An empirical investigation of the capital asset pricing model: studying stocks on the Zimbabwe Stock Exchange

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Abstract

Since the birth of the Capital Asset Pricing Model (CAPM), enormous efforts have been devoted to studies evaluating the validity of this model, a unique breakthrough and valuable contribution to the world of financial economics. Some empirical studies conducted, have appeared to be in harmony with the principles of CAPM while others contradict the model. The aim of this paper is to study if the CAPM holds on the Zimbabwe Stock Exchange, meaning:

1. If higher beta yields higher expected return
2. If the intercept equals zero/average risk-free rate and slope of SML equals the average risk premium and
3. If there exist linearity between the stock beta and the expected return

Monthly stock returns for twenty (28) firms listed on the Zimbabwe Stock Exchange are used. The data ranges from January 2003 to December 2008, a period of six years. To test the CAPM, this study will use approach methods as described by Black, Jensen and Scholes (1972) time-series test as well as Fama and MacBeth (1973) cross-sectional test. It turns out that each of the investigation conducted is a confirmation of the other that the empirical investigations carried out during this study do not fully hold up with CAPM. The data did not provide evidence that higher beta yields higher return while the slope of the security market line is negative and downward sloping. The data also provide a difference between average risk free rate, risk premium and their estimated values. However, a linear relationship between beta and return is established.

Keywords: Stock Exchange, Capital Asset Pricing Model, Arbitrage Pricing Theory, Security Market Line, Average Risk Premium
1.0 Introduction

Since the birth of the Capital Asset Pricing Model (CAPM), enormous efforts have been devoted to studies evaluating the validity of this model, a unique breakthrough and valuable contribution to the world of financial economics. Some empirical studies conducted, have appeared to be in harmony with the principles of CAPM while others contradict the model. These differences in previously conducted studies serve as a major stimulating factor to my curiosity. Being a student, it is a privilege using this paper particularly, to deeply enhance the principles of CAPM and evaluate the validity of the model using stocks from the Zimbabwe Stock Exchange.

1.1 Brief Presentation of CAPM

One of the significant contributions to the theory of financial economics occurred during the 1960s, when a number of researchers, among whom William Sharpe was the leading figure, used Markowitz’s portfolio theory as a basis for developing a theory of price formation for financial assets, the so-called Capital Asset Pricing Model (CAPM). Markowitz’s portfolio theory analyses how wealth can be optimally invested in assets, which differ in regard to their expected return and risk, and thereby also how risks can be reduced.

The foundation of the CAPM is that an investor can choose to expose himself to a considerable amount of risk through a combination of lending-borrowing and a correctly composed portfolio of risky securities. The model emphasizes that the composition of this optimal risk portfolio depends entirely on the investor’s evaluation of the future prospects of different securities, and not on the investors’ own attitudes towards risk. The latter is reflected exclusively in the choice of a combination of a risky portfolio and risk-free investment or borrowing. In the case of an investor who does not have any special information, that is better information than other investors, there is no reason to hold a different portfolio of shares than other investors, which can be described as the market portfolio of shares.

The Capital Asset Pricing Model (CAPM) incorporates a factor that is known as the “beta value” of a share. The beta of a share designates its marginal contribution to the risk of the entire market portfolio of risky securities. This implies that shares designated with high beta coefficient above 1 is expected to have over-average effect on the risk of the total portfolio while shares with a low beta coefficient less than 1 are expected to have an under-average effect on the aggregate portfolio. In efficient market according to CAPM, the risk premium and the expected return on an asset will vary in direct proportion to the beta value. The equilibrium price formation on efficient capital market generates these relations.

After the publication of Markowitz’s (1959) Portfolio Selection book, Treynor (1961) started intensive work on the theory of asset pricing. The intention of Treynor's paper is “to lay the groundwork for a theory of market value which incorporates risk “. Shortly after Treynor began his work on asset pricing, Sharpe also set out to determine the relationship between the prices of assets and their risk attributes. The paper published by Sharpe (1964) notes that through diversification, some of the risk inherent in an asset can be avoided so that its total risk is obviously not the relevant influence on its price; unfortunately little has been said concerning the particular risk component which is relevant. Sharpe aims to use the theory of portfolio selection to construct a market equilibrium theory of asset prices under conditions of risk and notes that
his model sheds considerable light on the relationship between the price of an asset and the various components of its overall risk.

After the publication of the Sharpe (1964), Lintner (1965) and Mossin (1966) articles, there was a wave of papers seeking to relax the strong assumptions that underpin the original CAPM. The most frequently cited modification is the one made by Black (1972), who shows how the model changes when riskless borrowing is not available; his version is known as the zero-beta CAPM. Another important variant is that of Brennan (1970), who proves that the structure of the original CAPM is retained when taxes are introduced into the equilibrium. Also, Mayers (1972) shows that when the market portfolio includes non-traded assets, the model also remains identical in structure to the original CAPM. Solnik (1974) and Black (1974) extended the model to encompass international investing.

The capital asset pricing models of Sharpe-Lintner-Black (SLB) have been subjected to extensive empirical testing in the past 30 years (Black, Jensen and Scholes, 1972; Blume and Friend, 1973; Fama and MacBeth, 1973; Basu, 1977; Reiganum, 1981; Banz, 1981; Gibbons, 1982; Stambaugh, 1982 and Shanken, 1985). In general, the empirical results have offered very little support of the CAPM, although most of them suggested the existence of a significant linear positive relation between realised return and systematic risk as measured by \( \beta \). The model is considered as the backbone of contemporary price theory for financial markets and it also widely used in empirical investigations, so that the abundance of financial statistical data can be utilized systematically and efficiently.

1.2 Problem Statement

Since the birth of the Capital Asset Pricing Model (CAPM), enormous efforts have been devoted to studies evaluating the validity of this model, a unique breakthrough and valuable contribution to the world of financial economics. Some empirical studies conducted, have appeared to be in harmony with the principles of CAPM while others contradict the model. These differences in previously conducted studies serve as a major stimulating factor to my curiosity, the validity of the CAPM in application with historical data collected from the Zimbabwe Stock Exchange.

1.3 Objectives of the Study

The aim of this paper is to study if the CAPM holds on the Zimbabwe Stock Exchange, meaning:
1. If higher beta yields higher expected return
2. If the intercept equals zero/average risk-free rate and slope of Security Market Line (SML) equals the average risk premium and
3. If there exist linearity between the stock beta and the expected return

1.4 Organizational Structure

The paper is organized in six (6) sections. Section one (1) is the introductory section of the paper. It highlights the purpose of the research, brief background, basis of the CAPM and
presents an organizational structure of the entire paper. Section two (2) illustrates an in-depth theoretical framework of the model, support/strength and challenges/weakness of the model. Section three (3) introduces the testing methods, outsourcing of data and application of data to methods to conduct empirical study. Section (4) contains results and findings from the empirical study. Section (5) also contains conclusion. The last section, “References” contains sources used to produce this paper.

2. Theoretical Framework

This section of the paper contains illustrative and in-depth theoretical framework. Substantial evidences favouring the model are presented as well as contra evidences. It also includes a brief description of the Arbitrage Pricing Theory (APT) and a comparison of this theory to the CAPM. The context of this section seeks simplicity intended to suit persons with little or no previous knowledge on the Capital Asset Pricing Model (CAPM).

2.1 The Theory of CAPM

The Capital Asset Pricing Model often expressed as CAPM of William Sharpe (1964) and John Litner (1965) points the birth of asset pricing theory. It describes the relationship between risk and expected return and is used in the pricing of risky securities. The CAPM is still widely used in evaluating the performance of managed portfolio and estimating the cost of capital for firms even though, it is about four and a half decades old. The Capital Asset Pricing Model, CAPM emphasizes that to calculate the expected return of a security, two important things needs to be known by the investors:

• The risk premium of the overall equity/portfolio (assuming that the security is only risky asset)
• The security’s beta versus the market.

The security’s premium is determined by the component of its return that is perfectly correlated with the market, meaning the extent to which the security is a substitute for investing in the market. In other word, the component of the security’s return that is uncorrelated with the market can be diversified away and does not demand a risk premium.

The CAPM model states that the return to investors has to be equal to:

• The risk-free rate
• Plus a premium for the stocks as a whole that is higher than the risk-free rate.
• Multiplied by the risk factor for the individual company.

This can be expressed mathematically as

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

Where

\[ E[R_i] = \text{Expected Return} \]
\[ R_f = \text{Risk-free rate} \]
\[ \beta_i = \text{Beta of the security } i \]
\[ E[R_m] = \text{Expected Return on the market} \]
\[ E[R_m] - R_f = \text{Market premium} \]

Equation one (1) shows that the expected return on security \( i \) is a linear combination of the risk-free return and the return on portfolio \( M \). This relationship is a consequence of efficient
set mathematics. The coefficient Beta, \( \beta \) measures the risk of security \( i \), and is related to the covariance of security \( i \) with the tangency portfolio, \( M \). Therefore, the expected return will equal the risk-free asset plus a risk premium, where the risk premium depends on the risk of the security. The equation describing the expected returns for security \( i \) is referred to as the Security Market Line (SML). In the SML equation, expected returns are linear and the coefficient beta is:

\[
\beta_i = \frac{\sigma_{im}}{\sigma^2_m}
\]

The security market line, SML is sometimes called the Capital Asset Pricing Model (CAPM) equation. It states the relationships that must be satisfied among the security’s return, the security’s beta and the return from portfolio \( M \). The CAPM model introduces simple mechanism for investors and corporate managers to evaluate their investments. The model indicates that all investors and managers need to do is an evaluation and comparison between expected return and required return. If the expected result is otherwise unfavourable, it is necessary to abort intentions for potential investment in the particular security.

### 2.1.1. Implications of the Theory

The CAPM is associated with a set of important implications which are often the bases for establishing the validity of the model. They are as follows:

- Investors calculating the required rate of return of a share will only consider systematic risk to be relevant.
- Shares that exhibit high levels of systematic risk are expected to yield a higher rate of return.
- On average there is a linear relationship between systematic risk and return, securities that are correctly priced should plot on the SML.

### 2.1.2. Assumptions of the Theory

The CAPM is associated with key assumptions that represent a highly simplified and natural world. Given sufficient complexities, to understand the real world and construct models, it is necessary to assume away those complexities that are thought to have only a little or no effect the its behaviour. Generally it is accepted that the validity of a theory depends on the empirical accuracy of its predictions rather than on the realism of its assumptions. The major assumptions of the CAPM are:

- All investors aim to maximize the utility they expect to enjoy from wealth holding.
- All investors operate on a common single-period planning horizon.
- All investors select from alternative investment opportunities by looking at expected return and risk.
- All investors are rational and risk-averse.
- All investors arrive at similar assessments of the probability distributions of returns expected from traded securities.
- All such distributions of expected returns are normal.
- All investors can lend or borrow unlimited amounts at a similar common rate of interest.
- There are no transaction costs entailed in trading securities.
- Dividends and capital gains are taxed at the same rates.
• All investors are price–takers: that is, no investor can influence the market price by the scale of his or her own transactions.
• All securities are highly divisible, i.e. can be traded in small parcels.

2.2. Evidence of the Theory

It was earlier stated in this paper that considerable research has been conducted to test the validity of the CAPM. Some of these findings provide evidence in support of the Capital Asset Pricing Model while others present evidence raising questions about the validity of the model. Among other test providing evidence of the model are two classic studies, Black, Jensen and Scholes and Fama and MacBeth.

2.2.1 The Black-Jensen-Scholes Study (1972)

In their studies, Black, Jensen and Scholes use the equally-weighted portfolio of all stocks traded on the New York Stock Exchange (NYSE) as their proxy for the market portfolio. They calculated the relationship between the average monthly return on the portfolios and the betas of the portfolios between 1926 and 1966, a period of forty years. The findings from their study provided a remarkable tight relationship between beta and the monthly return.

Given the result from their study, Black, Jensen and Scholes did not reject the linearity predicted by CAPM because there existed a positive linear relationship between average return and beta, although the intercept appeared to be significantly different and greater than the average risk-free rate of return over the period studied.

2.2.2. The Fama and MacBeth Study (1973)

The next classical test to be discussed in support of the CAPM is the study conducted by Fama and MacBeth (1973). They evaluated stocks traded on NYSE with similar period as that of Black, Jensen and Scholes’ study. They also took as their proxy for the market portfolio an equally weighted portfolio of all NYSE stocks and focused on two implications of CAPM;
• Linearity between the expected return and the beta of a portfolio.
• Expected return being determined purely by a portfolio’s beta and not by the “residual variance” or non-systematic risk of the portfolio.

They regressed the result after estimating betas and historical average returns and obtained the following regressions:

\[ r_p = \alpha_0 + \alpha_1 \beta_p + \alpha_2 \beta^2 + \varepsilon_p \]
\[ r_p = \alpha_0 + \alpha_1 \beta_p + \alpha_2 \beta^2 + \alpha_3 RV_p + \varepsilon_p \]

Given,

\[ RV_p = \frac{\sum \delta^2_{\varepsilon_t}}{N} \]

Where
N = number of stocks
P = portfolio
RV = Average of residual variance
The logic of the test is that, given the SML equation holds as predicted by CAPM then,
• \( \alpha_0 \) should be equivalent to the average risk-free interest rate,
• \( \alpha_1 \) should be equivalent to the “excess return on the market and
• \( \alpha_2 \) and \( \alpha_3 \) should be equivalent to zero.

Fama & MacBeth performed a significance test and concluded that \( \alpha_2 \) and \( \alpha_3 \) were not significantly different from zero which serves as an evidence and support to the CAPM theory.

2.3 Challenges to the Theory

Even though, the CAPM is still applied in financial institutions and taught in schools around the globe, it is indeed a subject to criticism. Researchers around the world question the application of the Capital Asset Pricing Model as a result of empirical studies conducted. Fama and French present some of the most famous contradictions. Fama and French (1992) present evidence on the empirical failures of the CAPM. In their study, portfolio group formation of similar size and betas from all non-financial stocks traded on the NYSE, National Association of Securities Dealers Automated Quotations (NASDAQ) and AMEX between 1963 and 1990 are taken into consideration. Fama and French used the same approach as Fama and MacBeth (1973) but arrived at very different conclusion, no relation at all. Fama and French (1996) reach the same conclusion using the time-series regression approach applied to portfolios of stocks sorted on price ratios and find that different price ratios have much the same information about expected returns. In short, Fama and French concluded that firm size and other accounting ratios are better predictors of observed returns than beta.

Roll (1977) criticized all efforts to test the Capital Asset Pricing Model. The basis of the Roll’s Critique is the efficiency of the market portfolio’s implication in CAPM. The market portfolios by theory include all types of assets that are held by anyone as an investment. In application, such a market portfolio is unobservable and people usually substitute a stock index as a proxy for the true market portfolio. Roll argues that such substitution is not innocuous and can lead to false inferences as to the validity of the CAPM and due to the lack of ability to observe the true market portfolio, the CAPM might not be empirically testable. In a nutshell, tests must include all assets available to investors.

A major turning point in empirical tests of the CAPM was the devastating Roll (1977) critique. Previous tests of the CAPM examine the relationship between equity returns and beta measured relative to a broad equity market index. However, Roll demonstrates that the market, as defined in the theoretical CAPM, is not a single equity market, but an index of all wealth. The market index must include bonds, property, foreign assets, human capital and anything else, tangible or intangible that adds to the wealth of mankind. Roll points out that "the portfolio used by Black, Jensen and Scholes was certainly not the true portfolio". Moreover, Roll shows that unless this market portfolio was known with certainty then the CAPM never could be tested. Finally, Roll argues that tests of the CAPM are at best tests of the mean-variance efficiency of the portfolio that is taken as the market proxy. But within any sample, there will always be a portfolio that is mean-variance efficient; hence finding evidence against the efficiency of a given portfolio tells us nothing about whether or not the CAPM is correct.

In order to construct a framework that is both more realistic and at same time, more tractable than the discrete time model, Merton (1973) developed an Intertemporal CAPM
(ICAPM) by assuming that time flows continuously. One of Merton's key results is that the static CAPM does not in general hold in a dynamic setting and “that the equilibrium relationships among expected returns specified by the classical Capital Asset Pricing Model will obtain only under very special additional assumptions”. In particular, Merton demonstrates that an agent's welfare at any point in time is not only a function of his own wealth, but also the state of the economy. If the economy is doing well then the agent's welfare will be greater than if it is doing badly, even if the level of wealth is the same. Thus the demand for risky assets will be made up not only of the mean variance component, as in the static portfolio optimization problem of Markowitz (1952), but also of a demand to hedge adverse shocks to the investment opportunity set.

Around the time that the shocking truth of the Roll critique was sinking in, Ross (1976) developed the arbitrage pricing theory (APT) as an alternative model that could potentially overcome the CAPM’s problems while still retaining the underlying message of the latter.

2.4. Arbitrage Pricing Theory - An Alternative

The arbitrage pricing theory (APT) has been proposed as an alternative to the capital asset pricing model (CAPM). It is a new and different approach to determine asset prices and centers around the law of single price: similar items cannot sell at different prices. The theory was initiated by the economist Stephen Ross in 1976. APT states that the expected return of an asset can be modeled as a linear function of various macro-economic factors or theoretical market indices, where a factor’s specific beta coefficient represents the sensitivity of changes in each factor. The model obtained rate of return will then be used to price the asset accurately, having the asset price equal to the expected end of period price discounted at the rate implied by the model. In such case, if the price diverges, arbitrage is expected to bring it back into line.

The model is associated with a couple of assumptions and requirements that are established in an attempt to get rid of impurities in the latter. The assumptions are that:
• Security returns are generated by a multi-factor model
• The return generating process model is linear

Additionally, it is required that there must be perfect competition in the market, and the total number of factors may never surpass the total number of assets.

The equation representing this model is as follows;

\[ r_i = \beta_0 + \beta_{iA} F_A + \beta_{iB} F_B + \ldots + \beta_{iK} F_K + \epsilon_i \]

Where
- \( r_i \) = the rate of return on security \( i \), a random variable;
- \( \beta_0 \) = the expected level of return for the stock \( i \) if all indices have a value of zero.
- \( \beta_{iK} \) = the \( i \)th security's return responsiveness to factor \( k \);
- \( F_A \) = non-diversifiable factor A;
- \( F_B \) = non-diversifiable factor B, and so on;
- \( \epsilon_i \) = the idiosyncratic risk or residual term, which is independent across securities.
2.5 Relating APT to the CAPM

The APT along and the CAPM are two influential theories on asset pricing. The APT differs from the CAPM in a sense that it is less restrictive in its assumption. It allows for an explanatory model of asset returns. Furthermore, it assumes that each investor will hold a unique portfolio with its own particular array of betas, as opposed to the identical market portfolio. The interpretation of the factor introduces the major difference between the two models. For CAPM, the factor is the market index \( M \) (the value-weighted index of all risky securities) while for the APT, this could be \( M \), but is not restricted to \( M \). For instance, the factor could be a proxy for \( M \).

That is, APT still makes a prediction given some proxy for \( M \) something that CAPM cannot provide. In both cases, there is a simple linear relationship between expected excess returns and the security’s beta. In some ways, the CAPM can be considered a special case of the APT in that the security market line represents a single-factor model of the asset price, where beta is exposure to changes in the market.

3. Empirical Method

This section presents the testing methods of the CAPM which are later used to obtain results for further analysis. Given the procedures, data are outsourced and applied to methods to conduct studies.

3.1 Sample Selection

The data used of this study covers the period of six (6) years, from 2003-01-01 to 2008-12-31. This period was select as a result of unavailable historical data for some of the stocks as well as the market index. Initially, the thirty (30) most traded stocks on the Zimbabwe Stock Exchange with a period of ten (10) years was a focus of this study. In order to maintain a longer time frame and maximum number of firms, six years were chosen and two firms were omitted because they did not meet my periodic requirements.

3.2 Data selection

During this study, I am using monthly stocks returns from companies listed on the Zimbabwe Stock Exchange for the period of six (6) years. The stocks are the most traded on the stocks and their data were obtained from the Zimbabwe Stock Exchange’s in the form of daily prices.

In the studies conducted by Black et al (1972), average monthly data are used while during this study, I chose to use the last day closing prices of the month to represent monthly data. Also, the existing monthly Zimbabwean Treasury bill is used as a proxy for the risk-free rate. The yields were obtained from the Central Statistical Office Publications and are expected to reflect the short-term changes on the Zimbabwean financial market. All stocks’ returns used for the purpose of this paper are not adjusted for dividends. However, the results are not expected to be greatly affected by such since earlier researchers, including Black et al (1972) have applied similar measures.
3.3 Testing Methods

To test the CAPM for the Zimbabwe Stock Exchange, a six year period is used as well as methods introduced by Black et. al (1972) and Fama-MacBeth (1973). Considering the short observation period, the investigation is divided into three main periods. These periods are the portfolio formation period, estimation period, and testing period.

3.3.1 Portfolio Formation Period

The portfolio formation period is the first step of the test. During this period, Black et.al (1970) used a time series test o the CAPM to regress excess return on excess market return. Similarly, this study uses this period to estimate beta coefficient for individual stocks using monthly returns for the period 2003-01-30 to 2008-12-31. The betas estimation is conducted by regression using the following time series formula:

\[ R_{it} - R_{ft} = a_i + \beta_i (R_{mt} - R_{ft}) + e_{it} \]  \hspace{1cm} (5)

Where

- \( R_{it} \) = rate of return on stock \( i \) (\( i = 1 \ldots 28 \))
- \( R_{ft} \) = risk free rate at time \( t \)
- \( \beta_i \) = estimate of beta for stock \( i \)
- \( R_{mt} \) = rate of return on the market index at time \( t \)
- \( e_{it} \) = random disturbance term in the regression equation at time \( t \)

Equation, five (5) above is also expressible as

\[ r_{it} = a_i + \beta_i r_{mt} + e_{it} \]  \hspace{1cm} (6)

Where

- \( r_{it} = R_{it} - R_{ft} \) = excess return of stock \( i \) (\( i = 1 \ldots 28 \))
- \( r_{mt} = R_{mt} - R_{ft} \) = average risk premium.
- \( a_i \) = the intercept.

The intercept \( a_i \) is supposed to be the difference between estimated return produced by time series and the expected return predicted by CAPM. The intercept \( a_i \) of a stock is zero equivalent if CAPM’s description of expected return is accurate.

The individual stock’s beta once obtained after series of estimation are used to create equally weighted average portfolios. The equally weighted average portfolios are created according to high-low beta criteria. Portfolio one contains a set of securities with the highest betas while the last portfolio contains a set of low beta securities. Organizing and grouping securities into portfolios is considered a strategy of partially diversifying away a portion of risk whereby increasing the chances of a better estimation of beta and expected return of the portfolio containing the securities.
3.3.2 Initial Estimation Period

Within this estimation period, regression is run using the beta information obtained from the previous period. The purpose of this period is to estimate individual portfolio betas. Fama-MacBeth applied crossed-sectional regression on its data and regress average excess return on market beta of portfolios. The formula used to calculate portfolios’ beta is

\[ r_{pt} = a_p + \beta_p r_{mt} + e_{pt} \]

Where
- \( r_{pt} \) = average excess portfolio return
- \( \beta_p \) = portfolio beta

When the regression result is obtained, the data is used to investigate if high beta yields high returns and vice versa.

3.3.3 Testing Period

After estimating the portfolios’ betas in the previous period, the next step is estimating the ex-post Security Market Line (SML) by regressing the portfolio returns against portfolio betas.

To estimate the ex-post Security Market Line, the following equation is examined:

\[ r_p = \gamma_0 + \gamma_1 \beta_p + e_p \]

Where
- \( r_p \) = average excess portfolio return
- \( \beta_p \) = estimate of beta portfolio \( p \)
- \( \gamma_0 \) = zero-beta rate
- \( \gamma_1 \) = market price of risk and
- \( e_p \) = random disturbance term in the regression equation

The hypothesis presented by CAPM is that the values of \( \gamma_0 \) and \( \gamma_1 \) after regression should respectively be equivalent to zero and market price of risk, the average risk premium.

Finally, the test for non-linearity is conducted between total portfolio returns and portfolio beta. The equation used is similar to equation eight (8) but this time, a beta square factor is added to the equation as shown below:

\[ r_p = \gamma_0 + \gamma_1 \beta_p + \gamma_2 \beta_p^2 + e_p \]

To provide an evidence for CAPM, \( \gamma_2 \) should equal zero and \( \gamma_0 \) should equal average risk free rate. The value of \( \gamma_1 \) could be negative but different from zero.

4. Results and Analysis

In this part, results obtained from the application of the empirical methods discussed in the previous chapter are presented. The methods are the basis for the test of CAPM. Equally, analysis of the results obtained will be made within this section. To strengthen the reliability of
the results, two types of investigation was carried out. I am firstly presenting results of the investigation conducted with data under the entire period from 2003-01-01 to 2008-12-31 using diversification through portfolio formation. The second investigation also contains data of the entire period from 2003-01-01 to 2008-12-31 but is not subject to diversification through portfolio formation.

4.1.1 Initial Estimation

With a condition that the relationship between stocks and betas is established, the next stage is to form portfolios using the sizes of the individual betas. Using this information, six portfolios were formed and regressed using equation (7). The individual portfolio beta estimate along with its average access return is given in table one (1).

<table>
<thead>
<tr>
<th>Portfolio Nr.</th>
<th>Portfolio Beta</th>
<th>Average Excess Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.913725</td>
<td>-0.02342</td>
</tr>
<tr>
<td>2</td>
<td>1.143300</td>
<td>-0.01011</td>
</tr>
<tr>
<td>3</td>
<td>0.990369</td>
<td>0.141996</td>
</tr>
<tr>
<td>4</td>
<td>0.919562</td>
<td>0.154653</td>
</tr>
<tr>
<td>5</td>
<td>0.836960</td>
<td>0.074082</td>
</tr>
<tr>
<td>6</td>
<td>0.723490</td>
<td>0.104535</td>
</tr>
</tbody>
</table>

Table one. Portfolio Beta Estimates

The result in table one (1) containing portfolio betas and their average excess returns, presents the nature of high beta/high return and low beta/low return criteria described by the CAPM. The characteristics of the result do not provide support of the hypothesis. That is, portfolio one with the highest beta does not have a high return in comparison to portfolio four, which has a lower beta but is associated with the highest return amongst all the portfolios. To support the theory, returns on portfolios should match their betas.

4.1.3 Testing

The SML coefficients are estimated using equation (8) since the values of the portfolio betas are known. The results are summarized in the table below:

<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma_0$</td>
<td>0.211545</td>
<td>0.071002</td>
<td>2.979441</td>
<td>0.0408</td>
</tr>
<tr>
<td>$\gamma_1$</td>
<td>-0.126779</td>
<td>0.061413</td>
<td>-2.064358</td>
<td>0.1079</td>
</tr>
</tbody>
</table>

Table (2). Statistics for SML Estimation.

The hypothesis presented by CAPM is that the values of $\gamma_0$ and $\gamma_1$ after regression should respectively be equivalent to zero and market price of risk, the average risk premium. The null hypothesis that the intercept $\gamma_0$ is zero, is rejected at 5% level of significance since the probability value is smaller than 0.05. This actually means that the coefficient is significantly different from zero, which is a contradiction to the theory of CAPM.
Conducting a test for the second coefficient $\gamma_1$ indicates that the value of the coefficient is significantly different from zero at 10% significance level since its probability value is larger than 0.1. The calculated value is 0.00202 while the estimated value is $-0.126779$, which appears to be a contradiction to CAPM.

The last step is to test for non-linearity between average excess portfolio returns and betas. To do this, equation (9) is used in regression using a beta square factor. The result is summarized below:

<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma_0$</td>
<td>0.274750</td>
<td>0.390477</td>
<td>0.703626</td>
<td>0.5324</td>
</tr>
<tr>
<td>$\gamma_1$</td>
<td>-0.232966</td>
<td>0.645410</td>
<td>-0.360959</td>
<td>0.7421</td>
</tr>
<tr>
<td>$\gamma_2$</td>
<td>0.039141</td>
<td>0.236471</td>
<td>0.165520</td>
<td>0.8791</td>
</tr>
</tbody>
</table>

Table (3) Statistics for Non-Linearity Test

To provide an evidence for CAPM, $\gamma_2$ should equal zero and $\gamma_0$ should equal average risk free rate. The value of $\gamma_1$ must equal the average risk premium. The nature of $\gamma_2$ shall determine the linearity condition between risk and return. The test indicates that the value of the intercept $\gamma_0$ is not significantly different from zero since its p-value is greater than 0.1. However, this value is not equal to the average risk free rate, 0.006164 and is thus evidence against CAPM. Though the coefficient of $\gamma_1$ is negative, the test indicates that it is also not significantly different from zero since its absolute p-value is greater than 0.1. As well, the coefficient is not equal to the average market premium as described by CAPM. The test conducted for $\gamma_2$ indicates that the coefficient is not significantly different from zero and provides an evidence for CAPM. Well, having the coefficient not significantly different from zero signifies that the expected rate of returns and betas are linearly related to each other.

4.2 Second Result

It was mentioned earlier in the beginning of this section that this second investigation will disregard the usage of portfolio diversification method to observe what different would surface in the result with comparison to the first investigation of this paper. By so doing, I am proceeding directly to the testing since I am not forming portfolios to estimate their betas. Similar stocks betas estimated in the earlier investigation are used to estimate the security market line for all twenty-eight (28) stocks or securities.

4.2.1 Testing

I ran a regression using equation eight (8) to estimate the SML and obtained the following results:

<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma_0$</td>
<td>0.788551</td>
<td>0.313753</td>
<td>2.513285</td>
<td>0.0185</td>
</tr>
<tr>
<td>$\gamma_1$</td>
<td>-0.360325</td>
<td>0.309676</td>
<td>-1.163555</td>
<td>0.2552</td>
</tr>
</tbody>
</table>

Table (4). Statistics for SML Estimation.
Again, hypothesis presented by CAPM is that the values of $\gamma_0$ and $\gamma_1$ after regression should respectively be equivalent to zero and market price of risk, the average risk premium. The null hypothesis that the intercept $\gamma_0$ is zero is rejected at 5% since the p-value is smaller than 0.05. This actually means that the coefficient is significantly different from zero, which is a contradiction to the theory of CAPM.

Conducting a test for the second coefficient $\gamma_1$ indicates that the value of the coefficient is not significantly different from zero since its p-value is greater than 0.1. Comparing the value of the slope to the average excess return on the market or the average risk premium, the calculated value is 0.00202 while the estimated value is –0.360325, which appears to be a contradiction to CAPM.

The last step is to test for non-linearity between average excess stock returns and betas. To do this, equation (9) is used in regression using a beta square factor. The result is summarized below;

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma_0$</td>
<td>0.844785</td>
<td>0.474856</td>
<td>1.779036</td>
</tr>
<tr>
<td>$\gamma_1$</td>
<td>-0.483630</td>
<td>0.831888</td>
<td>-0.581364</td>
</tr>
<tr>
<td>$\gamma_2$</td>
<td>0.050411</td>
<td>0.314672</td>
<td>0.160203</td>
</tr>
</tbody>
</table>

Table (5) Statistics for Non-Linearity Test

If CAPM is to be supported, $\gamma_2$ should equal zero and $\gamma_0$ should equal average risk free rate. The value of $\gamma_1$ must equal the average risk premium. The nature of $\gamma_2$ shall determine the linearity condition between risk and return. The test indicates that the value of the intercept $\gamma_0$ is significantly different from zero at 10% since its p-value is smaller than 0.1. This value is not equal to the average risk free rate, 0.006164 and is evidence against CAPM. For the coefficient of $\gamma_1$, the test indicates that it is not significantly different from zero since its P t-value is greater than 0.1. As well, the coefficient is not equal to the average market premium as described by CAPM. The test conducted for $\gamma_2$ indicates that the coefficient is not significantly different from zero and provides an evidence for CAPM. Well, having the coefficient not significantly different from zero signifies that the expected rate of returns and betas are linearly related to each other.

5. Conclusions

This section of the paper contains summary of findings obtained from the analysis. These findings are the basis for conclusion on how well CAPM responds to the data used in the investigation. At a later part, I am presenting an area of interest for further research purposes.

5.1 Conclusion

This study has been established to investigate the validity of CAPM on Zimbabwe Stock Exchange. It uses monthly stock returns from 28 firms listed on the Zimbabwe Stock Exchange ranging from 2003-01-31 to 2008-12-31. The stocks used in the study are considered the most traded on the Zimbabwean financial market.

Methods used to evaluate the model are similar to those introduced by Black et. al (1972) and Fama-MacBeth (1973), which are the time series and cross-sectional approaches. The
purpose of this paper has been to examine whether the model, CAPM holds truly on the
Zimbabwe Stock Exchange by testing:
1. If higher beta yields higher expected return
2. If the intercept equals zero and slope of SML equals the average risk premium
3. If there exist linearity between the stock beta and the expected return

To examine this, the data were handled in two different ways to assess if there might be a considerable difference in the investigation methods. The Findings are summarized below:

5.1.1 Result from the First Investigation

1. Using portfolio formation to diversify away most of the firm-specific part of risk thereby enhancing the beta estimates, the findings from the first investigation appears inconsistent with the theory’s basic hypothesis that higher beta yields higher return and vice versa.
2. The CAPM model implies that the prediction for the intercept be zero and the slope of SML equals the average risk premium. The findings from the test are also inconsistent with theory of CAPM, indicating evidence against the model.
3. The hypothesis and implications of CAPM predicts that there exist a linear relationship between expected return and beta. It occurred that the findings from the test are consistent with the implications and provide evidence in favour of CAPM.

5.1.2 Result from the Second Investigation

1. Using stocks beta estimates without portfolio formation, the findings from the second investigation still appear inconsistent with the theory’s basic hypothesis that higher beta yields higher return and vice versa.
2. The CAPM model implies that the prediction for the intercept be zero and the slope of SML equals the average risk premium. Similarly, the findings from the test are also inconsistent with Theory of CAPM, indicating evidence against the model.
3. The hypothesis and implications of CAPM predicts that there exist a linear relationship between expected return and beta. It occurred that the findings from the test are also consistent with the implications and provide evidence in favour of CAPM.

Given the above, it turns out that each of the investigation conducted is a confirmation of the other that the empirical investigation carried out does not fully hold up with CAPM.

6. References

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