as aforementioned (i.e. conducting a linear regression). Table 2 captures these outcomes, together with the results of the tests of significance for the variables of interest (namely: alpha and beta). The portfolio betas (as per design), decrease from Portfolio 1, which has a beta of 1.03 to Portfolio 5, which has a beta of 0.57. The market has a beta of 1. A beta higher than 1 (e.g. portfolio 1), means that the portfolios returns are highly sensitive to the returns of the market. The beta is also positive meaning that the portfolios return goes up and down with the market. Portfolios 2 to 5 are positive as well, so the returns of all those portfolios go up when the market portfolio goes up and go down when the market return goes down.

It is interesting to note that the beta of the portfolios, from portfolio 1 to portfolio 5 does not go down in any sort of average manner. The betas for portfolios 2 to 5 are all around 0.6. This indicates that they are not highly volatile to the returns of the company. This could be explained by the fact that South African stock exchange is saturated with established, mature companies whose returns are not volatile. The is further enhanced by the fact that the selection of data (i.e. companies), was based on market value.

β = 0 is rejected for all portfolios at both the 5% and 1% confidence levels. This means that, to a certain degree the variance of returns of the portfolios (and thus stocks), is explained by the variance in return of the market. This is however not the case for the alpha. At both the 5% and 1% confidence levels, alpha = 0 is not rejected. This serves to reject the null hypothesis that asset returns are a function of the risk free rate and the market premium. Some variation in returns is clearly predicated on other factors and these should be investigated. It is thus possible, since CAPM doesn't capture all variation in returns, that managers can perform better or worse than the market. These findings are in agreement with those of Van Rensburg and Robertson (2003), and Ward and Muller (2012). Managers should thus be compensated for better performance or else, dealt with accordingly for poor performance.

	Portfolio 1	**Portfolio 2**	**Portfolio 3**	**Portfolio 4**	**Portfolio 5**
Alpha	-0.0005	-0.0008	0.001	-0.001	0.0002
t-stat	0.47	-0.6	0.052	-0.88	0.13
sig	0.64	0.55	0.96	0.38	0.9
Beta	1.0369	0.6616	0.62	0.5842	0.5725
t-stat	20.92	10.48	11.73	10.1	9.39
sig	0	0	0	0	0

Table 2: Portfolio Parameters

Table 3 provides summary statistics for the three indices of interest, namely: RESI 20, INDI 25 and TOP 40. The range for the indices excess returns are considerably greater than for the five portfolios constructed based on betas. RESI20 has the lowest monthly excess return of -26% but it also has the highest excess monthly return of 16%. This represents a wide range of 42%. INDI 25 has a range of 23% and TOP 40 has a range 29% which is surprising given that TOP 40 includes large companies from varied industries and therefore, you would expect decreased volatility in terms of returns.

	N	Minimum	Maximum	Mean	Std Deviation
RESI 20	120	-26%	16%	0.10%	7.19%
INDI 25	120	-13%	10%	1.02%	4.39%
TOP 40	120	-17%	12%	0.58%	4.90%
JSE ALSI	120	-7%	4%	-0.05%	2.00%

Table 3: Summary of Excess Index Returns

Table 4 captures the parameters for the returns of the three indices as a function of the market return. β = 0 is rejected for all three indices at both the 5% and 1% confidence levels. Therefore, some variation in the returns of the indices is explained by the variation in the market return. With alpha, the results are varied. For the INDI 25 and TOP 40 indices, alpha = 0 is rejected. This is not in accordance with CAPM as it means that some variation in return is explained by other unknown factors. For RESI 20, we fail to reject that alpha = 0. We conclude to say the variation in returns of resource stocks can be reliably predicted by CAPM. This supports the findings of Bradfield and Barr (1988) and Ward (2015) who found that CAPM holds for mining shares. The reason that can be put down for this is the dominance of resources shares in terms of capitalisation value, on the market as represented by the ALSI. The adjusted R-squared, known as the co-efficient of determination, for each index is presented. The RESI 20 has an adjusted R-squared of: 0.76, INDI 25: 0.71 and TOP 40: 0.99. These R-squared indicate that much of the variance in the returns of the Indices, is expalined by the variance of the market. This, however, does not imply a causal relationship. It is likely that this “good fit” is a result of the high concentration of the indices on the ALSI. This, can be confidently said to be the reason why the TOP 40 provides such a high R-squared.

	RESI 20	INDI 25	TOP 40
Alpha	0.0025	0.0111	0.007
t-stat	0.77	5.05	15.98
sig	0.44	0.00	0.00
Beta	3.1526	1.8543	2.450
t-stat	19.44	16.824	112
sig	0	0	0
R-squared	0.76	0.71	0.99

Table 4: Index Parameters

4.2 Chapter Conclusion

This chapter presents the results of the study, in accordance with the methodology described in Chapter 3. The findings are varied. In terms of the portfolios, each created based on a ranking system of the individual stocks sensitivity to the market, CAPM was rejected. High beta portfolios did not perform better than low beta portfolios. In fact, the opposite held true, in that lower risk portfolios outperformed higher risk portfolios. These results agree with those of Lintner and Douglas (1968) and Gibbons (1972). They, however contradict the results of of Fama & Macbeth (1973).

In term of Indices, the performance of the resources index was in line with CAPM dictations. This supports the findings of other authors who argued that the South African market is highly segmented and CAPM can be rejected or accepted as valid depending on the segment/industry observed.

5 CONCLUSION

CAPM remains the most investigated asset-pricing model. Despite numerous empirical failings, CAPM is hugely popular amongst researchers because of the simplicity in its design and its intuitive appeal. While CAPM has been extensively researched in developed economies, there remains wide scope for assessing its applicability in emerging economies. Furthermore, testing CAPM's suitability to predict returns on indexes within a stock exchange is an under-serviced prospect. In this study, we investigated whether CAPM reliably predicts stock returns, by using portfolios of stocks constructed using beta. In addition, we assessed CAPM's prediction of index returns by regressing the three popular indices against the market return.

CAPM, was found to not accurately capture or explain the variance of returns on individual stocks in the South African market. Some variance in returns was not explained by the combination of the risk free rate and the market premium. This should serve as encouragement for researchers to assess what other factors play a role in determining the returns on assets in South Africa. Some factors to consider are market size and the book-market-ratios which have been shown to have explanatory power by Fama and French (2004) in other countries.

With Indices, the analysis on the Industrial index and the TOP 40 index provided similar answers to the analysis done on stocks. CAPM did not fully capture the variation in returns of these indices. However, interesting to note the findings of the analysis done on the Resources index, which supports CAPM.

BIBLIOGRAPHY

1. Banz R (1981). The Relationship between return and market value of common stocks. Journal of Financial Economics Vol 9, No 1, 3-18.

2. Bhandari, L. (1998). Debt/equity ratio and expected common stock returns: Empirical evidence. The Journal of Finance, 43(2), 507-528.

3. Black, F. (1972). Capital market equilibrium with restricted borrowing. Journal of business,Vol4, No 3, 444-455.

4. Black F., Jensen M., Scholes M. (1972). The Capital Asset Pricing Model: Some Empirical Tests.

5. Blanco B. (2012). The use of CAPM and FAMA and French Three Factor Model: portfolio selection. Journal of Public and Municipal Finance. Vol. 1, No. 2.

6. Bondt, W. F., & Thaler, R. (1985). Does the stock market overreact?. The Journal of Finance, Vol. 40, No. 3, 793-805.

7. Choundary K., Choundary S. (2010). Testing Capital Asset Pricing Model: Evidences from Indian Equity Market. Eurasian Journal of Business and Economics. Vol. 3, No. 6, 127-138.

8. Echterling F., Eierle ., Ketterer S. (2015). A Review of the literature on methods of computing the implied cost of capital. International Review of Financial Analysis. Vol., 42. 235-252.

9. Elton E., Gruber M., Brown S., Goetsmann W., (2003). Modern Portfolio Theory and Investment Analysis. Sixth Edition. John Wiley & Sons, Inc.

10. Fama, E., & French, K. R. (1992). The cross-section of expected stock returns. The Journal of Finance, Vol.47, No. 2, 427-465

11. Fama E., French K. (1992). Common risk factors in the returns of stocks and bonds. Journal of Financial Economics. Vol. 3. 3-56.

12. Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. The Journal of Political Economy, Vol. 8, No. 3, 607-636.

13. French Craig W. (2003). The Treynor Capital Asset Pricing Model. Journal of Investment Management Vol. 1, No. 2, 60-72.

14. Hou K., van Dijk M., Zhang Y., (2011). The Implied Cost of Capital: A New Approach. Fisher Colege of Business Working Paper Series.

15. Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. The Journal of Finance, Vol. 48, No. 1, 65-91.

16. MacKinlay, A. C. (1995). Multifactor models do not explain deviations from the CAPM. Journal of Financial Economics, Vol. 38, No. 1, 3-28.

17. Mangram M. (2013). A simplified Perspective of The Markowitz Portfolio Theory. Global Journal of Business Research. Vol.7, No.1.

18. Markowitz, H.M. (1952). Portfolio Selection. Journal of Finance, Vol. 7, No. 1, 77–91.

19. Nel W. (2001). The application of the Capital Asset Pricing Model (CAPM): A South African perspective. African Journal of Business Management. Vol. 5, No. 13.

20. Oke B. (2013). Capital Asset Pricing Model (CAPM): Evidence from Nigeria. Research Journal of Finance and Accounting. Vol. 4, No. 9.

21. Perold A. (2004). The Capital Asset Pricing Model. Journal of Economic Perspectives. Vol. 18, No. 3, 3-24.

22. Roll R., Ross S., (1995). The Arbitrage Pricing Theory Approach to Strategic Portfolio Planning. Financial Analysts Journal. January-February.

23. Roll R. (1977). A Critique of The Asset Pricing Theory's Tests- Part 1: On past and potential Testability of the theory. Journal of Financial Economics. Vol. 4, 129-176.

24. Rosenberg, B., Reid, K., & Lanstein, R. (1985). Persuasive evidence of market inefficiency. The Journal of Portfolio Management, Vol. 11, No. 3, 9-16.

25. Schulmerich M., Leporcher Y. (2015). Applied Asset and Risk Management: A Guide to Modern Portfolio Management and Behaviour-Driven Markets.

26. Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. The Journal of Finance, Vol. 19, No. 3, 425-442.

27. Simons K. (1998). Risk –Adjusted Performance of Mutual Funds. New England Economic Review.

28. Ward M., Muller C. (2012). Emperical testing of the CAPM on the JSE. Investment Analysts Journal. No. 76.

29. Ward M. (2015). Risk on the Johannesburg Stock Exchange. Vol. 8, No 2.