MODELING RISK AND RETURN RELATIONSHIP WITH REFERENCE TO COMPANIES LISTED ON THE ZIMBABWE STOCK EXCHANGE

BY

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APPROVAL FORM

I Leo Dzingirai do hereby declare that this submission is my own work apart from the references of other people’s work, which has duly been acknowledged. I hereby declare that this work has been presented neither in whole nor in part for any degree at this university or elsewhere.

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Certified by

MR. D. MUREKACHIRO ................................................................. ...........................................................
Supervisor Signature Date

MR. K. BASIRA ................................................................. ...........................................................
Chairperson Signature Date
DEDICATION

To my lovely mother...
ACKNOWLEDGEMENTS
I am highly indebted to God who has given me the gift of the Holy Spirit, to guide and show me the right path. I would like to express my deepest appreciation to my supervisor Mr. D. Murekachiro for the support and knowledge. The completion of this dissertation would not have been possible without his guidance throughout this entire project.

I would also like to acknowledge Mr. B. Kusotera for assisting me on this project. Special gratitude goes to the department of Mathematics and Physics at Bindura University of Science Education for the enormous academic knowledge imparted. Credit also goes to all my colleagues, who were very supportive and for the experience we shared together during this programme.
ABSTRACT
The relationship between risk and return is one of the most important concepts in investment theory. This relationship drives the theoretical foundation of many investment models such as the Capital Asset Pricing Model, which offers powerful and intuitively pleasing predictions about how to quantify risk. This study examines the relationship between risk and return for firms listed in the Zimbabwe Stock Exchange (ZSE). The study was carried out for the period February 2009 to February 2015 for 51 stocks listed on the ZSE. Combining Black, Jensen and Scholes with Markowitz methods of testing the CAPM, the whole period was tested and stocks’ betas were used instead of portfolio betas. Time series regression and mean variance analysis were used to test the relationship between expected returns and risk. The high beta-high returns relationship hypothesis was not fully exhibited by the ZSE stocks although there was a linear relationship between returns and beta coefficients. In addition, it was noted that non-systematic risk had no effect on expected returns. The researcher recommends that further studies considering factors that affect stock returns such as interest rates, exchange rates and inflation should be considered. These studies may be extended by employing advanced models like ARCH, GARCH, etc. Investors should make use of these models so that they will be able to understand risks and return associated with their investments.
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**ACRONYMS**

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<td>APT</td>
<td>Arbitrage pricing theory</td>
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<td>CAPM</td>
<td>Capital Asset Pricing Model</td>
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<td>LIBOR</td>
<td>London Interbank Borrowing Rate</td>
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<td>LSE</td>
<td>London Stock Exchange</td>
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<td>MPT</td>
<td>Modern Portfolio Theory</td>
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<td>RBZ</td>
<td>Reserve Bank of Zimbabwe</td>
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<td>ZSE</td>
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CHAPTER 1
INTRODUCTION

1.1 Introduction
The nature and performance of financial systems in developing countries must be judged in relation to an individual country’s level of development. Whether these financial systems are relatively simple or highly complex, the primary role of the financial system in any economy is to mobilize resources for productive investment. The financial system provides the principal reasons to transfer funds or savings from individuals and companies to private enterprises, individuals and others in need of capital for productive investment. An efficient financial system channels resources to activities that will yield the highest rate of return for the used funds. These resources stimulate economic growth; provide enterprises with the ability to produce more goods and services and generate jobs.

Well performing and formal financial market offer to investors a variety of short and long term investment instruments by providing qualified financial intermediaries that enable individuals to make reasonable and adequate decisions about the risks and rewards of investing their funds. These instruments package risk and returns effectively so that the investors who wish to participate in a well-structured and appropriate market can do so. Investing in stock markets is one of the main activities of large number of economic subjects. This activity was particularly driven by development of information technology as well as deregulation and globalization, which is typical of the current financial markets. The development of information technology has enabled even small retail investors, who generally do not have appropriate knowledge and experience, to take advantage of the direct purchase or sell of securities on the stock market. Different models for stock valuation describing the relationship between risk and return on the given investment can be used as a tool to support investment decision making.

Capital Asset Pricing Model (CAPM) is a model that describes the relationship between risk and expected return. The CAPM was developed by building on the portfolio theory pioneered by Markowitz. Sharp (1964), Lintner (1965) and Mossin (1967) laid the basis for the CAPM as a model of general equilibrium in the market. The model provides an equilibrium linear relationship
between expected return and risk of a stock. One can estimate expected return of a security through the CAPM. Usually an investor assuming higher risk is expected to earn higher return and vice versa. Under the CAPM, the measure of risk is considered to be beta and, therefore, stocks with higher beta are expected to generate higher return than that with lower beta. Various econometric models can be used in modelling and building analysis of different factors in financial market studies, in this paper, the Markowitz Model is going to be applied to model the relationship between risk and expected return of the industrial index for companies listed on the Zimbabwe Stock Exchange (ZSE).

1.2 Background of the study
Campbell and Schiller (1988) and Fama and French (1992) through their studies found that stock returns in long term are influenced by variables such as Price-Earnings ratio, previous returns, organization term structure, risk/volatility of performance and quality of management. This was contrary to earlier studies that had a view that in the future stock returns cannot be predicted. Fama and French further observed that those variables after adjusting for market risks and with regard to all sectors of firms have explanatory and predictive capability.

The stock market has been given much attention as evidenced by the vast amount of work by academicians and practitioners at different educational levels (Léon, 2008). Firms are exposed to a variety of risks that may negatively affect their financial performance when making investment decisions. Managing risk is one of the basic tasks bestowed to investors and firms once it has been identified and known. The risk and return are directly related to each other which means an increase in one will subsequently increase the other and vice versa. The more volatile an investment’s return is, the greater the chance investors’ will experience a loss (P. Slovic, 2000).

In modern business environment, there is rapid change that has forced firms and individuals to devise new ways of investing to minimize the rate of risks in order to get high returns from their investment especially in the Zimbabwean perception. The introduction of bonds notes in Zimbabwe in late 2016 created a two-tier economy which resulted in investors seeking to preserve value on the equities market and escape from bond notes, which have caused valuation adjustments of assets, resulting into a more volatile environment. Investors trading at the Zimbabwe Stock Exchange take a risk of putting their money in an investment in exchange of a return on their
investment. Sometimes the investments with high-risk yield minimum or no return and securities yielding high returns are not necessarily the most risky. When making financial decisions, the more an investor is informed, the more rational he will be in assessing risk and return.

In finance, total risk of investing can be classified in two main groups, that is, systematic risk and unsystematic risk. Systematic risk is due to the influence of external factors on an organization (Khajador & Valtchanov, 2014). Such factors are normally uncontrollable from an organization’s point of view. It is a macro in nature as it affects a large number of organizations operating under a similar stream or same domain. It cannot be planned by the organization. Systematic risk of a security or a portfolio in comparison to the market as a whole is measured by Beta. Beta gives a sense of a stock’s market risk compared to the greater market. Beta is also used to compare a stock’s market risk to that of other stocks. Beta is represented by the Greek letter β. It is calculated using regression analysis, and one can think of beta as a tendency of a security’s returns to respond to swings in the market. A beta of 1 indicates that the security’s price will move with the market. A beta less than 1 indicates that the security will be less volatile than the market. A beta greater than 1 indicates that the security’s price will be more volatile than the market.

Unsystematic risk is also known as firm-specific risk or diversifiable risk (Khajador & Valtchanov, 2014). Unsystematic risk is the risk caused by factors associated with a particular firm. Examples include the risk of a bad or fraudulent management, the risk of a plant, a labor strike, or a lawsuit. These risk factors are not likely to be present to all the firms in a portfolio at the same time hence it can be diversified.

1.3 Zimbabwe Stock Exchange: An Overview
The Zimbabwe Stock Exchange (ZSE) is the country’s official stock exchange in Zimbabwe whose origins date back to the arrival of the Pioneer Column in 1896 and today it is operated in accordance with the 1996’s Zimbabwe Stock Exchange Act: Chapter 24.18. There are three indices, the Industrial Index, the Mining Index and the All Share Index. The All Share Index was introduced on 1 January 2018. Trading is done manually on the ZSE and is conducted in a daily call over that begins at 9.00 am and at noon. Settlement is on a t+3 basis and is against physical scrip delivery. Foreign participation on the ZSE commenced in 1993 when exchange control regulations were lifted. Currently foreign investors may hold up to 10% of a listed company and
collective foreign ownership cannot exceed 40%. However, these rulings do not apply to holdings acquired before 1993. Old Mutual Plc and PPC shares are fungible and, may be traded on the Johannesburg Stock Exchange (JSE) and also on London Stock Exchange (LSE) in case of Old Mutual. A Chief Executive Officer (CEO) who supervises and monitors the trading process to ensure transparency in the market and to prevent manipulation heads ZSE. All traders for listed securities are declared and confirmed by the ZSE. With a market capitalization of 5.5 billion, the ZSE has an average daily turnover of +1.5million and an average 75traders per day. Market performance since dollarization in February 2009 is about 300% and a year to date (YTD) return of 38%.

1.4 Roles of the Zimbabwe Stock Exchange

- **Critical link**
  The ZSE provides critical link between companies that need funds to set up new business or to expand their current operations and investors that have excess funds to invest in such companies that can bring good returns.

- **Market Regulation**
  It provides a regulated market place for buying and selling of shares at process determined by supply and demand not withstanding other macro-economic fundamentals.

- **Market integrity and fairness**
  The ZSE provides a properly constituted and regulated environment that ensures market integrity and fairness among stock market participants.

- **Fair trading and supervision of the stock market**
  They supervise and monitor the trading process to ensure transparency in the market and that no unfair practices are done to manipulate the market. Any off market deals and any unethical criminal activities like inside are dealt with within the framework of the rules and regulations governing the stock market transactions in Zimbabwe.
1.5 Problem Statement
The general idea behind CAPM is that investors need to be compensated in two ways; time value of money and the risk faced. In investment, risk is the probability of losing part or all cash invested and return is what you make on the investment. The risk return trade-off is an effort to achieve a balance between the desired lowest possible risk and the highest possible return. The risk return trade-off explains that the higher risk give possibility of higher returns, but however, there are no guarantees and just as risk means higher potential returns, it also means higher potential losses. Therefore, when making financial decisions, investors should be more informed so that they can be able to assess risk and return. In Zimbabwe, there has been an increasing need to invest in securities due to availability of disposable incomes for the local investors. This study is keen to examine the risks and expected returns for the industrial index for companies listed on the ZSE, analyze the correlation and the interdependency between risk and expected return of the companies, and test the applicability of the Capital Asset Pricing Model.

1.6 Aim
The aim of the study is to examine the validity of the Capital Asset Pricing Theory on modeling the relationship between risk and expected return for the industrial index at the ZSE.

1.7 Objectives
- To determine the relationship between risk and return on the Zimbabwe Stock Exchange
- Construct an optimal portfolio using Markowitz Model

1.8 Research Questions
- What is the relationship between risk and expected return of stocks on the ZSE?
- What is the optimal portfolio on the ZSE?

1.9 Scope of the study
The study focuses on the risk and expected return of the industrial index on the ZSE. This will be achieved by analyzing and doing regression analysis and use of the Python Package. Data for this study will be obtained from the ZSE website. Daily closing data for the companies from February
2009 to February 2015 will be used for this analysis. This study’s main thrust is to build a mathematical model that chooses the best optimal returns. The mean-variance model will be used in building the mathematical model that optimizes returns and the CAPM model will be used in estimating risk.

1.10 Significance of the study
The main objective of this research is to investigate the relationship between stocks risk and expected return on investment on the ZSE and prospect how this affects investors’ decision. Because investors are risk averse, when they are deciding to whether or not to invest in a particular stock, they want to know how the stock will contribute to the risk and return of their portfolio (Pamane and Vikpossi, 2010). Investing money in the assets where the risk is less has always been difficult to decide, that means investors need to see risk and return before investing. Many authors have already searched about the concept of risk-return on different financial markets and results differ from positive to negative correlation between the variables according to the model used (Pamane and Vikpossi, 2010). However, most of these studies have been in developed countries financial markets and only very, few take into account the emerging countries financial markets specifically the ZSE. Based on this remark, it is important to focus and pay attention on how the concept of Risk-Return is viewed and measured at the ZSE and to analyze the different factors influencing it. This study can be helpful to investors, brokers and students for future stock market investment in the stock industry of Zimbabwe.

1.11 Assumptions
- All investors look only one –period expectations about the future
- Investors are price takers and cannot influence the market individually
- There is a risk free rate which an investor may lend or borrow money
- Investors are risk averse
- No taxes and transaction costs
1.12 Limitations
- Data used in the study is only from the foreign currency era, not taking into account the Zimbabwean dollar era
- The study only takes into account the companies under the industrial index
- End of the month share prices are not adjusted to account for cash and stock dividends due to unavailability of data resulting in the underestimation of stock returns

1.13 Definition of Terms
- Stock market – collection of markets and exchanges where the issuing of equities, bonds and other sorts of securities takes place
- Risk – the probability that an investment’s actual return will be different from expected. It is the variability of returns from the expected returns
- Expected return – is the return that investors feel is most likely to occur based on currently available information
- Beta – is the sensitivity of the movement of the past share price of a stock to the movement of the market as a whole

1.14 Chapter Summary
This chapter gave an overview of the risk and return relationship, outlining the background, statement of problem, research objectives and the scope of the study. It also introduced the CAPM which is used to explain the relationship between risk and expected return of an investment. The relationship between risk and expected return exists in the form of a risk-return trade off, by which it is meant that it is only possible to earn higher returns by accepting higher risk.

1.15 Organization of study
The outcome of this study is presented in five chapters. The introduction, background, problem statement, significance and objectives are presented in the current chapter. Second and third chapters are on literature review and methodology respectively. The fourth chapter is on data analysis and presentation. The last chapter consolidates the major findings and conclusions of the study.
CHAPTER 2
LITERATURE REVIEW

2.1 Introduction
The development of the theoretical relationship between risk and expected return is built on two economic theories, i.e. Portfolio theory and Capital Market theory. Portfolio theory deals with the selection of portfolios that maximize expected returns consistent with individually acceptable levels of risk. Capital market theory deals with the effects of investor decisions on security prices. Financial performance remains the key fundamental driver of investment decisions for a majority of investors. It is therefore imperative for investors to invest in companies that register impressive performance.

In this Chapter, the researcher aims at discussing the different theories that explain risk and return relationship on stocks on the Zimbabwe Stock Exchange as well as look at other methods that other researchers have used in solving the underlying project. The review of literature of this study will help the researcher to identify the factors influencing risk and return and the importance of risk in evaluating investment decision.

2.2 Theoretical Framework
Three theories explain the relationship between risk and return. These are; Portfolio Theory by Markowitz (1952), Capital Asset Pricing Model by Sharpe (1964) and Arbitrage Pricing theory by Ross (1976). CAPM builds on the model of portfolio selection developed by Harry Markowitz in 1952 while Arbitrage Pricing theory builds on CAPM. CAPM and Arbitrage Pricing theory are used to predict or estimate financial asset prices and help the investors to plan and to take efficient investment decisions. This study is going to borrow the concepts from these theories in order to analyze risk-return tradeoff within the Zimbabwe Stock Exchange.

2.2.1 Portfolio Theory
The portfolio theory was proposed by Markowitz (1952) and can also be referred to as the Modern Portfolio Theory (MPT). The theory attempts to maximize portfolio expected return for a given amount of portfolio risk, or equivalently minimize risk for a given level of expected return, by carefully choosing the proportions of various assets. MPT provides a framework to construct and
select portfolios based on the expected performance of the investments and the risk appetite of the investor. MPT, also commonly referred to as mean-variance analysis, introduced a completely new terminology, which now has become the norm in the area of investment management (Fabozzi, Gupta & Markowitz 2002).

Markowitz (1952), advocated that being risk averse, investors should diversify their portfolios. He found that the risk-return tradeoff of investments could be improved by diversification and cast diversification in the framework of optimization. Markowitz was interested in the investment decision-making process and he assumed that investors order their preferences according to utility index, with utility as a convex function that takes into account investors’ risk-return preferences. The theory also assume that stock returns are joint normal. Consequently, the return of any portfolio is a normal distribution, which can be characterized by two parameters: the mean and the variance. According to Markowitz (1952), although MPT is widely used in practice in the financial industry its basic assumptions have been widely challenged by fields such as behavioral economics.

2.2.2 Capital Asset Pricing Model
This model was originally developed by Markowitz (1952) and developed over a decade later by others, including Sharpe (1964). The Capital Asset Pricing Model (CAPM) describes the relationship between risk and expected return, and it serves as a model for the pricing of risky securities. The general idea behind CAPM is that investors need to be compensated in two ways: time value of money and risk.

Gunsel and Cukur (2007) argue that the capital asset pricing model relates the expected return of an asset to its riskiness measured by the variance of the asset’s historical rate of return relative to its asset class. Fama (2004) puts forth that CAPM model decompose a portfolio’s risk into systematic and specific risk. Wang (2005) argues that the central principle of the CAPM is that, systematic risk, as measured by beta (β), is the only factor affecting the level of return. In their study to validate the model. Fama and French (2004) supports the portfolio theory that investors choose portfolios that are mean-variance efficient, and found along the efficient frontier of portfolios. Early studies of (Blume, 1970; Black, Jensen and Scholes, 1972; Blume and Friend, 1973; Fama and MacBeth, 1973) on testing CAPM reported evidence consistent with the mean-variance efficiency of the market portfolio. The CAPM assumes that any portfolio that is mean-
variance efficient and lies on the efficient frontier is also equal to the market portfolio. The model derives the equilibrium relationship between expected return and risk for assets and portfolios using characteristics of the investor wealth allocation decision. The CAPM converts the algebraic condition on asset weights in the mean-variance efficient portfolios, into a testable forecast about risk-return relationship by identifying a portfolio that must be efficient if asset prices are to clear the market of all assets (Javid, 2008).

The model is built upon a number of assumptions, some of which are realistic, others of which are not, Pamane & Vikpossi (2010). These assumptions may be divided into groups about investors and capital markets. With beta, as a measure of non-diversifiable risk (systematic risk) of an asset relative to that of the market portfolio, the CAPM defines the required return on an investment as follows:

\[
E(R) = R_f + \beta (R_m - R_f)
\]

Where,

- \( E(R) \) = Expected rate of return of an asset
- \( R_f \) = Risk free interest rate
- \( \beta \) = systematic risk or beta of an asset
- \( R_m \) = market return

### 2.2.3 Arbitrage Pricing Theory

The Arbitrage Pricing Theory (APT) was developed by Ross (1976) and was later extended by Huberman (1982). It is viewed by many as an extension or more testable alternative to the CAPM. APT assumes that the rate of return on any security is a linear function of multi factors. The theory is derived under the assumptions of perfectly competitive and frictionless markets. In equilibrium, all portfolios that can be selected from among the set of assets under consideration and that can satisfy the conditions of using no wealth and having no risk must earn no return on average.

Under the APT, it is necessary to obtain a riskless portfolio in order to eliminate both unsystematic and systematic risk. A riskless arbitrage portfolio can be done by meeting three conditions: selecting percentage changes in investing ratios that are small; diversifying across a large number of assets and choosing changes so that for each factor the weighted sum of the systematic risk
components is zero (Gerh and Ferson, 1995). According to arbitrage, if there are two assets that have the same risk, theoretically their expected returns should be same. If their expected returns were different, the arbitrageurs would sell the asset with a lower return and buy the asset having a higher return thereby making some risk free profit.

2.3 Risk and Return
The relationship between risk and return is an essential factor in all human decision making. Risk is explained theoretically as the fluctuation in returns of a security. The CAPM of Sharp (1964) and Linter (1965) argues for a linear relationship between expected return and systematic risk (beta). Elsas et al, (2003) argue that low risks are associated with low potential returns while high risks are associated with high potential returns. The risk return trade-off is an effort to achieve a balance between the desire for the lowest possible risk and the highest possible return. Baca, Garbe and Weiss (2000) argue that CAPM actually suggests that the relationship between risk and return depends on the average level of returns during the period under consideration. In particular, a positive (negative) relationship between risk and return is predicted conditional on the market return being greater (less) than the risk free rate.

The work of Markowitz (1952), which developed the basic portfolio theory, described a linear relationship between risk and return, and proved to be useful for portfolio and asset management. Uncovering the relationship between risk and return provides a better understanding of price dynamics and can serve as a guide for building new asset pricing models (Pamane & Vikpossi, 2010). Working on an emerging stock market, Salman (2002) provides empirical evidence to support the positive and linear relationship between risk and return.

The CAPM implies that if a security’s beta is known, it may be used to calculate the parallel-expected return. The relationship is known as the Security Market Line (SML) equation. The relationship between risk and return can be explained by the figure below:
The graph shows the relationship between risk and expected return. The x-axis represents the risk (beta), and the y-axis represents the expected return. The market premium \((R_m - R_f)\) is determined from the slope of the SML.

Although a good amount of literature has been developed in the context of risk-return relationship judging its linearity through widely acclaimed CAPM, the unrealistic assumption behind the theoretical base has not permitted to fully validate them empirically.

2.4 Risk and Return Indicators
Five main indicators of investment risk apply to the analysis of stocks. They are \(\alpha\), \(\beta\), r-squared, standard deviation and the Sharpe Ratio. These statistical measures are historical predictors of investment risk/volatility and are all major components of CAPM. The CAPM is a standard financial and academic methodology used for assessing the performance of equity, fixed-income and mutual fund investments by comparing them to market benchmarks. All of these risk measurements are intended to help investors determine the risk-return parameters of their investments.
1. \( \alpha \)

\( \alpha \) is a measure of an investment’s performance on a risk-adjusted basis. It takes the volatility (price risk) of a security or fund portfolio and compares its risk-adjusted performance to a benchmark index. The excess return of the investment relative to the return of the benchmark index is its alpha.

2. \( \beta \)

\( \beta \) is a measure of the volatility, or systematic risk of a security or a portfolio in comparison to the market as a whole. \( \beta \) act as the tendency of an investment’s return to respond to swings in the market.

3. \( R^2 \)

\( R^2 \) is a statistical measure that represents the percentage of a fund portfolio’s or security’s movements that can be explained by movements in a benchmark index. Is the statistical measurement of the correlation between a stock’s performance and a specific benchmark index, it shows what degree a stock or portfolio’s performance can be attributed to a benchmark index.

4. \( \sigma \)

Standard deviation measures the dispersion of data from its mean. In finance, standard deviation is applied to the annual rate of return of an investment to measure its volatility (risk). A volatile stock would have a high standard deviation. With stocks, the standard deviation tells us how much the return on a stock is deviating from the expected returns based on its historical performance.

5. Sharpe Ratio

The Sharpe ratio is a measure for calculating risk-adjusted return of an asset. It tells us whether a portfolio’s returns are due to smart investments or a result of excess risk. Although one portfolio can reap higher returns than its peers can, it is only a good investment if those higher returns do not come with too much additional risk. The greater a portfolio's Sharpe ratio, the better its risk-adjusted performance has been. A negative Sharpe ratio indicates that a less risky asset would perform better than the security being
analyzed. It is calculated as the mean returns earned by an asset or a portfolio in excess of the risk-free rate per unit of volatility.

\[ \text{Sharpe ratio} = \frac{r_x - r_f}{\text{StdDev}_x} \]

Where:
- \( r_x \) = Expected stock return
- \( r_f \) = Risk free rate of return
- \( \text{StdDev}_x \) = Standard deviation of stock’s return (volatility)

2.5 Measures of Risk
Investors are usually risk averse, they do not dislike uncertainty of returns but rather, they dislike the possibility of low returns, so the issue of utility normally comes into play.

2.5.1 Semi-variance of Return
This measure is used to curb against the low returns. It seeks to quantify the view of not disliking uncertainty of returns but rather disliking low returns. It is calculated as follows

\[ \int_{\mu}^{\infty} (x - \mu)^2 f(X) d(X) \]

Where \( \mu \) is the mean and \( f(X) \) is the probability density function of the return

2.5.2 Value at Risk (VaR)
Value at Risk measures the potential loss in value of a risky asset or portfolio over a defined period for a given confidence interval. According to Lindberg (2005), Value at Risk is the loss in market value over time horizon \( t \) that is exceeded with probability \( 1 - p \). Historical simulations represent the simplest way of estimating the Value at Risk. This implies that VaR can be calculated using historical figures (Cabedo and Moya, 2003). The bigger the VaR at some confidence level, the more risky the portfolio is. This means that an investor who is extreme risk averse will prefer an extreme low VaR. The VaR at level \( 1-\alpha \) of a portfolio \( VaR_\alpha \) is defined by

\[ P(R_p \leq -VaR_\alpha) = \alpha \]

There are three key elements of value at risk; a special level of loss in value, a fixed time period over which risk is assessed and a confidence interval
2.5.3 Shortfall Probabilities
This method measures the probability of returns falling below a certain level, so one has to come up with a benchmark in order to employ it. It is useful in monitoring exposure to risk but like semi-variability of return, it pays no attention to the distribution of returns which are in excess of the benchmark, in sometimes it ignores the returns above the benchmark.

2.6 Determinants of Return
There are various determinants that affect stock returns; this study has discussed six determinants namely: return on capital employed, expenditure on research and development, short-term to long term investments, gearing ratio, interest rate and inflation.

2.6.1 Return on Capital Employed
Profitability ratios indicate ability of the management to convert sales into profits and cash flow. The main ratios commonly used are gross margin, operating margin and net income margin. The gross margin is the ratio of gross profits to sales. The gross profit is equal to sales minus cost of goods sold. The operating margin is the ratio of operating profits to sales and net income margin is the ratio of net income to sales. The operating profit is equal to the gross profit minus operating expenses, while the net income is equal to the operating profit minus interest and taxes (Kheradyar, Ibrahim & Mat, 2011).

The return on asset ratio, which is the ratio of net income to total assets, measures a company's effectiveness in deploying its assets to generate profits. The return on investment ratio, which is the ratio of net income to shareholders' equity, indicates a company's ability to generate a return for its owners. Profitability is also measured by return on equity (Haugen, Talmor & Torous, 1991).

2.6.2 Expenditure on Research and Development
Research and Development (R&D) is a general term for activities in connection with corporate or governmental innovation. R&D differs from the vast majority of corporate activities in that it is not often intended to yield immediate profit, and generally carries greater risk and an uncertain return on investment (Aretz, Bartram and Dufey, 2007). R&D activities are conducted by specialized units or centers belonging to a company, or can be out-sourced to a contract research organization, universities, or state agencies (Danielson, Hirt and Block, 2009; Rahman and Ramos, 2013). Research and development is one of the means by which business can experience future...
growth by developing new products or processes to improve and expand their operations (Bosire, 2013). New product design and development is more often than not a crucial factor in the survival of a company. In an industry that is changing fast, firms must continually revise their design and range of products. This is necessary due to continuous technology change and development as well as other competitors and the changing preference of customers. Without an R&D program, a firm must rely on strategic alliances, acquisitions, and networks to tap into the innovations of others (Elsas, El-shaer and Theissen, 2003).

2.6.3 Short-Term to Long Term Investments

Investing is a long-term process. Short-term investment funds include cash, bank notes, corporate notes, government bills and various safe short-term debt instruments. While many companies try to play the market or speculate with day trading it is a risky business and one really need to understand what they are doing before trying short-term investments. Short term investing generally refers to holding any particular investment for less than one year while long-term investments go beyond one year. Conversely, long-term traders incur much fewer trading fees, since positions are held for a long period. Short-term traders see long term investing as boring, and frankly, that is just fine for most traders, especially inexperienced investors (Kariuki, 2013). However, even many very experienced and professional investors buy in to the long-term strategy. Long-term investors should seek out companies that have a proven record of accomplishment of stability and growth. While newer companies can still be good options for long-term growth, there is less risk involved when a business already has a proven record of accomplishment (Kheradyar, Ibrahim and Mat, 2011).

2.6.5 Interest Rate

According to Duffie and Kan (2003), in theory the relationship between interest rates and stock is negative. This is due to the cash flow discounting model according to which, present values of stocks are calculated by discounting the future cash flows at a discount rate. Fama and Schwert (1977) puts forth that if the discount rate increases, the present value of stocks decline and vice versa. This discount rate is a risk adjusted required rate of return and equal to the level of interest rates in the economy.

Therefore, an increase in interest rates lowers present values of stocks directly. Nelson (1992) argues that even a relatively small rise in interest rates can have a major effect on present values if it is spread out over several years. In addition, rising interest rates reduce cash flows by reducing
the profitability of the firms. Due to these two reasons, present values of stocks decline and so do current stock prices. The inverse holds true as well.

2.6.6 Inflation
Culberson (2003) highlight that when inflation increases, purchasing power declines and each dollar can buy fewer goods and services. For investors interested in income-generating stocks, or stocks that pay dividends, the impact of high inflation makes these stocks less attractive than during low inflation, since dividends do not keep up with inflation levels. Dusak (2009) further indicated that lowering purchasing power, the taxation on dividends causes a double-negative effect. Despite not keeping up with inflation and taxation levels, dividend-yielding stocks do provide a partial hedge against inflation.

However, the price of dividend-paying stocks is impacted by inflation, similar to the way bonds are affected by increasing rates, and the prices generally decline. So owning dividend-paying stocks in times of increasing inflation usually means the stock prices will decline. Huberman (1981) argue that investors looking to take positions in dividend-yielding stocks are given the opportunity to buy them cheap when inflation is rising, providing attractive entry points.

2.7 Mean-Variance Model
Classical portfolio theory, as it existed in about 1975 had the mean variance analysis as a way to allocate assets in a world of risk (George Box, 2009). Over the last three decades, mean-variance analysis has been increasingly applied to asset allocation. The mean-variance portfolio optimization theory of Markowitz et al. (1958) is a single period theory on the choice of portfolio weights that provide optimal tradeoff between the mean and variance of the portfolio return of a future period. In many respects, asset allocation is a more suitable application of mean-variance analysis than is stock portfolio selection. West (2006) says mean-variance analysis requires not only knowledge of the expected return and standard deviation each asset but also the correlation of returns for each pair of assets. Whereas a stock portfolio selection problem might involve hundreds of stocks (hence hundred correlations), an asset allocation problem typically involves a handful of asset classes (for example stocks, bonds, cash, real estate and gold). Mean-variance analysis weighs risk (variance) against expected return and variance of an asset and attempt to make more efficient investment choices by seeking the lowest variance level. By combining stocks
with different variances and expected returns in a portfolio (diversification), the variance and expected return of the portfolio can be altered as the price movement of another stock in the portfolio may offset the price movement of one stock.

2.8 Efficient Frontier
The efficient frontier is the set of optimal portfolios that offers the highest expected return for a defined level of risk or the lowest risk for a given level of expected return. Portfolios that lie below the efficient frontier are sub-optimal, because they do not provide enough return for the level of risk. Portfolios that cluster to the right of the efficient frontier are also sub-optimal, because they have a higher level of risk for the defined rate of return. The CAPM assumes that the risk-return profile of a portfolio can be optimized; an optimal portfolio displays the lowest possible level of risk for its level of return. Additionally, since each additional asset introduced into a portfolio further diversifies the portfolio, the optimal portfolio must comprise every asset, (assuming no trading costs). All such optimal portfolios that is one for each level of return comprise the efficient frontier. Since unsystematic risk is diversifiable, the total risk of a portfolio can now be viewed as beta. Below is an example of an efficient frontier

2.9 Stock Market trends in Zimbabwe
The Zimbabwe Stock Exchange (ZSE) regulates the stock market in Zimbabwe. ZSE is a relatively well-developed stock market with 63 listed companies, which achieved a market capitalization of 153.6 percent in 2010, ahead of the median 14.3 percent of low-income sub-Saharan countries. Foreign participation at the ZSE trading, which was introduced in mid-1993, following the partial lifting of exchange control regulations, saw annual turnover going up from US$53 million in 1990 to US$150 million in 1995, representing an increase of 184.61 percent. The listing of Ashanti Goldfields in 1996 brought a major excitement in the economy that saw the industrial index going up, and further pushing up market capitalization to US$3.64 billion in December 1996. From 1999 to 2003, the ZSE became a net capital exporter of portfolio funds as foreign participation on the ZSE fell, according to ZSE statistics. Despite an increase by 14.19 percent in the total number of listed companies on the ZSE from 2000 to 2005, stock market capitalization decreased by 1.26 percent during the same period. According to Makina (2009), the ZSE offered investors the
highest returns in Africa in 2005 and for most of 2006, despite a deep economic recession in Zimbabwe. There was a marginal increase of 2.53 percent in the total number of companies listed on the ZSE, from 79 at the end of 2005 to 81 at the end of 2010 and during the same period, stock market capitalization went up by 61.74 percent to reach a US$3.89 million mark by the end of 2010, whilst the annual turnover went up 19 percent, from US$329 million to US$392 million. Since February 2009, share prices have been quoted in US Dollars (the legal tender) consequent to the country's hyperinflation, which rendered the Zimbabwean Dollar impractical for trading on the bourse. Recapitalization of some listed companies took place between 2009 and 2013 and raised US$250.6 million. The ZSE performance has been influenced largely by the monetary policies put forward by the Reserve Bank of Zimbabwe (RBZ).

2.10 Empirical Literature

Elsas, et al., (2003) investigated on the relationship between beta and returns revisited Evidence from the German stock market, exploratory basis was used to establish whether there exist any differences in the risk-return patterns of quoted companies at the Ghana Stock Exchange. Secondary data for 5 years was used. Mean and standard deviation were used to show the relationship between the variables. The results concluded that there was a positive significant relationship between risk and return as higher returns was associated with higher value of beta. They suggested that other determinants of returns like firm size and book-to-market ratio need to be visited to see whether these variables retain their explanatory power once, the conditional nature of the relation between beta and return is taken into account.

Khajador and Valtchanov (2014) found that the original CAPM model did not explain the assumed relation between risk and expected return in the model. Their study was conducted on the Large Cap index listed on the Stockholm Stock Exchange (SSE) covering 24 companies. According to the study, the industrial sector had more positive correlations coefficients than the financial sector. They stated that the natural recommendation would be for investors and other users to be aware of the flaws within the model when using it.

Pamane and Vikpossi (2010) analyzed the relationship between risk and expected return in the BRVM Stock Exchange and the results of their study disproved the hypothesis that the CAPM’s prediction for the intercept is that it should equal zero and the slope should equal the excess returns
on the market portfolio. The results demonstrated that the residual risk had no effect on the expected returns of stocks. The results also justify the fact that the operating activities of the firms have an impact on their stock returns.

Poornima and Swathiga (2017) carried out a study on relationship between risk and return of ten stocks on the New York Stock Exchange (NSE) using the capital asset pricing model. Five stocks in automobile sector and another five from IT sector were taken for the sample and the study revealed that automobile sector showed positive relationship between risk and return. It also shows that the automobile companies performed better and had increased growth in the market when compared to IT companies, which had negative average returns, based on the CAPM expected return. The automobile companies showed higher expected returns.

Mazviona B (2013) used the capital asset pricing model to test its applicability on the Zimbabwe Stock Exchange after currency reform. The study was carried out for the period 19 February 2009 to 31 December 2012 for 65 stocks listed on the Zimbabwe Stock Exchange. The results showed that the high beta-high returns relationship was not exhibited by the stocks data and the slope of the SML was not equal to the market risk premium. CAPM did not fully hold although there was a linear relationship between returns and beta coefficients.

Bundoo (2000) performed a sectored analysis using the CAPM and market model on the companies listed on the Mauritius stock exchange. A sample of 40 listed firms was used and beta estimates were calculated. Secondary data was used for the years between (2004 - 2009). Data analysis was done using CAPM and the results proved that there was a positive significant relationship between risk and return as higher returns was associated with higher value of beta.

Cohen and Pogue (1974) examined French stock exchange using six-year data from 1990 to 1995 on daily basis to find the relationship between systematic risk and average stock returns. The study used an explorative survey and secondary data was used for analysis. Data was analyzed using capital asset pricing model. The results concluded that investors should invest in stocks, which have low systematic risk, and low market price and sell the stocks that have high systematic risk and high in market price.
2.11 Summary
Investors of any rank at stock markets are interested in knowing how much return their investment can earn. For making better investment decisions, it is imperative for investors to have knowledge about investment risk and return. Investment return is an important element that any investor takes into consideration in making investment decisions. Similarly, the risk that is associated with a particular investment return is even more important to investors as it influences the return levels.

Studies have showed mixed results in relation to the effect of risk and return of for listed firms. Bundoo (2000) and Elsas et al (2003), among others, concluded that there was a positive relationship between risk and return as higher returns was associated with higher value of beta. On the other hand, some empirical evidence shows that there exists statistically insignificant relationship between risk and expected return. The study aims to provide empirical evidence on the relationship between risk and expected return by testing its existence and its nature on stocks listed on the Zimbabwe Stock Exchange.
CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction
This chapter introduces the logical framework to be followed to meet the objectives stated in the first chapter of this study. The research design, population of interest, data instruments and how the data will be collected and analyzed to come up with findings, interpretations and conclusions are discussed.

3.2 Research Design
This study adopted descriptive research design. According to Bryan & Bell, (2007) research design is the framework for the collection of data and the following analysis. Descriptive research design involves the process of collecting data in order to answer the questions concerning the status of the objectives of the study. This research design is appropriate for this study because it ensures in-depth analysis and description of the various phenomena under investigation. The emphasis was on investigating the relationship between risk and the expected return of the firms listed on the ZSE using the CAPM. The dependent variable for the study was the expected return whereas the independent variable was the average risk premium.

3.3 Research Instrument
According to Saunders et al., (2009) research instruments are tools that are used to collect data in a systematic way. The data was analyzed using a programming software known as Python version 3.6. The researcher used various textbooks to provide the literature review, theories and basic information. The internet was also used to access the closing stock prices of the companies on the Zimbabwe Stock Exchange.
3.4 Model Assumptions

Assumption 1

- All the investors are risk averse i.e. they will minimize the expected utility of their end period wealth.

Assumption 2

- All investors use the same expected return and covariance matrix of stock return to form the optimal risky portfolio

Assumption 3

- A fixed risk-free rate exists, and allows the investors to borrow or lend unlimited amounts to the same interest rate.

Assumption 4

- There are no market imperfections i.e. there are no taxes or trading costs.

3.5 Data Collection

The study used secondary data on firms listed on the Zimbabwe Stock Exchange. Secondary data is when the researcher uses the data, which has already been collected by others (Pannerselvam, 2005). The data used in this research was collected from the ZSE website. Data collection is important in assembling the required information with an aim of achieving the research objective. The study population comprised of sixty (60) companies listed under the industrial index on the Zimbabwe Stock Exchange, however the researcher is going to use fifty-one (51) sample since these were the companies that continuously traded during the period under study. The study period of interest was six years from 2009 to 2015. In their study, bell used average monthly data; however, this study will use the average weekly stock prices. This is because using high frequency data such as daily observations can result in the use of noisy data and therefore yield inefficient results. On the other hand, using longer times such as yearly observations might result in changes of beta over the examined period introducing biases in beta estimates (Were. A, 2012). The market return is obtained from the ZSE Industrial Index (ZSEINDX).
3.6 Data Analysis
Data analysis involves transforming and modeling of data with the purpose of discovering the relationship to support the research conclusion. The researcher is going to use average weekly stock prices to establish the relationship between risk and return. The LIBOR rate based on United States Dollar is going to be used as proxy for the risk free rate. The estimation of the beta coefficients for each stock for the companies under the study will be performed using the weekly returns from February 2009 to February 2015.

The model is as follows:

\[ R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + \varepsilon_{it} \]

Where:

- \( R_{it} - R_{ft} \) is the risk premium on the \( i \)'th stock in period \( t \)
- \( \alpha_i \) is the alpha coefficient or the intercept
- \( R_m \) is the return on the market
- \( (R_{mt} - R_{ft}) \) is the market risk premium
- \( \beta_i \) is the beta of the \( i \)'th stock
- \( \varepsilon_{it} \) is the error term which is assumed to be random

3.7 Summary
In this chapter, the methodology which shall be used to carry out this study was laid. Its focus was on giving an insight into the methodology used in conducting the study. The research design, data collection techniques and the data analysis procedure were highlighted. The following chapter focuses on data representation, analysis and discussion. This is followed by a discussion regarding conclusions and recommendations basing on the findings.
CHAPTER 4
DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 Introduction
In this chapter, the researcher is concerned with the analysis of collected data as well as the presentation of the obtained results. Data was analyzed using Capital Asset Pricing Model (CAPM) as stated in the previous chapter. The calculation and presentation of results were obtained using Python programming software’s packages because of their strength in analysis of financial data. The results enable us to answer questions as to how risk and return are related on the Zimbabwe Stock Exchange (ZSE) and portfolio diversification within the exchange.

4.2 Analysis of Data and presentation of findings
The daily stock price data for the period from February 2009 to February 2015 was obtained from the Zimbabwe Stock Exchange. This daily data were then used to calculate the average weekly stock returns and the average market returns

4.2.1 Importing the Data onto Python 3
The data obtained from ZSE was available on excel sheets in the .xlsx format. Before importing the data, the file was converted into a csv (comma delimited) file format. To upload the data into Python 3, relevant libraries were first imported as below

```python
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
get_ipython().magic('matplotlib inline')
import statsmodels.api as sm
import statistics as stats
from scipy import stats as scistat
sns.set(style="darkgrid", color_codes=True)
from pylab import rcParams
```
from datetime import datetime, date
rcParams['figure.figsize'] = 10, 5
from statsmodels.tsa import stattools as sts

To read the csv file, the following code was run:

```python
In [2]: stocks = pd.read_csv("C:\Users\Leo\Desktop\Python\leo_data.csv", header=0, index_col=[0], parse_dates=[0])
print("All in all there are {} missing values".format(stocks.isnull().sum().sum()))
stocks.head()
```

The corresponding output for the first five rows for the uploaded data can be viewed as below:

![Figure 4.1: Uploaded ZSE Data](image)

**4.2.2 Converting to weekly data**
The weekly closing prices on stocks and market were computed by taking the average weekly price for each stock. The researcher chose weekly data because using longer time period (e.g. monthly) might result in changes of beta over the examined period introducing biases in beta estimates. On the other hand, high frequency data such as daily observations can result in the use of noisy data and thus yield inefficient estimates. To compute the weekly prices, the following Python code was used:

```python
In [3]: stocks.index = pd.to_datetime(stocks.index)
weekly_data = stocks.groupby(pd.Grouper(freq='W')).mean()
weekly_data.head()
```

The corresponding output can be viewed as below:
To visualize how prices of stocks has behaved over the period of study, we plot a combined plot of selected companies under study. The plot can be visualized as below.

**Figure 4.3: Combined plot**

**4.3 Testing for stationarity assumption**

The prices of the stocks were tested for the presence of stationarity. The stationarity tests were performed to find out if the data can be predictable and if it is possible to apply predictive models to it. We can therefore forecast the return and risk of the counters basing on previous values. Some of the data satisfied the assumption, however data from other companies was not normally
distributed hence the researcher had to do log-transform data using Python ADF package. For example, the p-value of CAFCA was 0.546061 and after the log transformation, it is zero. Testing for stationarity is important because using non-stationary data may result in misleading results.

```python
In [23]: def Stationarity(data, window = 12,yscale = "none"):
    data = data.dropna()
    #Perform Dickey-Fuller test:
    test = stats.ardf(data, autolag='AIC')
    #to make the results of the test more readable
    doutput = pd.Series(test[0:4], index=['Test Statistic','p-value','#Lags Used','Number of Observations Used'])
    for key,value in test[4].items():
        doutput['Critical Value (%s)'%key] = value
    print(doutput)

def Distribution(in_data):
    in_data = in_data.dropna()
    print('Kurtosis = ', in_data.kurtosis())
    print('Skew = ', in_data.skew())
    return in_data.describe()

for stock in stocks_indexed1:
    the_stock = "Stock: " + stock
    print("\n" + the_stock)
    print("-------- Augmented Dickey Fuller Test --------")
    Stationarity(in_data[stock])
    print("\n")
```

**Stock: CAFCA**

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>p-value</th>
<th>#Lags Used</th>
<th>Number of Observations Used</th>
<th>Critical Value (1%)</th>
<th>Critical Value (5%)</th>
<th>Critical Value (10%)</th>
<th>dtype</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.461026e+01</td>
<td>3.558539e-27</td>
<td>1.000000e+00</td>
<td>3.118726e+02</td>
<td>-3.451553e+00</td>
<td>-2.870875e+00</td>
<td>-2.571746e+00</td>
<td>float64</td>
</tr>
</tbody>
</table>

**Figure 4.4: Before log transformation**

And after log transformation

```python
In [25]:
```

```python
```
It can be concluded that the log-transformed data is now stationary. The researcher is going to use the log-transformed data for the rest of the project.

4.4 Mean and Variance
Markowitz (1952) indicated mean and variance as the only needed characteristics of the return distribution of securities for constructing portfolio. To researcher used python software to calculate the mean and variance of the counters and the results are shown below.

The highest mean gives the favorable return. NATFOOD had the highest mean return of 0.8906 and the highest risk of 0.2961. This supports the notion that high risk yields higher returns. It can be seen that there is an inverse relationship on other counters between risk and return. Such stocks needs to be diversified by other stocks with higher returns to realize return. Investors will not put their funds on stocks that yields negative returns since they are risk averse. However, this information alone is not adequate for us to make a decision. There is need to take into account the issue of risk ($\sigma$), $\beta$ of a security. It can be seen that ART has a high risk and with a negative return.
hence, it is not wise to invest into it. There is a high possibility of the portfolio not performing well with ART as part of it and the investor will incur losses. Consider INNSCOR, have a lower risk even the mean return is low hence allocating funds to this company might result in a small return. CAPM therefore answers this question.

4.5 Covariance Matrix
Covariance measures the direction of a group of stocks (Kierkegaard et al, 2006). Two stocks exhibit high covariance when their prices tend to move together. In opposition, low covariance describes two stocks that move in opposite directions. According to Markowitz (1952), the risk of a portfolio is not the variance of the individual stocks but the covariance of whole portfolio. The more they move in the same direction, the greater is the chance that economic shifts will drive them all down at the same time. Similarly, a portfolio composed of risky stocks might actually be a conservative selection if the individual stock prices move differently. When constructing a portfolio or choosing which stocks to invest in, an investor will select stocks that will work well together, that is to say stocks that do not move in the same direction. This will mean that if one is going in the positive direction the other one is moving in the negative direction hence investors realize profits either way. The following code was run to construct the covariance matrix

![Figure 4.7: Covariance Matrix](image-url)
According to the covariance matrix, it can be seen that GENBELT and HIPPO have the highest covariance between them. Therefore, it is not wise for investors to invest in both of these stocks since they are likely to be affected in the same way in case of an economic shift.

4.6 Beta estimation

\( \beta \) is a measure of the volatility, or systematic risk of a security or a portfolio in comparison to the market as a whole. A \( \beta \) of less than 1 indicates that the security will be less volatile than the market and a \( \beta \) of greater than 1 indicates that the security’s price will be more volatile than the market. The betas were computed by regressing the excess returns of stocks for companies listed under the industrial index on the Zimbabwe Stock Exchange on the market premium. The estimated regression model is of the form:

\[
R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + \mu_i
\]

Where:

- \( R_{it} \) is the rate of return on asset i at time t,
- \( R_{ft} \) is the risk-free rate at time t
- \( R_{mt} \) is the rate of return on the market portfolio at time t
- \( \beta_i \) is the beta estimate of the i’th stock
- \( \mu_i \) is the error term which is assumed to be random

To compute the betas, and relevant statistics, OLS regression was carried out on all counters

The following table indicates results for ZIMPAPERS
From the above outputs, the $\beta$ for ZIMPAPERS is 2.37, which indicates that the securities prices will be more volatile than the market hence it might not be wise for investors to invest in this security. Investors are more interested in securities that are less volatile than the market. The OLS results can be summarized on Table 4.1.
Table 4.1: Regression Results

<table>
<thead>
<tr>
<th>Stock</th>
<th>StDev</th>
<th>Beta</th>
<th>R Squared</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABCH</td>
<td>3.638205</td>
<td>1.22062</td>
<td>0.241435</td>
<td>0.00000</td>
</tr>
<tr>
<td>AFDIS</td>
<td>2.433074</td>
<td>1.35091</td>
<td>0.281367</td>
<td>0.00000</td>
</tr>
<tr>
<td>AFSUN</td>
<td>0.528941</td>
<td>0.71965</td>
<td>0.115399</td>
<td>0.00000</td>
</tr>
<tr>
<td>ARISTON</td>
<td>0.220369</td>
<td>0.50625</td>
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From the above figure, it can be seen that most of the beta values are less than one, which means that the stocks are less volatile as compared to the market index (ZSEINDX). HIPPO and BARCLAYS have $\beta$ values of 2.12 and 2.06 respectively, which means that they are more volatile as compared to the market and hence it is risky to invest in these stocks. It can be seen that not all companies, which have higher risks, also have higher returns. Seedco have a high beta of 1.68 but negative mean return of -0.04 Therefore, we can conclude that the high beta-high returns view of the CAPM is not shown. Mazviona B (2013) who concluded that the high beta-high returns relationship was not fully exhibited by the ZSE stocks supports this. From the above figure, it can be seen that BORDER has a standard deviation of 4.08. This shows more variability of this stock’s
returns. The researcher went on to calculate $R^2$, the statistical measurement of the correlation between a stock’s performance and the market index. It shows what degree a stock or portfolio’s performance can be credited to the market index. The $\alpha$, which is a measure of an investment’s performance on a risk-adjusted basis, was also calculated. The excess return of the investment relative to the return of the market index is its $\alpha$. On risk adjusted basis, when investing in stocks after calculating their $\beta$’s we need to know if there is any risk that is left that an investor will face. This is where the $\alpha$ comes in. A positive value of $\alpha$ means that the stock will give a positive return whereas a negative value of $\alpha$ means that the stock’s $\beta$ value did not cater for all the risk for that stock relative to the market.

4.7 Portfolio Formation
Portfolio diversification is the most fundamental concept of risk management. Taking account of covariance and expected return, investors can create a diversified portfolio that maximizes expected return for a given level of risk. Combining stocks into portfolios diversifies away most of the firm specific part of returns thereby enhancing the precision of the estimates of beta and the expected rate of return on the portfolios on securities (Michailidis et al, 2006). In order to determine an efficient portfolio that offers the highest expected return for the lowest risk for a given level of expected return we draw the efficient frontier. The efficient frontier for all the counters under study can be visualized as below.

![Efficient Frontier](image_url)
From the above figure, the efficient frontier shows areas in which investors can pick stocks and portfolios to invest in, judging on the risk associated the return of the stock. CAPM assumes that investors are risk averse, and therefore they will go where there is low risk but reasonable returns, that is the middle of the above efficient frontier. The researcher then went on to calculate the optimal portfolio and another portfolio with minimum volatility for the most risk-averse investors. Portfolio 1 is the optimal portfolio and Portfolio 2 is the portfolio with minimum volatility. Table 4.2 and Table 4.3 illustrates portfolio 1 and portfolio 2 respectively.

| Returns         | -0.004765 |  
| Volatility      | 0.146225  |  
| Sharpe Ratio    | -0.032585 |  
| ABC Weight      | 0.000230  |  
| AFDIS Weight    | 0.018328  |  
| AFSUN Weight    | 0.024379  |  
| ARISTON Weight  | 0.034411  |  
| ART Weight      | 0.013175  |  
| ASTRA Weight    | 0.013609  |  
| BARCLAYS Weight | 0.002887  |  
| BORDER Weight   | 0.033676  |  
| CAFCW Weight    | 0.000819  |  
| CB2H Weight     | 0.020809  |  
| CFI Weight      | 0.006566  |  
| COLCOM Weight   | 0.038644  |  
| DAIW Weight     | 0.029728  |  
| DELTA Weight    | 0.012114  |  
| DAIR Weight     | 0.037866  |  
| ECONET Weight   | 0.031203  |  
| EDGARS Weight   | 0.014625  |  
| FBCH Weight     | 0.016125  |  
| FIDEILTV Weight | 0.006907  |  
| FIRST MUTUAL Weight | 0.024743 |  
| GENDLET Weight  | 0.001663  |  
| HIPPO Weight    | 0.001954  |  
| HUYANGI Weight  | 0.027625  |  
| INNISCOR Weight | 0.026324  |  
| LAFARGE Weight  | 0.007702  |  
| MASH Weight     | 0.025075  |  
| MEDTECH Weight  | 0.041331  |  
| NATFOOD Weight  | 0.028275  |  
| NICOZ Weight    | 0.041865  |  
| NMB Weight      | 0.015993  |  
| NTS Weight      | 0.000480  |  
| OK Weight       | 0.004492  |  
| OLD MUTUAL Weight | 0.040779  |  

Table 4.2: Portfolio 1

From the above table, it can be seen that the risk of investing in portfolio 1 is 0.1462 and the corresponding returns would be -0.0048. It also shows the respective weights that each counter
will carry in order to optimize the portfolio returns. For example, OLD MUTUAL will carry 4.08% of the portfolio.

Table 4.3: Portfolio 2

| Returns | 0.012195 |
| Volatility | 0.166692 |
| Sharpe Ratio | 0.073162 |
| ABCH Weight | 0.032795 |
| AFDIS Weight | 0.021943 |
| AFSUN Weight | 0.008615 |
| ARISTON Weight | 0.021676 |
| ART Weight | 0.022226 |
| ASTRA Weight | 0.031720 |
| BARCLAYS Weight | 0.000674 |
| BORDER Weight | 0.013840 |
| CAPCA Weight | 0.022237 |
| CBZH Weight | 0.007795 |
| CFTI Weight | 0.003946 |
| COLCOM Weight | 0.038474 |
| DAWN Weight | 0.001698 |
| DELTA Weight | 0.085924 |
| DAIR Weight | 0.029226 |
| ECONET Weight | 0.039696 |
| EDGARS Weight | 0.031685 |
| FBCH Weight | 0.021245 |
| FIDEILITY Weight | 0.026583 |
| FIRST MUTUAL Weight | 0.030476 |
| GENBELT Weight | 0.004822 |
| HIPPO Weight | 0.008736 |
| HUNYANI Weight | 0.033845 |
| INNISCOR Weight | 0.011938 |
| LAFARGE Weight | 0.017519 |
| MASH Weight | 0.006557 |
| MEDTECH Weight | 0.012167 |
| NATFOOD Weight | 0.032616 |
| NICOZ Weight | 0.018795 |
| NMB Weight | 0.001757 |
| NTS Weight | 0.031295 |
| OK Weight | 0.022038 |
| OLD MUTUAL Weight | 0.026825 |
| REDL Weight | 0.006577 |

The risk associated in investing in portfolio 2 is 0.1667 that is higher than the first portfolio. The corresponding returns for portfolio 2 is 0.0121 and this provides evidence that an increase in risk will result in increase in return. Investing in portfolio 2 will bring about return although the risk is a bit high. These values are the optimal solution to the portfolio hence we can conclude that selecting and assigning weights of a portfolio through optimization by the CAPM is much better than assigning equal weights without consideration of risk and return.
4.8 Summary
The results presented in this chapter show that the high risk-high returns relationship did not fully hold on the Zimbabwe Stock Exchange. This is in agreement with Mazviona B (2013), who found that the high beta-high returns hypothesis was not fully exhibited by the ZSE stocks. From the findings, it is also noted that most of the counters has positive beta values. Positive beta indicate that the stock tend to move in the same direction with the market. The following chapter presents the conclusion and recommendations.
CHAPTER 5

SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction
In this project, the researcher performed the mean-variance analysis to model the relationship between risk and expected return on the Zimbabwe Stock Exchange. The Capital Asset Pricing Model was then used to estimate the beta coefficients for the companies. This chapter gives a conclusion drawn from the research as well as recommendations on the performances on the Zimbabwe Stock Exchange. Highlights of key findings, together with conclusions that address research objectives, are given. The recommendations and suggestions are based on the findings in the previous chapter and the objectives of the study.

5.2 Summary of findings and Conclusions
The objective of the study was to perform risk and return analysis using the Capital Asset Pricing Model from weekly stock returns of the companies listed under the industrial index on the Zimbabwe Stock Exchange from February 2009 to February 2015. The research set out to determine the levels of risk and expected return on the Zimbabwe Stock Exchange Industrial index. The sample size was fifty-one (51) which were also the constituent companies for the ZSEINDX which traded continuously during the period under study.

The Capital Asset Pricing theory indicates that higher risk (beta) is associated with a higher level of return. However, the results of the study do not support this hypothesis since high beta-high returns relationship was not exhibited on the stocks. In order to diversify away most of the firm specific part of the returns, thereby enhancing the precision of the beta estimates, the securities were used to form two portfolios. The test for presence of stationarity was carried out and most of the counters were stationary, however, log-transformation was done for those counters that did not conform to the stationarity assumptions so that mathematical models can be applied to the data. Lai et al. (2011) argues that assigning equal weights in a portfolio is a serious problem in financial investments since real world situation, equal weights do not results in best expected returns with minimum risk. Mean-Variance optimization provides, in a remarkable simple way,
an efficient portfolio that fulfill some general wanted features if you combine it with the GARCH models as the variance predictor.

This study used the Mean-Variance model in optimizing a portfolio but other methods like Lagrange multipliers can be used to optimize the returns while minimizing risk in portfolio selection. Many literatures suggest that there are many factors influencing stock market returns. In the Zimbabwean context, it could be said that money supply, real activities, oil prices and foreign stock market movements might have significant influence on stock market returns. Stock prices are very sensitive to political waves, announcements on economic transformations, inflation as well as special events. These factors might have some implications for investors in Zimbabwe volatility in stock returns stems from the fact that stock returns might no longer be seen to carry their true intrinsic value and would lead investors to lose confidence in the stock market. The historical data on volatility could be used to predict future volatility but it was hard to conclude about the accuracy of this since the volatility depends on specific assets, data frequency, and the time-horizon of the data used and also errors of measurement.

5.3 Recommendations
It is important that surveys be conducted to establish if investors purely make investment decisions based on risk-return considerations since the study has established that if one accepts higher risks then the returns would also be higher. From the research findings, some recommendations can be made in order to improve one’s investment decisions. Based on these findings, we realize that the beta coefficient can act as a good measure for determining an investment portfolio pegged on historical trends since one is able to analyze the stock volatility before deciding which counter to invest in. While choosing an ideal portfolio three factors are an important consideration; an investor’s investment objectives, the risk tolerance, and the time horizon hence an investor can therefore be described as risk tolerant, risk neutral or risk averse.

Other measures of risk can be used other than CAPM to ensure a precise and accurate prediction of the variance. Before deciding on investing on the stock market, one should assess the performance of the stock market first and again before choosing counters to include in your portfolio, one should have clear information of the counter in terms of current performance if it is not encountering losses month-in month-out. Shiller (2003) purports that one should be aware
of market fluctuations of stock prices before making any decision about investment in stocks. To the investors, there is need to look at all risk measures rather than sorely looking at return of the security or the portfolio of the risk involved. To the companies there is need to employ people with deep understanding of mathematicians, statisticians who have financial literacy that will help them monitor the movement of their stock positions on the stock market. Getting their managers learn about financial literacy and diversify their brains to other areas like statistics and mathematics and just not rely on management alone, hence they will be good managers.

5.4 Limitations of the study
Like any other scientific work, this study on the risk-return trade-off has some limitations. The main limitations are mostly related to the empirical study approach and particularly the data set and methodology. Not all the companies listed in the Zimbabwe Stock exchange were picked for the sample, only the companies that formed the ZSEINDX for that particular period of time were considered. This was a challenge because the study could not give a very fine picture of the status for the entire Zimbabwe Stock Exchange. The scope of this study has been limited to the period of six years from February 2009 to February 2015 due to the time given to complete the study. If more time had been available and data from a wider-frame was available, more analysis could have been undertaken to observe the dynamics of the indices during abnormal periods such as economic slowdowns and financial crises.

5.5 Suggestions for further research
From the research findings, it would be helpful to replicate the study in another setting particularly taking a longer period than the 6 years that were used in this study. For instance a ten-year period under a different set of economic circumstances could produce a surprising set of results this may also shed more light on the discriminative impact of such economic factors on different sectors. Other factors affecting stock returns other than risk should also be considered. These factors include interest rates, exchange rates and inflation.
References


APPENDIX
APPENDIX 1

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APPENDIX 2

Portfolio 1 Weights

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APPENDIX 3

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APPENDIX 4

CODE A

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parse_dates=[0])

print("All in all there are {} missing values".format(stocks.isnull().sum().sum()))

stocks.head()

stocks.index = pd.to_datetime(stocks.index)

weekly_data = stocks.groupby(pd.Grouper(freq='w')).mean()

weekly_data.head()

stocks_indexed = pd.DataFrame(weekly_data[stocks.columns].values)

stocks_indexed.columns = list(weekly_data.columns)

stocks_indexed.head()
```
**CODE B**

```python
stocks_indexed.to_csv('stocks_indexed.csv')

stocks_indexed1 = stocks_indexed.drop('RF', axis=1)

#COMBINED PLOT

stocks[['ECONET','AFDIS','DELTA','FBCH','GENBELT','ART','BARCLAYS','ASTRA','OK']].plot()

data.set_xlabel('Date')

plt.ylabel('Price')

plt.title('Combined Plot')

plt.savefig('Combined plot')

**CODE C**

def Stationarity(data, window = 12,yscale = "none"):
    data = data.dropna()

    #Perform Dickey-Fuller test:
    test = sts.adfuller(data, autolag='AIC')

    # to make the results of the test more readable
    dfoutput = pd.Series(test[0:4], index=['Test Statistic', 'p-value', '#Lags Used', 'Number of Observations Used'])

    for key,value in test[4].items():
        dfoutput['Critical Value (%s)'%key] = value

    print(dfoutput)

def Distribution(in_data):
    in_data = in_data.dropna()

    print('Kurtosis = ', in_data.kurtosis())
    print('Skew = ', in_data.skew())
    print('Returns.describe()')

for stock in stocks_indexed1:
    the_stock = "Stock: " + stock
    print("n" + the_stock)
print("--------- Augmented Dickey Fuller Test ---------")
Stationarity(returns[stock])
print("\n")

CODE D
# split dependent and independent variable
X = log_returns['ZSEINDX']
beta = []
r = []
p_val =[]
constant = []
for stock in stocks_indexed1:
    # split dependent and independent variable
    y = log_returns[stock]
    # Add a constant to the independent value
    X1 = sm.add_constant(X)
    # make regression model
    model = sm.OLS(y, X1)
    # fit model and print results
    results = model.fit()
    print(results.summary())
    # lets get slope/beta
    slope, intercept, r_value, p_value, std_err = scistat.linregress(X, y)
    beta.append(slope.round(5))
    r.append(r_value.round(5))
    p_val.append(p_value.round(5))
    constant.append(intercept.round(5))
# standard deviations
sds = []
rs = []
for stock in stocks_indexed1:
    sds.append(stats.stdev(returns[stock].tolist()))
for i in r:
    rs.append(i*i)
sds[0]
rs[0]

risk_measures = pd.DataFrame()

risk_measures = risk_measures.append(risk_measures)
risk_measures["Stock"] = stocks_indexed1.columns
risk_measures["StDev"] = sds
risk_measures["Beta"] = beta
risk_measures["R Squared"] = rs
risk_measures["P-Value"] = p_val

risk_measures

CODE E

port_results = []
port_volatility = []
sharpe_ratio = []
stock_weights = []

# set the number of combinations for imaginary portfolios
num_assets = len(selected)
num_portfolios = 50000

# set random seed for reproduction's sake
np.random.seed(101)

# populate the empty lists with each portfolios returns, risk and weights
for single_portfolio in range(num_portfolios):
    weights = np.random.random(num_assets)
    weights /= np.sum(weights)
    returns = np.dot(weights, returns_annual)
    volatility = np.sqrt(np.dot(weights.T, np.dot(cov_annual, weights)))
    sharpe = returns / volatility
    sharpe_ratio.append(sharpe)
    port_returns.append(returns)
    port_volatility.append(volatility)
    stock_weights.append(weights)

# a dictionary for Returns and Risk values of each portfolio
portfolio = {'Returns': port_returns,'Volatility': port_volatility,'Sharpe Ratio': sharpe_ratio}

# extend original dictionary to accommodate each ticker and weight in the portfolio
for counter,symbol in enumerate(selected):
    portfolio[symbol+' Weight'] = [Weight[counter] for Weight in stock_weights]

# make a nice dataframe of the extended dictionary
df = pd.DataFrame(portfolio)

column_order = ['Returns', 'Volatility', 'Sharpe Ratio'] + [stock+' Weight' for stock in selected]

# reorder dataframe columns
df = df[column_order]

# plot frontier, max sharpe & min Volatility values with a scatterplot
plt.style.use('seaborn-dark')

df.plot.scatter(x = 'Volatility',y = 'Returns',c = 'Sharpe Ratio',cmap = 'RdYlGn',edgecolors = 'black',figsize=(10, 8),grid=True)
plt.xlabel('Volatility (Std. Deviation)')
plt.ylabel('Expected Returns')
plt.title('Efficient Frontier')
plt.savefig('Efficient Frontier.png', dpi=1000, bbox_inches='tight')
plt.show()

# find min Volatility & max sharpe values in the dataframe (df)
min_volatility = df['Volatility'].min()
max_sharpe = df['Sharpe Ratio'].max()

# use the min, max values to locate and create the two special portfolios
sharpe_portfolio = df.loc[df['Sharpe Ratio'] == max_sharpe]
min_variance_port = df.loc[df['Volatility'] == min_volatility]

# plot frontier, max sharpe & min Volatility values with a scatterplot
plt.style.use('seaborn-dark')
df.plot.scatter(x='Volatility', y='Returns', c='Sharpe Ratio', cmap='RdYlGn', edgecolors='black', figsize=(10, 8), grid=True)
plt.scatter(x=sharpe_portfolio['Volatility'], y=sharpe_portfolio['Returns'], c='red', marker='D', s=200)
plt.scatter(x=min_variance_port['Volatility'], y=min_variance_port['Returns'], c='blue', marker='D', s=200)
plt.xlabel('Volatility (Std. Deviation)')
plt.ylabel('Expected Returns')
plt.title('Efficient Frontier')
plt.savefig('Efficient Frontier 2.png', dpi=1000, bbox_inches='tight')
plt.show()

# print the details of the 2 special portfolios
print(min_variance_port.T)
print(sharpe_portfolio.T)

#risk_measures.to_csv("Risk measures.csv")

min_variance_port.T.to_csv("min_var_port.csv")
sharpe_portfolio.T.to_csv("sharpe_port.csv")