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TESTING THE FAMA AND FRENCH FIVE-FACTOR MODEL ON THE JSE-LISTED FIRMS

NELUVHALANI KHATHUTSHELO

STUDENT NO: 11576211

MASTER OF COMMERCE IN COST AND MANAGEMENT ACCOUNTING

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BY

NELUVHALANI KHATHUTSHELO

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Prof. Vusani Moyo: Supervisor

Dr. Arthur Reynolds: Co-supervisor

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DECLARATION

I, the undersigned **Neluvhalani Khathutshelo (11576211)**, hereby declare that this dissertation titled: **Testing the Fama and French Five-Factor Model on The JSE-listed Firms**, for the Master of Commerce (MCOM) in Cost and Management Accounting submitted to the School of Management Sciences at the University of Venda has not been submitted previously, in part or in full, for any degree at this or any other university. I declare that I investigated and authored this dissertation completely alone and have not used sources or resources other than the ones mentioned. All reference material and sources used, quotes and citations that were taken from publications, or that were following the meaning of those publications, were fully acknowledged and a list of references was given.

Signature: **Date:** 07 April 2021

Mr. Neluvhalani Khathutshelo

Student number: 11576211

DEDICATION

This dissertation is dedicated to my mother, Tshimangadzo Neludane and my late uncles, Thilivhali and Mashudu Neludane. Thank you for the unwavering support that you gave me throughout my studies. I also want to express my heartfelt gratitude to my wife, Nicky Neluvhalani for her constant support and encouragement throughout this study. Furthermore, I would like to thank my siblings for their emotional support throughout this study as well. And finally, I also want to dedicate this research to my children Dakalo, Khathutshelo Tenda II, and Muditambi Tshimangadzo Neluvhalani.

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ABSTRACT

The Capital Asset Pricing Model (CAPM) has its fair share of weaknesses and problems such as its well documented series of unrealistic assumptions. As a response Fama and French (1992) introduced the Fama and French three-factor model (FF3FM), but it remains unpopular among investors, practitioners and academics compared to the CAPM because it is deemed not cost effective and thought of as not being better than the CAPM. In 2015, Fama and French introduced the Fama and French five-factor model (FF5FM) that augmented profitability and investment into their FF3FM. Cakici (2015), Jiao and Lilti (2017), Foye (2018) and others have tested the five-factor model using data from their respective stock markets. The findings of these studies may not necessarily apply to South Africa because of institutional differences between countries. However, South African studies used different testing methods compared to this study. Therefore, given this background, this study sought to test the effectiveness of the FF5FM against the CAPM and the FF3FM in estimating stock returns on the Johannesburg Securities Exchange Limited (JSE Ltd).

This study tested the performance of the FF5FM against the CAPM and the FF3FM using data from the JSE-listed firms. The study sought to find out if the FF5FM performs better than the CAPM and the FF3FM when estimating stock returns of JSE-listed firms. Specifically, this study tested the CAPM, FF3FM and FF5FM using all the JSE-listed firms to determine which model explains better the common variation and the cross section of expected future stock returns. In addition, the study investigated whether the value factor became redundant when the additional factors, profitability and investment were added to the FF3FM as per Fama and French (2015).

Using the bespoke Generalized Method of Moments (GMM) of Hansen (1982) to carry out the regressions with data from the JSE for the period 2003 – 2019, the results show that profitability is a more reliable factor than investment in explaining share returns. The results also show that the FF5FM performs better than the other two models in estimating returns based on the assumption that most holding periods are significantly shorter than 16 years. Furthermore, the test results rejected the hypothesis that the value factor becomes redundant in explaining stock returns when more factors are added to the FF5FM.

Key words: Beta; Capital Asset Pricing Model; Fama and French five-factor model; Fama and French three-factor model; Modern Portfolio Theory; and Risk-free rate.

ACRONYMS AND ABBREVIATIONS

AltX	Alternative Equity Exchange
ALSI	All Share Index on the Johannesburg Securities Exchange
BE	Book equity
BE/ME	Book-to-Market Ratio
CAPM	Capital Asset Pricing Model
CMA	Investment factor
F&F	Fama and French
FF3F	Fama and French Three-Factor Model
FF5F	Fama and French Five-Factor Model
GMM	Generalised Method of Moments
GRS	Gibbons, Ross, and Shanken
HML	High Minus Low (the value factor)
JSE Ltd	Johannesburg Securities Exchange Limited
ME	Market equity
MKT	Market factor
MPT	Modern Portfolio Theory
OLS	Ordinary least square
RMW	Profitability factor
SMB	Small Minus Big (the size factor)
Size-BE/ME factors	Size and Book-to-Market factors
UMD	Up Minus Down

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CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE STUDY

According Grayburn, Hern, and Lay (2002), the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965) remains the leading asset pricing model that analysts, investors and finance academics use to estimate the equity investors expected rates of return. Romano (2005) concedes that the CAPM has become the industry standard for regulatory decisions based on the cost of equity. A survey study conducted by Graham and Harvey (2001, 2008) on 392 CFOs found that 73.5% of the CFOs used the CAPM to calculate the cost of equity. Another study by Bancel and Mittoo (2014), where a survey was conducted with several European financial experts, revealed that 80% of the CFOs used the CAPM to estimate the cost of equity. These studies all confirm the popularity of the CAPM in estimating the expected returns of equity by investors, practitioners, and academics.

The CAPM is promoted as a theoretical model because it is easy to convey, derive and implement as it consists of only one factor, which is the stock's beta (Perold, 2004). A study by Mullins (1982) found that the benefit of the CAPM is that it quantifies risk and provides a widely applicable, relatively objective routine for translating risk measures into estimates of expected return. The strength of the CAPM lies in its simple logic and intuitive economic predictions about how to measure risk, and about the relationship between expected return and risk (Fama & French, 2004). It is plausible that the ease of use and application of the CAPM may have led organizations to ignore its potential weaknesses and problems such as its well documented series of unrealistic assumptions. As a response to the weaknesses and anomalies of the CAPM, Fama and French (1992) showed that factors related to firm size, book-to-market equity, and the aggregate stock market compensate for non-market risk component (Fama & French, 1993; Frankel & Lee, 1998).

Although the CAPM remains popular and widely used in estimating expected returns of equity, a lot of its anomalies have however been identified. A study by Banz (1981) provided prominent evidence for the presence of size effect on the estimation of equity returns. This size effect showed that the CAPM underestimates the average returns on small size stocks and it overestimated the average returns on the big stocks. A study by Fama and French (1992) showed the most convincing evidence that the CAPM has little ability in explaining cross-sectional variation in most equity returns. Following the evidence of Fama and French (1992), the case against the CAPM gathered momentum and it has been presented in numerous subsequent studies including those of Grinold (1993), He and Ng (1994) and Fama and French (1993, 1995) that the empirical record of the CAPM is poor enough to invalidate the way it is used in applications. Furthermore, Chui and Wei (1998) confirmed the absence of a relationship between asset return and beta in five Pacific Basin emerging markets. A study by Benson and Faff (2012) argued that the CAPM like most models is partly wrong because it does not always conform with market reality. According to Fama and French (1993), the cross-section of average return on U.S common stocks showed little relation with the beta of the CAPM of Sharpe (1964) and Lintner (1965). These findings led to the emergence of the Fama and French (1992) three-factor model (FF3FM) which extends the CAPM by adding size and value factors.

The development of the three-factor model was a result of several studies, most notably that of Fama and French (1992). According to Fama and French (1992) market, size and value are the three main risks that allow the estimation of the expected return of an asset. The FF3FM have been supported by several studies including those of Doganay (2006), Basiewicz and Auret (2010) and Godwin (2010) who found that FF3FM had greater power in explaining return variations relative to the standard CAPM and also addresses anomalies that arise as a result of size and value factors.

Besides all these purported strengths of the FF3FM, the survey results of Oxera (2006) and Hasan, Rahman, Baten, and Uddin (2017) indicate that FF3FM remains unpopular among investors, practitioners and academics when compared to the CAPM. Hasan *et al.* (2017) aver that the FF3FM remains unpopular because it is not cost effective to collect the extra information required for implementing the FF3FM, and that investors, practitioners and academics think that the FF3FM is not always better than the CAPM. The FF3FM has been criticised for lacking a clear theoretical foundation as it does not explain why size and BE/ME ratio are proxies for risk (Oxera, 2006). Some critics of Fama and French (1992) pointed out to survivorship bias (Amihud, Christenson, & Mendlson, 1993, Kothari, Shanken, & Sloan, 1995 and Foster, Smith, & Whaley, 1997) for their data selection procedures and data mining (Black, 1993). A study by Lau and Teh (2017) argued that the monthly sampling interval is the primary reason the size effect showed up and dominated the role of beta in cross-section tests. A study by Novy-Marx (2013) and Aharoni, Grundy, and Zeng (2013) showed that firms with a high profitability generate higher returns than unprofitable firms and a relation exists between an investment proxy and average returns. These findings led to the emergence of the Fama and French (2015) five-factor model which extends the three-factor model by adding profitability and investment factors.

Fama and French (2015) proposed the Fama-French five-factor model (FF5FM) that captures the size, value, profitability and investment patterns in stocks in the wake of findings by Novy-Marx (2013) and Aharoni *et al.* (2013) which found evidence of a relationship between gross profitability and investment with average stock returns. The FF5FM is better than the FF3FM in explaining expected returns, and the main conclusion of the FF5FM is that when the profitability and investment factors are included, the value factor becomes redundant (Fama & French, 2015b).

The Fama and French (2015) model was developed using data from the US from July 1963 to December 2014. In addition to Fama and French (2015), several studies including those of Cakici (2015), Djamaluddin, Roffi, and Djunarno (2017), Kubota and Takehara (2017), Ozkan (2018), Erdinc (2018) and others tested the FF5FM and the resultant findings were mixed. A study by Cakici (2015) examined the FF5FM and found compelling evidence in support of the FF5FM in North America, Europe, and other developed markets. The results of his study showed that profitability and investment factors are weaker in Japan and the Asia Pacific markets, meaning that the FF5FM is country specific. The study of Cakici (2015) was further supported in a study by Djamaluddin *et al.* (2017) and Erdinc (2018) that showed that the FF5FM gave a better estimation of stock returns in their respective markets, namely Indonesia and Turkey. According to the findings of Cakici (2015), Djamaluddin *et al.* (2017) and Erdinc (2018) it was found that the FF5FM performed better than the FF3FM in explaining average stock returns. A study by Blitz, Hanauer, Vidojec, and van Vliet (2018) found that like the FF3FM, the FF5FM is unable to explain the momentum premium and continues to ignore it. Their study also found that the FF5FM is probably not going to put an end to empirical asset pricing discussions or lead to consensus.

1.1 Problem statement

The FF5FM was developed using data from the US (Fama & French, 2015a), subsequent tests on the 5-factor model used data from markets such as Brazil (Martins & Eid Jr, 2016), Jordan (Alrabadi & Alrabadi, 2018), and China (Guo, Zhang, Zhang, & Zhang, 2017). Martins and Eid Jr. (2016) found that the time-series regressions, market factor, *SMB*, and *HML* seem to capture most of the variations in average returns. The new factors, *RMW* and *CMA*, showed less explanatory power and have been less studied. Alrabadi and Alrabadi (2018) found that none of the CAPM, FF3FM and FF5FM can fully explain the cross section of stock returns. Guo *et al.* (2017) found strong size, value, and profitability patterns in average returns. The findings of these studies may not necessarily apply to South Africa because of institutional differences between countries such as market characteristics, profitability of firms, level of investment in firms, and sophistication of financial markets. Furthermore, Cakici (2015) found that the validity of the five-factor model is country specific.

This study commenced in 2016 but other South African researchers started and completed their studies on the five-factor model earlier, just before the completion of this study. In South Africa, Cox and Britten (2019) and, Mosoeu and Kadongo (2019) have tested the five-factor model using data from the JSE. A study by Cox and Britten (2019) tested the effectiveness of the five-factor model and the additional factors in explaining returns on the JSE. Their study found that profitability and investment did indeed contribute to explaining returns on the JSE and in addition, profitability is a contributing factor in a quality premium. On the other hand, Mosoeu and Kadongo (2019) tested the adequacy of the FF5FM in explaining average stock returns on selected emerging and developed equity markets, including the JSE and found that the performance of the FF5FM depended on the market upon which it is being tested. Their study applied the standard Generalized Method of Moments (GMM) to carry out the regressions and their approach has a problem of over-identification which may also affect the reliability of the findings. This study tested the performance of the FF5FM against the CAPM and the FF3FM by applying a bespoke GMM estimation approach developed by Hansen (1982) based on robust instruments that use the higher moments and cumulants of the sample observations. Furthermore, this study investigated if the value factor becomes redundant once profitability and investment are added to the FF3FM. Therefore, given this background and the estimation approach adopted for this study, the performance of the FF5FM against the CAPM and the FF3FM in explaining average stock returns is yet untested on the JSE.

1.2 Aim of the study

The aim of this study was to test the performance of the FF5FM against the CAPM and the FF3FM using JSE data and to find out if it performs better than the CAPM and FF3FM when estimating future stock returns on the JSE. Specifically, this study tested the CAPM, FF3FM and FF5FM with 165 ALSI firms to determine which model explains better the common variation and the cross section of expected stock returns. Furthermore, this study aimed to investigate if the value factor becomes redundant once profitability and investment are added to the FF3FM.

1.3 Objectives of the study

The objectives of this study are to:

- Test the performance of the FF5FM and find out if it improves the descriptions of expected stock returns compared to the CAPM and FF3FM on the JSE.
- Determine if the value factor becomes redundant in explaining expected stock returns when profitability and investment factors are added to the FF3FM on the JSE.

1.4 Research hypotheses

The hypotheses for this study are:

- H1 = The FF5FM model offers a better estimation of expected future stock returns on the JSE compared to the CAPM and FF3FM.
- H2 = The value factor becomes redundant in explaining expected stock returns with the addition of profitability and investment factors to the FF5FM on the JSE.

1.5 Significance of the study

This research could contribute towards a dialogue on asset pricing models by supplying some evidence on whether the FF5FM outperforms both the FF3FM and the CAPM in estimating the returns of the JSE-listed firms.

The findings of this study could therefore provide an important insight into the interrelations between expected stock returns, size, book-to-market, profitability, and investment factors. Overall, this study is envisaged to add to the existing body knowledge on the performance of the FF5FM against the CAPM, FF3FM and make a significant contribution to researchers and analysts.

1.6 Scope of the study

This study focused on testing the performance of the FF5FM against the CAPM and the FF3FM using JSE stock returns data of the nine sectors for a period of 16 years from July 2003 to June 2019. For this study, the population comprised 371 firms that are publicly traded on the nine sectors of the JSE.

1.7 Delimitations of the study

The period of this study was limited to 16 years from 2003 to 2019 covering publicly traded firms listed on the ALSI covering the nine sectors on which those firms are listed on the JSE. This study had two samples, Sample A and Sample B, with Sample A including the fiscal crisis period of 2007 and 2008, and Sample B excluding the fiscal crisis of the same period. The reason for having two samples was to exclude mispricing issues when analysing the results of the samples.

1.8 Definition of key terms

The following terms are defined as applicable to the current study:

Capital Asset Pricing Model (CAPM)

The Capital Asset Pricing Model (CAPM) describes the theory of the relationship between risk and return which states that the expected risk premium on any security equals its beta times the market risk premium. The CAPM is a popular model which is widely used throughout finance for pricing risky securities and generating expected returns for assets given the risk of those assets and cost of capital (Brealey, 2017).

Beta

A beta coefficient measures a security's sensitivity to market risk. Beta is used in the CAPM to measure how much the stock and entire market move together (Vernimmen, Quiry, Le Fur, Dallocchio, Salvi & Wiley, 2018).

Modern Portfolio Theory (MPT)

Modern Portfolio Theory (MPT) is an investment theory based on the idea that risk-averse investors can construct portfolios to optimize or maximize expected return based on a given level of market risk, emphasizing that risk is an inherent part of higher reward (Markowitz, 1952; Schwartz & Ingersoll, 1988; Setayesh, 2013).

Systematic risk

Systematic risk refers to events that (systematically) affect the returns of all or an exceptionally considerable number of firms in an economy. Examples of such events are unexpected global events such as the 9/11 World Trade Centre in the US and unexpected changes in economic variables such as interest rates and oil prices. This type of risk is also called market risk or non-diversifiable risk, as this type of risk can never be eliminated, irrespective of the size/diversity of the portfolio (Els, Erasmus & Viviers, 2014).

Unsystematic risk

Unsystematic risk refers to events that negatively affect the returns of a limited number of firms in an economy. Examples of such negative events are strikes, pollution, lawsuits, etc., as these events only affect a restricted number of firms, they are also referred to as firm-specific risk. By including several, diverse securities in a portfolio, firm-specific risk can be minimised and even eliminated. This type of risk is also known as diversifiable risk (Els *et al.* 2014).

Reliability and Validity

Reliability in research refers to the degree to which research collection methods produce stable and consistent results. This means that a specific measure can be reliable if its repeated application on the same object of measurement produces the same results. And on the other hand, validity in research refers to the extent to which data collection methods accurately measure what they were intended to measure. Therefore, for the results from a study to be considered valid, the measurement procedure must first be reliable (Messick, 2016).

1.9 Outline of the study

The rest of this study is structured as follows:

Chapter 1: Introduction and background to the study. This chapter introduces the research and presents the background, statement of the problem, research objectives, research question, significance of the study, definition of concepts, research methodology, data analysis, delimitations of the study and ethical considerations. It then concludes with a summary of the chapter and introduces Chapter 2.

Chapter 2: Literature review. The literature review of this study is made up of only secondary information, journal articles, textbooks, and other relevant sources which were collected and then reviewed. The literature chapter of this study discusses the theoretical aspects of the CAPM, FF3FM, and FF5FM models. This study further reviewed empirical studies of emerging and developed markets. It ends with a summary of the chapter and then introduces Chapter 3.

Chapter 3: Research design and methodology. This chapter presents the research paradigm, methodology and design employed for performing the analysis. This process is carried out by describing the population, sampling period, data collection procedures, different sectors and the different variables used in the analysis and interpretation of the different models applied in this chapter. Ethical considerations are discussed. It then concludes with a summary of the chapter and introduces Chapter 4.

Chapter 4: Presentation and interpretation of results. This chapter presents the data interpretation and empirical analysis of the FF5FM model in the study. The chapter also presents the performance of the factor model analysis and the robustness test of the asset pricing models applied in the study. Tables and figures aid in illustrating the results of the findings. It ends with a summary of the chapter and then introduces Chapter 5.

Chapter 5: Conclusion and recommendations. Finally, this chapter presents a summary of the study. Conclusions are drawn from the analysed data and findings of the study. It draws conclusions on the performance and applicability of the FF5FM from a South African perspective. This chapter also highlights the limitations of the study and presents recommendations for future research.

1.10 Summary

Chapter One introduced the study by providing information on the background of the research area. This chapter provided the problem statement, aim and objectives, significance, and scope of the study. This chapter also emphasised the justification of the study from a South African perspective. It also included information about the limitations and outline of the study. Chapter Two presents the review of theoretical and empirical literature related to the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature relating it to the main capital asset pricing models. The chapter briefly introduces the history of the JSE and outlines the history and development of modern portfolio theory. Chapter Two also discusses the CAPM and the empirical tests of the model. A discussion on the FF3FM is also included in this chapter including size and book-to-market ratio and the empirical tests of the model. Lastly, this chapter offers a detailed discussion on the FF5FM. It concludes with a summary of the chapter and then introduces Chapter Three.

2.2 Johannesburg Securities Exchange Limited (JSE Ltd)

The JSE was established in 1887 and it is the largest stock exchange in Africa. It is the 17th largest exchange in the world with a market capitalisation of R14.57 trillion. The JSE is also a member of The World Federation of Exchanges (The World Federation of Exchanges, 2019). There are two separate boards on the JSE, the main board and AltX board. As of 31 March 2019, a total of 363 firms were listed on the main board with a market capitalisation of R14.57 trillion and 45 firms were listed on the AltX board with a market capitalisation of R14.87 billion **(Table 2 and 3)**. The AltX caters to firms that are not yet ready to list on the main board (Listed companies – JSE, 2019).

As of 30 April 2018, the ALSI was made up of 165 firms, and firms included in this index represented 99% of the market capitalisation of all listed firms on the main board of the JSE. The JSE trades in equities, securities, exchange-traded notes, and warrants. The JSE consists of 9 sectors which are made up of five large sectors, namely Basic Resources, Industrials, Consumer Goods, Consumer Services, and the Financial sector. Four smaller sectors, namely Oil and Gas, Telecommunication, Healthcare and Technology make up the rest (Listed companies – JSE, 2019).

The JSE is also subjected to influences from the political climate in the nation. A good example of this was the reshuffling of the Minister of Finance in 2015 and 2017 that had a negative impact on the JSE. The novel coronavirus or Covid-19 is also wreaking havoc on global stock markets. On the JSE, the ALSI had lost about R2.3 trillion since the middle of April 2020 because of Covid-19. Few sectors on the JSE have been spared the brunt of this virus, but the petrochemicals sector is being hit particularly hard due to the crashing oil prices globally (JSE Mid-Term Report, 2020).

2.3 History of modern portfolio theory (MPT)

The Modern Portfolio Theory (MPT) is an investment theory based on the idea that risk-averse investors can construct portfolios to optimize or maximize expected return based on a given level of market risk, emphasizing that risk is an inherent part of higher reward. Its key insight is that an asset's risk and return should not be assessed by itself, but by how it contributes to a portfolio's overall risk and return (Markowitz, 1952; Schwartz & Ingersoll, 1988; Setayesh, 2013). The idea behind MPT involves creating a portfolio of multiple investments to limit the overall risk any one investment poses to the portfolio. The more unique that stocks and other assets an investor owns, the less risk each one poses to the portfolio (Sharpe, Alexander, & Bailey, 1999; O'Brien & Srivastava, 1995).

Harry Markowitz introduced the MPT in his 1952 publication "Portfolio Selection" where he offered mathematical proof that a diversified financial portfolio will be less volatile than the sum of its individual parts. MPT provides investors with a portfolio construction framework that maximizes returns for a given level of risk, through diversification (Markowitz, 1952).

Generally, investing is a trade-off between risk and return. MPT assumes that investors are risk averse, meaning that given two portfolios that offer the same expected returns, investors will prefer the less risky one. It is important to understand the concept of risk because without it there would be no reward. Investors are compensated for bearing risk and, in theory, the higher the risk, the higher the expected return (Setayesh, 2013).

Despite the theoretical importance of MPT, critics such as Setayesh (2013) and Low *et al.* (2016) questioned whether it is an ideal investment tool, because its model of financial markets does not match the real world in many ways. Similarly, studies by Rachev, Stoyanov, and Fabozzi (2011), Rachev and Mittnik (2000), and Doganoglu, Hartz, and Mittnik (2007) also criticized the MPT because of its assumptions that returns followed a Gaussian distribution, and they proposed the use of stable distributions instead. Like any theory, MPT does not claim to be perfect, but its insightfulness has helped the development of corporate finance significantly over the years. The MPT provided a foundation for the development of the leading capital asset pricing models (O'Brien & Srivastava, 1995).

2.3.1 The Sharpe-Lintner CAPM

The CAPM is used to estimate a stock's return given its systematic risk index, the market return, and the risk-free rate. It uses a single risk factor referred to as market beta (Reilly, Brown, & Leeds 2019). Sharpe (1964) and Lintner (1965) used the MPT of Markowitz (1952) as the base to develop the CAPM. This model is an extension of the MPT and provides investors with a portfolio construction framework that maximizes returns for a given level of risk, through diversification. A single index model was developed by Sharpe (1964) and it was a much more computationally efficient method than the tedious method of Markowitz (1952), where the return on an individual security is related to the return on a common index. The CAPM is a model for pricing an individual security or portfolio. The security market line (SML) is used for individual securities and its relation to the expected returns and systematic risk (beta) to show how the market must price individual securities in relation to their security risk class. The reward-to-risk ratio for any security is calculated by the SML in relation to that of the overall market. Thus, when the expected rate of return for any security is deflated by its beta coefficient, the reward-to-risk ratio for any individual security in the market is equal to the market reward-to-risk ratio. Therefore, the market reward-to-risk ratio is effectively the market risk premium, and this leads to the overall CAPM model where the regression model of the CAPM is stated as:

$$r_a = r_f + \beta_a(r_m - r_f) \qquad (1)$$

Where: r_f is the rate of return for a risk-free security; r_m is the broad market's expected rate of return; and β_a is the beta of the asset.

The Sharpe-Lintner CAPM was applied in this study because it is a well-known and widely used model rather than the other CAPM models such as the Black CAPM, C-CAPM, ICAMP and APT. This model is the one that Sharpe (1964) and Lintner (1965) successfully set out to find. It shows the relationship between expected return and risk that is consistent with investors behaving according to the prescriptions of portfolio theory. The CAPM establishes that expected returns on securities are proportional to beta, a factor which reflects the volatility or the systematic risk index of a security or a portfolio in comparison to the market. Unsystematic risk is not rewarded with greater expected returns since it can be eliminated through diversification. The CAPM allows to calculate the expected return of a stock or portfolio given its beta, the MRP and the risk-free rate.

2.3.1.1 The main problems with the CAPM

Tassell (2007) quotes James Montier, an analyst at Dresdner Kleinwort, saying that the CAPM is empirically bogus – it does not work in any way, shape, or form. “The CAPM is, in fact, Completely Redundant Asset Pricing (CRAP),” he says, claiming that financial markets are in denial of this fact. Financial economists, Fama and French (2004) argued that the failure of the CAPM in empirical tests implied that most applications of the model are invalid. The CAPM’s empirical problems may reflect its theoretical failings, which are a result of the model’s many simplifying assumptions. The model assumes that all active and potential shareholders have access to the same information and agree about the risk and expected return of all assets (Bodie, Kane & Marcus, 2019). The CAPM assumes that economic agents optimise over a short-term horizon and in fact investors with longer-term outlooks would optimally choose long-term inflation-linked bonds instead of short-term rates as this would be more risk-free to such an agent (Campbell & Vicera, 2003). The CAPM further assumes that there are no taxes or transaction costs, although this assumption may be relaxed with more complicated versions of the CAPM (Fama & French, 2004).

Most practitioners and academics agree that risk is of a varying nature (non-constant). A critique of the CAPM is that the risk measure used is still constant (non-varying beta) (French, 2016). Recent research has empirically tested time-varying betas to improve the forecast accuracy of the CAPM (French, 2016). The traditional CAPM uses historical data as the inputs to solve for a future return of an asset. However, history may not be enough to use for predicting the future and modern CAPM approaches have used betas that rely on future risk estimates (French, 2016). The CAPM assumes that the probability beliefs of active and potential shareholders match the true distribution of returns. A different possibility is that active and potential shareholders’ expectations are biased, causing market prices to be informally inefficient (Daniel, Hirshleifer & Subrahmanyam, 2001). The CAPM assumes that all active and potential shareholders will consider all their assets and optimize one portfolio. This differs with portfolios held by individual shareholders where humans tend to have fragmented or multiple portfolios (Merton, 1973). Empirical tests show that market anomalies like size and value effect cannot be explained by CAPM (Fama & French, 1992).

The main problem of the CAPM stems from the notion that it is only testable when composed of the entire market portfolio. It is almost impossible to gather the required information altogether, meaning that the CAPM would be made untestable (Roll, 1977). Another problem is the robustness of results – the results of the CAPM are sensitive to changes in specific data characteristics (Oxera, 2006). The estimation of the beta parameter may change significantly according to the time horizon, data frequency and benchmark used. Empirical research questions the applicability of the CAPM by pointing out to the problems of designing the market portfolio and variability in significance of the beta/return relationship (Roll, 1977, Fama & French, 2004, Bodie *et al.* 2019, Prono, 2015). According to Novak (2015), the main weakness of the CAPM is the implementation issue rather than its underlying concept.

There are several empirical contradictions of the CAPM. The most prominent is the size effect of Banz (1981), where he found that market equity adds to the explanation of the cross-section of average returns provided by market betas. Average returns on small stocks are too high given their beta estimates, and average returns on large stocks are too low (Fama & French, 1992). Stattman (1980), Rosenberg, Reid and Lanstein (1985) and Chan, Hamao and Lakonishok (1991) supply evidence for the presence of value effect showing that average returns are positively related to the ration of a firm's book value of equity to its market value equity. Another contradiction of the CAPM is the positive relation between leverage and average return documented by Bhandari (1988). It is plausible that leverage is associated with risk and expected return, but in the CAPM, beta should capture leverage risk. Bhandari (1988) found however, that leverage helped explain the cross-section of average stock returns in tests that included size *(ME)* as well as beta. Finally, Basu (1983) showed that earnings-price ratio *(E/P)* helped explain cross-section of average returns on U.S. stocks in tests that also include size and market beta. Ball (1978) argued that *E/P* is catch-all proxy for unnamed factors in expected reruns; *E/P* is likely to be higher for stocks with higher risks and expected returns, whatever the unnamed sources of risk.

Despite Fama and French (1992), several other researchers such as Pettengill, Sundaram and Mathur (1995), van Rensburg and Robertson (2003) and Strydom and Charteris (2013) concurred that the CAPM proved to be a poor fit to empirical data in the international financial markets.

2.3.1.2 Practical applications of the CAPM in business and academia

The CAPM has clearly stood and passed the test of time since it was introduced more than 50 years ago (Benson & Faff, 2012). It has remained the pre-eminent model that analysts, investors and finance academics use in investment applications to estimate the cost equity or investor's expected rate of return. The CAPM is still widely used in various capital markets because of its simple logic and ease of use (Perold, 2004; Fama & French, 2004; Smith & Walsh, 2012). A survey on 392 Chief Financial Officers (CFOs) in the US conducted by Graham and Harvey (2001, 2008) found that 73.5% of them used the CAPM to estimate the cost of equity. In a survey of several European financial experts by Bancel and Mittoo (2014), it was revealed that 80% of them use the CAPM to estimate the cost of equity. In South Africa, the survey done by Correia and Cramer (2008) and Du Toit and Pienaar (2005) found that 71.4% of local firms relied on the CAPM to estimate the cost of equity. A survey conducted by PriceWaterhouseCoopers (2019) of 27 corporate financial analysts in South African firms also found that CAPM was the preferred method chosen by firms.

Furthermore, Fernandez (2008) randomly analysed 100 corporate finance textbooks and found that 89 of them explicitly recommended the CAPM to estimate the cost of equity. Welch (2008) found that around three quarters of professors recommend using the CAPM to estimate the cost of capital. Similarly, the CAPM is also an important topic in corporate finance course curricula worldwide (Oke, 2013). A study by Fernandez, Aquirrealloa, and Corres (2011a) showed that academics and practitioners use the CAPM in estimating the cost of equity. The reasons for its popularity in academia is because the CAPM is a correct model that is both easy to use and apply (Fernandez, Aquirrealloa, & Corres, 2011b). This suggests that the CAPM produces wrong discount rates less often than any of the alternative models (Partington, 2012).

2.3.1.3 Empirical tests of the CAPM

The testability of the CAPM needs a model to consist of a set of assumptions, mathematical development of the model through manipulation of those assumptions, and a set of predictions. Based on the assumption that the mathematical manipulations are error free, the model is testable in one of two ways, normative and positive. Normative tests examine the assumptions of the model, while positive tests examine the predications of the model. Empirical tests of the CAPM are focused on three testable implications, namely; the intercept is zero, beta completely captures the cross-sectional expected returns, and that the market excess return is positive.

Early tests of the CAPM

Most of the early tests of the CAPM employed the methodology of first estimating betas using series regression and then running a cross sectional regression using the estimated betas as explanatory variables to test the hypothesis implied by the CAPM. The first empirical test of the CAPM was conducted by Lintner (1965) and it was duplicated by Douglas (1967) who obtained comparable results to Lintner's (1965) original test. The early tests of Blume and Friend (1973), Jensen, Black and Scholes (1972), Miller and Scholes (1972), Fama and Macbeth (1973), Basu (1977), Banz (1981), Gibbons (1982), Shanken (1985), Harvey (1989), Fama and French (1992) and Kothari *et al.* (1995) firmly reject the Sharpe-Lintner CAPM. Roll (1977) argued that the market portfolio in the CAPM is unobserved and that empirical tests that use the stock index to approximate the market portfolio do not supply valid CAPM tests. However, Stambaugh (1982) showed that tests of the CAPM are sensitive to the specification of the market benchmark. Chan, Louis and Lakonishok (1993) argued that noise in the return data limits the ability of empirical tests to conclude on the positive relation between beta and returns. Later studies focused on the empirical issues related to using realised rather than expected returns in the CAPM tests (Bray *et al.* 2005), the errors-in-variables problem (Kim, 1995), and the time-variation in assets risk premia (Jagannathan & Wang, 1996). Some of the major empirical tests that invalidated the CAPM were published by Blume and Friend (1973), Jensen *et al.* (1972), Miller and Scholes (1972), Fama and Macbeth (1973), Basu (1977), Banz (1981), Gibbons (1982), Shanken (1985), Harvey (1989), Fama and French (1992) and Kothari *et al.* (1995).

Later tests of the CAPM

A study by Michailidis, Tsopoglou, Papanastasiou and Feridum (2006, 2019) tested the validity of the CAPM in Athens stock market by using weekly returns of 100 companies. They constructed 10 portfolios, each containing 10 firms. To calculate beta for each portfolio, they tested the relationship between beta and portfolios returns. Their results showed that portfolios with high beta did not earn high returns, and the intercept (α) of the model is not equal to zero, which means that the CAPM is not valid in explaining the relationship between risk and return in the Athens stock market. These findings are supported in a study by Choudhary and Choudhary (2010) which tested the validity of the CAPM for the Indian stock market using monthly stock returns from 279 firms of the Bombay Stock Exchange 500 index listed on the BSE from January 1996 – December

2009. The findings of the study are not supportive of the theory's basic hypothesis that higher risk (beta) is associated with higher level of return. The findings of their study showed that higher risk (beta) is not associated with a higher level of return and the evidence invalidated the CAPM.

The findings of studies by Michailidis *et al.* (2006, 2019) and Choudhary and Choudhary (2010) are contradicted in a study by Bradfield, Barr and Affleck-Graves (1988) which found the use of the CAPM to be empirically supported, and that the South African Government treasury bill (T-bill) rate was an accurate estimate of the risk-free rate in the CAPM. The findings of Bradfield *et al.* (1988) are supported in a study by Hasan, Alam, Amin and Rahaman (2014) which used monthly stock returns on the Bangladesh Stock Exchange for the period from 2005 – 2009. The all share price index is used as the proxy for the market portfolio and the Bangladesh 3-month government treasury bill as the risk-free asset. The results of the coefficients of square beta and unique risk show that the expected return-beta relationship is linear in portfolios and that firm specific risk has no effect on the expected return of the portfolios. The intercept terms for the portfolios are slightly different from zero. These findings support the validity of the CAPM.

South African tests of the CAPM

Findings on whether the CAPM is valid or invalid in the South African market are mixed. In South Africa, several studies were conducted by researchers such as van Rensburg and Robertson (2003), Basiewicz and Auret (2010), Strugnell, Gilbert and Kruger, (2011), and Hoffman (2012) with the intention of finding individual factors that are best at predicting the return that an investor would obtain by investing in shares. However, these studies document the invalidity of the CAPM in the South African market. Most notably, studies by van Rensburg and Robertson (2003); Basiewicz and Auret (2010); Strugnell *et al.* (2011) and Hoffman (2012) found a negative relationship between beta and returns, which contradicts the theory that risk should be equal with returns. van Rensburg and Robertson (2003) concluded their study with the statement that their findings were an unambiguous contradiction of the CAPM as they found that beta had a negative relationship with average returns over the sample period. After considering the results of van Rensburg and Robertson (2003), Strugnell *et al.* (2011) conducted a similar study over a longer period and similarly concluded that beta is irrelevant.

Another South African study by Muller and Ward (2013) tested the CAPM by sorting shares into portfolios based on beta, and plotting the cumulative value of portfolios over a long study period, the study found that the beta of an equally weighted portfolio of shares has an inverse relationship to actual return. The findings of their study concluded that the CAPM is not applicable in South Africa as beta is unable to accurately predict the actual returns that investors obtain. Similarly, other South African studies such as Pettengill *et al.* (1995), Baker, Bradley and Wurgler (2011), and Frazzini and Pedersen (2011) found an inverse relationship between risk, as represented by beta, and returns in the South African market.

Validity of the CAPM

Generally, considering the empirical findings discussed above, it is not easy to discard the CAPM outright. On the one hand, there is strong empirical evidence invalidating the CAPM and on the other hand, the empirical findings are not enough to discard the CAPM.

The findings invalidating the CAPM are not unique to the South African market. Fama and French (1992) found that beta was not able to explain the cross-section of share returns in the U.S and that the relationship between risk and return was flat. Irrespective of its popularity, importance and extensive usage by academics and the corporate financial world over time, empirical support for the CAPM is poor, casting doubt about its capacity to make it clearer on the actual movements of asset returns (Oke, 2013).

2.3.2 The Fama and French three-factor model (1992)

Fama and French (1992) showed that firms with low market capitalization and stocks of firms with a high book-to-market ratio do better than the market as a whole. They added two factors, size factor and value factor, to the CAPM to reflect a portfolio's exposure to these two classes (Fama & French, 1992). Thus, Fama and French (1992) developed a model that uses market factor size and value factor to estimate expected returns. According to Fama and French (1992) market volatility, size and value are the three main risks that determine the expected returns of stocks. Fama and French (1992) argued that investors are not only concerned about market risk alone as hypothesized by the CAPM, but they are also concerned about the size and value of the stocks. Thus, the three-factor developed by Fama and French (F&F) is an extension of the CAPM (Fama & French, 1992). Fama and French (1992) constructed the risk factors, market, size and value based on the observations that market beta was not able to explain the cross-section of shares in the U.S as they found out that the relationship between market risk and return was flat. They provided some evidence that for small cap stocks, the covariance between returns is higher than it is for large cap stocks. Likewise, the covariance of returns, measured by the book-to-market ratio, is higher for high value stocks than the covariance of returns for stocks with a low book-to-market ratio. Fama and French (1992) therefore extended the CAPM to incorporate the two additional factors, firm's size, and value. The FF3FM therefore comprises the firm's size, firm's value, and the market risk factor as in the CAPM. The regression form of the Fama and French (1993) three-factor model is stated as:

$$R_{it} - R_{ft} = \alpha_i + \beta_{mi} (R_{mt} - R_{ft}) + \beta_{si} SMT_t + \beta_{vi} HML_t + e_t \quad (2)$$

Where: $R_{it} - R_{ft}$ is the measure of a stock's excess return; α_i is Jensen's alpha and is the intercept of the regression model; β_{mi} measures the market beta; $(R_{mt} - R_{ft})$ is the market return minus the risk-free interest rate (the market risk premium); SMB_t is small minus big market capitalisation (proxy for firm size); HML_t is high minus low book-to-market ratios (proxy for value); β_{si} & β_{vi} are factor loadings other than market beta and the beta for momentum; and e_{it} is an error term.

These factors are calculated with combinations of portfolios composed of ranked stocks and historical market data. Moreover, once SMB_t and HML_t are defined, the corresponding coefficient β_{si} and β_{vi} are determined by linear regressions and can take negative values as well as positive values (Fama & French, 1992). Fama and French (1992) argued that portfolios formed based on the ratio of book-value of equity to market value and size earn higher returns than what is predicted by the CAPM. They even found that the *B/M* ratio is more powerful than the size effect in explaining cross-sectional average returns. Moreover, they found that when allowing for variations in beta that are unrelated to size, the relationship between beta and average return is flat. For this reason, they naturally argued that the CAPM is dead. In the FF3FM, beta of the CAPM is still the most important risk factor as it still accounts for 70% of average stock returns. However, the size of the stocks in a portfolio and book-to-market/value of the stocks made significant differences.

2.3.2.1 Size and Book-to-market/value

Fama-French (1992) tested thousands of stock portfolios using their three-factor model and found that a combination of beta, size and value an explanatory power of 90% of a diversified portfolio returns, compared with the average of only 70% given by the CAPM. This means that when analyzing the returns of a diversified stock portfolio against the stock market, 90% of the return could be explained by the portfolio's sensitivity to the market (beta), the size of the stocks in the portfolio (size), and the average weighted book-to-market/value *(BTM)*.

Commencing with the studies of Basu (1977, 1983); Banz (1981) and continuing with Fama and French (1992), these studies first documented what has come to be known as the size effect on US stock data. They showed that stocks with high earnings/price ratios earned significantly higher returns than those with low earnings/price ratios. Furthermore, returns for firms with low *ME* will be found to be significantly higher than firms with large market capitalisations. The natural response to this points to the notion that small firms have higher betas than large firms. According to Kampman (2011), the resultant beta differences will not be significant enough to explain the small-big capitalisation return disparity. In the South African context, studies of Robins, Sandler, and Durand (1999), van Rensburg and Robertson (2003) found that the size effect is minimal when evaluating shares on the JSE, and that the size effect is most pronounced in the smallest shares on the JSE. Other studies by Auret and Sinclaire (2006) and Basiewicz and Auret (2010) that pursued a more robust methodology found that size is a crucial factor on the JSE, even though the factor is still most prevalent in exceedingly small shares.

Rosenberg *et at.* (1985) first documented the book-to-market effect or value effect using US data, and this was later confirmed by Hsia, Fuller and Chen (2000) using Japanese data, Fama and French (1992) using similar US data, and Davis (1994) using international market data. The effect postulates that there exists a positive relationship between a firm's book-to-market ratio and forecasted returns, and a return premium should be given to stocks with higher book-to-market ratios. That is, *BTM* ratio = book value of equity/market value of equity appeared to resonate strongly with expected returns. Fama and French (1992) showed that a cross-sectional regression of book-to-market ratios on realised returns yielded a positive coefficient that was six standard deviations different from zero. Studies by Fama and French (1998) and Hoffman (2012) found that high *BTM* firms outperform low *BTM* firms in the market. One view posited for this effect is that value shares may be undervalued, as investors assume that those shares that have previously performed badly may continue to perform badly, and growth shares are overvalued as their strong past performance causes investors to accept a price of the share that is above a fundamentally true price (Fama & French, 1998). When the overreaction is eventually corrected, the result may be high returns for value shares in developed markets such as the U.S and low returns for growth shares in developing markets such as South African (Basiewicz & Auret, 2010).

2.3.2.2 Empirical tests of the FF3FM

A study by Griffin (2002) showed that the Fama and French factors are country specific and concludes that the local factors therefore provide a better explanation of time-series variation in stock returns than the global factors. Fama and French (2012) also analysed models with local and global risk factors for four developed market regions (North America, Europe, Japan and Asia Pacific) and concluded that local factors work better than global developed factors for regional portfolios.

Other tests of the FF3FM

A study by Hearn and Piesse (2013) addressed the liquidity issue by augmenting the FF3FM to include a priced liquidity factor for both South African and Kenyan markets for the period 1991 – 2007. The liquidity factor in this study was found to significantly improve portfolio return estimation. The study also showed that illiquidity was both a consistent and a priced characteristic in South African and Kenyan markets. While the importance of the size factor was never in doubt in emerging and developed markets, the primary risk part prevalent in emerging markets has been illiquidity (Valery, 2015). A study by Tony-Okeke (2015) supports this finding by showing that a Fama-French liquidity adjusted-four factor model performs significantly better in explaining expected returns. He concluded that the value *(BE/ME)* factor is insignificant on the JSE with large stocks outperforming small stocks and liquid stocks outperforming illiquid ones. A study by Hasan *et al.* (2014) that used data from Bangladesh for the period from 1999 – 2003 and used a sample from non-financial firms listed on the Dhaka stock exchange found that stock returns are determined not only by market beta, but also by other variables such as firm market capitalisation, firm sales, book-to-market value. This study was also supported by a Homsud, Wasunsakul and Phunganark (2009) study that compared the FF3FM and the CAPM in the Thailand stock market, using data for 421 firms and they also found that the FF3FM supply better explanation for stocks and portfolio returns over the CAPM.

An Australian study attributed to Faff (2001) used monthly data for 24 Australian industries over an 8-year period from 1991 – 1999 to investigate the validity of the FF3FM using the Generalised Methods of Moments test (GMM). The study showed that for the sample period used, the GMM test supplies staunch support to the FF3FM. The author also saw a negative relationship between size and portfolios rate of return and showed that the relationship between risk premium and market return and book-to-market equity are positively significant. The Australian study of Faff (2001) concurred with that of Drew, Naughton and Veeraraghavan (2003) that used data from four Asian emerging markets, Hong Kong, Korea, Malaysia and Philippines from 1991 – 1999 to investigate the ability of the FF3FM to explain the variation in average stock returns. Their study found evidence that the FF3FM had superior power in explaining the average stocks return in all four countries.

A study by Ajili (2003) performed a test on the CAPM and FF3FM on the French stock market using data from 1976 – 2001. The results of her study showed that the FF3FFM explains better the common variations in stock returns than the CAPM. In other words, the FF3FM is good in explaining the cross-section of returns. She tested the FF3FM with a set of market portfolios and showed that only the value-weight market portfolio can explain the cross-section in stock returns. Similarly, Gokgoz (2008) tested the CAPM and the FF3FM on the Borsa Istanbul using data for the period 2001 – 2006 and found that the FF3FM applies to the Borsa Istanbul. Chui and Wei (1998) also showed similar evidence in the Pacific-Basin emerging markets (South Korea, Hong Kong, Malaysia, Thailand, Taiwan).

South African tests of the FF3FM

Tests on the ability of the FF3FM to explain average share returns have been conducted in developed and developing markets in studies such as Fama and French (1992), Homsud *et al.* (2009), Kungu (2015), Basiewicz and Auret (2010), Soumaré, Aménounvé, Diop, Méité and N'sougan (2013), and others and they consistently found that the FF3FM was able to explain share returns better than the CAPM. In the South African context, there are a number of empirical studies that have tested the validity of the FF3FM in the South African market and the results of these studies are however mixed (Valery, 2015). Studies by De Villiers, Lowlings, Petit and Affleck-Graves (1986), Bradfield *et al.* (1988), Page and Palmer (1991) and Auret and Cline (2011) found no significant size effect on the JSE. On the other hand, van Rensburg and Robertson (2003) and Strugnel *et al.* (2011) found both a significant size and value effect on the JSE. A study by Auret and Sinclair (2006) tested the FF3FM on the JSE where it applied monthly data for stocks from all sectors of the JSE for the period 1990 – 2000. Their findings matched those of Fama and French (1992) as a significant positive relationship was found between the size factor, *BE/ME* factor, and expected stock returns. Similarly, a study of the FF3FM on the JSE by Basiewicz and Auret (2010) found that the FF3FM is a better predictor of actual share returns than the CAPM. A recurring issue for the successful application of the FF3FM on the JSE is liquidity, and the FF3FM does not perform well in illiquid markets as this may result in biases in estimated returns through the mismeasurement of the risk parameters (Valery, 2015).

2.3.2.3 Problems with the FF3FM

The FF3FM has been criticised for lacking a clear theoretical foundation to identify the risk factors that the model captures. This then raises several questions, including why the size and value factors are proxies for risk, whether these factors apply in the South African context (Oxera, 2006). The FF3FM also lacks clarity on whether the *HML* and *SMB* capture risk or whether these are just persistent mistakes by investors, and the difficulty of practically applying the model itself. A major criticism of the FF3FM is that it cannot explain the momentum effect which is seen in many markets. The FF3FM predicts the reversal of future returns for short-term stocks with high and low returns. Thus, the continuation of short-term returns is left unexplained. Daniel and Titman (1997) supplied another criticism to the FF3FM by arguing that it is not the covariance structure that explains the cross-section of stock returns, but characteristics such as behavioural biases and liquidity. The essence of the criticism lies on the fact that Fama and French (1992) consider size and *BE/ME* as risk factors, while Daniel and Titman (1997) consider them as factors that reflect mispricing errors by investors.

In a survey study conducted by Welch (2008) on 400 finance professors and academics, the findings revealed that only 10% of them recommended using the FF3FM to estimate the equity investors expected rates of return. In another survey study conducted by Truong, Partington and Peat (2008) on 74 Australian firms, none of the respondents indicated that they used the FF3FM to estimate the cost of equity, 28% used a multi-factor asset pricing model, and 72% always used the CAPM. Further survey results of Hasan *et al.* (2017) found that the FF3FM remains unpopular and not widely used by investors, practitioners and academics when compared to the CAPM because it is not cost effective to collect the extra information required for implementing the FF3FM, and that investors, practitioners and academics think that the FF3FM is not always better than the CAPM. Similarly, Faff (2004) and Brounen, de Jong and Koedijk (2004) found that the FF3FM is not widely used in practical applications because it is too complex to implement. Studies by Amihud *et al.* (1993), Kothari *et al.* (1995) and Foster *et al.* (1997) pointed out survivorship bias, and Black (1993) pointed out data choice procedures and data mining as the reasons why the FF3FM is not widely used. It is important to note that the Fama and French (1992) model was developed and tested primarily on US data, majority of which comprised industrially intensive industries, and thus, the resultant conclusions may only be relevant to markets with a set of characteristics.

2.3.3 The Fama and French five-factor model (2015)

Studies by Titman, Wei and Xie (2004), Novy-Marx (2013) and Aharoni *et al.* (2013) investigated the apparent link between profitability and investment with stock returns, and they found evidence of a relationship between gross profitability and investment with average stock returns. A study by Novy-Marx (2013) found that firms with high profitability generate significantly higher returns than unprofitable firms, and another study by Aharoni *et al.* (2013) found that a statistically significant relationship exists between an investment proxy and average returns. A study by Fama and French (2014) found that the three-factor model is an incomplete model for expected returns as the three factors miss much variations in average returns related to profitability and investment. Fama and French (2014) also argued that their three-factor model did not account for these two factors. Another key factor that led to the development of the FF5FM is the dividend discount model that indicate that profitability and investment are also related to average returns (Fama & French, 2006). Despite the success of their three-factor model, Fama and French (2015) then proposed a five-factor model that captures profitability and investment patterns in stocks in the wake of evidence found by Titman *et al.* (2004), Novy-Marx (2013), Aharoni *et al.* (2013) into the three-factor model. The study of Fama and French (2015) used *operating profitability (OP)* as a measure of a firm's profitability and the change in total assets as a measure of *investment (Inv)*. The profitability factor is measured as the return of a well-diversified portfolio of stocks with high operating profitability minus the return of low operating profitability and is called *RMW (robust minus weak)*. Similarly, the investment factor is measured as a low-investment portfolio minus a high-investment portfolio and is called the *CMA (conservative minus aggressive)*. When the profitability and investment factors are included into the FF3FM, the regression form of the Fama and French (2015) five-factor model is stated as:

$$R_{it} - R_{ft} = \alpha_i + \beta_{mi}\left(R_{mt} - R_{ft}\right) + \beta_{si}SMB_t + \beta_{vi}HML_t + \beta_{rmwi}RMW_t + \beta_{cmai}CMA_t + e_{it} \qquad (3)$$

Where: $R_{it} - R_{ft}$ is the measure of a stock's excess return; α_i is Jensen's alpha and is the intercept of the regression model; β_{mi} measures the market beta; $\left(R_{mt} - R_{ft}\right)$ is market return minus the risk-free interest rate (the market risk premium); SMB_t is small minus big market capitalisation (proxy for firm size); HML_t is high minus low book-to-market ratios (proxy for value; β_{si} & β_{vi} are factor loadings other than market beta and the beta for momentum; e_{it} is an error term; RMT_{it} are diversified portfolios of stocks with robust and weak profitability (proxy for profitability); and CMA_{it} is the difference between the returns on diversified portfolios of the stocks of low and high investment firms (proxy for investment).

Profitability factor *(RMW)*

There is evidence produced by Novy-Marx (2013) that showed that profitability plays a significant role when it comes to forecasting a stock's expected return. Several other researchers, among which are Fama and French (2006), and Nichol and Dowling (2014) have established that book-to-market and profitability are related negatively and thus work well as predictors of mean returns. A firm is said to be profitable when its earnings exceed its expenses, and thus, it has been established that profitable firms on average generate higher expected returns and tend to grow rapidly than unprofitable firms (Fama & French, 2006). Profitability factor is defined as the difference between average stock returns of the robust and weak portfolio.

Investment factor *(CMA)*

FF5FM measures investment as a change in total assets (Fama & French, 2015b), and as previously investigated by Fama and French (2006), the investment factor remains small and insignificant. However, when it is measured at the firm level, Aharoni *et al.* (2013) found that profitability when measured as income before extraordinary total assets, and *B/M* ratio are all significantly correlated to returns. The investment factor is the difference between average stock returns of the conservative and aggressive portfolio.

The FF5FM can explain between 71% and 94% of expected returns' volatility for the portfolios they examined (Fama & French, 2015a). While the FF5FM does not perform well at the global level, it does so at a country level (Cakici, 2015). The Fama and French (2015) model has been tested in several markets by many researchers such as Martins and Eid Jr. (2016) who tested the FF5FM from 2000 – 2012 for Brazil; Nguyen, Ulku and Zhang (2015) tested the FF5FM from 2008 – 2015 for Vietnam; Abbas, Khan, Aziz and Sumrani (2014) tested the FF5FM from 2004 – 2014 for Pakistan; Chiah, Chai, Zhong and Li (2016), and Heaney, Koh and Lan (2016) tested the FF5FM from 1982 – 2013 and 1993 – 2015 for Australia respectively; Acaravci and Karaomer (2017) tested the FF5FM from 2005 – 2016 for Turkey in the field of finance and academia. According to the results of the analysis of these tests, it was found that the FF5FM performed better than the CAPM and FF3FM in explaining average stock returns in these markets. This study could also add to research already conducted by Mahlophe (2015) and Mosoeu and Kadongo (2019) on the FF5FM by testing its performance and applicability on the South African market.

2.3.3.1 Five concerns with the FF5FM

Fama and French (2015) proposed to augment their classic Fama and French (1992) model with profitability and investment factors, resulting in a five-factor model that is likely to become the new standard in asset pricing studies. Although the FF5FM exhibits significantly improved explanatory power, a study by Blitz *et al*. (2018) found that it may still not address certain important questions left unanswered by FF3FM and this may raise a few concerns. The study of Blitz *et al.* (2018) raised five concerns with the FF5FM. The first concern is that the FF5FM maintains the CAPM relation between market beta and return despite mounting evidence that the empirical relation is flat, or even negative. The second concern is that the FF5FM continues to ignore the widely accepted momentum effect in favour of profitability. Because momentum is too important to ignore, most studies use the three-factor model and augment it with the momentum factor to create four-factor alphas. In their own defence, Fama and French (2015) argued that profitability is a sign of future dividend payments which results in the share price being equated to the present value of those future payments. The third concern is that there are a few robustness concerns about the new factors. It is still unclear whether profitability and investment were effective before 1993 or clear in other asset classes, while for other factors such as value and momentum, this is known to be the case. The fourth concern is, while risk-based explanations were key for justifying the factors in the FF3FM, the economic rationale for the two factors is much less clear. Their rationale for including profitability and investment factors is that they should imply expected returns. But it is still unclear if the higher expected returns for firms with high profitability or low investment are due to higher risk or just a case of mispricing. The fifth and final concern of the FF5FM is that it does not seem as if this five-factor model is going to settle the asset pricing debate or lead to consensus.

2.3.3.2 Empirical tests of the FF5FM

When Fama and French (2015, 2016) tested the FF5FM using US data and other international data, they found evidence that supports that their five-factor model performs better than both the CAPM and FF3FM in explaining the returns of *Size-B/M, Size-OP and Size-Inv* on sorted portfolios. The five-factor model has subsequently been tested by many researchers such as Nguyen *et al.* (2015), Abbas *et al.* (2014), Sundqvist (2017), Erdinc (2018), and others in the field of finance, and the results of these studies suggest that the performance and applicability of the FF5FM may be country specific.

International tests of the FF5FM: Fama and French (2015)

Fama and French (2015) tested the five-factor asset pricing model that added profitability and investment factors to the market, size, and value-growth factors of the FF3FM motivated by the dividend discount model. Their study focused on four international markets, more specifically, the four regions of North America, Europe, Japan, and Asia Pacific where average stock returns increased with the book-to-market ratio *(B/M)* and profitability and which are negatively related to investment. The relation between average returns and *B/M* was found to be strong and positive for the Japanese region, but average returns showed little relation to profitability or investment. The study of Fama and French (2015) found that a five-factor model that adds profitability and investment factors to the FF3FM absorbs the patterns in average returns. In addition, Fama and French (2015, 2016) also found that the main problem of FF3FM is its failure to capture fully the low average returns of small stocks whose returns behave like those of low profitability firms that invest aggressively.

Other tests of the FF5FM

Nguyen *et al*. (2015) tested the FF5FM with a sample period from September 2008 – July 2015 for the Vietnamese stock market and found that it performs best in relation to explaining average returns of three sets of nine portfolios sorted B/M, profitability, and investment. This study found that the FF5FM is well suited for the Vietnamese stock market. The empirical results of the study were consistent with the findings of a study by Erdinc (2018) who tested the FF5FM with a sample from June 2000 – May 2007 for the Turkish stock market and the findings of his study were that both the CAPM and FF3FM cannot properly explain cross-sectional variations in portfolio returns. The study found that the FF5FM is best suited for the Turkish stock market.

A study by Huynh (2017) compared the ability of the FF3FM and FF5FM to explain the clear profitability of a broad choice of anomalies in Australia stock returns. Huynh (2017) focused his study on the spread return to long-short trading strategies designed around anomalies. The number of anomalies that remained after the risk adjustment decreases under the FF5FM. Furthermore, with the size of reduction in alpha being modest, testing showed that it is statistically significant in many cases. Unfortunately, both the FF3FM and FF5FM repeatedly failed the Gibbons, Ross, and Shaken (1989) (GRS) test, and this failure suggested that the quest for a better asset pricing model is not complete. The findings of Huynh (2017) were contradicted in a study by Djamaluddin *et al.* (2017) which empirically tested the FF5FM for the Indonesian stock exchange using data for the period 2011 – 2015. This study was to supply evidence that would contribute to the effort to explain that the FF5FM could be used to predict stock returns that may occur in the future. The resultant findings gave a better estimation of predicting stock returns compared with the CAPM and FF3FM.

A study by Erdinc (2018) tested three asset pricing models for the Turkish stock market, that is, the CAPM, FF3FM, and FF5FM for the sample period June 2000 – May 2017. The results showed that the FF5FM explains better the common variation in stock returns than the FF3FM and CAPM. Additionally, the CAPM has no power in explaining monthly excess returns for sorted portfolios. Although the FF3FM appears to have significant coefficients, intercepts in this model have significant t-values which may show that the model has problems in explaining the portfolio returns. This study made use of equal weight market portfolios for all the models to explain the cross-sectional variations in the average stock returns. These findings were supported in another study by Acaravci and Karaomer (2017) who tested the FF5FM in the Borsa Istanbul (BIST) during the 132 months' period July 2000 – June 2016. The excess returns on 14 different intersection portfolios showed results that had no errors according to the results of Gibbons *et al.* (1989) (GRS) test of FF5FM. Hence, the FF5FM appears to be valid in the BIST. Additionally, the FF5FM appears to explain variations on excess portfolio returns.

South African tests of the FF5FM

In the context of the South African market, there are very few studies on the FF5FM, one of those is by Mahlophe (2015), Cox and Britten (2019) and Mosoeu and Kadongo (2019) amongst others. The study by Mahlophe (2015) was aimed at testing the effect of selected market anomalies on expected returns in different sectors of the JSE. More specifically, his study aimed to compare the performance of different asset-pricing models and their ability to account for market anomalies in different sectors of the JSE. Additionally, his study also tested the applicability of the FF5FM in estimating the expected return on the JSE. His study concluded that the FF5FM is applicable on the JSE, however, it is inconclusive on whether four or five factors apply to the South African market. On the other hand, a study by Cox and Britten aimed to evaluate the FF5FM on the JSE using a different database to that of Charteris, Rwishema and Chidede (2018). Additionally, their study sought to determine whether effects such as size and value were still present on the JSE when profitability and investment were added. Their study concluded that the added factors contributed to explaining returns on the JSE, however, the addition of the profitability factor was an improvement on the JSE since it was a more reliable factor than the investment factor. Another study by Mosoeu and Kadongo (2019) tested the adequacy of the FF5FM in explaining average stock returns for emerging and selected developed equity markets. Their study found that the performance of the FF5FM depended on the market upon which it is being tested. This study aimed to test the performance of the FF5FM and find out if it performs better than the CAPM and FF3FM when estimating expected future stock returns on the JSE. Specifically, this study tested the FF5FM against the CAPM and the FF3FM with 193 different market portfolios to determine which model explains better the common variation and the cross-section of expected future stock returns. Therefore, the above studies left a research gap which this study sought to address.

2.3.3.3 Country specific differences of the FF5FM

The FF5FM was initially examined using data from the US (Fama & French, 2015a), however later tests and evaluations have been conducted in various countries around the world. A study by Cakici (2015) examined the FF5FM and found compelling evidence in support of the FF5FM in North America, Europe, and other developed markets. The results of his study showed that profitability and investment factors are weaker in Japan and the Asia Pacific markets. Another study by Acaravci and Karaomer (2017) examined the FF5FM on the Turkish stock market from 2005 to 2016 and found that there was no pricing error according to Gibbons *et al.* (1989) GRS-F test of FF5FM. Therefore, it was consequentially found that the FF5FM is valid in the Turkish BIST. And additionally, the FF5FM has the power to explain variations on excess portfolio returns. A further study by Guo *et al*. (2017) examined the FF5FM on the Chinese stock market for period 1995 to 2015 and found strong size, value, and profitability patterns in average returns of the Chinese bourse. Additionally, the investment factor CMA was found to be redundant for the Chinese stock market. Finally, a study by Foye (2018) evaluated the FF5FM by using a widespread sample of 18 countries from three different regions, Eastern Europe, Latin America, and Asia, and discovered that it consistently outperformed the FF3FM in the Eastern European and Latin American regions by producing reduced intercepts and GRS statistics. However, for the Asian factors, the FF5FM did not supply a better description of equity returns in the region.

It is clearly self-evident from the above discussion and analysis that the FF5FM is useful for different countries, but its application is country specific. Therefore, any information acquired in the application of the FF5FM in one country cannot be summarily applied in another country. Furthermore, each country will need to be evaluated and analysed individually. It is for this reason that information that is acquired in one country, such as in the British stock market (LSE), will not necessarily be applicable in another country such as in the South African stock market (JSE).

2.3.3.4 Hypotheses of the study

- H1 = The FF5FM model offers a better estimation of expected future stock returns on the JSE compared to the CAPM and FF3FM.
- H2 = The value factor becomes redundant in explaining expected stock returns with the addition of profitability and investment factors to the FF5FM on the JSE.

2.4 Summary

The focus of this chapter was to bring forth the literature review and arguments for the three main asset pricing models from a single-factor model into a multi-factor model that is used to estimate expected stock returns. The JSE was briefly reviewed in this chapter as well. The development of the MPT led to the subsequent development of the famous CAPM, which is a single risk factor model. However, it was found that the single-risk factor model had shortcomings which missed much of the variations in stock returns. The resultant shortcomings of the CAPM led to the development of the FF3FM. The FF3FM has been criticised for lacking theoretical foundation and furthermore, it was proven that the factors incorporated in the model missed variations captured by profitability and investment. This led Fama and French to develop the FF5FM model. This study aims to test the performance of the FF5FM model against the CAPM and FF3FM, and to find out whether it is applicable on the JSE. The research gap in this study led to the development of the hypothesis of the current study. Thus, the current study also expands on the body of literature. Chapter Three presents the research methodology of the study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The CAPM, FF3FM, and FF5FM are asset pricing models developed to estimate expected share returns. This study was aimed at finding out an asset pricing model that best describes expected share returns of the JSE-listed firms. Chapter Three begins by developing and explaining the quantitative research paradigm of the study. It then proceeds to describe the research design and approach adopted in the study. This is followed by a detailed discussion of the population and sample of the study. The chapter then presents a discussion on the data collection and analysis methods used in the study. This discussion includes the specification of the regression models that were used in the study. The definition of variables and construction of variables are introduced later on in the chapter. The construction of the Fama-French factors and portfolio sorts is introduced and discussed in detail in Chapter Three. Chapter Three ends with a brief discussion of possible statistical errors tests and an outline of the ethical considerations of the study.

3.2 Research paradigm

According to Hall and Kuhn (1963), a research paradigm is a set of common beliefs and agreements shared between scientists or researchers about how problems should be understood and addressed. Studies by Guba and Lincoln (2005) and Antwi and Hamza (2015) emphasized that most of the scientific or quantitative research use positivism approach to research while qualitative research use interpretivism approach as research frameworks. After an in-depth analysis of what constitutes this study's research paradigm, the study concluded that this study would be quantitative in design and follow a descriptive format that employs positivism as a conceptual framework. This type of research paradigm is more suitable for this study because it is widely used in economics and finance and involves a systematic empirical investigation of observable phenomena via experiments, surveys, testing, and structured content analysis.

3.3 Research design and approach

Research design is the strategy which is used to collect subjects or, data and use this to test the hypothesis of the study (Welman, Kruger & Mitchell, 2004). Antwi and Hamza (2015) describe a quantitative study as a study design that is specific, well structured, has been tested for validity and reliability, and can be explicitly defined and recognized. A study by Fox and Bayat (2007) further stated that quantitative research is categorized into three common approaches, namely: historical, descriptive, and experimental research. The purpose of a quantitative research is to describe phenomena and explore the relationship between variables, thereby collecting data without introducing any alterations or introducing any new treatment to the historical data (De Vos, Strydom, Fouche & Delport (2011).

A quantitative research method was suitable for this study because the researcher's role was limited to data collection, analysis and interpretation through an objective perspective which is supported in studies by Collins (2010) and Quinlan, Babin, Carr, Griffin and Zikmund (2015). Quantitative research design uses structured tools to generate numerical data and uses both descriptive and inferential statistics to interpret, organize and represent the collected data (Sekaran & Bougie, 2016). This type of research design was deemed suitable for this study because it is widely used in finance and economics and involves a systematic empirical investigation of observable phenomena via experiments, surveys, testing, and structured content analysis. The results are derived using statistical or mathematical techniques obtained over multiple time periods for the same firms.

The research approach applied in this study is similar to that used in the extant literature of Fama and French (1993, 2015) that examined the relationship between firm characteristics and the cross-section of stock returns. The constructed factors are based on the annual balance sheet and income statement data of a firm and the ensuing monthly factor returns computed using monthly data. From July each year portfolios and factors were formed based on the year end data for the period ending December from the preceding year. To mitigate survivorship bias, delisted firms were included up to the date they were delisted. Furthermore, shares that had a share price of 50c and lower were excluded from the analysed due to the large returns from these small-cap shares owing to small price movements distorting the results.

3.3.1 Population of the study

A population is defined as a study object which comprises of individuals, organizations, or events from which a sample is drawn (Welman *et al.* 2004). The population for this study consisted of all firms that are continuously listed on the JSE for the period July 2003 – June 2019, in this case all 371 firms that are listed on the JSE. The JSE consists of nine sectors which are made up of five large sectors in terms of market capitalization, namely: Basic Resources, Industrials, Consumer Goods, Consumer Services, and the Financial sector. Additionally, four smaller sectors in terms of market capitalization, namely: Oil and Gas, Telecommunications, Healthcare, and Technology make up the rest of the sectors, but they have insufficient number of firms and were combined into a single sector. For this study, this sector is described as "Additional". A population numbering 375 firms on the JSE was analysed across these nine sectors.

The Basic Resources sector consists of firms that trade in forestry and paper, industrial metals and mining, and chemicals. The Industrial Sector comprises firms that are in the construction, building materials and support services, industrial engineering, and industrial transportation environment. The Consumer Goods sector consists of firms that trade in food production, beverages, and automobiles. The Consumer Services sector consists of firms that trade in food and drug retailers, media firms, and travel and leisure firms. The Financial sector consists of firms dealing in banking, life insurance, non-life insurance, real estate, investments, and equity investments. The "Additional" sector consists of different sectors such as Oil and Gas, Telecommunications, Healthcare, and Technology.

3.3.2 Sample of the study

Sampling involves the selection of research participants from an entire population and is performed in various formats according to the type of the study selected (Blanche, Durheim & Painter, 2014). Sampling may also be defined as a process of selecting individuals in a study in a manner that is representative of the observed population (Blanche *et al.* 2014). It was further argued by Wimmer and Dominick (2014) that a sample that is not representative of the population, regardless of its size, is inadequate for testing purposes. In sampling, only a few items from the entire population are selected and the selected item is called a sample. Sampling methods are generally classified into probability sampling – random sampling and non-probability sampling – non-random (Quinlan *et al.* 2015). The sample period used for this study consists of 16 years' worth of data starting from July 2003 – June 2019.

This study used a probability sampling (random sampling) method that consists of firms that were continuously listed on the JSE for the study period under observation, and such firms also had complete financial data for the study period under observation. Firms must have been listed for a minimum of three years for them to be included in the study sample. Therefore, a total of 165

ALSI firms were listed on the JSE, comprising of the Top 40, Mid Cap and Small Cap indices. After considering all the necessary adjustments, the total sample size of the study comprised 165 ALSI firms on the JSE based on market capitalization. Firms must have been listed for at least three years to be included in the study sample.

3.3.3 Data collection

The data for the study period 2003 to 2019 was collected from three different database sources, CEIC (CEICdata.com, 2019) supplemented by IRESS (IRESS, 2018) and JSE (Listed companies – JSE, 2019). The collected data was used to construct a panel dataset. The factors were constructed based on yearly data, while the monthly factor returns were calculated using monthly data. Monthly share price data and annualized dividend yields were collected for each stock while the accounting data was obtained annually. The collected annual accounting data included total assets, total liabilities, outstanding shares, owner's equity, operating income, and operating expenses. The collected monetary data was quoted in the South African Rand currency (R). This study used cross-sectional secondary data from listed firms on the JSE and the data consisted of annual variable data obtained from CEIC, IRESS and the JSE. The study excluded financial and non-financial data of listed firms with missing data or those with less than three consecutive annual observations. Sampled stocks listed on the JSE at any point during the period under observation were included in the sample to avoid survivorship bias which might arise if only those stocks that remained listed throughout the period were examined. The data from the JSE was accessed for share information, and a firm's financial information was obtained from IRESS.

The JSE is among the world's largest stock markets in terms of market capitalization and value of stocks traded (in US dollars), it is in the top twenty on both measures (WFE, 2019). The JSE is dominated by many small stocks which are infrequently traded. This gives rise to inaccurate beta estimates because the stock prices have not adjusted to reflect all available information (van Rensburg & Robertson, 2003; Drew, Naughton & Veeraraghavan, 2004). As such, studies of the South African market typically adjust for illiquidity by excluding infrequently traded stocks (van Rensburg & Robertson, 2003). This study addressed the liquidity issue by drawing inspiration from Pástor-Stambaugh (2003) and Valery (2015) and that augmented the FF5FM to include a priced liquidity factor and employed the use of the Top 40 Index as a proxy for the market.

3.3.4 Data analysis

Data analysis is the process of systematically searching, arranging, organizing, breaking the data into manageable units, synthesizing, and searching for patterns. The collected secondary data was collated, tabulated, and analyzed. Data was analyzed using STATA software since it is an econometric software that can handle panel data. This study used panel data or cross-sectional data for analysis with total observations of 31 680 (165 firms x 16 years x 12 months) and various sectors of the JSE were selected for this cross-sectional data analysis.

3.3.5 Regression models

This study tested the performance of the CAPM, FF3FM and FF5FM in the estimation of share returns on the JSE.

The regression model of the CAPM is stated as:

$$r_a = r_f + \beta_a(r_m - r_f) \quad (4)$$

Where: r_f is the rate of return for a risk-free security; r_m is the broad market's expected rate of return; and β_a is the beta of the asset;

The regression form of the Fama and French (1993) three-factor model is stated as:

$$R_{it} - R_{ft} = \alpha_i + \beta_{mi}\,(R_{mt} - R_{ft}) + \beta_{si}SMT_t + \beta_{vi}HML_t + e_t \quad (5)$$

Where: $R_{it} - R_{ft}$ is the measure of a stock's excess return; α_i is Jensen's alpha and is the intercept of the regression model; β_{mi} measures the market beta; $(R_{mt} - R_{ft})$ is the market return minus the risk-free interest rate (the market risk premium); SMB_t is small minus big market capitalisation (proxy for firm size); HML_t is the high minus low book-to-market ratios (proxy for value); β_{si} & β_{vi} is the factor loadings other than market beta and the beta for momentum; and e_{it} is the error term;

The regression form of the Fama and French (2015) five-factor model is stated as:

$$R_{it} - R_{ft} = \alpha_i + \beta_{mi}\left(R_{mt} - R_{ft}\right) + \beta_{si}SMB_t + \beta_{vi}HML_t + \beta_{rmwi}RMW_t + \beta_{cmai}CMA_t + e_{it} \quad (6)$$

Where: RMW_{it} are diversified portfolios of stocks with robust and weak profitability (proxy for profitability); and CMA_{it} is the difference between the returns on diversified portfolios of the stocks of low and high investment firms (proxy for investment).

Individual linear regressions produced information for testing and evaluating the performance of how good each model claims to be: the alpha (the model's intercept), the *t*-statistics for each term, and the R^2 (how much of the variation in the dependent variable was explained by the whole model). Within this framework, a time history of linear regression results was tested and presented numerically with descriptive statistics (Racicot & Rentz, 2016).

3.3.6 Definition of variables and portfolio sorts

Historical data was used in evaluating whether a consistent relationship exists between variation in the independent variables and variation in the dependent variables.

Fama and French (1993, 2015) define *Market Equity (ME)* as the valuation of the current market price of a share of common stock versus an indicator of the firm's ability to generate profits from assets held by the firm. For this study, *ME* is a firm's month end closing share price multiplied by the number of outstanding shares. It is computed every month end as it is used for value weighted return calculations and the calculation of the *BE/ME* ratio.

Following Fama and French (1993, 2015), *Book Equity (BE)* is defined as book value of common equity, plus deferred taxes, and investment tax credit. It is similar to Fama and French (1993, 2015) studies, where they have the book equity calculated as stockholders' equity, plus deferred taxes and investment credit, minus book value of preferred stock. The variables used to calculate *BE* and all other accounting data used in this study is collected on an annual basis at the end of every fiscal year of the corresponding firm.

Commencing with Basu (1977, 1983), Banz (1981) and later on Fama and French (1993, 2015), *Size* is defined as stocks with a lower market value (mid- and small-caps) that realise higher returns than those with a higher market value or capitalization (large-caps). In this study, *Size* is used to form portfolios in June of year *t* according to the size of the market capitalisation of the involved firms. Therefore, the end of June value of *ME* for year *t* is used as a measure of size of a firm.

Book-to-Market Ratio (BE/ME) is the book value of common equity, plus deferred taxes, and investment tax credit (Fama & French, 1993, 2015). It is calculated as the book value of ordinary equity, divided by the market value of the total ordinary share capital of a firm. For this study, *BE/ME* value for July of year *t* is calculated as *BE* for the fiscal year ending in June year *t* – 1, divided by *ME* at end of June of year *t* – 2.

Commencing with Fama and French (1992, 2015) and later on Novy-Marx (2013), *Operating Profitability (OP)* is defined as the difference between the returns of a diversified stock portfolio with robust profits and a weaker, similar portfolio with lower profitability or the return-on-equity given a stock's market capitalization. It is measured by revenues minus cost of goods sold, minus selling, general, and administrative expenses, minus interest expense all divided by book equity. For this study, the *OP* for June of year *t* is measured as operating income after depreciation minus interest expenses and then divided by *BE*, all from the last fiscal year end in *t* – 1.

Following Fama and French (2015), *Investment (INV)* is defined as the change in total assets annually. For this study, the *INV* of June of year *t* is measured as change in total assets from the end of fiscal year *t* – 2 to the end of fiscal year *t* – 1, divided by total assets at the end of fiscal year *t* – 2. Additionally, Novy-Marx (2013) argued against using measures which may hold expensed investments.

$$INV = \frac{total\ assets_{\ t-1} - total\ assets_{\ t-2}}{total_{\ t-2}} \tag{7}$$

Following Fama and French (2015), portfolio sorts are defined thus, SA is defined as the small and aggressive portfolio stock used to construct factors; SC is defined as the small and conservative portfolio stock used to construct factors; SH is defined as the small and high portfolio stock used to construct factors; SN is defined as the small and neutral portfolio stock used to construct factors; SL is defined as the small and low portfolio stock used to construct factors; SR is defined as the small and robust portfolio stock used to construct factors; BA is defined as the big and aggressive portfolio stock used to construct factors; BC is defined as the big and conservative portfolio stock used to construct factors; BH is defined as the big and high portfolio stock used to construct factors; BL is defined as the big and low portfolio stock used to construct factors; and BR is defined as the big and robust portfolio stock used to construct factors.

3.3.7 Construction of the Fama-French factors and portfolios

3.3.7.1 Fama-French factors

The factors of this study were constructed and calculated based on the approach used by Fama and French (2015). *MKT* (the market factor), $R_m - R_f$, is calculated as a value weighted monthly return of all stocks minus the South African Treasury Bill rate with a maturity of one month. As a supplement to *MKT*, the FF3FM needs size and value factors (*SMB* and *HML*, respectively). At the end of June, year *t* is the period that factor breakpoints are formed for the JSE. The sample is individually sorted on market capitalization and *B/M*. Sorting on market capitalization, big stocks (B) are categorized as those comprising 90% of the JSE's entire market capitalization at the end of year *t – 1*.

The lowest 10% of the JSE's entire market capitalization are then categorized as small stock (S). Nonetheless, sorting on *B/M*, three-value groups are created: High (H), Neutral (N), and Low (L) using the top 30th and bottom 70th percentiles of *B/M* of the big stocks as breakpoints. Six interconnecting portfolios are created using the size and *B/M* portfolios: SH, SN, SL, BH, BN and BL. The *SMB* and *HML* factors are created from 2 x 3 sorts of these portfolios. The SMB_v was calculated as [(SH + SN + SL)/3 – (BH + BN + BL)/3] and *HML* was calculated as [(SH + BH)/2 – (SL + BL)/2].

The FF5FM augments the FF3FM with profitability and investment (*RMW* and *CMA*, respectively). *RMW* and *CMA* factors are calculated in an equivalent manner to *HML* with the exception that the second sort used *OP* or *Inv*, rather than *BM*. The *RMW* factor was created by sorting on *OP*, where the following three profitability groups were created: Robust (R), Neutral (N), and Weak (W) using the top 30th and bottom 70th percentiles of *OP* of the big stocks as breakpoints. Six interconnecting portfolios were formed using this size and *OP* portfolios: SR, SN, SW, BR, BN, and BW. The *RMW* factor was calculated as [(SR + SN + SW)/3 – (BR + BN + BW)/3]. In an equivalent manner, the *CMA* factor was calculated by sorting *Inv* of the big stocks as breakpoints. Six interconnecting portfolios were created by using this size and *Inv* portfolios: SC, SN, SA, BC, BN and BA. The *CMA* factor was calculated as [(SC + BC)/2 – (SA + BA)/2]. Equally, the process of calculating the *RMW* factor is similar to that of the *CMA* factor, it also creates another size factor, SMB_i which was calculated as [(SC + SN + SA)/3 – (BC + BN +

BA)/3]. The dual-sorting method applied to shape the factors created three size factors (SMB_v, SMB_p, SMB_i). Following Fama and French (2015), the size factor applied in the asset pricing tests was calculated as an average of these three: [SMB = ($SMB_v + SMB_p + SMB_i$)/3].

Therefore, following the lead of Fama and French (2015), factors for this study were constructed in the following manner: All the shares were sorted according to their market cap to define small-sized and big-sized shares. Fifty percent of the market cap was used as the break point for *Size*. For all other factors, yearly sample 30th and 70th percentiles were used as breakpoints in the sorting method. After the determination of the breakpoints, the shares in the sample were independently distributed for every year into six *Size-B/M* (where *B/M* is book-to-market ratio) portfolios, six *Size-OP* (where *OP* is operational profits divided by book equity showing profitability) portfolios and six *Size-Inv* (where *Inv* is yearly increase in total assets) portfolios created from the intersections of the yearly breakpoints. All portfolios were value-weighted according to their market cap. Monthly returns were calculated for each of the 18 portfolios. After calculating the sorted portfolio returns, the actual factor returns were calculated (**Table 1**).

Table 1: Construction of the size, value, profitability, and investment factors

Table 1 shows the construction of the size, value, profitability, and investment factors based on the Fama and French (2015) approach for 165 JSE-listed firms for the period 2013 – 2019, 192 months. Independent sorts are used to allocate shares to two *Size* groups and three *OP*, and *Inv* groups. For FF3FM, a total of six value weighted portfolios are created based on the connections of each 2x3 factor sort. In each 2x3 sort, the first sort is based on *Size*, small (S) or big (B). the second sort describes the *B/M* group, high (H), medium (M), or low (L), the profitability (*OP*) group, robust (R), average (A), or weak (W), the investment group, conservative (C), moderate (M), or aggressive (A). for the FF5FM, 16 value weighted portfolios are formed based on the connections of each 2x2x2x2 factor sorts. Each factor is sorted into two groups: two *Size* groups, two *B/M* groups, two *OP* groups and two *Inv* groups. In each 2x2x2x2 sort, the first sort is *Size*, followed by *B/M*, *OP*, and finally, *Inv*. The factors are *SMB* (*Small-Minus-Big*), *HML* (*High-Minus-Low B/M*), *RMW* (*Robust-Minus-Weak OP*), and *CMA* (*Conservative-Minus-Aggressive Investment*). SMB_v signifies the *Size/Value* sorts, SMB_p signifies the *Size/OP* sorts, and SMB_i signifies the *Size/Investment* sorts.

Sorts	Breakpoints	Factors
Size and *Value*: 2x3 sorts on *Size* and *B/M*	*Size*: JSE median split	SMB_v = (S/H + S/M + S/L)/3 – (B/H + B/M + B/L)/3 *HML* = (S/H + B/H) / 2 – (S/L + S/L)/2
Size and *Profitability*: 2x3 sorts on *Size* and *OP*	*B/M* = 30th, and 70th percentile JSE split	SMB_p = (S/R + S/A + S/W)/3 – (B/R + B/A + B/W)/3 *RMW* = (S/R + B/R)/2 – (S/W + B/W)/2
Size and *Investment*: 2x3 sorts on *Size* and *Investment*	*OP* = 30th, and 70th percentile JSE split *Inv* = 30th, and 70th percentile JSE split	*SMB* = (S/C + S/M + S/A)/3 – (B/C + B/M + B/A)/3 *CMA* = (S/C + B/C)/2 – (S/A + B/A)/2
FF5FM sorts: 2x2x2x2 sorts on *Size*, *B/M*, *OP*, and *Inv*	*Size*: JSE median split	*SMB* = (S/H/R/C + S/H/R/A + S/H/W/C + S/H/W/A + S/L/R/C + S/L/R/A + S/L/W/C + S/L/W/A)/8 – (B/H/R/C + B/H/R/A + B/H/W/C + B/H/W/A + B/L/R/C + B/L/R/A + B/L/W/C + B/L/W/A)/8
	B/M: JSE median split	*HML* = (S/H/R/C + S/H/R/A + S/H/W/C + S/H/W/A + B/H/R/C + B/H/R/A + B/H/W/C + B/H/W/A)/8 – (S/L/R/C + S/L/R/A + S/L/W/C + S/L/W/A + B/L/R/C + B/L/R/A + B/L/W/C + B/L/W/A)8
	OP: JSE median split	*RMW* = (S/H/R/C + S/H/R/A + S/L/R/C + S/L/R/A + B/H/R/C + B/H/R/A + B/L/R/C + B/L/R/A)/8 – (S/H/W/C + S/H/W/A + S/L/W/C + S/L/W/A + B/H/W/C + B/H/W/A + B/L/W/C + B/L/W/A)/8
	Inv: JSE median split	*CMA* = (S/H/R/C + S/H/W/C + S/L/R/C + S/L/W/C + B/H/R/C + B/H/W/C + B/L/R/C + B/L/W/C)/8 – (S/H/R/A + S/H/W/A + S/L/R/A + S/L/W/A + B/H/R/A + B/H/W/A + B/L/R/A + B/L/W/A)/8

Table 2 presents the sorted portfolio groups that constructed the Fama-French factors. There are two size groups and three book-to-market *(B/M)*, three operating profitability *(OP)* and three investment *(Inv)* groups. The resulting groups are labelled with two letters. The first letter describes the group size, small (S) or big (B). The second letter describes the *B/M* group, high (H), neutral (N) or low (L); the *OP* group, robust (R), neutral (N) or weak (W); the *Inv* group, conservative (C), neutral (N) or aggressive (A). Stocks in each part are value-weighted to calculate the component's monthly returns and for model comparison (see **Table 17)**.

Table 2: Sorted portfolio groups to construct Fama-French factors

Table 2 shows the sorted portfolio groups that are used to construct the Fama-French factors based on the Fama and French (2015) approach for 165 JSE-listed firms for the period 2013 – 2019, 192 months. The stocks in each part are value-weighted so that they are calculated monthly and for model comparison. Each factor was sorted into the following groups; two *size* groups, three *B/M*, three *OP* and three *Inv* groups. The first letters describe the group *size*, small (S) or big (B), and the second letters describe the *B/M* group as high (H), neutral (N), and low (L). The *OP* group was described as robust (R), neutral (N) or and (W), and the *Inv* group was described as conservative (C), neutral (N) and aggressive (A).

Portfolio construction to determine Fama-French factors		
SMALL	Book-to-market *(B/M)*	High (SH) Neutral (SN) Low (SL)
	Profitability *(OP)*	Robust (SR) Neutral (SN) Weak (SW)
	Investment *(Inv)*	Conservative (SC) Neutral (SN) Aggressive (SA)
BIG		
	Book-to-market *(B/M)*	High (BH) Neutral (BN) Low (BL)
	Profitability *(OP)*	Robust (BR) Neutral (BN) Weak (BW)
	Investment *(Inv)*	Conservative (BC) Neutral (BN) Aggressive (BA)

3.3.7.2 Fama-French portfolio sorts

The portfolio sorts of this study are constructed based on the Fama and French (2015) approach which used the 5x5 and 2x4x4 sorts to evaluate the FF5FM, and following that literature, the asset pricing tests of this study were conducted on double-sorted (3x3; 3x4) and triple-sorted (2x2x3) portfolios because of the smaller investment world of the JSE. Similar to the approach applied to construct the factors, the test portfolios were also created at the 1st of July of every year *t*. Financial and non-financial firms are used in the creation of the test portfolios. Share returns on the test portfolios were calculated as monthly surplus returns from the 1st of July year *t* to the end of June year *t – 1*. The rebalancing of the test portfolios is performed end of June each year. **Table 3** presents sorts based on size and value, and then either profitability or investment, respectively and it then also showed sorts based firstly on size, then on either investment or profitability and then on profitability or investment respectively. In line with Fama and French (2012), the four *Size* breakpoints for the JSE are the 50th; 30th; and 70th percentiles of the JSE's aggregate market capitalisation. The *B/M*, *OP*, and *Inv* three breakpoints were calculated using the 30th, 70th; 30th, 70th; and 30th, 70th percentiles respectively of the JSE's big shares. The JSE's median market capitalisation was used to calculate the size breakpoint (**Tables 2 and 3**).

Table 3: Construction of portfolio sorts

Table 3 shows the formation and construction of the size, value, profitability, and investment test portfolios sorts into three sort groups based on the Fama and French (2015) approach for 165 JSE-listed firms for the period 2013 – 2019, 192 months. Shares are sorted individually into nine and twelve portfolios. The 3x3 and 3x4 sorts formed three *Size* groups, followed by three or four *Value*, *Investmen*t or *Profitability* groups. The 2x2x3 sorts are performed by sorting them individually into two Size groups, then into two groups of the following factors (*HML*, *O*P, and *CMA*). Lastly, three groups of the last factor (*OP*/*CMA*) are created. All sorts are based on the financial data available at the end of the previous December. Value weighted monthly surplus returns are calculated for each portfolio from July – July and the rebalancing of the portfolios was done annually.

3x3 Sorts	3x4 Sorts	2x2x3 Sorts
Size, B/M	*Size, B/M*	*Size, B/M, OP*
Size, OP	*Size, OP*	*Size, B/M, Inv*
Size, Inv	*Size, Inv*	*Size, OP, Inv*

3.4 Statistical error tests

In general, the nature of the models used in this study may possibly lead to misspecification of the panel data regressions arising from amongst others, outliners and multicollinearity. Thus, the following tests were run in anticipation of such statistical errors.

3.4.1 Outliner test

This study employed a trimming procedure similar to studies by Kruger and Toerien (2014), Page and Auret (2014), and Cox and Britten (2019) to lessen the influence of statistical errors. According to Qian, Zhou, Kong, and Zhu (2009), outliners are any value greater than a percentile of all the observed data points and they are primarily controlled through winsorisation. Baltagi (2009) described winsorisation as the trimming of data so that any extreme values that do not contribute in the study can be removed. Winsorising data is about replacing extreme values, this study applied the winsorisation method were extreme values were replaced by percentiles specified by choice. This study winsorised the data to the 99th percentile level with the aid of the latest Stata 15 software.

3.4.2 Multicollinearity test

It became apparent to test whether high correlations existed amongst the explanatory variables in asset pricing models. The existence of high correlations creates problems in differentiating between individual variable effects since both variables may be explaining a similar point. This study used the variance inflation factor (VIF) to test for multicollinearity in order to avoid the misspecification of the model. The risk of multicollinearity is that it may lead to false regressions, inflated R^2 values, and inaccurate considerable levels. Mugumisi and Mawanza (2014) stated that when the VIF of a variable exceeds 10 (VIF>10), it indicates that the variables are multicollinear. However, the tolerance measure can also be used, which is the reciprocal of the VIF. If the tolerance level is less than 0.10 (1/VIF), it indicates that the variables are multicollinear and must be removed from the model to avoid misspecification.

3.5 Ethical considerations

According to Patton (2015) and Collins (2010), research ethics is a system of moral conduct seen during a research process where behavioural rules and expectations about the most acceptable concern towards experimental subjects, respondents, employees, employers, and sponsors are morally put into consideration. This study did not directly interact with experimental subjects, humans, or any confidential data. The only ethical considerations were limited to the validity and reliability of the data obtained from CEIC, IRESS and the JSE databases. It is imperative that the measurement instruments involved in the collection of the data are found to be both valid and reliable. Regarding the validity and reliability of the measurement instruments that were utilized in this study, the Global Competitive Index (Global Competitiveness Report, 2017) ranked South Africa number one in the world for the regulation of securities exchanges. Therefore, for all intents and purposes, the databases of CEIC, IRESS and the JSE offered data that is valid (accurate) and reliable (repeatable) to the end-user.

3.6 Summary

Chapter Three addressed all issues pertinent to the overall research methodology that was adopted for the study, namely: research paradigm, research design and approach, study population, sample size, and data collection methods and analysis. The study employed a positivism research approach and used a secondary data collection method and included a quantitative approach to analyze the data for share returns on the JSE. All the relevant data was collected from various sources; the CEIC, IRESS, and JSE databases. The duration of the sample period for this study was 16 years, from January 2003 to December 2019. Chapter Three briefly discussed the regression models followed by the construction of the Fama-French factors and portfolios which were discussed in greater detail. Ethical considerations of the study were also summarized in this chapter. The next chapter presents data analysis and interpretations followed by the estimation and discussion of the findings of the CAPM, FF3FM, and FF5FM models.

CHAPTER 4: PRESENTATION AND INTERPRETATION OF RESULTS

4.1 Introduction

This chapter presents and discusses the results of the study. With the aid of tables, this chapter begins with a discussion and presentation of factor statistics of the CAPM, FF3FM and FF5FM for JSE-listed firms. It then continues to describe and present in detail the Fama-MacBeth testing procedure adopted in the study. This is followed by a detailed discussion and presentation of numerous factors and tests on the portfolio sorts used in the study. The chapter then briefly presents a discussion on the estimation approach applied in the study. This discussion includes the independent regression results based on the robustness test for JSE-listed firms. The performance and comparative presentation of the different asset pricing models is introduced later in the chapter. The remarks based on the results of the comparative models are briefly discussed in this chapter. Chapter Four ends with a discussion of the empirical findings of the study.

4.2 Factor statistics

Fama and French (2015) used data for the period 1963 – 2013 from North America, Europe, Asia Pacific, and Japan regions. They found that average stock returns for North America, Europe, and Asia Pacific increased with the *B/M*, and the profitability factor is negatively related to the investment factor. For Japan, the relation between average returns and *B/M* is strong, but average returns showed a slight relation to profitability or investment factors. Guo *et al.* (2017) used a sample period for 1995 – 2013 for the Chinese stock market. They found that the profitability factor significantly improved the description of average returns, however, the investment factor only made negligible contributions. This is inconsistent with the results of Foye (2017) who used an extensive sample of 18 comprehensive countries from various regions. However, a profitability or investment premium could not be distinguished in the Asian factors and the FF5FM did not provide an improved description of share returns in this region.

In the South African context, the results of a study by du Pisanie (2018) showed that additional factors in the FF5FM provided the best explanation of share returns on the JSE out of all the models evaluated. Other findings included: more factors in an asset pricing model give better results and the results from models with the same number of factors are close together. Cox and Britten (2019) concurred and used statistics for each factor for the sample period 1994 – 2017 each year and the average for the whole sample period of 23 years. Their study showed the average monthly returns for the years shown and later for the whole sample period. The additional factors of profitability and investment contributed to explaining share returns on the JSE; however, profitability is more consistent than investment.

Factor statistics provide a crucial step towards an understanding of the full data sample that is presented for the duration of the sample period. The annual summary factor statistics were analysed from a sample of 165 firms and are presented in **Tables 4** and **5**. The average monthly returns presented in **Tables 4 and 5** are for the years shown and include the average statistics for the entire 16-year sample period. The market factor presents a positive average monthly surplus return of 0.569 % and is included in both tables to make it more extensive.

Differentiating the size factors in the FF3FM, **Table 4** shows a prominent change among the returns when the second factor is value against the profitability or investment factor. The size-value model posted a return of -0.472% in relation to -0.519% for profitability and -0.334% for investment. When compared with the other two models, the standard deviation for the size-value model was found to be lower. The results of this study are consistent with those of Novy-Marx (2013) in terms of the high book-to-market shares of 0.171% and robust profitability shares of 0.341% presented a greater premium in relation to the low book-to-market shares and weak profitability shares. Furthermore, other studies such as Fama and French (2015), and Cox and Britten (2019) found equivalent results that firms that invested conservatively had a premium over those that invested aggressively by an average of -0.019 on monthly basis. Factors which reached the highest standard deviations were the market and investment factors.

Table 5 shows a comparable size effect where big shares surpassed small shares in the sample period with a premium of -0.541%. The value factor for the FF3FM is similar to the FF5FM since both show a positive return. Value shares were the largest in absolute terms and outperformed growth shares by 0.282%. The profitability premium is stronger compared to the FF3FM at 0.442% which is consistent with earlier literature. The investment premium is weaker in the FF5FM compared to the FF3FM. Standard deviations are lower in the FF5FM except the size factor comprising the size-value model, which came in lower than in the FF5FM. The markings *, **, and *** next to values in the *t-statistic* from **Tables 4 – 17** denote the various considerable levels at 1%, 5%, and 10% levels, respectively.

Table 4: Factor returns for the CAPM and FF3FM models

Table 4 shows the factor returns for the CAPM and FF3FM for 165 JSE-listed firms for the period 2013 – 2019, 192 months. *MKT* denotes the market factor calculated as the return on the ALSI less the three-month South African Treasury bill (TB) yield. SMB_v denotes the *Size/Value* sorts. *HML* denotes the value factor (*High-Minus-Low*). SMB_p denotes the *Size/OP* sorts. *RMW* is the profitability factor (*Robust-Minus-Weak*). SMB_i denotes the *Size/Investment* sorts. *CMA* denotes the investment factor (*Conservative-Minus-Aggressive*).

Period	*MKT*	SMB_v	*HML*	SMB_p	*RMW*	SMB_i	*CMA*
2003 – 2004	0.972%	0.955%	0.904%	1.671%	-0.320%	1.546%	0.210%
2004 – 2005	2.646%	0.663%	1.486%	0.878%	0.670%	0.911%	-0.137%
2005 – 2006	2.540%	-0.845%	0.301%	-0.979%	-0.453%	-0.954%	-0.817%
2006 – 2007	1.718%	0.875%	0.535%	0.929%	0.917%	0.691%	-1.101%
2007 – 2008	-0.990%	-2.152%	-0.611%	-2.273%	0.130%	-2.315%	0.350%
2008 – 2009	-2.507%	0.981%	0.969%	0.761%	-1.117%	0.917%	-0.454%
2009 – 2010	1.480%	-1.166%	1.552%	-1.232%	0.641%	-0.920%	0.934%
2010 – 2011	0.977%	-0.796%	-0.271%	-0.674%	1.120%	-0.562%	0.948%
2011 – 2012	0.298%	-0.868%	-0.916%	-0.891%	1.813%	-0.910%	0.359%
2012 – 2013	1.262%	-1.272%	-0.115%	-0.899%	1.656%	-0.816%	-0.921%
2013 – 2014	1.676%	-1.289%	1.339%	-0.955%	-1.433%	-0.860%	-0.206%
2014 – 2015	-0.427%	-0.184%	-2.856%	-0.856%	0.666%	-0.343%	-1.408%
2015 – 2016	-0.512%	-0.276%	-0.973%	-0.679%	0.645%	-0.798%	1.445%
2016 – 2017	-0.277%	-0.988%	0.512%	-1.158%	0.678%	-0.839%	0.921%
2017 – 2018	-0.731%	-0.799%	-0.598%	-1.062%	0.569%	-0.742%	-1.216%
2018 – 2019	0.982%	-0.403%	1.478%	-0.899%	-0.723%	0.650%	0.782%
Average return	0.569%	-0.472%	0.171%	-0.519%	0.341%	-0.334%	-0.019
Standard deviation	1.347%	0.889%	1.152%	0.991%	0.897%	0.962%	0.867%
t-statistic	0.146	*-1.340	*1.340	0.327	-0.054	0.083	0.004
Min	-1.173%	-1.024%	-1.296%	-1.688%	-1.445%	-1.729%	-1.333%
Max	1.313%	0.951%	1.001%	1.794%	0.981%	1.662%	2.188%
Median	0.017%	-0.482%	0.320%	-0.409%	0.057%	-0.518%	0.086%

Table 5: Factor returns for the FF5FM model

Table 5 shows the factor returns for the FF5FM for 165 JSE-listed firms for the period 2013 – 2019, 192 months. *MKT* refers to the market factor calculated as the return on the ALSI less the three-month South African TB yield. SMB signifies the size factor (*Small-Minus-Big*) and *HML* denotes the value factor (*High-Minus-Low*) – see Table 2. *RMW* is the profitability factor (*Robust-Minus-Weak*). *CMA* is the investment factor (*Conservative-Minus-Aggressive*).

Period	***MKT***	***SMB***	***HML***	***RMW***	***CMA***
2003 – 2004	0.972%	1.961%	-0.163%	-0.802%	-0.177%
2004 – 2005	2.646%	0.788%	0.991%	0.148%	-0.481%
2005 – 2006	2.540%	-0.633%	0.231%	-0.233%	0.443%
2006 – 2007	1.718%	0.349%	0.916%	1.397%	-0.503%
2007 – 2008	-0.990%	-2.914%	0.757%	0.972%	-0.509%
2008 – 2009	-2.507%	0.343%	0.527%	-0.532%	-0.796%
2009 – 2010	1.480%	-1.100%	0.931%	0.648%	0.269%
2010 – 2011	0.977%	-0.273%	0.237%	0.906%	0.716%
2011 – 2012	0.298%	-0.776%	-0.454%	1.248%	-0.498%
2012 – 2013	1.262%	-1.795%	0.931%	2.199%	-0.275%
2013 – 2014	1.676%	-1.258%	0.560%	-0.491%	-0.195%
2014 – 2015	-0.427%	-1.247%	-1.783%	0.539%	-1.524%
2015 – 2016	-0.512%	-0.822%	-0.167%	0.487%	0.918%
2016 – 2017	-0.277%	-0.820%	0.151%	0.312%	1.199%
2017 – 2018	-0.731%	0.915%	0.364%	-0.950%	-0.446%
2018 – 2019	0.982%	-1.379%	0.487%	1.226%	1.258%
Average return	0.569%	-0.541%	0.282%	0.442%	-0.037%
Standard deviation	1.347%	1.151%	0.668%	0.853%	0.745%
t-statistic	0.146	**1.816	***1.623	*1.770	0.009
Min	-1.173%	-1.178%	-0.994%	-0.868%	-0.775%
Max	1.313%	0.804%	1.961%	1.750%	0.901%
Median	0.017%	-0.536%	0.389%	0.222%	-0.074%

4.3 Fama-MacBeth (1973) testing procedure

This study followed and applied on the JSE, a similar testing procedure to that of Fama-MacBeth (1973) that evaluated for considerable premiums in the cross-section of returns. The results of the numerous factors and portfolio sorts that were tested are presented per model to determine how well each model picked up on the factors and portfolios.

4.3.1 The CAPM

Table 4 presents the results from the Fama-French analysis using the CAPM to clarify the returns on portfolios sorted by different traits. Earlier research such as Roll (1977), Fama and French (1992, 2004, 2016), Penttengill *et al.* (1995), van Rensburg and Robertson (2003), Tassell (2007), Strydom and Charteris (2013) and Novak (2015) confirmed that the CAPM performed poorly in terms of explaining the cross-section of returns and it had also been proven that the alphas were all negative. The CAPM overpriced portfolio returns across all the sorts were evaluated during the analysis of this study. The 3x3 size and profitability sort has the largest alpha which stands at -0.687% (0.262). When compared to other models, the alphas are larger with no significant premiums except in the 2x2x3 size, profitability, and investment sort portfolio.

The premium had a negative score at -0.404% (0.265), with most premiums being negative and this proved that a portfolio with a larger beta earned lower returns. These findings are consistent with studies of van Rensburg and Robertson (2003). The highest AR^2 stood at 16.633% and it was comparatively low with six out of ten sorts having AR^2 which was beyond 10%, which was a sensible outcome for the CAPM.

Table 6: The CAPM results based on the Fama-MacBeth testing procedure

Table 6 shows the CAPM results based on the Fama-MacBeth testing procedure for 165 JSE-listed firms for the period 2013 – 2019, 192 months. *MKT* denotes the market factor calculated as the return on the ALSI less the three-month South African TB yield and α signifies the alpha. The *t-statistic* denotes the test statistic, and AR^2 denotes the adjusted R-squared.

The CAPM	α	*t-stat*	*MKT*	*t-stat*	AR^2
3x3 size/value	-0.573%	*-0.978*	-0.182%	*-0.255*	14.955%
3x3 size/profitability	-0.687%	*-1.133*	0.191%	*0.265*	16.633%
3x3 size/investment	-0.645%	*-1.186*	0.156%	*0.211*	8.721%
3x4 size/value	-0.513%	*-0.938*	-0.295%	*-0.402*	10.254%
3x4 size/profitability	-0.400%	*-0.948*	-0.299%	*-0.558*	13.762%
3x4 size/investment	-0.626%	*-1.174*	-0.123%	*-0.142*	6.814%
2x2x3 size/value/profitability	-0.551%	*-0.927*	-0.327%	*-0.577*	11.440%
2x2x3 size/value/investment	-0.523%	*-0.984*	-0.274%	*-0.516*	9.941%
2x2x3 size/investment/profitability	-0.538%	*-1.167*	-0.220%	*-0.425*	15.744%
2x2x3 size/profitability/investment	-0.310%	*-0.658*	-0.404%	*-1.120*	11.998%

4.3.2 The size – value FF3FM

Table 7 presents the results of the FF3FM related to the numerous portfolio sorts of shares listed on the JSE. Notably, the size-value model under-priced most portfolios which were opposite to that of the CAPM. The 3x4 size and profitability sort was still the only sort that had a minor negative intercept and those intercepts are normally not considerable. The 2x2x3 size, value and investment sort had a considerable unexplained part returns which was still considerable. Considerable intercepts were shown by the size-value FF3FM in the 3x4 size and value sort as well as in the size, profitability, and investment sort.

A negative market premium theme had developed through the different sorts that had been analysed thus far. A negative considerable premium of -0.983% (0.136) was found in the 3x4 sort and equally, significant premiums are also found in the 3x3 size and value and 3x3 size and profitability sorts. The largest premium was found in the 2x2x3 size, value, and investment sort at

-1.490% (0.114), while the last two sorts which were built on size, investment and profitability and size, profitability and investment showed considerable premiums of -0.676% (0.199) and -0.933% (0.136) respectively.

Only six out of the ten sorts showed a considerable size premium. At -0.630% (0.137), the 2x2x3 size, value and profitability sort showed the strongest size premium and the 3x4 size and investment sort produced the largest considerable premium at -0.713% (0.155).

Only three sorts produced a considerable value premium and with the bulk of the premiums being positive. This result is consistent with earlier studies of Kruger and Toerien (2014) and that of van Heerden and van Rensburg (2015) into the value effect on the JSE. There was a less widespread of the value premium as it was captured by the size-value FF3FM.

As predicted, the AR^2 was higher in the CAPM as extra risk factors are captured by the added factors. The best description of the model was captured in the size and profitability sort with an AR^2 of 38.165%.

Table 7: The size – value FF3FM results based on the Fama-MacBeth testing procedure

Table 7 shows the size – value FF3FM results based on the Fama-MacBeth testing procedure for 165 JSE-listed firms for the period 2013 – 2019, 192 months. *MKT* denotes the market factor calculated as the return on the ALSI less the three-month South African TB yield. *SMB* denotes the mean of the small stock portfolio returns less the mean of the big stock portfolio returns. *HML* denotes the mean of the two high *BE/ME* portfolio returns less the mean of the two low *BE/ME* portfolio returns and α denotes the alpha. The *t-statistics* are shown in parenthesis. AR^2 denotes the adjusted R-squared.

The size – value FF3FM	α	*MKT*	*SMB*	*HML*	AR^2
3x3 size/value	0.433% (0.625)	-0.818% (-1.421)	-0.450% (-1.756)	0.452% (1.223)	30.984%
3x3 size/profitability	0.665% (0.848)	-0.907% (-1.423)	-0.291% (-0.674)	-0.380% (-0.630)	38.165%
3x3 size/investment	0.184% (0.259)	-0.529% (-0.940)	-0.456% (-1.174)	0.749% (1.368)	11.970%
3x4 size/value	0.504% (1.458)	-0.983% (-1.977)	-0.473% (-1.496)	0.551% (1.327)	28.411%
3x4 size/profitability	-0.115% (-0.122)	-0.436% (-0.918)	-0.338% (-0.886)	0.397% (0.640)	29.873%
3x4 size/investment	0.247% (0.417)	-0.642% (-1.228)	-0.713% (-1.818)	1.105% (2.172)	25.382%
2x2x3 size/value/profitability	0.402% (0.853)	-0.832% (-0.422)	-0.630% (-1.953)	0.519% (0.458)	31.669%
2x2x3 size/value/investment	1.159% (2.216)	-1.490% (-1.849)	-0.584% (-1.730)	0.502% (1.553)	31.610%
2x2x3 size/investment/profitability	0.297% (0.621)	-0.676% (-1.466)	-0.451% (-1.251)	0.488% (1.161)	32.865%
2x2x3 size/profitability/investment	0.666% (1.552)	-0.933% (-1.977)	-0.538% (-1.309)	0.548% (0.927)	28.965%

4.3.3 The size – profitability FF3FM

The results from the size-profitably FF3FM are displayed in **Table 8**. Normally, the intercepts seem better than when the portfolio sorts are linked with the size-value FF3FM. A total of six out of the ten sorts showed a considerable number of unexplained returns while all 2x2x3 sorts showed a strong considerable intercept. Therefore, this model offered the most considerable intercepts, but it was weaker than the size-value model when describing returns.

A considerable market premium was present in each of the four 2x2x3 sorts and absent in the 3x3 size and profitability sort and it was considered considerable at the 1% level in three out of the four sorts. At -1.740% (0.112) and -1.733% (0.111), the premium was found to be greatest and strongest in these two 2x2x3 sorts, namely the size, value and investment and the size, profitability, and investment sorts. These results mirror those in the size-value model. It has also been found that when the size-profitability model was compared to the size-value model, a stronger market premium was found in the 3x4 size and value sort when the former model was applied.

The size-profitability model does not keep a considerable size-premium to a similar degree as the size-value model. The size, value and profitability sort offers the only considerable premium at -0.515% (0.192), and this is symptomatic of how big size portfolios outperform small size portfolios. This result is consistent and concurs with the summary statistics.

At -0.996% (0.135), this stood for a negative profitability premium in the size and value sort. Considerable profitability premiums were captured by the size-profitability model in two different sorts, namely the size and value 3x3 sort and the 2x2x3 size, value, and profitability sort. These are the only sorts which presented a considerable profitability premium.

The size-profitability model had a greater adjusted R^2 than the size-value model. The size-profitability model described the 3x3 size and profitability sort with an AR^2 of 43.394%.

Table 8: The size – profitability FF3FM results based on the Fama-MacBeth testing procedure

Table 8 shows the size – profitability FF3FM results based on the Fama-MacBeth testing procedure for 165 JSE-listed firms for the period 2013 – 2019, 192 months. *MKT* denotes the market factor calculated as the return on the ALSI less the three-month South African TB yield. *SMB* denotes the mean of the small stock portfolio returns less the mean of the big stock portfolio returns. *RMW* denotes the mean of the two robust *OP* portfolio returns less the average of the two weak *OP* portfolio returns and α denotes the alpha. The *t-statistics* are shown in parenthesis. AR^2 denotes the adjusted R-squared.

The size – profitability FF3FM	α	*MKT*	*SMB*	*RMW*	AR^2
3x3 size/value	1.243% (1.933)	-1.613% (-2.925)	-0.273% (-0.655)	-0.996% (-1.992)	38.900%
3x3 size/profitability	0.278% (0.412)	-0.610% (-1.123)	-0.296% (-0.700)	0.328% (0.937)	43.394%
3x3 size/investment	-0.286% (-0.494)	-0.150% (-0.215)	-0.336% (-0.890)	0.215% (0.374)	12.273%
3x4 size/value	0.976% (2.414)	-1.368% (-2.375)	-0.300% (-1.116)	-0.332% (-0.685)	29.829%
3x4 size/profitability	-0.183% (-0.335)	-0.356% (-0.789)	-0.235% (-0.555)	0.321% (0.981)	34.780%
3x4 size/investment	0.263% (0.447)	-0.521% (-0.947)	-0.389% (-0.969)	-0.127% (-0.150)	17.766%
2x2x3 size/value/profitability	1.234% (2.883)	-1.443% (-2.395)	-0.515% (-1.407)	0.484% (1.719)	38.680%
2x2x3 size/value/investment	1.582% (2.998)	-1.740% (-3.106)	-0.416% (-1.234)	-0.414% (-1.149)	23.639%
2x2x3 size/investment/profitability	1.190% (3.202)	-1.525% (-3.212)	-0.201% (-0.712)	0.243% (0.746)	38.981%
2x2x3 size/profitability/investment	1.425% (3.828)	-1.733% (-3.401)	-0.279% (-0.759)	-0.284% (-0.754)	35.967%

4.3.4 The size – investment FF3FM

Table 9 presents the results from testing of the size-investment FF3FM. The alphas in the size-investment model were closer to zero compared to the size-profitability model but it was better than the alphas in the size-value model. Out of ten sorts, four displayed negative alphas and six displayed positive alphas, while two of the 2x2x3 sorts had considerable alphas. At 1.239%, the size, value and investment sort had the largest alpha. When compared with other FF3FM, the size-investment model was left unexplained in the three-way sorts.

A total of six portfolio sorts show a considerable premium and they are usually common across all the FF3FM that had already been evaluated. The size-investment model is consistent much like the other FF3FM that had already been assessed in the way in which it captured the premium in all the three-way sorts. At -1.533% (0.112), the size, value and investment sort had the greatest premium while the size, value, profitability, and size, profitability and investment sorts also had considerable premiums at -0.922% (0.146) and -0.959% (0.144) respectively.

Considerable size premiums were absent in some of these sorts once the size-investment model had been used. The most considerable premium was in the size, value, and profitability sort at -0.468% (0.242) which was a general sign that a big firm's portfolio outperforms that of a small firm found in their negative premiums. When using other models, the market or investment factors could not find the size premium.

The 3x4 size and investment sort, the size, investment and profitability sort, and the size, profitability and investment sort were the only three sorts that presented a considerable investment premium. The size, investment and profitability sort presented the most considerable investment premium at 5% level at 0.540% (0.163). Positive premiums through all the different sorts were a sign that moderate investment portfolios were determined to outperform aggressive investment portfolios which are consistent with a study by Cooper, Gulen and Schill (2008) which found that moderate investment translates to better returns.

The AR^2 is similar to the size-value model and could not explain the returns on the 3x3 size and investment sort. The size-value model best explained the returns on the 3x3 size and investment sort with an AR^2 of 38.245%.

Table 9: The size – investment FF3FM results based on the Fama-MacBeth testing procedure

Table 9 shows the size – investment FF3FM results based on the Fama-MacBeth testing procedure for 165 JSE-listed firms for the period 2013 – 2019, 192 months. *MKT* denotes the market factor calculated as the return on the ALSI less the three-month South African TB yield. *SMB* denotes the mean of the small stock portfolio returns less the mean of the big stock portfolio returns. *CMA* denotes the mean of the two-conservative portfolio returns less the mean of the two-aggressive portfolio returns and α denotes the alpha. The *t-statistics* are shown in parenthesis. AR^2 denotes the adjusted R-squared.

The size – investment FF3FM	α	*MKT*	*SMB*	*CMA*	AR^2
3x3 size/value	-0.120% (-0.157)	-0.463% (-0.920)	-0.268% (-0.815)	0.446% (0.625)	38.245 %
3x3 size/profitability	0.431% (0.686)	-0.898% (-1.655)	-0.336% (-0.938)	0.129% (0.154)	31.584 %
3x3 size/investment	-0.258% (-0.472)	-0.293% (-0.484)	-0.257% (-0.602)	0.335% (0.852)	19.242 %
3x4 size/value	0.210% (0.420)	-0.587% (-1.160)	-0.268% (-0.784)	0.229% (0.338)	31.512 %
3x4 size/profitability	-0.141% (-0.187)	-0.571% (-1.446)	-0.158% (-0.297)	0.341% (0.735)	25.495 %
3x4 size/investment	-0.177% (-0.276)	-0.339% (-0.595)	-0.287% (-0.702)	0.576% (1.565)	24.654 %
2x2x3 size/value/profitability	0.744% (1.822)	-0.922% (-1.918)	-0.468% (-1.235)	0.590% (1.317)	31.202 %
2x2x3 size/value/investment	1.239% (3.995)	-1.533% (-3.223)	-0.384% (-1.134)	0.330% (0.805)	27.418 %
2x2x3 size/investment/profitability	0.524% (1.103)	-0.810% (-1.712)	-0.340% (-0.994)	0.540% (1.732)	37.495 %
2x2x3 size/profitability/investment	0.587% (1.245)	-0.959% (-1.953)	-0.368% (-0.929)	0.428% (1.399)	36.217 %

4.3.5 The profitability – investment FF3FM

The results of the profitability-investment model are presented in **Table 10**. This model provides inspiration to evaluate whether profitability and investment could duplicate the results of the other models. All the models that had been evaluated displayed similar alphas. The profitability-investment factor model showed the worst performance of all the models evaluated. The profitability-investment factor model showed the best performance in relation to the returns left unexplained by the other factors. However, its descriptive power in relation to the different premiums was lacking.

There was a lack of any considerable market premiums out of the ten available sorts. The 3x3 size and value sort was the only sort that showed the most considerable premium at -0.598% (0.225). Seven out of the ten sorts showed a negative premium while three of them show a positive premium, which is a clear sign that there was no obvious pattern in the way the premiums were directed.

In two out of the ten sorts, the profitability-investment model captured a considerable profitability premium with the 3x3 size and value sort having presented a premium in the size-profitability and profitability FF3FM. The profitability-investment model captured the largest and most considerable profitability premiums in the 3x3 size and investment sort at -0.699% (0.191) and -0.677% (0.156) respectively.

The investment premium was taken in a much better manner than the size-investment model. All the investment premiums were positive which was consistent with earlier literature and results, and that is indicative of moderate investment portfolios outperforming aggressive investment portfolios. These results are similar to those of the size-investment model. The 2x2x3 size, investment and profitability sort show the most considerable premium and the 2x2x3 size, value and profitability sort show the greatest premium at 0.569% (0.145) and 0.839% (0.154) respectively.

The AR^2 is weaker than the other FF3FM but kept on a similar pattern that least explained the returns in investment-based sorts. The profitability-investment model best described the 3x3 size and value sort portfolio with an AR^2 of 35.935%.

Table 10: The profitability – investment FF3FM results based on the Fama-MacBeth testing procedure

Table 10 shows the profitability – investment FF3FM results based on the Fama-MacBeth testing procedure for 165 JSE-listed firms for the period 2013 – 2019, 192 months. *MKT* denotes the market factor calculated as the return on the ALSI less the three-month South African TB yield. *RMW* denotes the mean of the two robust *OP* portfolio returns less the average of the two weak *OP* portfolio returns. *CMA* denotes the mean of the two-conservative portfolio returns less the mean of the two-aggressive portfolio returns and α denotes the alpha. The *t-statistics* are shown in parenthesis. AR^2 denotes the adjusted R-squared.

The profitability – investment FF3FM	α	*MKT*	*RMW*	*CMA*	AR^2
3x3 size/value	0.134% (0.158)	-0.598% (-1.319)	-0.699% (-1.519)	0.288% (0.385)	35.935%
3x3 size/profitability	-0.233% (-0.349)	-0.300% (-0.605)	0.237% (0.581)	0.428% (0.920)	28.468%
3x3 size/investment	-0.286% (-0.490)	-0.244% (-0.437)	-0.677% (-1.709)	0.202% (0.738)	17.640%
3x4 size/value	-0.323% (-0.598)	-0.303% (-0.877)	-0.464% (-1.273)	0.140% (0.186)	25.894%
3x4 size/profitability	-0.343% (-0.622)	-0.327% (-0.627)	0.248% (0.622)	0.472% (0.944)	26.975%
3x4 size/investment	-0.423% (-0.956)	0.124% (0.147)	-0.467% (-0.998)	0.667% (1.725)	16.433%
2x2x3 size/value/profitability	-0660% (-1.157)	0.218% (0.311)	-0.128% (-0.174)	0.839% (1.831)	22.215%
2x2x3 size/value/investment	-0.339% (-0.672)	-0.328% (-0.689)	-0.361% (-0.908)	0.368% (0.967)	18.888%
2x2x3 size/investment/profitability	-0.655% (-1.443)	0.319% (0.641)	0.241% (0.644)	0.569% (1.923)	32.247%
2x2x3 size/profitability/investment	-0.468% (-0.921)	-0.160% (-0.240)	-0.213% (-0.499)	0.470% (1.559)	32.442%

4.3.6 The FF5FM

Table 11 display the results from the Fama-French analysis by applying the five-factor model. The model generated intercepts that are linked with other models. The FF5FM has three considerable intercepts similar to the size-value three-factor model. The alphas are considerable for size and value sorts, and size, value, and profitability sorts. At 0.968% (0.140), this is the most considerable intercept. The model under-priced the returns since all of them had positive alphas.

There is a considerable market premium in four out of the ten sorts and thereafter, an intensely considerable premium in two out of three considerable two-way sorts. The results of this study are consistent with prior studies such as Cakici, Fabozzi and Tan (2013), Fama and French (2018), and Gonzalez and Jareno (2018) that found considerable market premiums in the size and value sorts. A considerable premium of -1.178% (0.156) was found in the three-way sort of size, value and profitability and the most considerable premium was found in the 3x4 size and value sort at -1.244% (0.134). The market premium is normally negative which is comparable to the results from other models and this signifies a converse connection between beta and portfolio returns. Overall, the application of the market factor is not as widespread as with prior models and as such its choice in the three-way sorts is not up to a similar degree.

A total of four sorts out of ten have considerable size premiums and at -0.928% (0.124) the 3x3 size and value sort presented the greatest premium and with the size, value and profitability sort presenting a premium of -0.679% (0.137). The FF5FM captured a considerable premium of similar sorts as the size-value model apart from two of the three-way sorts whose premium is not clear when applying the five-factor model. A total of nine out of ten premiums were negative, which meant that big sized portfolios outperformed smaller ones as shown in the premiums chosen in the other models.

Five out of ten sorts presented a considerable value premium with the size and value sorts having considerable market, size value premiums and with three sorts considerable at the 5% level. Out of all the premiums, the greatest premiums were found in 3x4 size and value sort and the 3x4 size and investment sort at 0.682% (0.132) and 1.440% (0.133) respectively. Negative premiums are not considerable which suggests that larger and undervalued firms have considerable premiums related with their size and comparative value in relation to the market price.

Just one considerable profitability premium is obtainable in the 3x4 size and investment portfolio, but at 0.998% (0.156), it is not as strong as the market, size, or value premiums even though it is considerable at the 5% level. There is enough evidence to suggest the availability of a premium connected with robust profitability even though the measure of its strength was doubtful in the cross-section of returns on the JSE. This could be interpreted as being consistent with the size and value premiums as large and well-established firms could have strong profitability.

The investment premium is commonly positive, which implies that moderate investment is compensated. Though the strongest premiums are found to be both negative at -0.799% (0.150) and -0.743% (0.110) respectively, large firms are undervalued because substantial growth in assets are not instantly priced by the market. The investment premium is found to be more effective than the profitability premium.

The AR^2 is usually bigger when applying the FF5FM and it struggled to explain portfolios sorted on size and investment. The highest adjusted R^2 stood at 56.473% while five sorts had an AR^2 beyond 45% and another three of them in their high thirties. This result is convincing, and its conclusion is consistent with earlier research concerning the explanatory power of the model.

Table 11: The FF5FM results based on the Fama-MacBeth testing procedure

Table 11 shows the FF5FM results based on the Fama-MacBeth testing procedure for 165 JSE-listed firms for the period 2013 – 2019, 192 months. *MKT* denotes the market factor calculated as the return on the ALSI less the three-month South African TB yield. *SMB* denotes the mean of the small stock portfolio returns less the mean of the big stock portfolio returns. *HML* denotes the mean of the two high *BE/ME* portfolio returns less the mean of the two low *BE/ME* portfolio returns. *RMW* denotes the mean of the two robust *OP* portfolio returns less the average of the two weak OP portfolio returns. *CMA* denotes the mean of the two-conservative portfolio returns less the mean of the two-aggressive portfolio returns and α denotes the alpha. The *t-statistics* are shown in parenthesis. AR^2 denotes the adjusted R-squared.

The FF5FM	α	MKT	SMB	HML	RMW	CMA	AR^2
3x3 size/value	1.332% (1.533)	-1.618% (-1.814)	-0.928% (-2.326)	-0.716% (-1.490)	0.460% (0.937)	-0.799% (-1.763)	45.497%
3x3 size/profitability	0.420% (0.578)	-0.724% (-1.179)	0.217% (0.342)	0.975% (1.849)	-0.326% (-0.670)	0.619% (1.122)	56.473%
3x3 size/investment	-0.576% (-0.654)	0.317% (0.321)	-0.149% (-0.231)	-0.391% (-0.838)	-0.254% (-0.480)	-0.151% (-0.190)	10.984%
3x4 size/value	0.806% (1.594)	-1.244% (-1.993)	-0.612% (-1.827)	0.682% (2.144)	0.553% (1.177)	-0.743% (-2.489)	40.554%
3x4 size/profitability	0.350% (0.657)	-0.736% (-1.550)	-0.228% (-0.495)	0.291% (0.788)	-0.154% (-0.281)	0.175% (0.276)	45.255%
3x4 size/investment	-0.930% (-0.997)	0.715% (0.731)	-0.520% (-1.574)	1.440% (2.125)	0.998% (1.703)	0.619% (1.285)	30.600%
2x2x3 size/value/profitability	0.968% (1.879)	-1.178% (-1.797)	-0.679% (-1.957)	0.347% (1.291)	0.363% (0.977)	-0.258% (-0.714)	49.722%
2x2x3 size/value/investment	0.434% (0.831)	-0.652% (-1.145)	-0.420% (-0.952)	0.449% (1.414)	0.296% (0.717)	0.154% (0.265)	38.240%
2x2x3 size/investment/profitability	0.265% (0.514)	-0.460% (-0.875)	-0.193% (-0.332)	-0.251% (-0.457)	-0.118% (-0.135)	0.136% (0.218)	52.925%
2x2x3 size/profitability/investment	0.347% (0.533)	-0.651% (-0.962)	-0.453% (-1.277)	0.337% (0.857)	0.118% (0.130)	0.354% (0.961)	39.979%

4.4 Tests of the portfolio sorts

As mentioned in Chapter Three of this study, the portfolios are constructed and calculated based on the approach used in Fama and French (2015), but owing to the smaller investment environment on the JSE, this study used the more viable 3x3, 3x4, and 2x2x3 portfolio sorts. The portfolio sorts are discussed and presented in the following manner:

4.4.1 Sorts of 3x3: 9 portfolios

Table 12 presents the portfolio average monthly excess returns for the whole 16-year period sorted individually by three size groups and then three groups of either value, profitability, or investment. Some form of unevenness can be found amongst the portfolio returns. Among all these are the high book-to-market portfolios that presented better returns than the low-to-market portfolios across all size groups, and this proved consistent with the value factor. The performance of small and mid-sized growth portfolios was poor, and across the value groups, big high book-to-market shares showed a monthly average return of 0.242%. Small portfolio stocks with robust profitability and big portfolio stocks with average profitability had a positive average excess return of 0.099% per month.

Big portfolio stocks came out on top against conservative and aggressive sorts respectively, while small firms with moderate investment outperformed the conservative and aggressive groups. The worst performer was the small portfolio stock that invested aggressively and ended up with an average monthly excess return of 0.805%.

Lastly, this study stated that firms that invested aggressively outperformed those that did not, and this assertion found support in studies such as Foye (2018), and Cox and Britten (2019). On the other hand, Cooper *et. al* (2008) and Aharoni *et al.* (2013) argued that there was no correlation between investment level in a firm and returns. Unless a firm is large enough and with extensive resources, an aggressive investment approach can be harmful to its operations. Similarly, an organic growth rate can be equated to a moderate investment level in a small firm.

Table 12: 3x3 portfolios sorts

Table 12 shows the results of the average excess monthly returns and standard deviations sorted individually in three size groups and three groups of either value, profitability or investment for 165 JSE-listed firms for the period 2013 – 2019, 192 months. Small, Mid, and Big denotes the sorted portfolio groups and *Std. dev.* denotes the standard deviation in *italics*.

Size		**Small**	**Mid**	**Big**
Value	**High**	0.080%	0.092%	0.242%
	Std. dev.	*3.219%*	*3.876%*	*5.692%*
	Medium	-0.107%	-0.158%	0.015%
	Std. dev.	*3.765%*	*3.687%*	*4.633%*
	Low	-0.549%	-0.561%	0.103%
	Std. dev.	*4.409%*	*4.169%*	*4.681%*
Profitability	**Robust**	-0.019%	-0.319%	-0.161%
	Std. dev.	*3.760%*	*4.040%*	*4.784%*
	Average	-0.126%	-0.214%	0.099%
	Std. dev.	*3.814%*	*4.103%*	*4.894%*
	Weak	-0.317%	-0.449%	-0.220%
	Std. dev.	*3.676%*	*3.839%*	*4.867%*
Investment	**Conservative**	-0.053%	-0.150%	-0.062%
	Std. dev.	*3.429%*	*3.438%*	*4.486%*
	Moderate	0.005%	-0.370%	-0.197%
	Std. dev.	*3.510%*	*3.704%*	*4.745%*
	Aggressive	-0.805%	-0.419%	0.031%
	Std. dev.	*5.164%*	*4.309%*	*4.890%*

4.4.2 Sorts of 3x4: 12 portfolios

Table 13 presents the portfolio average monthly excess returns for the whole 16-year period sorted individually by size (three groups) and then four groups of either value, profitability, or investment.

As in the size and value sorts, big share portfolios follow a recognisable course to the 3x3 sorts where they outperform small shares. In cases where big shares portfolios are value shares, there are possibilities that they may be more unstable than small share portfolios. A prominent feature in the small size group is that growth portfolios have proven to be more unstable than the value portfolios. As a result, in the big size group, value portfolios achieved lower standard deviations compared to growth portfolios.

In terms of the size and profitability sorts, they showed a recognisable pattern when it comes to size. As such, big portfolios inherently outperform small portfolios, and this led to a situation in which mid-size portfolios underperformed in both small and big portfolios across all profitability groups. When profitability has been factored in, the two average portfolios continuously showed better returns compared to the robust or weak portfolios. As mentioned earlier, big share portfolios enjoyed greater standard deviations compared to the other size groups. The average profitability portfolios showed higher standard deviations in contrast to other profitability groups. A discernible pattern has been drawn in the data which has proved that portfolios that performed better had higher standard deviations.

Once the second sort was investment, big share portfolios showed a better performance over the other size groups apart from portfolio of small shares that invested moderately conservatively at an average monthly excess return of 0.132%.

Table 13: 3x4 portfolios sorts

Table 13 shows the results of the average excess monthly returns and standard deviations on portfolios sorted individually by three size groups and four groups of either value, profitability or investment for the 3x4 portfolio sorts for 165 JSE-listed firms for the period 2013 – 2019, 192 months. Small, Mid, and Big denotes the sorted portfolio groups and *Std. dev*. denotes the standard deviation in *italics*.

Size		Small	Mid	Big
Value	**High**	0.096%	-0.077%	0.197%
	Std. dev.	*3.307%*	*4.725%*	*6.475%*
	Medium high	-0.207%	-0.131%	-0.052%
	Std. dev.	*4.101%*	*3.640%*	*5.110%*
	Medium low	-0.708%	-0.352%	-0.055%
	Std. dev.	*4.680%*	*4.193%*	*4.697%*
	Low	-0.680%	-0.792%	-0.111%
	Std. dev.	*5.817%*	*4.463%*	*4.795%*
Profitability	**Robust**	-0.115%	-0.351%	-0.091%
	Std. dev.	*4.104%*	*4.094%*	*5.032%*
	Average robust	-0.094%	-0.228%	0.028%
	Std. dev.	*4.063%*	*4.208%*	*5.194%*
	Average weak	-0.086%	-0.089%	-0.026%
	Std. dev.	*4.055%*	*4.025%*	*5.146%*
	Weak	-0.410%	-0.711%	-0.341%
	Std. dev.	*4.016%*	*4.341%*	*5.078%*
Investment	**Conservative**	-0.97%	-0.155%	0.077%
	Std. dev.	*3.702%*	*4.015%*	*4.465%*
	Moderate conservative	0.132%	-0.265%	-0.084%
	Std. dev.	*4.083%*	*3.730%*	*4.793%*
	Moderate aggressive	-0.141%	-0.145%	-0.092%
	Std. dev.	*4.277%*	*4.059%*	*4.852%*
	Aggressive	-0.978%	-0.597%	-0.099%
	Std. dev.	*4.420%*	*4.428%*	*5.286%*

4.4.3 Sorts of 2x2x3: 12 portfolios

Table 14 presents the portfolio average monthly excess returns for the whole 16-year period based initially on size and value, then on either profitability or investment, respectively.

Big portfolios in the profitability sort showed higher returns than small portfolios, which is consistent with the evidence in Auret and Cline (2011). Throughout all the size groups, high book-to-market portfolios outperformed low book-to-market portfolios. High book-to-market portfolios with robust or average profitability tended to have higher standard deviations and returns than those with weak profitability. Low book-to-market portfolios with weaker profitability across both size groups tended to have greater standard deviations. Big portfolios in the investment sort typically had higher returns than small portfolios. The investment levels followed a distinct pattern: in small portfolios, moderate and conservative investment outperformed while in big portfolios, the aggressive investment portfolios outperformed. In small growth portfolios, this study found greater standard deviations compared to small value portfolios, while large value portfolios had greater standard deviations than large growth portfolios. Moderate or aggressive investment levels showed the highest standard deviations.

Table 14: 2x2x3 portfolio sorts

Table 14 shows the results of the average excess monthly returns and standard deviations for 2x2x3 portfolio sorts based firstly on size and value, and then either profitability or investment respectively that used size and value as an inflexible sorting trait for 165 JSE-listed firms for the period 2013 – 2019, 192 months while *Std. dev*. denotes the standard deviation in *italics*.

Value		**Small**		**Big**	
		High	**Low**	**High**	**Low**
	Robust	-0.334	-0.366	0.169	-0.173
	Std. dev.	*6.081*	*3.744*	*6.092*	*4.880*
Profitability	**Average**	-0.034	-1.253	0.168	0.173
	Std. dev.	*3.961*	*4.529*	*5.341*	*5.105*
	Weak	-0.204	-0.843	-0.147	-0.224
	Std. dev.	*3.533*	*6.137*	*5.116*	*5.337*
	Conservative	-0.248	-0.179	0.102	-0.048
	Std. dev.	*3.739*	*4.118*	*5.662*	*4.670*
Investment	**Moderate**	0.072	-0.688	-0.085	-0.216
	Std. dev.	*3.866*	*4.810*	*5.672*	*4.816*
	Aggressive	-0.422	-1.032	0.127	0.016
	Std. dev.	*4.329*	*4.856*	*5.618*	*5.149*

Table 15 presents the portfolio average monthly excess returns for the whole 16-year period sorted based initially on size, then on either investment or profitability and then on profitability or investment, respectively.

Big portfolios in the size, investment, and profitability sort typically outperformed small portfolios apart from the small, conservative, robust sort. The small size, conservative investment and robust profitability are a more profitable portfolio combination. The conservative investment outperformed the aggressive investment apart from the small size and weak profitability portfolio.

In the big portfolios, average profitability outperformed robust and weak profitability portfolios irrespective of the investment levels. Big portfolios tended to have greater standard deviations in the average monthly excess returns, while conservative investment portfolios showed lower standard deviations when contrasted to the aggressive investment portfolios.

Big portfolios in the size, profitability and investment sort typically outperformed small portfolios. The robust profitability portfolios partially outperformed the weak profitability portfolios while in the robust profitability portfolios, conservative investment portfolios outperformed the aggressive investment portfolios.

Table 15: 2x2x3 portfolio sorts

Table 15 shows the results of the average excess monthly returns and standard deviations for 2x2x3 portfolio sorts based firstly on size, then on either investment or profitability and otherwise, sorts based on size and then on profitability or investment that used size and value as an inflexible sorting trait for 165 JSE-listed firms for the period 2013 – 2019, 192 months and *Std. dev*. denotes the standard deviation in *italics*.

Investment		Small		Big	
		High	**Low**	**High**	**Low**
Profitability	**Robust**	0.093	-0.670	-0.019	-0.290
	Std. dev.	*3.817*	*4.333*	*5.680*	*5.232*
	Average	-0.126	-0.641	0.059	0.007
	Std. dev.	*4.438*	*4.406*	*5.033*	*5.301*
	Weak	-0.501	-0.247	-0.180	-0.216
	Std. dev.	*3.812*	*4.700*	*5.016*	*5.495*
Investment	**Conservative**	-0.014	-0.411	-0.009	-0.058
	Std. dev.	*4.019*	*3.639*	*5.175*	*5.333*
	Moderate	0.227	-0.004	-0.222	-0.162
	Std. dev.	*4.316*	*4.038*	*4.699*	*5.641*
	Aggressive	-0.696	-0.851	-0.104	0.047
	Std. dev.	*4.611*	*4.555*	*5.498*	*4.319*

4.5 Robustness test

This study applied a modified GMM estimation approach based on robust instruments that use the higher moments and cumulants of the sample observations. Regressions are tracked in brief intervals with the coefficients being around individual periods with the aim of determining the different statistics that must be analysed. Consequently, the focus of the robustness test is the results found throughout the 16-year sample period against the averaging of distinct regression results. The results from the tests will be twofold; firstly, from the model comparison analysis and secondly, from the cross-sectional return analysis.

4.5.1 Results of the regression model based on the robustness test

Table 16 shows that this study rejected the second hypothesis which stated that the *HML* factor becomes redundant in explaining expected stock returns with the addition of profitability and investment factors to the FF5FM on the JSE. This study found that adding the *HML* factor to the other four factors decreases the average absolute intercept value in 3 out of 10 sets of portfolio returns. Furthermore, the exclusion of the *HML* factor in 1 out of 6 sets results in constantly lower average absolute intercept value. Though in 2 out of 6 sets of portfolio returns that this study sought to explain with the five risk factors, the full FF5FM complemented by the *HML* factor provides a better performance. Therefore, this study found inconclusive evidence and must reject the hypothesis. The rejection of the hypothesis is also supported by the evidence that the adjusted R^2 is always larger when there are five factors instead of just four. Therefore, the results of this study proved that the *HML* factor is furthest from being a redundant factor on the JSE which is consistent with the findings of Fama and French (2015) and Grudios (2015). Furthermore, the finding of Fama and French (2015) that the *HML* factor was incorporated by profitability and investment has no standing on the JSE.

Table 16: Independent regression results based on the robustness test per factor being regressed on four other factors

Table 16 shows the results of the independent regression of a selected factor being regressed on four other factors for 165 JSE-listed firms for the period 2013 – 2019, 192 months. The factors are constructed using individual sorts of stocks into two *size* groups, three *B/M* groups, three *OP* groups, and three *Inv* groups. *Int.* denotes the *Intercept* and *MKT* denotes the market factor which is calculated as a value weighted monthly return on the ALSI less the three-month South African TB yield. *SMB* denotes the mean of the small stock portfolio returns less the mean of the big stock portfolio returns (**see Table 5**). *HML* denotes the mean of the two high *BE/ME* portfolio returns less the mean of the two low *BE/ME* portfolio returns. *RMW* denotes the mean of the two robust *OP* portfolio returns less the average of the two weak *OP* portfolio returns. *CMA* denotes the mean of the two-conservative portfolio returns less the mean of the two-aggressive portfolio returns. AR^2 denotes the adjusted R-squared.

	Int.	***MKT***	***SMB***	***HML***	***RMW***	***CMA***	AR^2
MKT							
co-efficient	0.1180		-0.54	-0.56	-0.55	-0.27	0.36%
t-statistic	*2.53*		*-5.29*	*-6.22*	*-6.57*	*-2.11*	
p-value	0.13		0.00	0.00	0.00	0.16	
SMB							
co-efficient	0.1137	-0.32		-0.27	-0.37	-0.13	0.24%
t-statistic	*1.23*	*-5.29*		*-2.98*	*-5.55*	*-0.43*	
p-value	0.38	0.00		0.00	0.00	0.86	
HML							
co-efficient	0.1126	-0.37	0.20		-0.24	0.30	0.34%
t-statistic	*0.72*	*-6.22*	*-2.98*		*-2.43*	*4.97*	
p-value	0.65	0.00	0.00		0.13	0.00	
RMW							
co-efficient	0.1156	-0.41	-0.48	-0.26		-0.49	0.39%
t-statistic	*1.75*	*-6.57*	*-5.55*	*-2.43*		*-6.34*	
p-value	0.21	0.00	0.00	0.13		0.00	
CMA							
co-efficient	0.1145	-0.10	-0.13	0.39	-0.43		0.35%
t-statistic	*1.49*	*-2.11*	*-0.43*	*4.97*	*-6.34*		
p-value	0.28	0.16	0.86	0.00	0.00		

4.6 Performance of the different asset pricing models

This part of the study determines whether the intercept values of the regressions are indistinguishable from zero and how well the models capture variance in average returns. This study conducted a model comparison that assessed which of the asset pricing models that are evaluated best explained the returns of portfolios built on unrelated sorts for the factor model analysis. It also followed the objectives of Fama and French (2015) which showed that the result of significance is the comparative performance of the asset pricing models to each other contrary to the statistical validation or invalidation of the asset pricing model in tests with power. This process aided the study in the identification of the asset pricing model that best describes the returns of the tested portfolios. The added factors, profitability, and investment aided in assessing the performance of each asset pricing model individually to determine which one improved the explanatory power of earlier models. This supplied an overall image on the applicability of the FF5FM in explaining share returns on the JSE.

The study presents the tests from two stages. In the first stage, the regressions are presented yearly with averages being achieved over the test period, in this case covering the 16-year sample period. In the second stage, as a robustness test, regressions are also presented over the course of the 16-year sample period for an individual regression for each portfolio and for each model.

4.6.1 Model differentiation – comparative presentation

For comparative purposes, this study drew inspiration from a study by Cox and Britten (2019) that calculated a total of six statistics so that the models could be assessed. This was made possible by incorporating a modernised adaptation of the Fama and French (2015) statistics as per Fama and French (2016). These statistics are then estimated from the time-series regressions in the following manner:

I. The average absolute value of alpha $A|\boldsymbol{\alpha}|$, also known as the intercept, was determined for each model. A model is said to be able to explain returns when the intercept is indistinguishable from zero. Consequently, a lower alpha means that more can be explained by the factors in the model.

II. The next statistic that was used calculated the spreading of the intercept's comparative to the spreading of test portfolio average excess returns. It was computed as the average of the alphas $A|\boldsymbol{\alpha}|$ proportionally to the average absolute deviation $A|\boldsymbol{y}|$ of each test portfolio's average time-series return since the market portfolio excess returns $\frac{A|\alpha|}{A|yy}$. Consequently, a lower statistic means less can be unexplained by the factors in the model.

III. This statistic made use of a ratio of the average squared intercepts and deviations above $\frac{A|\alpha|^2}{A|y|^2}$.

IV. Sampling errors were some of the consequences left unresolved by the model. A higher statistic resulted in more spreading in the intercept which in-turn caused sampling errors. This statistic is calculated as $\frac{As^2}{A|\alpha|^2}$.

V. The GRS statistic which is widely recognised and used as a model's ability to price returns tests whether the estimated intercepts from a multiple test portfolio are jointly zero. The GRS statistic was used as a test of a model's ability to price returns. As a means of measuring the performance of the mode, a lower GRS statistic means the better the performance of the model. A proper factor model has an intercept that is statistically indistinguishable from zero. Models that have dissimilar number of factors are also accounted for in the GRS statistic. It is calculated using the following formula:

$$\frac{T-N-K}{N} * \hat{\alpha}'\hat{\Sigma}\hat{\alpha} * \left[1 + E_T(f_t)'\hat{\Omega}^{-1}E_T(f_t)\right]^{-1} \quad (8)$$

where there are T observations, N portfolios and K factors. $E_T(f_t)$ is the expected return on the factors, $\hat{\Omega}^{-1}$ is the inverse covariance matrix of factor returns, $\hat{\alpha}$ is the vector of the alphas from the regressions, and $\hat{\Sigma}$ is the covariance matrix of estimated residuals.

VI. The average adjusted R^2 that is calculated considered that a model that has more factors has higher R^2 values by default. This process allowed models that were on an equal footing to prove which ones could explain more of the returns.

Most importantly, these statistics could be applied on models that have different numbers of factors by comparing them.

4.6.2 Comparative model results

The results presented in **Table 17** prove the first hypothesis which states that the FF5FM performs better than both the CAPM and FF3FM when estimating expected future stock returns on the JSE.

3x3 Portfolio sorts

The best performing three-factor model holds size and value factors in the 3x3 size and value sorted portfolios with an alpha of 0.880% which marginally outperforms the size and profitability FF3FM. The FF3FM holds that size and either value, profitability or investment factors outperform both the CAPM and FF5FM models. The added factors only offer a better performance when they are augmented with size. The FF3FM of size and profitability had the best performance with a statistic of 1.950 after the analysis of dispersion of intercepts due to sampling error.

The FF5FM outperforms the CAPM and FF3FM with statistic of 1.928, with the size and investment model coming second best at 1.884. The new factors show what was the most probable cause of the dispersion of intercepts which led to an improved modelling of the returns. The AR^2 produces the highest statistic for the size-value model compared to the other models.

The size-profitability FF3FM in the size and profitability sort provided the lowest intercept at 0.848% and it also produced the lowest pricing error across all the sorts. The least unexplained returns are found in the size-profitability model of the size and profitability sort. The highest statistic across all sorts and models was found in the FF5FM at 2.121. The FF3FM of size and profitability failed to improve on the AR^2 of 64.509% of the FF5FM.

The lowest intercept in the size-investment model was produced by the size and investment sort. The size and value sort produced a better performance than size-profitability model. The FF3FM of size and investment presented the best possible scores across all the models and sorts with a statistic of 85.10%. The other FF3FM of size and either profitability or investment produced exceptional performances. Only the FF5FM outperformed the size-investment model in explaining returns out of the FF3FM and CAPM. An AR^2 above 63% was found in the FF3FM of size and one other factor.

The GRS statistics test has rejected that all the alphas are jointly zero, and therefore rejecting all the models as well. Nevertheless, what was of importance was the relative performance of the model rather than the statistical rejection of the said model. The highest GRS statistics and worst performer across all three sorts was found in the CAPM and profitability-investment FF3FM. The

FF5FM presented a better GRS statistic in two out of the three sorts, which is consistent with Fama and French (2015).

Finally, in the 3x3 sorts, the FF5FM does not offer any improvement, but performed in a satisfactory manner in explaining share returns.

3x4 Portfolio sorts

Portfolios constructed on a two-way had results which were virtually indistinguishable to the 3x3 sorts. The AR^2 was lower through each respective 3x4 sorts with the FF5FM producing the greatest AR^2 through each respective 3x4 sorts. Nevertheless, the CAPM continuously disappointed in most measures through each respective 3x4 sorts. All the models that had been analysed in this study had an inferior performance on a larger sort.

At 0.907%, the size-value model produced the lowest intercepts from the size and value portfolios. The adjusted R^2 of the FF3FM was highest in the size-value model at 58.729%. In terms of AR^2, the size-investment model offered a better performance than the size-profitability model in this kind of sort.

The smallest intercept was found in the size-profitability model which stands at 0.957% and stems from the size and profitability portfolios. The FF5FM presents the best statistic at 1.977 while the size-value and size-profitability model's performance can be thought to be satisfactory at 1.700 and 1.749, respectively. The size-profitability model had the highest AR^2 in comparison to the FF3FM and CAPM, and the only model that outperformed it was the FF5FM. At 0.975%, the lowest pricing error was produced by the size-investment model from the size and investment 3x4 sorts and the least of the unexplained deviation of 93.6% was found in the size and investment model. The FF5FM performs similarly better than the CAPM and FF3FM just like in the 3x3 sorts when it comes to dispersion owing to sampling error. The AR^2 of all the models seem to be high but the FF5FM was still the best performing model compared to other two models.

The results of the GRS were identical in the 3x3 sorts when it comes to the models that had been assessed: this means that the models were rejected, and the alphas were not jointly zero. Furthermore, the highest GRS statistics was found in the CAPM and profitability-investment model which was a sign of mediocre performance. On the other hand, the best performance in two of the three sorts was found in the FF5FM, with the size-value model performing best in the size and profit sort.

2x2x3 Portfolio sorts

The worst performers are once again, the CAPM and profitability-investment models while the FF5FM produced the greatest AR^2 values. On the other hand, the best performer in the size, value and profitability sort was the size-profitability and size-value models with intercepts of 0.973% and 0.994% respectively. The FF5FM presented a better performance than the size-investment model while the size-profitability model offered the best performance when it comes to dispersion owing to sampling error with a statistic of 1.879 and after that, the FF5FM produced the next best statistics. The FF5FM has been setting a familiar trend in terms of performance with five-factor model producing the highest AR^2 at 65.696%, and the size-profitability as well as the size-value models offering the next best measures.

The lowest intercept in the size-value model was produced by the size, value and investment sort closely followed by the FF5FM at 0.961% and 95.60% respectively. The highest AR^2 was found in the FF5FM and next in line is the size-investment and size-value models at 62.249% and 61.802% respectively.

At 0.984% %, this intercept presented the best returns in the size-value model in terms of the size, investment, and profitability sort. Following closely was the size-profitability model at 0.994%. The performance of the models in terms of sampling error in order of performance was the FF5FM followed by the size-investment and size-value models. The highest AR^2 was found in the size-profitability model of the FF3FM while the FF5FM presented the best performance.

The CAPM and profitability-investment FF3FM performed poorly in terms of the GRS statistics. Interestingly, the performance of the FF5FM was poor in both sorts while the size-value FF3FM and the CAPM performed well. Additionally, all the models are rejected when testing whether the alphas are jointly zero. Predictably and statistically, the FF5FM outperformed the other models with a statistic of 99.70%, with the size and investment model coming in next at 99.50%. Compared with other models, the AR^2 for the size-value model was the highest and produced a marginally worse performance than the FF5FM.

The lowest intercept was produced in the size-investment model which was found in the size and investment sort. In relation to returns left unexplained, the best results through all the models and sorts were found in the FF3FM of size and investment with a statistic of 85.10% and 93.60% individually. Altogether, the other FF3FM models of size and either profitability or investment also offered a reasonable performance. The FF5FM presented the best results in relation to the sampling error measure when it comes to the size and investment sort. Lastly, the size-investment model explains returns best from the tested models, FF3M and CAPM, and was only outperformed by the FF5FM.

The model comparison of this study delivered a significant common result. The FF5FM best describes returns from a statistical viewpoint owing to having the highest AR^2 across all sorts. The FF5FM also produced many measures of dispersion owing to sampling error that was the highest for an individual sort. It also presented a decreased GRS statistic, similar to that of Fama and French (2015), for most sorts evaluated. Therefore, statistically, its performance was satisfactory.

The FF5FM produced a satisfactory performance in terms of the sampling error explaining the dispersion on intercepts. Therefore, it performed better in terms of the dispersion of intercepts owing to sampling error rather than factual dispersion as modelled with certain risk factors. The FF5FM presented the highest AR^2 irrespective of sort. Altogether, the FF5FM proved to be a better and more suitable asset pricing model than the CAPM and FF3FM models for the South African stock market.

Table 17: Presentation of the comparative model results

Table 17 shows the performance and ability of the CAPM, FF3FM and FF5FM in explaining monthly excess returns on the various portfolio sorts and model comparison results for 165 JSE-listed firms for the period 2013 – 2019, 192 months. $A|\alpha|$ denotes the average absolute value of alpha. $\frac{A|\alpha|}{A|y|}$ denotes the ratio of the intercepts to the mean returns. $\frac{A|\alpha|^2}{A|y|^2}$ denotes the ratio of the average squared intercepts and deviations. $\frac{As^2}{A|\alpha|^2}$ denotes the average squared standard error of alpha divided by the standard average absolute intercept. AR^2 denotes the adjusted R-squared and GRS denotes the [Gibbons *et al.* (1989)] statistic. *MKT* denotes the market factor calculated as the return on the ALSI less the three-month South African TB yield. *SMB* denotes the mean of the small stock portfolio returns less the mean of the big stock portfolio returns. *HML* denotes the mean of the two high *BE/ME* portfolio returns less the mean of the two low *BE/ME* portfolio returns. *RMW* denotes the mean of the two robust *OP* portfolio returns less the average of the two weak *OP* portfolio returns. *CMA* denotes the mean of the two-conservative portfolio returns less the mean of the two-aggressive portfolio returns.

The various portfolio sorts	$A\|\alpha\|$	$\frac{A\|\alpha\|}{A\|y\|}$	$\frac{A\|\alpha\|^2}{A\|y\|^2}$	$\frac{As^2}{A\|\alpha\|^2}$	AR^2	**GRS**
3x3 size/value						
MKT	1.130%	1.145	1.179	1.133	44.134%	2.489
SMB HML MKT	0.880%	0.893	0.723	1.676	63.551%	1.488
SMB RMW MKT	0.893%	0.897	0.728	1.950	60.372%	1.662
SMB CMA MKT	0.953%	0.957	0.826	1.884	60.204%	1.537
RMW CMA MKT	1.199%	1.103	1.204	1.349	48.390%	3.814
SMB HML RMW CMA MKT	0.975%	0.979	0.864	1.928	63.602%	0.946
3x3 size/profitability						
MKT	1.126%	1.137	1.165	0.946	45.770%	5.234
SMB HML MKT	0.879%	0.887	0.714	1.712	62.419%	2.294
SMB RMW MKT	0.848%	0.856	0.665	1.840	64.509%	2.231
SMB CMA MKT	0.935%	0.944	0.705	1.685	62.273%	2.264
RMW CMA MKT	1.168%	1.179	1.252	1.194	51.912%	4.896
SMB HML RMW CMA MKT	0.912%	0.921	0.767	2.121	64.657%	2.352

3x3 size/investment						
MKT	1.155%	1.126	1.143	0.918	47.306%	6.422
SMB HML MKT	0.885%	0.863	0.677	1.551	63.710%	2.861
SMB RMW MKT	0.894%	0.873	0.691	1.594	63.953%	3.359
SMB CMA MKT	0.871%	0.851	0.658	1.652	65.636%	2.434
RMW CMA MKT	1.189%	1.150	1.212	0.946	54.153%	8.177
SMB HML RMW CMA MKT	0.911%	0.889	0.717	1.926	66.633%	1.455
3x4 size/value						
MKT	1.256%	1.136	1.162	1.117	40.096%	2.676
SMB HML MKT	0.907%	0.913	0.755	1.667	58.729%	1.580
SMB RMW MKT	0.943%	0.945	0.707	1.866	55.922%	1.869
SMB CMA MKT	0.972%	0.971	0.851	1.846	56.145%	1.746
RMW CMA MKT	1.298%	1.174	1.241	1.367	45.328%	3.728
SMB HML RMW CMA MKT	1.119%	0.914	0.926	1.709	59.504%	1.516
3x4 size/profitability						
MKT	1.178%	1.138	1.166	1.128	42.298%	3.522
SMB HML MKT	0.966%	0.934	0.788	1.749	57.562%	1.971
SMB RMW MKT	0.957%	0.925	0.774	1.700	58.275%	2.416
SMB CMA MKT	0.930%	0.905	0.800	1.666	58.933%	1.600
RMW CMA MKT	1.250%	1.217	1.334	1.226	49.373%	3.983
SMB HML RMW CMA MKT	0.922%	0.987	0.879	1.977	60.496%	1.597

3x4 size/investment						
MKT	1.719%	1.140	1.180	0.933	43.780%	3.522
SMB HML MKT	0.988%	0.951	0.816	1.611	57.562%	1.971
SMB RMW MKT	0.991%	0.970	0.866	1.567	58.275%	2.416
SMB CMA MKT	0.975%	0.936	0.792	1.774	58.933%	1.600
RMW CMA MKT	1.278%	1.225	1.353	1.136	49.373%	3.983
SMB HML RMW CMA MKT	0.995%	0.955	0.824	1.987	60.496%	1.597
2x2x3 size/value/profitability						
MKT	1.355%	1.117	1.124	1.116	41.963%	1.918
SMB HML MKT	0.994%	0.914	0.756	1.581	60.602%	0.791
SMB RMW MKT	0.973%	0.889	0.716	1.879	60.207%	0.832
SMB CMA MKT	1.196%	0.989	0.882	1.725	57.582%	0.900
RMW CMA MKT	1.309%	1.161	1.213	1.247	49.774%	1.869
SMB HML RMW CMA MKT	1.151%	0.952	0.819	1.700	65.696%	0.670
2x2x3 size/value/investment						
MKT	1.294%	1.134	1.158	0.988	43.598%	3.990
SMB HML MKT	0.992%	0.950	0.832	1.473	61.802%	1.981
SMB RMW MKT	1.153%	0.913	0.924	1.524	59.557%	3.191
SMB CMA MKT	1.127%	0.980	0.884	1.657	62.249%	1.999
RMW CMA MKT	1.331%	1.167	1.225	1.289	51.636%	5.852
SMB HML RMW CMA MKT	0.994%	0.962	0.835	1.833	66.612%	1.965

2x2x3 size/investment /profit						
MKT	1.198%	0.995	0.990	1.157	43.906%	4.108
SMB HML MKT	0.984%	0.800	0.749	1.746	60.609%	2.228
SMB RMW MKT	0.994%	0.928	0.779	1.690	62.992%	2.309
SMB CMA MKT	0.998%	0.940	0.814	1.810	61.674%	1.841
RMW CMA MKT	1.104%	1.111	1.111	1.351	52.943%	7.705
SMB HML RMW CMA MKT	0.999%	0.987	0.879	1.958	64.724%	4.937
2x2x3 size/profit/investment						
MKT	1.231%	0998	0.995	0.999	43.721%	1.976
SMB HML MKT	0.979%	0.973	0.853	1.462	59.862%	2.215
SMB RMW MKT	0.961%	0.956	0.826	1.557	61.154%	1.976
SMB CMA MKT	0.965%	0.959	0.832	1.616	61.923%	1.962
RMW CMA MKT	1.275%	1.147	1.185	1.109	52.915%	3.978
SMB HML RMW CMA MKT	1.126%	0.994	0.997	1.695	65.659%	3.395

4.6.3 Remarks based on the results of the comparative models

Apart from profitability, the FF5FM captures cross-sectional premiums that were associated with the other factors. In comparison with the size-value FF3FM, the captured premiums were mostly significant across the sorts and performed well as the other models in capturing premiums. Consequently, profitability and investment factors produced much needed improvements throughout the customary factors of size and value. In terms of relative performance, the FF5FM did not provide improvement on the size-value or size-profitability models. Rather, it performed quite satisfactorily in terms of the analysis and provided statistical improvements in explaining the returns.

Overall, the FF5FM has analytically and statistically proven to be a better and more suitable asset pricing model than both the CAPM and FF3FM models for the South African stock market.

4.7 Empirical findings

This study was modelled on Fama and French's (2015) model since the interest of this study was the relative performance of the models compared to each other. The goals of this study were two-fold, firstly, to evaluate the performance of the FF5FM and identify whether it improved the descriptions of expected share returns compared to the CAPM and FF3FM. Secondly, to find out if the *HML* factor became redundant in explaining share returns with the addition of profitability and investment factors. In terms of relative performance, the results showed that the FF5FM best explained the cross-section of returns which is consistent with studies such as Nguyen *et al.* (2015), Acaraci and Karaomer (2017), Zada, Rehman and Khwaja (2018) and Kubota and Takehara (2018). The identification of a negative size premium is consistent with recent studies such as Strugnell *et al.* (2011), Muller and Ward (2013) and Cox and Britten (2019). The results also showed inconclusive evidence that the addition of the *HML* factor to the other four factors made it redundant which is also consistent with studies by Gruodis (2015), Jiao and Lilti (2017) and Ozkan (2018).

A total of 18 portfolios that were sorted based on the size, book-to-market ratio, operating profitability, investment, and four risk factors were constructed (i.e.) *MKT, SMB, HML, RMW and CMA*. For comparative purposes, this study used the Fama and MacBeth (1973) testing procedure with the intention of obtaining the required analysis. In this regard, the FF5FM outperformed in explaining the cross-section of returns on portfolios sorted by different factors. **Tables 6 – 11** showed that the additional factors, profitability and investment, provided improvements over size and value. A size-profitability performed well in explaining returns while the FF5FM performed best in capturing the different premiums related to the fundamental risk factors in the cross-section of returns. The FF5FM performed better in the analysis and showed a statistical improvement in the explanation of returns.

Table 12 showed that there was a semblance of flexibility among the portfolio returns. High B/M portfolios showed greater returns than low B/M portfolios through all the size groups, which was consistent with the value effect. Furthermore, **Table 13** proved that two average profitability portfolios continually showed better returns than either the robust or weak portfolios. Large cap portfolios in the profitability and investment sorts reached higher returns compared to small cap portfolios as presented in **Table 14**. Finally, **Table 15**, which is generally comparable to **Table 14**, showed that conservative investment outperformed aggressive investment except for the small size and weak profitability portfolios.

Table 17 presented the comparative results of the CAPM, FF3FM and FF5FM models for all the portfolio sorts. The CAPM did not show any power in explaining the returns of portfolios, while the coefficients of the factors in the FF3FM appeared powerful. This shows that the CAPM and FF3FM are not true definitions of a model that explains the variations in monthly excess returns of portfolios. The FF5FM had statistically considerable coefficients for the Fama-French factors (i.e*.) SMB*, *HML*, *RMW*, and *CMA*.

In the South African context, only a limited number of studies such as Mahlophe (2015), Charteis *et al.* (2018), Cox and Britten (2019), and Mosoeu and Kadongo (2019) have evaluated the FF5FM to date. The results of their studies concluded that the FF5FM performed better when compared to other asset pricing models such as the CAPM and the FF3FM.

Overall, it can be said that the FF5FM has proved to be an enormous improvement compared to earlier asset pricing models. Therefore, the empirical results of this study are consistent with those of Fama and French (2015), Chia *et al.* (2015), Martins and Eid Jr. (2016), Acaraci and Karaomer (2017), Guo *et al.* (2017), Sundqvist (2017), Vieira, Maia, Klotzle, and Figueiredo (2017) and Erdinc (2018). The FF5FM was found to be more feasible and superior to both the CAPM and the

FF3FM models for the JSE. Since there are a limited number of studies on the FF5FM in South Africa, this study sought to fill this gap by contributing to empirical literature on the said subject.

4.8 Summary

Chapter Four presented and discussed the results of the analysed data regarding the performance of the FF5FM against both the CAPM and FF3FM models. Furthermore, the results of Chapter Four were presented and interpreted in three parts: factor statistics, Fama and French (1973) testing procedure, and descriptive statistics. It then contrasted the study's results to those of earlier studies with the aim of drawing expressive interpretations. A discussion and presentation of the Fama and MacBeth (1973) testing procedure results of all the tested models was introduced for this study. Chapter Four also presented the regression model results which used a modified GMM method of Hansen (1982) and interpreted the results thereof. The chapter then presented a detailed discussion and results of the performance of the different asset pricing models. It is evident from the presented and interpreted results that the following added factors: investment and profitability of the FF5FM delivered some augmentations over both the CAPM and FF3FM models in explaining stock returns on the JSE. The FF5FM also performed satisfactorily when analysed and delivered a statistical improvement in terms of the returns explained. The results of this study also proved that the *HML* factor is far from being a redundant factor on the JSE. Chapter Four ends with a discussion on the empirical results of the study. The next chapter concludes the study and proposes recommendations for further research.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Chapter Five concludes the study based on the findings and results from the previous chapter. This chapter also outlines the limitations of the study and offers recommendations for further research on the said topic.

5.2 Conclusion

Numerous researchers such as Rosenberg *et al.* (1985), Pettengill *et al.* (1995), Hsia *et al.* (2000), Fox and Bayat (2007), Loukeris (2009), Basiewicz and Auret (2010), Cakici (2015), Guo *et al.* (2017), Ozkan (2018), and others have long been interested in explaining share returns of listed firms. Several decades later, a variety of asset pricing models were developed to capture the fundamental risk factors that drive share returns. Two well-known asset pricing models, the CAPM and the Fama and French (1992) three-factor model, and more recently, the five-factor model, have been proposed to capture these risk factors. The CAPM laid the foundation built upon the seminal work of Markowitz (1952) which was later expanded by Fama and French (1992) to include size and value risk factors. More recently, Fama and French (2015) added two more risk factors, profitability, and investment to capture the underlying risk factors that drive these share returns.

The aim of this study was to test the performance of the FF5FM and to find out if it performs better than the CAPM and FF3FM when estimating expected future stock returns on the JSE as well as to determine if the value factor becomes redundant in explaining expected stock returns when profitability and investment factors are added to the FF5FM on the JSE. Specifically, the aim of this study was to test the CAPM, the FF3FM and the FF5FM using 165 ALSI firms to determine which model better explains the common variation and the cross section of expected future stock returns on the JSE. To the author's knowledge, the FF5FM has not been evaluated and applied in this manner on the JSE. Therefore, the research gap left uncharted in this study led to the development of the hypothesis of the current study.

The results of this study as presented in **Tables 4 – 8** proved that the FF5FM performed better than both the CAPM and the FF3FM models when estimating expected future stock returns on the JSE.

Test results in this study further showed that the CAPM was not a good descriptive model for share returns on the JSE Ltd and regarding relative performance, the added factors improved the CAPM in explaining portfolio returns. This was confirmed in a South African study conducted by Carter, Muller and Ward (2017) and equally, other international studies also found comparable results (Fama & French, 1992; Loukeris, 2009). However, with the inclusion of added factors such as size and value in the CAPM, the FF3FM had predictive power over the CAPM in some industries of the JSE. The FF5FM did show an improvement on the FF3FM regarding estimation, and it also performed better than the CAPM.

The FF5FM outperforms both the CAPM and the FF3FM models in explaining the cross-section of returns on portfolios of JSE listed stocks organised by different traits as shown in **Table 11**. The FF5FM has proven that it is capable of extensively explaining share price variations on the JSE to a level of fullness which is not the case with other models. Consequently, it gives an agreeable grasp of what is driving disparity in share prices. The test results of this study found that the market, size, and value factors are captured by the FF5FM and the same applies to the size-value model. This study further found that the FF5FM also captured profitability and investment factors across many of the sorts assessed. Unfortunately, the FF5FM does not perform well over lengthier periods, but given that in practical terms, shorter periods are used, the five-factor model can manage to capture cross-sectional premiums. Returns are contrarywise related to the market factor and bigger firms outperform smaller firms. The FF5FM is more suitable for realistic holding time horizons in the cross-section of returns. The results of this study are consistent with the studies of Cox and Britten (2019), du Pisanie (2018) and Mosoeu and Kadongo (2019) which performed similar time-series tests analysis. High *BM* stocks outperform on the JSE, which is consistent with earlier works of van Rensburg (2003), Strugnell *et al.* (2011) and Muller and Ward (2013). The FF5FM captures this well enough. Studies by Foye (2018) and Mosoeu and Kadongo (2019) were amongst the first that tested the five-factor model across several different markets by examining how the results from the asset pricing tests vary across each region. Their studies concluded that each region had its own market characteristics such as different accounting and legal environments, profitability of firms and sophistication of financial markets which might have affected the ability of the FF5FM to describe equity returns in each region. Therefore, the results of the FF5FM on equity returns on the JSE will be different and not be applicable to other regions.

The results from **Tables 12 – 15** confirmed that the robust profitability surpasses weak profitability, and this might be a sign of quality being priced into returns. With the assumption that the FF5FM best captured the premiums, the general result that large, undervalued firms with robust profitability outperform is consistent with the examination performed on the portfolio. Once the estimation period was prolonged in robustness tests, the profitability and investment premiums became additionally important and better captured despite less important premiums. Therefore, this study can conclude that the added factors, profitability, and investment, improve the FF5FM on the JSE and show that dissimilar factors could be priced over different time periods.

A study by Cox and Britten (2019) similarly concluded that the evidence of the robustness test results in comparison with the first tests showed that size and value are normally related with shorter periods while profitability and investment is done over longer periods. Consequently, profitability and investment could only be consistently assessed based on audited financial results at year-end. Furthermore, the two factors were related; investment increases productive capacity and the success of the investment depends on the added profitability that the investment brings. The end-result is that premiums related to profitability and investment need a long-term view for the FF5FM to price them.

The robustness test in **Table 16** and comparative model results in **Table 17** showed that the additional factors added to the explanatory power of the five-factor model following earlier conclusions of Nguyen *et al.* (2015), Sundqvist (2017), du Pisanie (2018) and Cox and Britten (2019). Test results suggest that the FF5FM is considered a suitable model for estimating returns based on the assumption that most holding periods are significantly shorter than 16 years. Therefore, the FF5FM would still be the best model to use to estimate the cross-section of returns in the South African market. Kruger and Toerien (2014) concluded that since the holding periods are typically shorter with anomalies being time-period reliant, the model's main performance in the robustness test does not change the conclusion that the added factors improve the ability of the asset pricing models to capture returns. The FF5FM is more suitable in a workable holding period in the cross-section of returns.

Finally, the results of this study rejected the second hypothesis that determined that the value factor becomes redundant in explaining expected stock returns when profitability and investment factors were added to the FF5FM on the JSE based on the results presented in **Table 16**. The conclusion from this study emanates from the results that average absolute intercept for the regressions with five factors are closer to zero, proving that additional variance in average returns is captured by the FF5FM. Altogether, the FF5FM has proven to be a better and more suitable asset pricing model than the CAPM and the FF3FM models for the South African stock market.

5.3 Achieving the objectives of the study

The primary objective of this study was to test the performance of the FF5FM against the CAPM and the FF3FM. A further two objectives were also outlined to find out if the FF5FM improves the descriptions of expected returns compared to the CAPM and FF3FM on the JSE, and to determine if the value factor becomes redundant in explaining expected stock returns when profitability and investment factors are added to the FF3FM on the JSE.

Firstly, the study proved that profitability was a more reliable factor than investment in explaining share returns on the JSE. Secondly, the FF5FM performed better than the CAPM and the FF3FM in estimating share returns based on the assumptions that most holding periods were significantly shorter than 16 years. Lastly, the hypothesis that the value factor becomes redundant in explaining share returns when more factors were added to the FF5FM was rejected.

5.4 Limitations of the study

This study was subjected to the following limitations; scope of the study, sample specifications and survivorship bias which are discussed below.

5.4.1 Scope of the study

This investigation was only limited to the JSE in South Africa which is categorised as an emerging economy, and the results of this study were not compared with those of other emerging economies. Therefore, the findings of this study cannot be generalised as the study was only limited to firms listed on the South African stock market. The JSE ALSI consists of 165 firms which is a 99% representation of the total market capitalisation of tradeable stock on the JSE. This implies that this study may also be prone to thin trading.

5.4.2 Sample specifications

This study was limited to 165 ALSI firms covering a 16-year period for the years 2003 to 2019. Several South African and international studies have used larger sample sizes and longer time periods with more firms and observations. Thus, the analysis of this could be extended to consider larger sample sizes and longer time periods, but the number of firms and observations is dependent on the number of listed firms on a stock exchange.

5.4.3 Survivorship bias

The issue of survivorship bias may have occurred when the data set was used during the analysis of the sample. The results thereof could have been affected by this occurrence. However, this could have been a concern during the preliminary stages of the data set, during the first 2 to 3 years when the data would have been missing.

5.5 Recommendations for further research

Recommendations can at best be said to be ideas that could be evaluated and applied when undertaking comparable studies for future research. Future research around asset pricing models can use this study as a launchpad for further studies because of the following:

Firstly, it is important to evaluate the FF5FM on different samples of both developed and emerging financial markets to gain even more evidence. This study found evidence that the findings of Fama and French (2015) regarding the second hypothesis of this study were US sample specific. Therefore, this study recommends further studies into different financial markets to investigate whether the *HML* or any other factor becomes redundant.

Secondly, a well-known investment style, Momentum, has been continually asserted by Fama and French (2015) as a risk factor that they would like to add to create a new six-factor model to evaluate its applicability on stock markets internationally. This novel idea could prove remarkably interesting indeed on stock markets around the world including the JSE. This idea was supported in a study by du Pisanie (2018) who advocated for the addition of Momentum on the JSE while removing *SMB* whose efficiency was questioned in a study by Muller and Ward (2013).

Thirdly, this study recommends that future studies should also undertake comparative studies amongst South African JSE listed firms as an emerging economy against listed firms in another emerging economy such as Argentina. Institutional differences such as market characteristics, profitability of firms, level of investment in firms, capital market development, and sophistication of financial markets should have a pronounced effect on the level of evaluation and applicability of the FF5FM in those countries' stock markets. Such an analysis could prove insightful with the possibility of reducing sample choice prejudice related to using firms listed on only one stock market.

Lastly and quite significantly, this study also recommends that recent but less recognised models such as the Hou-Xue-Zhang four-factor model (2015), which is based on the neoclassical Tobin *q*-theory of investment, could also be evaluated and applied from a South African perspective as well. Furthermore, other risk factors such as liquidity or momentum could also be included in addition to the profitability and investment factors to create new multi-factor models that may include an assortment of risk factors that could help to better explain stock returns.

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Table 18: Number of listed firms/securities and market capitalization on the JSE as of 31 March 2019

Table 18 shows the annual number of listed firms/securities on the mainboard, and Altx board and their market capitalization on the JSE as of 31 March 2019. Monthly and yearly changes are also displayed, including percentage changes as well.

Mainboard, Venture, Development Capital, and BEE	***Month – March 2019***	***Year to date 2019***	***Year to date 2018***	***% Change yearly***	***2018***	***2017***	***2016***
Firms listed	*318*	*318*	*322*	*-1.24%*	*326*	*324*	*328*
Number of new listings	-	1	1	0.00%	*11*	*13*	*11*
Number of delistings	2	8	3	166.67%	9	21	17
AltX							
Firms listed	45	45	49	-8.16%	46	53	60
Number new of listings	-	-	-	-	1	8	7
Number of delistings	-	2	4	-100.00%	8	11	8
Overall listing on the JSE							
Number of new listings	-	1	1	0.00%	12	21	18
Number of securities listed	2	10	7	42.86	17	32	25
Foreign listings	72	72	75	-4.00%	74	75	76
Domestic listings	291	291	296	-1.69%	298	302	312
Firms listed	363	363	371	-2.16%	372	377	388
Number of securities listed	928	928	815	13.87%	822	812	816
Market capitalization (Rbn at period)	16 181.7		14 290.9	13.23%	12 682.0	15 461.4	13 580.6

Table 19: Ranking of the JSE in The World Federation of Exchanges as of 31 March 2019

Table 19 shows monthly and annual ranking of the JSE in the World Federation of Exchanges and how it measures against other stock markets around the world in US$ terms.

	March 2019	***Ranking***	***February 2018***	***Ranking***	**Ranking at year ended**			
					2018	**2017**	**2016**	**2015**
Market capitalization (US$ million)	952 494	19	1 278 577	17	19	17	18	17
Market turnover (US$ million)	27 471	19	46 340	19	19	20	20	24
Year to date liquidity %	32.99%	27	40.70%	25	25	30	22	29
Monthly liquidity %	32.68%	26	41.12%	24	30	25	22	29

Table 20: Equity capital raised on the JSE as of 31 March 2019

Table 20 shows the monthly and annual equity capital raised on the JSE (R million) as of 31 March 2019. Monthly and yearly changes are also displayed, including percentage changes as well.

	Month ended March 2019	Year to date 2019	Year to date 2018	% Change Year on year	2018	2017	2016	2015
Acquisition of assets	473	773	448	72.56%	5 231	23 315	13 085	93 130
Rights issue	1 029	1 161	1 063	9.23%	5 097	32 688	24 160	35 842
Via prospectus (IPO)	-	-	-	0.00%	-	-	-	-
Share incentive	1 083	1 201	1 219	-1.45%	6 461	9 468	9 374	11 688
Waiver of the pre-emptive rights	8 466	10 848	5 110	112.27%	38 830	35 048	69 648	109 530
Total	11 051	13 983	7 840	78.35%	55 620	100 529	116 269	250 190

Table 21: Annualised JSE liquidity on the JSE as of 31 March 2019

Table 21 shows the annualised JSE liquidity on the JSE as of 31 March 2019 that used the monthly "local liquidity" value traded and Strate market capitalization. Monthly and yearly changes are also displayed, including percentage changes as well.

	Month ended March 2019	Year to date 2019	Year to date 2018	% Change Year on year	2018	2017	2016	2015
Overall JSE liquidity %	41.55%	36.23%	44.82%	-19.17%	44.70	35.90	34.9	42.80
Central Order Book Trades Liquidity %	39.36%	34.39%	41.90%	-17.92%	42.00	33.00	32.60	39.90

Source of Tables 18, 19, 20 and 21: JSE Ltd statistics database, and The World Federation of Exchange

ANNEXURE A

Page: 1

University of Venda
Creating Future Leaders

UNIVERSITY OF VENDA

PROOF OF REGISTRATION: ACADEMIC YEAR 2020

This document is issued without alterations

Student Name MR K NELUVHALANI MAIN CAMPUS

Student Number 11576211

Qualification Code and Name	Study Level	Faculty	Offering Type	Cost
MCOM MASTER OF COMMERCE	2ND YEAR	MANAGEMENT SCIENCES	MASTERS (SUCCESIVE) FULL TIME	20530.00

Qual #	Subject Code	Subject Description	Registration Date	Cancellation Date	Stats Credit	Primary Enrollment	Cost
1	CAC6000	COST AND MANAGEMENT ACCOUNTING 6000	26-JAN-2021		0.333	Y	15670.00
				TOTAL	0.333		15670.00

Other Costs

Registration Fee	4860.00
SRC Levy	0.00
Residence Fee	0.00

NB. Costs reflected in this document applies to the current academic year registration only and do not constitute a statement account

Registrar

Print Date : 07 April 2021

UNIVERSITY OF VENDA
STUDENT ADMINISTRATION
07 APR 2021
P/BAG X5050
THOHOYANDOU 0950

University Road, Thohoyandou, Limpopo, Private Bag x5050, Thohoyandou, 0950, Limpopo, South Africa
Tel: +27 15 962 8000, Fax: +27 962 4759, Email: info@univen.ac.za Web: www.univen.ac.za

ANNEXURE B

Item	Description	Amount	Motivation
Assistance *(Type)* Research assistant	The researcher will need one research assistant for the collection of data.	R13 000.00	This individual will be aiding the researcher with all the necessary collection of data. He/she will be critical for this endeavour.
Consumables *(specify)* Highlighter pens Heavy duty stapler Heavy duty puncher Memory card for storing data		R 873.50 R 750.00 R 600.00 R 2 500.00	These consumables will aid the researcher with the completion of his research study timeously.
Travelling Expenses *(specify)* *(Approved tariffs = 3.61)* Travelling to the JSE at least twice.	3.61 x 860km x 2	R 5 776.00	The researcher will need to travel to the JSE at least twice for data collection and to familiarize with the JSE procedures.
Subsistence *(specify)* Editing of final draft of proposal Editing of final draft of research dissertation	R38 per pg. x 75 pgs. R38 per pg. x 180 pgs.	R 2 850.00 R 6 840.00	Editing is one of the most important aspects in research writing and for this reason it cannot be excluded.
Printing *(specify)* Printing of final draft of research proposal Printing of final draft of research dissertation	75pgs x R9.99 x 5 copies 135pgs x R9.99 x 5 copies	R 3 746.25 R 6 743.25	Printing will allow the researcher to check for any mistakes and to fine comb the final draft for any mistakes as well.
Other *(specify)* Accommodation	Accommodation for two trips.	R 6 322.00	Accommodation at a reasonable establishment.
Total		R50 000.00	

ANNEXURE C

Editing and proof-reading report

Office No. 06

Department of English

University of Venda

P/Bag X 5050

Thohoyandou

0950

28 November 2020

To Whom It May Concern

This serves to confirm that I proof-read and edited the dissertation entitled "Testing the Fama and French Five-Factor Model on the JSE-listed Firms" by Neluvhalani Khathutshelo, Student Number: 11576211.

Regards

N. V. Demana

Vincent N. Demana

University of Venda
Department of English
University of Venda
Tel: +27- 015 962-8363 Cell: +27-739912237
E-mail: Vincent.demana@univen.ac.za
Website: http://www.univen.ac.za/
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ANNEXURE D

SURNAME : NELUVHALANI NAME : KHATHUTSHELO

STUDENT NO : 11576211 MODULES : CAC – 6000

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017												
Topic selection												
Writing and editing of the research proposal												
2018												
Writing and editing of the research proposal												
2019												
Writing and editing of the research proposal												
Presentation of the research proposal at the departmental level												
Effecting corrections and recommendations from departmental level												
Evaluation of the research proposal at the school higher degrees' committee												
Effecting corrections and recommendations from school higher degree's committee												
Data collection, analysis and writing of dissertation												
2020												
Data collection, analysis and writing of dissertation												
Editing of dissertation												
Printing, photocopying, spiral binding of dissertation and submission for marking												
Corrections, final binding, and submission dissertation												
2021												
Corrections, final binding, and submission dissertation												
Expected graduation date												