Is the Environmental, Social and Corporate Governance (ESG) score the missing factor in the Fama and French five-factor asset pricing model?

A research report submitted by

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DECLARATION

I, **Luyanda Malusi Qiniso Nsibande**, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Commerce in Accountancy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

Luyanda Malusi Qiniso Nsibande

Signed at: …Braamfontein, Johannesburg……………….……………………………

On the …2nd………………………….. day of …September……………………… 2022..

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ABSTRACT

Background: Companies are increasingly encouraged to focus on the creation of sustainable value. In South Africa, financial research institutions evaluate and track companies' performance based on environmental, social and governance-related criteria. These scores are intended to inform decisions by potential equity investors, amongst others. However, commonly-used asset pricing models do not include ESG scores.

Purpose: The purpose of this research is to discover whether the inclusion of Environmental, Social and Governance (ESG) scores in the Fama and French five-factor model (FF5) will improve the model's predicting power of expected returns on the Johannesburg stock exchange JSE

Methodology: For the largest 40 JSE-listed companies, statistical ordinary least squares (OLS) regression was employed with R statistics to analyse fundamental, share price and ESG score data over the five-year time period from 2015 to 2019. The researcher compared the predictive power of the FF5 model to that of the same model including ESG scores.

Findings: The results showed that the predictive power of the FF5 model is only marginally improved when the ESG scores are incorporated. These findings may indicate that equity prices are not significantly influenced by ESG scores.

Implications: The findings of this research provide the basis for further endeavours on the share-price implications of ESG performance. It makes a theoretical contribution by suggesting possible enhancements to traditional asset pricing techniques.

Key words: Environmental, social and governance (ESG), Fama-French Five-Factor Model, JSE, Predictive power

1 INTRODUCTION

1.1 Context of the study

1.1.1 Sustainability, and Sustainable and Responsible Investment

Of all the issues that plague modern society, it seems there is none that has drawn universal attention as has sustainability. In recent decades, a myriad of international alliances and organisations have been formed, projects initiated, future goals formulated, and money - in increasingly large amounts – spent in the name of sustainability (Scoones, 2007). Perhaps, underlying this movement is the recognition that if the Earth's ability to accommodate life was essentially impaired, there would seem to be little point in worrying about other issues (Thompson & Sparks, 2002).

In line with this, on September 2015, the United Nations (UN) launched the UN Sustainability Development Goals (SDGs hereafter). These are a collection of 17 goals that are focused on creating a more sustainable future for the world by addressing the most urgent of its problems, these include: the eradication of poverty, reducing the reliance and use of non-renewable energy sources in favour of more sustainable energy sources, economic growth, and climate action, among others (Miralles-Quirós, Miralles-Quirós & Nogueira, 2020). These goals form part of a globally agreed upon sustainability agenda planned to be reached by 2030 (United Nations, 2015). Soon after this, in 2016, world leaders signed the UN Paris agreement. This is a legally binding international treaty on climate change that was signed and adopted by 196 parties, such as states and the European Union, in Paris on 12 December of the same year as the launch of the SDGs. Working in 5 year cycles, the Paris agreement aims to limit global warming, and proved to be a landmark in the global climate change agenda, as it was the first time that a binding agreement united all nations for a common cause of combatting climate change (United Nations, 2015).

For the world to meet the SDGs and related sustainability agenda by 2030, participation and commitment is needed from all spheres, both private and public. In this context, nations, countries, regulators, business sectors, investors and ordinary citizens have led the charge to build a more sustainable future. For example, although historically, profitability has been the prime focus for business entities. There is now greater pressure from stakeholders, and society at large, for business entities to focus equally on the social and environmental concerns that affect their business – a concept commonly referred to as 'the triple bottom line', as coined by Elkington (1997).

In the accounting sphere, firms like KPMG now recognize the power of ESG to transform the businesses of their clients and are currently stirring the winds of change on the sustainability agenda by offering ESG advisory solutions that aim to drive sustainable innovation and help clients gain a competitive edge in business (KPMG, 2022). This, coupled with a focus on ESG training implemented by KPMG for their work personnel, in part, demonstrate the commitment of KPMG to the ESG agenda.

However, although most firms have developed an understanding that sustainability needs to be made core to their strategy and capital allocation process, there had been confusion on how best to credibly report on ESG performance to investors and other stakeholders (Harvard Business Review, 2022). There had also been a growing need for a universal uniform set of standards for measurement and reporting on ESG performance - just as we have for financial performance (Harvard Business Review, 2022). Fortunately, in recent years, regulators have also intensified their responses to these global cries. For example, the European Union released its Sustainable Finance Action Plan which came into effect over the course of 2021. This major piece of regulation is aimed at promoting sustainable investment by clarifying the revised and increased roles and duties asset managers and investors now have in relation to the sustainability agenda. In addition to this, the EU Commission also stressed its commitment to promote the Action Plan to other nations.

With this in mind, sustainable and responsible investment (hereafter SRI) is therefore expected to enjoy even more attention and focus then it did in the past – both from academic and corporate spaces. SRI can be understood as a paradigm that takes social and environmental aspects into account as part of financial analysis and investment decisions (Searcy & Elkhawas, 2012). SRI involves the selection and exclusion of securities based on sustainability criteria for investment purposes (Renneboog et al., 2008). Asset managers are now feeling the pressure to satisfy both investor and regulatory demands by changing the way they invest, with many now considering ESG criteria when forming their portfolios.

Lastly, in a widely covered press release, Larry Fink, the CEO of Blackrock, the world's largest asset manager, is quoted as saying: "Sustainable investing will be a core component for how everyone invests... We are only at the early stages" (Times, 2018, p. 1). He accentuates the idea that SRI is now at the centre stage for some of the largest investors around the world. Derwall, Guenster, Bauer & Koedijk (2005) also echoes this idea, noting that large institutional investors are showing a preference for investing in firms that are deemed socially, morally, and environmentally responsible.

1.1.2 Asset pricing and the Fama and French five-factor model

Asset pricing models are theoretical models that attempt to explain the pricing behavior of assets. Typically, assets are valued based on the delay and the risk of their respective payment(s). Although the effects of timing in the valuation of assets is not a hard concept to grasp, the valuation of the risk effects presents a greater challenge, and most times, tends to be the most important determinant of an asset's price or value (Cochrane, 2009). For example, Cochrane (2009) makes mention of the fact that in 2009, US stocks had produced a real return of approximately 9% on average over the last 50 years, however, only about 1% of this return was attributable to interest rates, the rest (about 8%), was a premium earned for holding risk. This highlights the importance and relevance of understanding risk and its interaction or correlation with returns, and asset pricing is an attempt to address this challenge.

Asset pricing theory can be used in the positive, and in the normative context. When observing the pricing of assets in the market, a position could be taken to try understand the actual pricing behavior of the assets and conclusions be formed around why the pricing of assets behaves in the way that it does, and should the observation not agree with a developed asset pricing model, a stance could be taken that the model needs improvement. This is an example of the positive use of asset pricing models, and how they are typically applied in academic spaces. Alternatively, a stance could be taken that the market is incorrect, and therefore, 'mis-pricing' the asset. This could present trading opportunities for investors (Cochrane, 2009). Thus, asset pricing models, although theoretically founded, could be useful tools for shrewd investors.

Although asset pricing models can be applied in the pricing of a variety of assets, its most common use is the pricing of shares or share portfolios, and this use, was also the context under this research was performed.

The seminal work of Treynor (1961), Sharpe (1964), Lintner (1965), Mossin (1966), and Black et al. (1972) resulted in the development of one of the most popular and widely used asset pricing models – the Capital Asset Pricing Model (CAPM). The CAPM is a single-factor model, and postulates that expected returns, as observed in markets like the Johannesburg Stock Exchange (JSE), are explained by a single factor – the share or portfolio's sensitivity to non-diversifiable risk (systematic or market risk). Although the subject of numerous empirical test failings on different markets, the CAPM still remains popular in its use and is the foundation for most asset pricing asset pricing models developed after it.

Another important model in asset pricing was the Arbitrage Pricing Theory (APT) developed by Ross (1976) as an alternative to the CAPM. With the APT, Ross (1976) showed that it was possible that more than one factor explains expected returns, and as such the APT is a multi-factor model, unlike the CAPM. The APT model was more generic in nature, with the factors not well defined by Ross (1976). The variables that were typically included as explanatory factors are macroeconomic factors such as inflation, gold prices, and GDP. This is, however, not prescriptive as the factors could be any factor that could correlate with the returns of the share, share portfolio or other asset that is subject to valuation.

After the work of Ross (1976), other scholars formed their own asset pricing models, adding factors that were believed to bare relationships with stock returns. One of the most prominent and empirically successful of these, is a three-factor model developed by Fama and French (1992) which has its foundation on the CAPM. While the CAPM was based solely on a stock's correlation with the market, the Fama and French (1992) three-factor model added two additional factors to this model that were observed in empirical tests to have a relationship with returns, namely, the size and the value factor. The size factor represents the excess returns that small capitalisation firm stocks produced relative to large capitalisation firm stocks, while the value factor represents the excess return that firm stocks with high book to market values generate relative to firm stocks with low book to market value, with the book to market factor being measured by the book to market ratio.

Although the Fama and French (1992) three-factor model was relatively an improvement to the CAPM model in a number of markets, it had its limitations. Some scholars found it to be an incomplete model for expected returns in some markets as it failed to capture much of the variation in average returns related to other risk factors, for instance, the three-factor model failed to capture the return premiums associated with robust profitability and concentrated investment in some markets. Therefore, responding to this critic, Fama and French (2015) developed another asset pricing model, which added two additional risk factors to the their three-factor model, namely, the profitability and the investment factor.

The Fama and French five-factor model (FF5F) aims to improve on, and better describe the expected returns of securities through five factors, namely: (1) market risk, (2) the outperformance of small capitalisation company stocks relative to large capitalisation company stocks (the size factor), (3) the outperformance of high book-to-market value company stocks (value stock) relative to low book-to-market value company stock (growth stock), (4) the outperformance of the stock of companies with robust profitability relative to the stock of those companies with weak profitability, and finally, (5) the outperformance of the stock of companies that invest conservatively relative to the stock of companies that invest aggressively. The rationale behind the model is that the stock of companies with a high market premium, small market capitalisation, high book-to-market value, robust profitability, and conservative investment – i.e., the five factors - tend to regularly outperform the overall market (Fama & French, 2015). It, therefore, aims to capture those risk factors that are priced by market participants that may have been missed by the asset pricing models discussed above.

However, although international and South African studies generally accepted the Fama and French (2015) five-factor model as an improvement to both the original CAPM and the Fama and French (1992) three-factor model (Charteris, Rwishema & Chidede, 2018; Cox & Britten, 2019; Fama & French, 2016), it still failed to fully explain the expected returns as observed on international markets and the JSE (Alrabadi & Alrabadi, 2018; Chiah, Chai, Zhong & Li, 2016).

Therefore, given the failure of the FF5F to *fully* explain stock performance; there may be scope to improve this model by incorporating an additional risk factor (Chiah et al., 2016). Motivated by the increasing importance of, and focus on ESG by investors and academics at large, this research proposes that this additional factor may be an ESG factor, measured by ESG performance scores. More detail is provided in chapter 2 of asset pricing, ESG and the relationships observed by researchers between ESG and expected returns in prior studies.

1.2 Purpose

The purpose of this research is to discover whether the inclusion of Environmental, Social and Governance (ESG) scores in the FF5 will improve the model's predicting power of expected returns on the Johannesburg stock exchange JSE

1.3 Research question

Does the inclusion of an ESG scores factor in the existing FF5F result in an improvement in the model's predicting power of returns of JSE-listed companies?

1.4 Significance of the study

The research will add on to existing empirical knowledge on asset pricing – more specifically, the FF5F. Prior literature has primarily focused on empirically testing the model on the JSE and various international markets (Charteris et al., 2018; Cox & Britten, 2019; Fama & French, 2016). In addition to this, some other studies have aimed to empirically test whether the inclusion of various other factors such as human capital (Maiti & Balakrishnan, 2018), momentum (Dirkx & Peter, 2020) and ESG scores (Maiti, 2021) would improve the predicting power of the FF5F. The study is unique in that, to the researcher's knowledge, to date, there are no published studies that have performed this investigation on the JSE. The research also contributes to previous endeavours that aimed to determine how ESG performance is related to share price.

Lastly, the primary role of asset pricing models such as the CAPM, the Fama and French three-factor model and the FF5F is to specify the suitable measures of risk and the appropriate risk to return trade-off (Korajczyk, 1999). They are widely used in finance and have proven to be useful tools for understanding portfolio performance. These models also provide investors with techniques that assist in portfolio construction and may also be used to estimate the expected future returns of risky securities. It can, therefore, be seen that improvement of the five-factor model's predicting power of expected returns on securities markets would have profound implications for corporate investors and academics alike.

1.5 Assumptions, limitations, and delimitations

As the purpose of the research is to investigate whether inclusion of ESG scores will improve the explanatory power of the FF5F in predicting expected returns, the research did not empirically test the validity of five-factor model in explaining expected returns, but rather, it investigated whether the model is improved by such inclusion.

The research was conducted on the JSE, and therefore, the results thence, may differ had the research have been conducted in another stock exchange market. In light of this, the generalisability of the findings of the research may be limited to JSE listed securities. Furthermore, the largest 40 companies on the JSE were chosen. Although this introduces an element of size-bias, it must be noted that the same companies were used in the traditional FF5 model and in the ESG-inclusive FF5 model.

In addition to this, the ESG performance scores data used in the research was sourced from the Refinitiv Workspace database, and may therefore, be subjective, and dependent on Refinitiv's underlying ratings approach which will be discussed in chapter 3. Use of a different ESG database may result in changes in the findings of the research.

1.6 Definitions of terms

Capital Asset Pricing Model (CAPM) is an asset pricing model that describes how the risk of an asset affects its expected return. In essence, it is premised on the idea that only undiversifiable risk, i.e., systematic risk, affects the expected returns of an asset (Perold, 2004).

Fama and French five-factor model is an extension of the Fama and French three-factor model that adds the profitability and investment risk factors to the three-factor model in describing the expected returns on assets (Fama & French, 2015). Fama and French three-factor model is an asset pricing model that builds on the CAPM by adding the size and value risk factors in describing the expected returns on assets (Fama & French, 1993).

Value-weighted returns refers to applying weights to assets based on the assets market value relative to the total portfolio market value (Vilkov, Uppal & Plyakha, 2014).

2 THEORETICAL FRAMEWORK: CAPM, THE FAMA-FRENCH THREE-FACTOR MODEL AND THE FAMA-FRENCH FIVE-FACTOR MODEL

2.1 Modern Portfolio Theory

The application of risk measurement in the context of an equity portfolio is attributed to Markowitz (1952). Prior to this, although scholars and practitioners were aware of the concept of risk and return, the failure to adequately quantify these measures made the goal of constructing an optimal portfolio very subjective, and often provided very little insight on the returns that investors could expect on their investments (Fabozzi, 2001).[1] In addition to this, investors would often focus on the risks of their individual assets, without understanding how combining such assets could affect the risk of the portfolio and its respective return (Fabozzi, 2001). Markowitz (1952) therefore emphasized the importance of not solely focusing on an asset's individual risk and return, but the risk and return that the asset contributes to the investor's portfolio. He employed statistical analysis and mathematical programming for risk measurement and the selection of an efficient set of assets in a portfolio, respectively, therefore providing a theoretical model for analysing risk and return, and the inter-relationships between these concepts.

With this concept –referred to as the Modern Portfolio Theory (MPT) – Markowitz birthed the concept of an 'efficient portfolio'. This is a portfolio of combined assets that, through diversification, is expected to yield the best possible level of return for a given level of risk. In essence, MPT is based on normative theory and provides practitioners with a framework that can be used to construct and select portfolios depending on the risk appetite of the investor and the expected performance of the investment (Fabozzi, Gupta & Markowitz, 2002). [2] The return component of a portfolio is frequently

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[1] An optimal portfolio is one designed with a perfect balance of risk and return. The optimal portfolio looks to balance securities that offer the greatest possible returns with acceptable risk or the securities with the lowest risk given a certain return.

[2] Normative theory is theory that describes the norm of behaviour that investors should pursue in constructing portfolios, as opposed to a theory that is in fact followed in practice (Fabozzi, Gupta and Markowitz, 2002).

measured by the proportionally weighted combination of the constituent assets' individual returns – also called the 'mean' - while the risk component is measured by the proportionally weighted combination of standard deviations of the individual assets from the portfolio mean. As the key contribution of MPT is diversification, investors would be wise to invest in assets that are not positively correlated, i.e., assets that are less synchronized, as the sum of their standard deviations would be less if compared to that of a portfolio consisting of perfectly correlated assets for a given level of return. Should an investor successfully construct a portfolio that optimises the risk versus return paradigm, such portfolio would line up along a line referred to as 'the efficient frontier line'.[3]

2. 2 CAPM

Asset pricing – and more specifically: how the risk of an asset affects its expected return - is a central question in finance that has been studied for many years. The CAPM, as was developed by Treynor (1961), Sharpe (1964), Lintner (1965), Mossin (1966) and Black, Jensen & Scholes (1972), was the first coherent framework for answering this question (Perold, 2004).

The CAPM is an extension of MPT and is dependent on an efficient capital market hypothesis from portfolio theory (Kumar, 2002). It is based on the following assumptions:

- All the investors are risk averse and want to be somewhere on the Markowitz (1952) efficient frontier, thus, maximizing the expected utility for their wealth.
- Investors can borrow and lend an unlimited amount of money at the risk-free rate.[4]
- Investors are price takers and have the same expectations with regards to the probability distribution of the future rate of return on their investments.

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[3] The efficient frontier is a set of optimal portfolios that yield the highest expected return for a given level of risk or the minimum risk for a given level of return.

[4] The Black et al. (1972) version of the CAPM does not include this assumption, but rather, achieves market efficiency by allowing for unrestricted short selling of risky assets.

- The invested assets are fixed, marketable and infinitely divisible, meaning it is possible to buy and sell fractional assets.
- There are no market imperfections, i.e., there are no taxes, regulations, restrictions or other transaction costs in buying and selling assets.
- Information is frictionless, and freely available to all investors simultaneously.

Under these assumptions, the CAPM establishes that the expected return of an asset (in this case a share) is a function of the risk-free rate and the asset's sensitivity to the excess return generated in the market. The CAPM can be represented by the formula below:

$$E(R)i = Rf + \beta i\,(Rm - R\,f) \qquad \textit{(1)}$$

Where $E(R)_i$ is the expected return on the share $_i$, Rf is the risk-free rate; $E(R_m)$ is the expected return on the market portfolio of assets; and $[E(R_m) – R_f]$ is the market risk premium. B_i is the sensitivity of share $_i$ to the excess return on the market and can be decomposed as follows:

$$Bi = \frac{Cov(Ri,Rm)}{Var(Rm)} \qquad (2)$$

where beta is the covariance of share $_i$ with the return on the market divided by the variance of the return on the market portfolio.

While the MPT illustrated a non-linear relationship between the expected returns and the risk of an asset; the CAPM displays a linear relationship between the two. The risk thereof, can be defined as comprising of two types of risk: systematic risk and idiosyncratic risk (see figure 1). The former risk is the undiversifiable risk that is faced by all investors resulting from macro-economic and political factors such as oil and gold prices, wars, political instability, inflation, biodiversity loss, etc. In the CAPM formula, this risk is captured by beta. If CAPM holds, the impact of systematic risk should be entirely captured by the sensitivity to the market premium. The latter type of risk: idiosyncratic risk, is born out of firm-specific factors attached to that share. For instance, the company's operations, industry, size or any other specific factors that increase the uncertainty of investing in that particular share. The CAPM assumes that systematic risk is the only priced factor in estimating returns (Charteris et al., 2018), and by holding the market portfolio, all idiosyncratic risk is diversified away from. Therefore, for an investor to earn greater returns, they would have to be willing to take on more risk, i.e., by having an increased sensitivity to the excess market return (Sharpe, 1964).

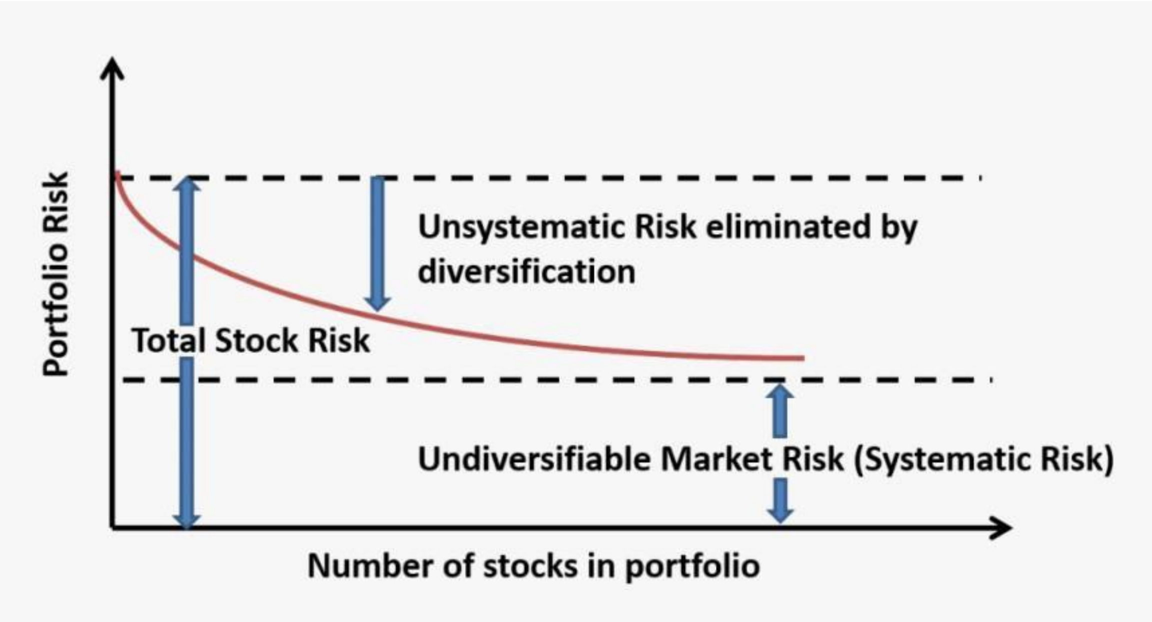

Figure1: Systematic and unsystematic risk diagram, Source: https://ordnur.com/academic-study/finance/difference-between-systematic-and-unsystematic-risk/

2.2.1 Tests on the CAPM

In contemporary culture, the CAPM has enjoyed a great deal of popularity, both academically and in practice. It is frequently the only asset pricing model taught in most undergraduate and postgraduate finance classes. In addition to this, it is heavily used by portfolio managers and investors for a host of reasons, including estimating the cost of equity for listed securities, selection of investment projects, evaluating the performance of mutual funds and other portfolios (Fama & French, 2004) and for the purposes of performing valuations. As such, the CAPM is viewed as a cornerstone in finance theory and practice, however, although much beloved, there is not a shortage of empirical evidence that challenges the ability of the CAPM to fully explain returns (Banz, 1981; Bhandari, 1988; Fama & French, 1992, 1996; Stattman, 1980).

According to Roll (1977) testing of asset pricing models often require assumptions of market efficiency, and the testing of the Efficiency Market Hypotheses (EMH) often requires the use of asset pricing models; therefore, one can view the two as being inextricably linked. This intuitively makes sense for the CAPM given that one of its underlying assumptions is the existence of an efficient market (Sharpe, 1964). Thus, the joint hypothesis problem may be ever present when testing asset pricing models such as the CAPM using EMH assumptions or vice versa, i.e., the results from the testing may indicate that the market is not efficient or the asset pricing model is misspecified or incomplete, or both (Roll, 1977). The implications of this are that it may be theoretically impossible to truly test an asset pricing model or to test for market efficiency (Cox & Britten, 2019). However, despite this, such tests do provide useful information about the risks, expected returns of asset prices and the drivers thereof. The linear relationship between risk and return is the substratum of the CAPM model, and accordingly, if the market is efficient; it will reward those who bear more risk (Cox & Britten, 2019).

2.2.1.1 International tests

The Black version of the CAPM has experienced less empirical challenge in comparison to the Sharpe (1964) and Lintner (1965) versions, although they share the prediction that the market portfolio is mean-variance-efficient (Fama & French, 2004). This means that differences in the expected returns across portfolios should be entirely explained by differences in the market beta, i.e., no other variable should be able to add anything to the explanation of expected returns (Fama & French, 2004). As expected, this prediction played a critical role in the subsequent earlier empirical tests of the CAPM. Most early studies relied on cross sectional regressions to test this prediction. This typically involved adding pre-determined explanatory variables to the month-to-month cross regressions of returns on beta, and if this resulted in the average slope of the additional variables not being reliably different from zero; this suggested that all differences in the expected returns were explained by beta – therefore, the CAPM would hold, see (Fama & MacBeth, 1973).

Basing their results on testing done on New York Stock Exchange (hereafter NYSE) common stock traded during the period of January 1926 through to 1968, Fama and MacBeth (1973) initially provided support for the CAPM after choosing squared market betas and residual variances from the regression of returns on the market return (in order to test the prediction that market beta is the only measure of risk that is needed to explain expected returns). From their results, they concluded:

> We…cannot reject the hypothesis of the two-parameter model that *no measure of risk, in addition to portfolio risk, systematically affects average returns,* (Fama & MacBeth, 1973, p. 633).

Following a different approach, Kothari, Shanken & Sloan (1995) used time-series regression to investigate whether average returns compensate for beta risk over the 1941 to 1990 period and between the 1927 to 1990 period for firms listed on the NYSE and AMEX. The study employed full-period annual betas instead of month- to-month betas and found evidence that average returns do indeed reflect substantial compensation for beta risk, however, Kothari et al. (1995) did acknowledge that this did not mean that beta accounted for *all* cross-section variation in expected returns (Kothari et al., 1995, p. 221).

2.2.1.1.1 Issues with the CAPM

One of the most prominent earlier studies to challenge the empirical validity of the CAPM was Basu (1977). The objective of the Basu (1977) research was to empirically research whether the investment performance of common stocks was related to their price-to-earnings ratios (hereafter P/E ratios). Using a sample of 1 400 industrial firms which traded on the NYSE between September 1956 to August 1971, the research found that when the stocks were sorted on P/E ratios, the stocks with higher E/P displayed higher expected future returns than that that was predicted by the CAPM.

Banz (1981) also highlighted problems linked with the use of the CAPM. Banz (1981) examined the relationship between the total market value of common stock for firms listed on the NYSE with their respective returns between the periods of 1936 to 1995. From the results, Banz (1981) observed that for the mentioned sample period, the common stock of small firms, on average, outperformed that of larger firms, i.e., smaller firms displayed higher average risk-adjusted returns, of about 0.4% per month, relative to larger firms – a concept commonly referred to as the ‘size effect’. These results provided some evidence that the average returns of stock were driven not only by systematic risk, but possibly some other factors as well – such as size – therefore suggesting that the CAPM was misspecified. However, on conclusion of the research, Banz (1981, p. 16) notes:

> There is no theoretical foundation for such an effect. We do not even know whether the factor is size itself or whether size is just a proxy for one or more true but unknown factors correlated with size.

After Banz (1981), several other authors observed the size effect. Reinganum (1981b) observed the size effect on a sample consisting of 566 firms listed on the AMEX and

NYSE between the 1963 to 1977 period, finding that the smallest size decile on their sample outperformed the largest by 1.77%. Similarly, performing research on a broader sample of NYSE and AMEX firms, Keim (1983) reported a size premium of at least 2.5% per month. In addition to this, Lamoureux and Sanger (1989) found a size premium of 2.0% per month for 20 size-sorted portfolios on the NASDAQ and noted that small firms displayed a lower beta than larger firms, this being in contradiction to the principles established on the CAPM as higher beta stocks were expected to produce higher average returns.

Stattman (1980) founds that average cross-sectional returns of US stocks were positively related to book-to-market (B/M) ratios. The research from both mentioned articles found that stocks with high B/M equity ratios, i.e., the ratio of the book value of a common stock to its market value produced higher average returns relative to those of low B/M stocks, and these returns were not captured by their betas (Rossi, 2016).

Further, Bhandari (1988) following the Fama and MacBeth (1973) methodology on the NYSE, also found expected common stock returns to be positively related to the ratio of debt to equity after having controlled for beta and firm size. Based on the observations, Bhandari (1988, p. 507) concluded:

> This relationship is not sensitive to variations in the market proxy, estimation technique, etc. The evidence suggests that the “premium” associated with the debt/equity ratio is not likely to be just some kind of risk premium.

Although researched by several authors beforehand as discussed above, it was not until Fama and French (1992) that research challenging the role of beta and the CAPM gained traction. Fama and French (1992) examined the size and book-to-market anomalies that were discovered by prior literature and made the case that the empirical shortcomings of CAPM were too important to ignore. Performing a study on a sample of stock listed on the NYSE, NASDAQ and AMEX over the period 1963 to 1990, Fama and French (1992) found that the combination of the size (proxied by market equity) and book-to-market equity combined to absorb the role of market beta in explaining cross-sectional returns. The research found that when the size deciles were subdivided into 10 beta-sorted portfolios, there ceased to be any relation between beta and returns. This observation of a flat relation between beta and expected returns led Fama and French (1992) to the conjecture that “beta is dead”, much to the criticism of the finance community at the time (see Kothari et al., 1995).[5]

2.2.1.2 CAPM tests on the JSE

Van Rensburg and Robertson (2003) provided one of the most credible analysis of unambiguous empirical contradiction for the CAPM on the JSE. Investigating the explanatory power of beta, following the methodology of Fama and French (1992) and using a full dataset of monthly share returns on the JSE for the period beginning on July 1990 to June 2000, having adjusted for fall corporate events (including delistings to avoid survivor bias). They found evidence of the size and the price-to-earnings effect, but more interestingly, they found that on the JSE, beta was inversely related to returns. It is suggested that their study may, however, have been challenged by the use of a short sample period (only 10 years) and a strong bias towards fledgling stocks due to the inclusion of many small capitalisation shares.

Building on the work and observations of van Rensburg and Robertson (2003), Strugnell, Gilbert & Kruger (2011) investigated whether the conclusions of van Rensburg and Robertson (2003) were robust and generally valid. Using monthly share price data covering the period 1994 to 2007, they found support for the inverse relationship between beta and returns, and evidence of the size and price-to-earnings effect. Although Strugnell et al. (2011) controlled for thin trading, Muller and Ward (2011, p. 2) contend that this study suffered from the same challenges as that of van Rensburg and Robertson (2003): having too short a time horizon and the inclusion of small capitalisation shares.

Using improved methodology (four different methodologies) and share price data of 160 shares on the JSE over 26 years covering the period 31 December 1986 to 31 December 2011 (a larger time horizon than van Rensburg and Robertson (2003) and Strugnell et al. (2011)), Muller and Ward (2011) attempted to re-examine South African

[5] Fama and French (1992) did however acknowledge a reliable relation between beta and average returns during the 1941 to 1965 sub- period, and this portion of their data constituted a significant part of the samples for earlier prior research tests that was supportive of CAPM such as Black, Jensen and Scholes (1972) and Fama and MacBeth (1973), however, even over this period, beta did not display any explanatory power when controlling for firm size (Van Rensburg, 2001, p. 46).

literature on CAPM in a more comprehensive manner for evidence of the relationship (or lack thereof) between beta and returns.[6] They found that contrary to the CAPM, there was indeed monotonic, inverse relationship between beta and returns on the JSE, thus supporting the findings of Fama and French (1992, 2004); Montier (2007); van Rensburg and Robertson (2003); Strugnell et al. (2011). Interestingly, they found that this inverse relationship ceased to exist after the first fifteen years of their study period, resulting in no association between beta and returns in the last seven years of their study period. In addition to these findings, Muller and Ward (2011) found a positive correlation between beta and size (proxied by market capitalisation); a negative relationship between beta and earnings yield; and no relationship between beta and the price to book ratio. They concluded that such results rendered the theory and use of a single factor CAPM redundant, and concurred with Fama and French (1992, p. 428): "If assets are priced rationally, our results suggest that stock risks are multi-dimensional".

Another important model in asset pricing was the Arbitrage Pricing Theory (APT) developed by Ross (1976) as an alternative to the CAPM. The APT differed from the CAPM as it was less restrictive and allowed for several factors to be considered when pricing assets – thus, making it a multi-factor model, as opposed to the single factor CAPM.

Roll and Ross (1980) found evidence in favour of the APT having studied individual equities during 1962 to 1972. Their results found that at least three to four factors were priced in generating returns, but they offered no explanation of the economic reasoning behind this observation and admitted that their test was weak. Another challenge with the Ross (1976) APT was that its factors – unlike the CAPM – were not explicitly defined. Therefore, due to its general nature, there were practical limitations to its applicability as it was a struggle to determine suitable factors (Reinganum, 1981a).

[6] The 160 shares selected by Ward and Muller (2012) represented about 99% of the JSE market capitalisation at the time of the study.

2.3 The Fama-French three-factor model

The Fama-French three-factor model (FF3F) was developed as a response to the poor empirical performance of the CAPM. Having noted the empirical contradictions of the CAPM in explaining expected returns (see Banz, 1981; Basu, 1977; Stattman, 1980; Rosenberg et al.,1985; Bhandari, 1988; Fama and French, 1996). Fama and French (1992; 1993) extended the CAPM to a three-factor model that captured the value and size premium in addition to the contribution of the excess market return. Size (as measured by market capitalisation) and book-to-market equity (the value effect) had been found to capture the cross-section of average returns that were often associated with size, leverage, E/P and book-to-market equity in earlier literature. The development of the FF3F represented an important expansion of the CAPM and a transition in research from single-factor models to multifactor models (Cox, 2018). It is important to note that based on the FF3F, size and book-to-market ratios proxied underlying stock risks and were not merely anomalies (Fama and French, 1992).

Fama and French (1992; 1993) based their model on the premise that average excess portfolio returns are sensible to three factors namely: (1): the excess market portfolio return; (2): the difference between the excess return generated by a portfolio of small stocks relative to the excess return generated by big stocks (this is commonly referred to as SMB, small minus big); (3): the difference between the excess return generated on a portfolio of high book-to-market stocks relative to that generated on low book-to-market stocks (HML, high minus low). These factors are captured in the FF3F formula as follows:

$$Ri = \alpha i + \beta i\,(Rmt - R\,f\,t) + si\,SMBt + hi\,HMLt + \varepsilon it \qquad (3)$$

where the R represents the return, R f is the risk-free rate, α is the alpha, $Rmt - R\,f\,t$ is the excess return on the market, SMB is the size factor, HML is the book-to-market equity factor, and ε is the error term. The sensitivities to each factor are given by β, s, h, respectively. The size and book-to-market factor capture the risks that are associated with size and book-to-market while the market factor explains the additional return earned above the risk-free rate. It can be rewritten as follows to incorporate different factors for the size and value effects:

$$Ri = Rf_t + \beta_i \lambda^{market} + s_i\lambda^{size} + h_i \lambda^{value} \quad (4)$$

where β_i, s_i, h_i are the sensitivitei s to each factor, Rf is the risk-free rat,e λ^{market}, λ^{size}, λ^{value} represent the premiums on each type of risk.

The model resulted in new flexible ways of empirically testing returns and has been applied in a variety of contexts. For example, it is possible to replace HML with book-to-market equity or the P/E ratio to measure the value effect (Cox, 2018). Following this is a discussion of empirical tests of the FF3F on international and local markets.

2.3. 1 Empirical tests of the FF3F

2.3.1.1 International tests

Drew, Naughton & Veeraraghavan (2003) tested the Fama-French multifactor model on what they describe as "one of the most challenging international markets": the Shanghai Stock Exchange in China. They found that the multifactor model that included an overall market factor, firm size and book to market equity could explain the cross-sectional patterns of stock returns for Chinese equities over the 1993 to 2000 period better than the CAPM. Interesting, however, they noted that the value effect was not as pervasive as it was for the US sample investigated by Fama and French (1996). They propose that this could be a result of most Chinese investors being 'quasi-rationals' and the overexploitation of the value related return premium by Chinese investors.[7]

Nartea, Ward & Djajadikerta (2009) also found some improvement in the explanatory power provided by the FF3F relative to the CAPM for small and emerging markets. Their results on the New Zealand stock market confirmed the robustness of the value effect, however, they found the size effect not to be as strong, attributing this to most stocks in the New Zealand market being small compared to international standards.

Brailsford, Gaunt & O'Brien (2012) also found similar results confirming the superiority of the Fama–French model on a dataset spanning 25 years (from 1982 to 2006) and covering 98% of all firms listed on the Australian Stock Exchange.

[7] Quasi-rationality describes the idea that human beings, contrary to rational economic theory, do not always make rational decisions and at times, their decisions are influenced by factors other than rationality, for example: intuition.

De Groot, Pang & Swinkels (2012) also provided support for the value and size effect for frontier emerging markets from testing observations covering 1 400 stocks from 24 frontier markets over a 12-year period, from 1997 to 2008. De Groot et al. (2012) found these results to be robust following the performance of robustness analysis such as an analysis by geographical region and financial liberalization.

Singh and Yadav (2015) provided additional support for the FF3F on another emerging market. Performing testing on the Indian stock market using time series hierarchical multiple regression, Singh and Yadav (2015) compared the performance of the CAPM, the FF3F and the FF5F model covering a period of fifteen years, from October 1999 to September 2014. This comparison was done by comparing the value of regression intercepts of the three models, with lower intercepts indicating that less variation in returns is left unexplained by the model in question – this being an indication of a good model. In addition to this, like this study, adjusted R-squared, which measures the amount of variation in returns (in percentages) that is explained by the model, was used as an additional form of comparison between the three models. The performance of the models was tested on portfolios that were sorted on four firm characteristics, being, market capitalisation, the BTM ratio, profitability, and investment. Although, the FF5F performed best among the three models, it was found that the FF3F performed better than the CAPM in these cases, as it captured the size and value effects that the CAPM failed.

Other studies, however, found the three-factor model to be an incomplete model for expected returns as it failed to capture much of the variation in average returns related to profitability and investment (Novy-Marx, 2013; Titman, Wei & Xie, 2004). Novy-Marx (2013) found profitability, as measured by gross profits-to-assets, to have the same power as book to market value (the value effect) in predicting the cross section of average returns. Novy-Marx (2013) challenged the interpretation of the value premium by Fama and French (1993) which related value stocks' high average returns to their low profitability. Novy-Marx (2013, p. 16) argued that "a direct analysis of profitability shows that the value premium is emphatically not driven by unprofitable stocks". They found that profitable firms earn substantially higher average returns than unprofitable firms on testing conducting in the US and other developed markets.

Titman et al. (2004, p. 698) documented a negative relation between abnormal capital investment (measured by firm capital expenditure) and future stock returns on US test data, also noting that “the negative relation between abnormal investments and stock returns cannot be explained by either the risks or the characteristics of the firm”. This further pointed to the insufficiency of the three-factor model in explaining returns.

2.3.1.2 Tests of the Fama-French three-factor model on the JSE

Similarly, to van Rensburg and Robertson (2003), Auret and Sinclaire (2006) investigated the role of book-to-market equity (BTM) in explaining returns on the JSE. The study hypothesised that BTM was expected to be related to returns according to the risk/return framework, therefore the ratio of BTM could be interpreted as a proxy for some kind of underlying risk, although Auret and Sinclaire (2006) did not postulate what those risk elements were. It was found that, like Fama and French (1992), BTM had a strong role in the explanation of stock returns on the JSE. In addition to this, the effects of both size and PE were almost completely subsumed by BTM when BTM was added to the van Rensburg and Robertson (2003) model of PE and size. Although BTM was found to have more explanatory power than size and PE, incorporating it in the van Rensburg and Robertson (2003) size and PE model did not lead to an improvement of the model. This was based on the requirement that all explanatory variables should be significant at the 5% level. This failure could be due to the high correlation between the other attributes which have shown high explanatory power in the van Rensburg and Robertson (2003) model. These attributes include the possibility of strong earnings being extrapolated too far into the future by naïve investors, selection biases and the unravelling of irrational market impulses (Auret & Sinclaire, 2006) .

Basiewicz and Auret (2009) provided further support for the size and value effect. Studying the cross-sectional returns on the JSE, the study provided convincing evidence of the presence of the size and value effect premia and established that the two premia survive adjustment for trading costs which was believed to have significant impact on the persistence and the magnitude of these effects. Consistent with the findings of Auret and Sinclaire (2006) , Basiewicz and Auret (2009) also found that the BTM effect had the strongest explanatory power relative to the earnings-to-price effect. It was however noted that estimates of the value premia were lower than had been shown by prior South African literature. This could potentially be attributed to illiquidity and the lack of testing for trading costs in prior South African studies (Basiewicz &

Auret, 2009). In addition to this, it was found that the value and size effect were independent of each other, and lastly, the study provided evidence that the BTM ratio best captured the underlying risk that was associated with value and subsequently, may be the best measure for the value premia.

Basiewicz and Auret (2010) went on to directly test and compare the FF3F to the CAPM and the APT model developed by Van Rensburg and Slaney (1997) on the JSE on a sample yielding 156 monthly observations, covering the period from June 1992 to July 2005 and 893 usable companies. It was found that the tests provided support for models explaining returns on the JSE, and more specifically, the FF3F accounted for the value and size effects for grouped data, with the size effect, however, being less prominent on ungrouped data. Interestingly, Basiewicz and Auret (2010) noted that small, value firms were mispriced by the model (whereas small, growth firms were mispriced by Fama and French (1993)). Moreover, the FF3F overestimated and underestimated the returns of large and small firms, respectively, this being the opposite effect to that observed on the US market. Nevertheless, the magnitude of the premia were very similar between both markets (Basiewicz & Auret, 2010) .

Consistent with Strugnell et al. (2011) that noticed that the size premium on the JSE seemed to reduce over time in the period 1994 to 2007, Hoffman (2012) and Muller and Ward (2013) found the that the size effect was not statistically significant (this was possibly due to the exclusion of the smallest stocks from the sample) and that momentum and some value-related effects resulted in abnormal excess returns on the JSE. This suggested that momentum and value capture the risks underlying shares listed on the JSE.

Contrary to the Muller and Ward (2013) finding however, Hammar (2016), after constructing portfolios based on four valuation multiples in addition to market capitalisation for a fourteen-year period (1999 to 2012), found significant evidence of a small firm premium on the JSE, regardless of the valuation multiple used. Small-capitalisation stock generated the highest returns over the study period. Moreover, evidence was found for the value effect as value stocks outperformed growth stocks when they were sorted based on P/E and cashflow-flow-to-price. The opposite effect was however noted when the portfolios were based on P/B and DY. Therefore, it has been suggested that these effects may be period-specific on the JSE (Hammar, 2016).

Boamah (2015) conducted robustness tests of the FF3F and the Carhart four-factor model on the JSE. [8] Evidence of size, BM (value) and momentum effects were found by the study, but these were only partially captured by both models. The Carhart four-factor model outperformed the FF3F, which failed to capture momentum effects, and the research concluded that the Carhart four-factor model may better describes JSE returns then the FF3F. Vermeulen (2016) investigated the relationships between share returns and nine variables that were believed to explain share returns on the JSE using a multiple regression analysis. The results produced insignificant relationships between share returns and most of the nine variables, which were: leverage, BM, size, earnings yield, earnings per share, earnings growth, return on equity, dividend pay-out and asset growth (Vermeulen, 2016). Of these, only BM, leverage and dividend pay-out were found to be explanatory variables, these results therefore, provided evidence of the value effect.

2.4 The Fama-French five-factor Model

2.4.1 Description of the Fama-French five-factor model

The Fama-French five-factor model (FF5F) was developed in Fama and French (2015) with the aim of improving on some of the empirical failings of the FF3F given that the model was found to not adequately capture cross-section returns. The FF5F is therefore an extension of the FF3F, with Fama and French (2015) adding an investment and profitability factor to the model in an attempt to address the empirical embarrassment of the FF3F. The FF5F is denoted by the equation below:

$$Rit = \mathrm{i} + \beta\mathrm{i}\,(\mathrm{Rmt} - \mathrm{R\,f\,t}) + \mathrm{si\,SMBt} + \mathrm{hi\,HMLt} + \mathrm{ri\,RMWt} + \mathrm{ci\,CMAt} + \varepsilon\mathrm{it} \qquad (5)$$

where α, R_F, $b_i(R_M — R_F)$, s_iSMB, $h_i\ HML_t$ and ε are defined as in the FF3F, r and c represent the loadings on the profitability and investment factors, respectively, and RMW and CMA represent the profitability and investment factors, respectively.

[8] The Carhart four-factor model is an augmentation of the Fama and French model proposed by Carhart (1997) that adds momentum as an additional factor.

Below follows a brief discussion of the theoretical background of the model and subsequently, the empirical test results thereon.

2.4.1.1 The theoretical background to the Fama-French five-factor model

Having studied the evidence of profitability (Novy-Marx ,2013) and investment factors (Titman et al., 2004) adding to the description of average returns on markets by prior literature, Fama and French (2015) use the dividend discount model to explain the reason these variables are related to returns. According to the dividend discount model, the market value of a share is the present value of the expected dividends that are attributable to that share. This is represented by the equation below:

$$M^t = \sum_{\tau=1}^{\infty} E(d_{t+\lambda})/(1+r)^{\lambda} \qquad (6)$$

In this equation, M^t represents the share price at time t, $E(d_{t+\lambda})$ is the expected dividend per share for period $t+\lambda$, and r is the approximate internal rate of return expected on the dividends or put differently: the cost of equity. By manipulating the equation, Fama and French (2015) was able to derive important relationships between expected returns, expected profitability, investment and BTM.

According to Miller and Modigliani (1961), the value of a firm at time t would be represented by the following equation:

$$M^t = \sum_{t=1}^{\infty} E(Y_{t+\lambda} - dB_{t+\lambda})/(1+r)^{\lambda} \qquad (7)$$

In this equation, $Y_{t+\lambda}$ represents the total earnings for the period $t+\lambda$ and $dB_{t+\lambda}$ = $dB_{t+\lambda} - dB_{t+\lambda-1}$ is the change in the total book equity. By dividing the equation by time t book equity, Fama and French (2015) derived the following equation:

$$\frac{Mt}{Bt} = \frac{\sum_{t=1}^{\infty} E(Y_{t+\lambda} - dB_{t+\lambda})/(1+r)^{\lambda}}{B_t} \qquad (8)$$

From this equation, three statements can be made about expected stock returns. Firstly, holding everything constant apart from the current stock value, Mt, and the expected return on the stock, r. a lower value of Mt, or equally, a higher value of the BTM ratio, Bt/Mt, would imply a higher expected return (Fama & French, 2015). Secondly, holding all constant, except for the expected future returns and the expected return on the stock, the equation informs us that higher expected earnings imply a higher expected return (Fama & French, 2015). Lastly, holding Bt, Mt. and the expected earnings constant, higher expected growth in book equity – investment –

implies a lower expected return (Fama & French, 2015). The equation therefore implies that since market capitalisation (Mt) is also responsive to forecasts of earnings and investments, Bt/Mt tends to be a noisy proxy (Fama & French, 2015) .

2.4.2.1 Empirical tests of the Fama-French five-factor model

Fama and French (2015) studied companies listed in the NYSE, NASDAQ and AMEX during July 1963 to December 2013. From testing the FF5F in numerous sorts, they found that the FF5F showed an improvement in explaining expected returns when compared to the FF3F as it produced lower intercepts. Fama and French (2015), however, found that there was very little difference between their FF5F and a four-factor model that excluded HML factor, for example, alpha drops from 0.075 to 0.073 per month in one of the analyses. This suggested that the HML factor was redundant in the dataset, as the HML associated returns were already captured by the other factors. In addition to this, Fama and French (2015) found that their model mispriced small stocks that had negative exposures to the profitability and investment factors. These stocks behaved like stocks that invested a lot despite having low profitability. Fama and French (2015) noted that high investment alone could be the cause of this issue.

Chiah et al. (2016) conducted their testing on the Australian Stock Exchange (ASX) using a sample of ordinary stocks traded thereon from January 1982 until December 2013 that represented more than 95% of Australian listed companies. The study therefore provided convincing out-of-sample tests of the empirical results formulated from US data. The study also had multiple objectives concerning the FF5F, some being: the investigation of whether the FF5F could explain more asset pricing anomalies relative to other competing asset pricing models, such as the three-factor model and the Carhart four-factor model and comparison of the domestic (Australian) Fama-French models with US Fama-French models. The latter objective was, in part, motivated by Griffin (2002) which showed that country-specific versions of the three-factor model may be more useful in explaining cross-sectional returns than a global three-factor model. This was also supported by Fama and French (2012).

From the study, Chiah et al. (2016) found evidence that profitability and investment factors had significant positive premiums and that the FF5F was better able to capture patterns of profitability and investment that the other competing models could not. It was found that the FF5F performed the best in capturing a wide range of the asset pricing anomalies on the AMX, and it produced fewer pricing errors, thus “supporting the superiority of this model” Chiah et al. (2016, p. 599)

Interestingly, however, contrary to the findings of Fama and French (2015), Chiah et al. (2016) found that the BTM factor did not become redundant with the inclusion of the profitability and investment factors. A similar finding as Chiah et al. (2016) was made by Hou et al. (2015) and Hou et al. (2017) with respect to the value factor not being redundant, possibly due differences in the specification of the factor whereby book-to-market whereby book-to-market rankings incorporating the most recent monthly share price in the denominator were used as opposed to the mimicking portfolio. Hou, Xue, and Zang (2015, 2017) compared the performance of numerous asset pricing models on the NYSE, AMEX and NASDAQ, which included the CAPM, the Fama and French (1993) three-factor model, the Carhart (1997) four-factor model, the Pástor and Stambaugh (2003) four-factor model, Hou et al. (2015) q-factor model and the Fama and French (2015) five-factor model. They found that the q-factor and the five-factor model out-performed the other models. Additionally, it was noted that the q-factor model out-performed the FF5F in factor spanning tests and in explaining profitability and momentum anomalies, with the five-factor model performing better in explaining value-verses-growth anomalies. In summary, the evidence from the Hou et al. (2017, pp. 21-22) conclude the research with the following statement:

> In all, our evidence suggests that fundamentals, such as investment and profitability, not liquidity, are the dominating driving forces in the broad cross section of expected returns.

Fama and French (2016) followed the advice of Lewellen, Nagel, and Shanken (2010) and considered anomalies that were not targeted by the FF5F and that proved troublesome for the FF3F, such as accruals, net share issues, momentum, and volatility. Their results showed that, except for accruals and momentum, the list of anomalies left unexplained by the FF3F shrink when the FF5F is used. The RMW and CMA slopes of the FF5F were able to capture the flat relation between market β and average return that had long been the embarrassment of the CAPM by offsetting the average return predictions of the market and SMB slopes (Fama & French, 2016). Again, it was found that small firms that pursue aggressive investment despite low profitability continued to prove troublesome for the FF5F, and, lastly, momentum was found not to add to the explanatory power of the FF5F (Fama & French, 2016).

Fama and French (2017) subsequently extended their testing beyond the US and included additional countries from North America, Asia and Europe in their sample and found that – except for Japan – their five-factor model maintained its explanatory power beyond the US. They found that with investment and profitability included, their model captured some patterns in returns of portfolios sorted on value, size, investment and/or profitability, that were left unexplained by their three-factor model. The FF5F however, did continue to fail to fully capture the low returns of small stocks whose returns behave much like the returns of firms with low profitability and aggressive investment.

Kubota and Kakehari (2017) investigated whether the FF5F explained the long-term pricing structure of stocks in the Japanese Tokyo Stock Exchange (TSE). It was found that both the CMA betas and the RMW betas were weakly associated with the cross-sectional variations of the stock returns in the Japanese market as the average returns generated by the profitability and investment factors were small and statistically insignificant, which is consist with the findings of Fama and French (2017), which identified the Japanese economy as an anomaly to the FF5F. This may suggest that factors that explain returns differ between emerging markets (Azimli, 2020).

2.4.2.2 Tests of the FF5F on the JSE

In South Africa, Charteris et al. (2018) sought to investigate whether an alternative three-factor model as proposed by Chen, Novy-Max, and Zhang (2011) and a FF5F could explain momentum on the JSE. The results of the study indicated that the CAPM, FF3F and the Carhart (1997) four-factor model could not explain the continuation of past returns on the South African market (momentum). On the contrary, for the models that included the investment and profitability factors as pricing factors, i.e., the alternative three-factor model of Chen et al. (2001) and the FF5F, Charteris et al. (2018) found that the pricing errors were much lower than was observed for the CAPM and the classical FF3F, albeit still significant. Profitability was found to be significantly and positively related to returns, with investment displaying a weaker relation to momentum than profitability.

Cox and Britten (2018) investigated the effectiveness of the FF5F in explaining returns on the JSE and found that when compared with the FF3F, the FF5F, on an overall basis, best explained the cross-section of returns on the JSE. In addition to this, Cox and Britten (2018) identified a significant value premium, inverse size premium and a negative relationship between beta and returns - the latter is consistent with the finding of van Rensburg and Robertson (2003). The study also found that profitability and investment contribute to the explanation of returns on the JSE, but just as was noted by Charteris et al. (2018), the profitability factor was found to be more consistent than the investment factor.

2.5 ESG and cost of capital

2.5.1 Background into ESG and financial performance research

There is a large body of literature that has investigated the relationship between sustainability and financial performance. The empirical evidence from studies, much like that of asset pricing models, tends to be inconsistent. Griffin and Mahon (1997) suggest that this can be sourced from differences in methodology and the choice of financial and sustainability proxies used. For studies that, like this study, use stock returns as a measure of financial performance, three categories were identified by Wagner et al. (2001), these being: portfolio studies, event studies and multivariate regression studies.

Portfolio studies usually involve constructing mutually exclusive portfolios based on various sustainability related indicators and then studying the respective return differences over the sample period. For example, Maiti (2021) adopted this approach when investigating the durability of the ESG factor in contrast to already established factors such as the size and value factors in explaining returns. Having formed portfolios based on PB, ESG and the individual Environment, Social and Governance components risk factors, Maiti (2021) results found evidence of an ESG risk factor at a 5% level of significance.

Event studies is said to present the most pronounced evidence of a link between environmental and stock market performance. This method studies the impact on the value of securities arising from a catalyst event. Capelle-Blancard and Petit (2019) used events study by investigating the stock market's reaction to ESG news (both positive and negative) for 100 firms listed on the Dow Jones Sector Titans indexes.

Such news was sourced from media, official authorities, NGOs, trade unions or the firms themselves. Over the 2002 to 2010 period, it was found that on average, firms faced a drop of 0.1% of their market value following negative ESG publicity but gain nothing from positive publicity. Moreover, Capelle-Blancard and Petit (2019) found that market participants are responsive to media, but not to firm press releases or NGO disclosures.

Lastly, some studies utilise multivariate regression or correlation analysis to investigate the link between ESG and financial performance. These studies are said to provide only limited evidence of this relationship. An example is La Torre et al. (2020) which investigated how ESG components affect stock returns. Having selected a sample of 46 Eurostoxx50 listed firms during 2010 to 2018, a two-step methodology was followed: the first, was a panel data analysis with the aim to identify a causal relationship between returns and the ESG index. Secondly, given the results of the panel data analysis, La Torre et al. (2020) then ran a multiple regression for each company in the sample with the aim of assessing how the ESG sub-indexes affect the returns of each firm. The results from the study indicated that although a linear correlation exists between the ESG index and stock returns, this correlation is weak, and sometimes even absent. The statistical analyses also highlighted that the stock return effects arising from ESG strategies are limited and may be concentrated to only some industries, for example, the energy and utilities sector.

From an ideological standpoint, business individuals against the pursuit of sustainability-related practices sometimes argue that the utilisation of firm resources for sustainability objectives decreases shareholder value (Derwall et al., 2005). The reasoning is that the costs involved in such pursuits, such as costs of abiding by ethical standards translate into higher operation and product costs, which erode competitive advantage, and subsequently, profitability (Walley & Whitehead, 1994).

Others, on the other hand, believe that the improvement of a firm's sustainability practices could enhance its input-output efficiency or generate new market opportunities (Derwall et al., 2005). For example, Porter and Van der Linde (1995) argued that active policies aimed at improving sustainability-related practices could create a competitive advantage for firms because of the more cost-efficient usage of resources. From this perspective, the benefits of sustainability-related practices should outweigh the costs, and firms that embrace this practice would be expected to report higher corporate earnings relative to less socially and environmentally responsible firms.

However, the extent to which ESG practices and policies translate to investment abnormal returns largely depends on the financial markets' ability to factor in the financial consequences of corporate social responsibility into share prices. From the review of asset pricing literature above, it was seen that market returns are proportional to underlying risk factors, and that the optimal investment portfolio is one that is well-diversified. Thus, following this reasoning, socially responsible investors should expect to report suboptimal returns as their portfolios would inherently lack diversity given that such portfolios are ordinarily grouped based on firm-specific characteristics – this being, for example, ESG scores. Under the efficient market hypothesis theory, any empirical evidence of anomalous returns on such stock would be indicative of the deficiency of the asset pricing model used and after the methodological shortcomings are corrected, such abnormal returns would cease to exist. An alternative view, however, is that SRI reflects the views of the firms' management on how well the entity will perform in the long run. Such sentiment may initially be mispriced because of short-term thinking by financial market participants, thus, suggesting that SRI may be incrementally profitable over the long-term (Derwall et al., 2005).

Alda (2020) studied the ESG-score impact on stock returns for 243 UK domestic equity

pension funds, divided into 22 SRI funds and 221 conventional funds from 2016 to 2018. Four annual ESG scores consisting of a total ESG score, an environmental score, a social score, and a governance score, each ranging from 0 (lowest) to 1 (highest) were obtained from Morningstar Direct including the daily return and monthly return for each fund. Alda (2020) found that SRI funds outperformed and higher ESG scores positively influenced stock returns for both SRI and conventional funds. Consolandi et al. (2020, pp. 18-19), basing their results on testing on a large sample of US-headquartered companies included in the Russell 3000 index from January 2008 to June 2019, also reach a similar conclusion, noting: "not only does ESG performance have a positive effect on stock returns, but also that, when financial relevance and financial intensity of materiality is taken into account, the market seems to reward more those companies operating in industries with a high level of concentration of ESG materiality". Consolandi et al. (2020) sourced their sustainability data from Truvalue Labs (TVL) which calculates ESG metrics based on the Sustainability Accounting Standards Board's 26 sustainability-related material business issues, with a score ranging from 0 to 100 (low to high) assigned on each, which was then exponentially weighted by Consolandi et al. (2020) to assess the firms' sustainability performance. Other studies document similar results for the US market (Derwall et al., 2005; Eccles et al., 2014; Kempf & Osthoff, 2007; Lee et al., 2013; Statman & Glushkov, 2009). These studies used ESG ratings provided by ASSET4, SAM and the MSCI KLD 400 Social Index to measure sustainability.

There is, however, a small body of research that found no statistically significant difference in risk-adjusted returns for portfolios sorted on high ESG stocks (Halbritter & Dorfleitner, 2015; Naffa & Fain, 2022). Halbritter and Dorfleitner (2015, p. 26) in their review of related literature note: "In summary, the findings of the empirical research provide evidence in favour of a link between returns and the CSP level, measured in terms of the environmental, social and corporate governance dimensions" supporting the view that most empirical test results are in support of the positive relationship between ESG performance and returns.

2.6 Hypothesis development

In this section the effects on share price of each of the factors in the Fama-French five-factor model will be analysed. In addition to this, the effects of ESG scores on share prices will also be analysed. To achieve this, empirical test results from the prior literature - some of which have been discussed above - will be referred to. On the strength of this, a hypothesis will be formulated on whether the addition of ESG scores as a sixth factor to the Fama-French five-factor model is expected to improve the predicting power of the model in estimating returns.

2.6.1 Market premium

This is the original factor captured in the CAPM model: the market factor with beta capturing the systematic risk of the asset or portfolio relative to the market. The market premium implies that the performance of a stock is dependent on the performance of the market as a whole, i.e., improved market performance will result in improved returns on a stock or portfolio. As discussed above, results from empirical tests are mixed and inconsistent on international markets with numerous anomalies identified. Fama and French (2004) found the relation between beta and returns to be 'too flat' with their results showing returns to be too high for low beta portfolios and too low for high beta portfolios. Empirical tests on the JSE yielded similar results with van Rensburg and Robertson (2003) and Ward and Muller (2012) observing beta as being inversely related to returns and Strugnell, Gilbert, and Kruger (2011) concluding that beta has no predicting power on the JSE. Contrary to this, however, Cox (2018) found evidence of a market return premium when comparing the performance of the CAPM, FF3F and FF5F on the JSE. The above inconsistencies may be a function of time differences in testing and the different methodologies employed.

2.6.2 Size

Size is defined as market capitalisation (Fama and French, 2015). This factor is included as 'Small Minus Big' (SMB) in the five-factor model reflecting the excess return by small firms relative to large firms. By implication, based on the five-factor model, inclusion of more small capitalisation firms in a portfolio is expected to increase returns, thus, outperforming the market in the long-run. Empirical tests on the US and international markets have observed excess returns generated by smaller firms relative to larger firms - the size effect as mentioned above (Banz, 1981; Fama & French, 1992). Basiewicz & Auret, (2009), Rensburg and Robertson (2003); Strugnell et al., (2011) also found evidence of the size effect on the JSE.

2.6.3 Value

The value factor is defined as the book value to market value ratio (Fama and French, 2015). It is included in the five-factor model as 'High Minus Low' (HML) reflecting the excess returns generated by firms with a high book value to market value (value stocks) relative to firms with a low book value to market value (growth stocks). Based on the five-factor model, a portfolio consisting of a larger proportion of high book to market value firms (value stocks) is expected to outperform a portfolio consisting of a large proportion of low book to market value (growth stocks) in the long run. Empirical tests on international markets observed the existence of the value effect (Basu, 1977; Stattman, 1980). Rensburg and Robertson (2003) and Strugnell et al. (2011) also confirm the existence of the value effect on the JSE.

2.6.4 Profitability

The profitability is defined as operating profit divided by book value of equity (Fama and French, 2015). It is included in the five-factor model as 'robust minus weak' reflecting the value-weighted returns on a diversified portfolio of stocks with robust profitability minus the value-weighted returns on a diversified portfolio of stocks with weak profitability. Based on the five-factor model, a portfolio consisting of a larger proportion of stocks with robust profitability is expected to generate returns in excess of that expected to be generated by a portfolio consisting of a larger proportion of stocks with weak profitability. Empirical tests on North America, Europe and Asia Pacific observed this relationship (Fama & French, 2017). This positive relationship between profitability and future returns was also observed on other international markets (Fama & French, 2015; Novy-Marx, 2013; Watanabe, Xu, Yao, & Yu, 2013) and on the JSE (Cox & Ross, 1976).

2.6.5 Investment

The investment factor is defined as the growth in total assets from fiscal year end t-2 to fiscal year end t-1 (Fama and French, 2015). It is included in the five-factor model as 'conservative minus aggressive', reflecting the value-weighted returns on a diversified portfolio of stocks of firms that invest conservatively minus the value-weighted returns on a diversified portfolio of stocks of firms that invest aggressively. Based on the five-factor model, a portfolio consisting of a larger proportion of stocks of firms that invest conservatively is expected to generate returns in excess of that expected to be generated by a portfolio consisting of a larger proportion of stocks of firms that invest aggressively, therefore implying a negative relationship between investment and returns. Multiple empirical tests on international markets observed this relationship, noting that high investment was followed by low average returns (Anderson & Garcia-Feijoo, 2006; Baker et al., 2003; Titman et al., 2004, 2013) This relationship was also observed on the JSE (Charteris et al., 2018; S. Cox & Britten, 2019).

2.6.6 ESG scores

ESG ratings and scores are used in most of the studies empirically testing sustainability performance effects on returns (Alda, 2020; Derwall et al., 2005; Eccles et al., 2014; Galema, Plantinga, & Scholtens, 2008; Kempf & Osthoff, 2007; Lee et al., 2013; Statman & Glushkov, 2009). The benefit of using ESG scores is that the sustainability effects on shares can be decoupled, and the effect of each dimension analysed separately. This may have the added benefit of informing researchers and investors of the most critical elements of sustainability for selected firms – a concept referred to as ESG materiality.

Most of the studies on the US market find ESG performance to have a positive relationship with returns, with some studies finding that high ESG firms significantly outperform low ESG firms (Derwall et al., 2005; Eccles et al., 2014; Galema et al., 2008; Kempf & Osthoff, 2007; Lee et al., 2013; Statman & Glushkov, 2009). Other studies find a significant positive relationship between specific elements of ESG and returns. Testing the relationship between ESG scores and returns in the cross-section based on KLD data from 1991 to 2006, including all Standard & Poor's (S&P) 500 and the MSCI KLD 400 Social Index companies, Mănescu (2011) finds that community relations criteria (social) displayed a significant positive influence on returns. Galema et al. (2008) on their study also found that the employee relations indicator (social) had a significant positive effect on the return.

Based on empirical evidence from prior literature, ESG performance may influence returns. To investigate this, the study therefore formed the below null and alternative hypotheses, respectively.

H_0 (null hypothesis): The inclusion of an ESG scores factor in the Fama-French five-factor model has no effect on the model's predictability of returns.

H_1 (alternative hypothesis): The inclusion of an ESG scores factor in the Fama-French five-factor model will improve the model's predictability of returns.

3 METHODOLOGY

3.1 Overview of methodology

The research follows a quantitative approach within a positivist paradigm, which allows for an objective measure of the research aim (Leedy & Ormrod, 2015). This is achieved using panel data analysis in order to collect and analyse the data.

3.1.1 Research plan

The goal of the study is to empirically test whether the inclusion of ESG scores on the FF5F improves the model's predicting power of returns on the JSE. The results of the study were analysed in such a way that if the results of the research found that inclusion of ESG scores improve the predicting power of the FF5F; this would support the researcher's proposal to extend the FF5F into a six-factor model that will better predict returns on the JSE. The researcher would achieve this goal by comparing the coefficient of determination (R-squared) of the existing five-factor model with the R-squared of the proposed six-factor model including ESG scores. This is done because R-squared is a measure that represents the model's explanatory power, and should the R-squared from the proposed six-factor model be greater than the existing five-factor model: the researcher would be able to conclude that inclusion of ESG scores in the five-factor model improves the model's predicting power of returns on the JSE and therefore recommend that the model be extended into a six-factor model incorporating an ESG scores factor.

3.2 Population and sampling

The population of the study was all JSE listed companies.

A non-random, purposive sampling technique is relied upon for investigation (Leedy & Ormrod, 2015). The sample consists of companies included on the JSE Top 40 index during the fiscal year-ends of 2015 to 2019. The JSE Top 40 index consists of the top 40 companies listed on the JSE by market capitalisation. This sample sufficiently represents the population of this study as companies included on the JSE Top 40 index represent approximately 80% of the market capitalisation of all companies listed on the JSE (Kotze, 2017). The fiscal years of 2015 to 2019 were chosen for a couple of reasons, one being to have as much JSE Top 40 company data being available for use in the research as there are some companies that listed on the JSE post 2014, and as such, no data would be available for such companies prior to 2015. Secondly, given the rampant effects of the COVID-19 pandemic on financial markets, and the world in general, the researcher sought to exclude the COVID-19 period from analysis in the study as this may skew the results of the research.

3.3 Data

For each company investigated, the researcher collected three types of historical data at each fiscal year-end in the sample period (2015 to 2019): the company's aggregate ESG combined score, its share price and fundamental information required to calculate the FF5 factors. Both ESG combined score data and share price data were obtained from the Refinitiv workspace database. One of the advantages of this is that the researcher was able to collect all the data needed for the research from one reputable source and this adds to reliability of the data and alignment in the methodologies employed in its preparation (Barbaric, 2021).

In addition to the above, although all types of data are secondary in nature, which often affects the validity and reliability of the data, they were obtained from a reputable source which is highly used in academic literature. Over the last 16 years, ESG scores provided by Refinitiv ESG, formerly known as ASSET4, have been used in more than 1 200 academic articles (Berg et al., 2021). Further, for the purposes of managing ESG investment risks, major asset managers, such BlackRock, have chosen Refinitiv as their global ESG data provider.[9] Refinitiv ESG data has been also referenced in an ESG white paper featured at the World Economic Forum in 2019 (World Economic Forum, 2020) and was analysed as one of three key ratings providers in a recent Organisation for Economic Co-operation and Development (OECD) report (Berg et al., 2021).

Refinitiv has ratings data for over 9 500 companies globally, including time series data that goes back to 2002. In reporting ESG data, Refinitiv makes use of percentile rank scores which range between 0 (minimum score) and 100 (maximum score), as well as letter grades (ranging from A+ to D-) and are easy to use and understand. The conversion between these two scoring formats is shown in the table 1 found in the appendix.

[9] https://www.responsible-investor.com/blackrock-taps-asset4/

Although some research relies on ESG disclosure scores in their assessment of ESG performance (Gutsche et al., 2017; Nollet et al., 2016), this study will utilise ESG performance ratings data. ESG disclosure scores, such as those provided by the Bloomberg Data Services database, usually provide a percentage figure that represents a firm's aggregated disclosure against quantitative ESG datapoints drawn from global standards that are deemed the most relevant in such firm's industry. On the contrary, ESG performance scores provide a percentage, numerical score or letter grade capturing a snapshot of a firm's expose to ESG risk and how effectively it manages such risk. Prior research has also noted that disclosures do not necessarily reflect actual company performance (Gregory et al., 2014; Gutsche et al., 2017), therefore motivated by this, the research avoided the use of ESG disclosure scores in favour of ESG performance data in order to further improve the validity of the research.

Suitable for this objective, the ESG scores provided by the Refinitiv database provide a comprehensive evaluation of a firm's sustainability impact and are prepared using verifiable data sourced from public domains such as annual reports, company websites, non-governmental organization (NGO) websites, stock exchange filings, corporate social responsibility reports, news reports, etc. The ESG data is updated by Refinitiv annually based on the company's fiscal year and aligned with corporate reporting patterns. A combination of human and algorithmic processes is utilised, which includes independent audits, logical error checks and management reviews to ensure that data quality is as high as possible. The scores are data-driven and account for most material industry metrics and have minimal company size and transparency biases (Refinitiv, 2021).

Refinitiv captures and calculates over 500 company-level ESG measures, and of these, selects a subset of 186 of the most relevant and comparable measures per the firms' industry and these are used for the overall ESG assessment and scoring. These measures are then grouped into 10 main categories that cover each ESG pillar. For the environmental component, issues surrounding resource use, emissions and innovation are considered. The social component considers the workforce, human rights, community and product responsibility, and lastly, the governance component considers factors around management, shareholders, corporate social responsibility strategy. These measures are then translated to a percentile-based score (ranging from 0 to 100) for each of the three pillars. The ESG pillar score is a relative sum of the category weights and these weights vary based on the industry for the environmental and social category, while weights for the environmental pillar vary based on the governance considerations as per the firm's country of origin (Refinitiv, 2021).

The environmental pillar score measures a firm's performance in implementing best environmental practices to avoid environmental risks and to capitalize on environmental opportunities in order to generate sustainable value for stakeholders (Refinitiv, 2021). The social score reflects how well a firm generates trust and loyalty with its workforce, customers and society through the use of best management practices (Refinitiv, 2021). Finally, the governance score measures the firm's implementation of best practice policies that are designed to ensure that those charged with its governance act in the best interests of its long-tern stakeholders (Refinitiv, 2021). The overall ESG score is obtained by aggregating these pillar scores based on the 10 category weights.

For the purposes of the research, however, a combined ESG score was selected as a better proxy for each respective company's ESG performance. The ESG combined score (ESGCS) provides a rounded and comprehensive scoring of a company's ESG performance based on its reported information as it pertains to the ESG pillars (as discussed above), along with an ESG controversies overlay that is captured from global media sources (Refinitiv, 2021). The primary goal of the score is to discount the ESG performance score based on negative stories in the media, and this is done by incorporating the impact of significant and material ESG controversies in the overall ESGC score (Refinitiv, 2021).

The controversy scoring is based on 23 ESG controversy topics, such as anti-competition behaviour, child labour, wage controversies, strikes, taxation fraud reports, etc. When the respective company has been involved in any such controversy, the score is calculated as a weighted average of the overall ESG score and the ESGC score per fiscal period, with the recent controversies being reflected in the latest completed period. In the event that a company is not involved in such controversy, the ESGC score is equal to the overall ESG score for that company (Refinitiv, 2021). Given that larger firms tend to attract relatively more media attention than smaller firms, severity weights are applied when performing the controversy scoring, for example, a firm with a market capitalisation less than 2 billion, would get a controversy weighting of a 100%, whereas a firm with a market capitalisation more than or equal to 10 billion, would get a weighing of only 33%. Medium sized firms, i.e., those with a market capitalisation greater than or equal to 2 billion, but less than 10 billion, get a weighing of 67%.

In addition, both types of data were readily available for the researcher from the said database and the researcher had the necessary skills required to reliably collect, sort via Excel, input the data into regression models and interpret the results therefrom.

3.3.1 ESG scores

The researcher was permitted access to the Refinitiv database for academic purposes.

The database has a search function that allowed for the researcher to input any company ticker and the database would then display multiple tiles relevant to that company. For example, the tiles available on the company included an overview of the company, the latest news and research about the company, pricing information and charts, detailed estimates relevant to the entity including forecasts of financial information, valuations, financials, ESG data, etc. For the purposes of obtaining the ESG data relevant for the research, the researcher selected the ESG data tile. Within the ESG data tile, a filter was conducted for the extraction of results; more specifically, the researcher filtered the search results to include ESG data for the last seven years from the research date. The ESG data therefore covered the fiscal years from 2015 to 2021, although only the 2015 to 2019 information was used. The information was extracted in a Microsoft Excel format, and at a minimum, included the following ESG information for each company included in the study sample: the period end, whether an ESG report is published and the respective ESG report auditor's name, an annual ESG score, an annual ESG controversy score and an annual combined ESG score. The annexure provides examples of the ESG data reports extracted by the researcher from the Refinitiv database.

3.3.2 Share price data

As discussed above, share price data was also obtained from Refinitiv. The share price data for the JSE top 40 from 2015 to 2019 was obtained by the researched under the 'company fundamentals' tile which included share prices, and other company fundamentals data.

3.4 Method

As this study used panel data in the form of annual returns and ESG scores data of the JSE top 40 companies from 2015 to 2019; a statistical ordinary least squares (OLS) regression model along with the R statistics package was relied upon to analyse this data for the purposes of answering the research question (Leedy & Ormrod, 2015).

The use of statistical regression models has been extensive in seminal studies developing and empirically testing asset pricing models, with almost all such studies relying on statistical regression models for attempts to determine the strength and character of the relationship between one of more independent variable(s) and expected returns.

For this research, two regression models were used. One was the FF5F as it exists, with factors defined as they were developed by Fama and French (2015). The other, was a statistical regression model like the first, with the sole difference being the addition of an ESG scores factor. Both statistical regression models are presented and explained below:

3.4.1 The Fama-French five-factor model

$$Rit = \mathrm{i} + \beta\mathrm{i}\,(\mathrm{Rmt} - \mathrm{R\,f\,t}) + \mathrm{si\,SMBt} + \mathrm{hi\,HMLt} + \mathrm{ri\,RMWt} + \mathrm{ci\,CMAt} + \varepsilon\mathrm{it} \quad (5)$$

Where: Rit is the return on stock i for year t; $\mathrm{R\ f\ t}$ is the risk-free rate; $\mathrm{Rmt} - \mathrm{R\ f\ t}$ is the value-weighted market portfolio return minus the risk-free rate; SMB is the return spread of small minus large stocks (i.e., the size effect); HML is the return spread of high and low B/M stocks (i.e., the value effect); RMW is the return spread of stocks of firms the most profitable firms minus the least profitable firms; CMA is the return spread of firms that invest conservatively minus aggressively and $\varepsilon\mathrm{it}$ is the error term. In addition, the variables $\beta\mathrm{i}$, si, hi, ri, ci represent the sensitivities to factor returns. In the above regression, the independent variables consist of each of the Fama-French five-factors, i.e., Small Minus Big (SMB), High Minus Low (HML), Robust Minus Weak

(RMW), Conservative Minus Aggressive (CMA), and the excess market return ($Rmt - Rft$) whilst the dependent variable is the return on the stock Rit.

Following the work of Fama and French (2015), each of the five factors were measured as follows: the market premium factor (RMt — RFt) was measured by the difference between the market portfolio returns and the risk free rate; the size factor (SMB) was measured by market capitalisation; the value factor (HML) was measured by book value to market value ratio; the profitability factor (RMW) was measured by operating profit divided by book value of equity and the investment factor (CMA) was measured by growth in total assets from fiscal year end t-2 to fiscal year end t-1.

3.4.2 The proposed six-factor model incorporating an ESG scores factor

$$Rit = \mathrm{i} + \beta\mathrm{i}\ (\mathrm{Rmt} - \mathrm{R\,f\,t}) + \mathrm{si\ SMBt} + \mathrm{hi\ HMLt} + \mathrm{ri\ RMWt} + \mathrm{ci\ CMAt} + \mathrm{liLeMLa} + \varepsilon\mathrm{it} \tag{9}$$

Where: all the factors – save for the proposed ESG factor – are defined and measured as per the FF5F above. The ESG factor (liLeMLa) is defined as the return spread of stocks of ESG leaders minus ESG laggards. Where ESG leaders are those firms with high ESG performance – as measured by ESG performance scores – and ESG laggards are those firms with low ESG performance. The independent and dependent variables remain as described in chapter 3.4.1. The ESG factor (liLeMLa) is an additional independent variable.

3.5 Analysis of data

The researcher used Microsoft Excel to sort the share return and ESG data collected from Refinitiv for each respective company for the sample period. Following this, 'R' – which is a programming language and free software environment for statistical computing and graphics – was used to analyse the data. The researcher had access to and the capability to utilise the R statistics package as required by this research. The R statistics package has the capability to receive and analyse data and consequently produce a statistical summary of the data provided. This summary includes residuals such as the minimum, one quartile, median, third quartile and maximum values; coefficients information such as estimated standard error, t-values, and p-values; and more importantly for this research, it also provided the multiple R-squared and adjusted R-squared.

R-squared can be defined as a statistical measure of the proportion of the variation in a dependent variable that is explained by the independent variables in a regression model. In the context of our research, R-squared was a statistical measure of the proportion of variation in returns (the dependent variable) that is explained by the five and six factors (the independent variables) of the FF5F and the proposed six-factor model including the ESG factor. Therefore, it follows that should the R-squared of the proposed six-factor model have exceed that of the FF5F: the researcher's null hypothesis (H_0) would be rejected in favour of the alternative hypothesis (H_1). In this instance, the researcher may then be able to conclude that the inclusion of ESG scores in the FF5F would improve the model's predictability of returns and therefore, propose that the model be extended into a six- factor model incorporating an ESG scores factor.

3.6 Validity and Reliability

In addition to the data validity and reliability provided by the use of the Refinitiv database, the choice to use statistical multi-regression for the purposes of the research was motivated by prior research, more specifically, Fama and French (2015). They have religiously relied on such regressions to measure the strength and character of the relationship between returns - the dependent variable - and independent variables such as book-to-market values, profitability, etc., (Fama & French, 1992; Fama & French, 1993; Fama & French, 2015). The use of the R programming language enabled the researcher to use reliability analysis and multivariate statistical fitting techniques, such as 'Alpha' which is one of several estimates of the internal consistency of a test. In addition to this, as already stated, R-squared was relied on to measure the relative predicting power of both regression models, however, since there exists the possibility that R-squared may automatically and spuriously be increasing as the ESG factor variable is added to the model, the research utilised adjusted R-squared as suggested by Raju et al. (1997), obtained under the "lm" function in R, to control for this possibility.

Lastly, although ESG data are generally subjective in nature and therefore, use of different databases may result in differing results (Halbritter & Dorfleitner, 2015), use of the Refinitiv ESG database may have overcome this as the model with which

Refinitiv calculate ESG scores data is fully automated and transparent which makes it, according to Refinitiv (2021, p. 6): “free from subjectivity and hidden calculations or inputs”. This served to increase the reliability and validity of the data therefrom.

4 DATA ANALYSIS AND PRESENTATION OF RESULTS

The research results will be presented as follows: first, a brief demographic overview of the population and sample of the study will be performed to understand the representativeness of the sample. Following this, will be an analysis of the distribution of the research data. Finally, the results of the research will then be presented and subsequently discussed for the purposes of answering the research question and research objectives of the study, and a summary of the findings and discussions provided, and a conclusion formulated.

4.1 Overview of the demographics of the population

This study was designed with the aim of investigating whether the inclusion of an ESG scores factor in the FF5F would improve the model's predicting power of expected returns on the JSE. The researcher further noted in the assumptions, limitations and delimitations section that the generalisability of the results of the research may be limited to those securities that are listed on the JSE. Therefore, the population for which the results of this research apply, is JSE listed securities.

The purposive sample that was chosen to represent the population above, is the JSE top 40. Of the 40 companies that make up the JSE top 40, the researcher was able to gather ESG data, share price data and financials data for 38 of such companies. For Prosus N.V and Pepkor Holdings Ltd, the researcher was unable to gather ESG scores data due to data paucity for the 2015, 2016, 2017 and 2018 financial years for these two companies. This meant that the researcher could not use these companies in the regression analysis, and thus, they have been excluded from further analysis. Factoring in this exclusion, the market capitalisation of the sample captures 82.57% of the JSE main board, compared to 91.52% when Prosus N.V and Pepkor Holdings Ltd were included (see table 2 in the appendix section). The sample collected is therefore still expected to be representative of the JSE population.

4.2 Discussion of the normality of the data and shape

To ensure that the research data collected was suitable for statistical tests and methods that the researcher planned to employ for the purposes of answering the research aim and research question, an analysis was performed on the data to assess the distribution thereof.

The research uses inferential statistical tests, such as t-tests, p-values, ANOVA, multi-regression analysis, etc. These inferential statistics operate on an assumption of normality for a given dataset, and their use on a dataset that is not normally distributed would provide results that are largely inaccurate – if not meaningless. Figure 2 (see appendix section) presents the results of the normal probability plot performed on the dataset.[10]

Figure 2 provides a plot of the sample percentile on the horizontal axis, and the associated return on the vertical axis. The plot provides evidence that the data approximates normal distribution, and therefore, the inferential statistical tests as found above are appropriate for use in analysing the research data collected.

4.3 Summary statistics

4.3.1 Factor statistics – FF5F

Table 3 presents the factor summary statistics results for the FF5F, excluding the ESG factor proposed by the research. The table records the coefficients, standard error, t-statistics and p-values for all the five factors included in the FF5F.

	Coefficients	*t Stat*	*P-value*	*Mean*	*Std deviation*
Intercept	0,314861	1,3354	0,184		
RmRf	2,004448	3,572**	0,0004	3,75%	11,07%
SMB	0,447573	3,806**	0,0002	28,37%	26,83%
HML	-0,93595	-4,33***	0,00002	-5,28%	29,38%
RMW	0,291889	0,913	0,362	6,28%	19,19%
CMA	0,215128	1,193	0,234	1,74%	38,36%

[10] A normal probability plot is a graphical tool used for assessing whether a dataset is approximately normally distributed (Chambers, Cleveland, Kleiner and Tukey, 1983).

R Square	0,343632

** Significant at 10% level, ** Significant at the 5% level, *** Significant at the 1% level*

Table 3 – summary statistics for the FF5F

Except for the profitability factor (RMW) and the investment factor (CMA), all the factors provided results that are significant, at least at a 5% level. The market premium factor (Rm-Rf) provided the highest coefficient, with a positive premium of +2.004 (rounded to three decimal places). Following this was the value factor (HML), which provided a negative premium of -0.935, indicating an inverse relationship between the BTM ratio and portfolio returns, also significant at a 1% level. The size factor (SMB) produced a positive premium of 0.447, with a p-value of 0.0002, indicating once again, significance at a 5% level of significance. The profitability factor produced a positive coefficient of 0.215, however, this observation was insignificant as the p-value (0.362) was above the 5% significance level. Similarly, although the investment factor also displayed positive corelation with expected returns (+0.215), this result was also insignificant at a 5% level of significance, producing a p-value of (0.234).

Notably, the R-squared for the un-adjusted FF5 model was 0.343.

4.3.2 Factor statistics – adjusted FF5F

Table 4 presents the factor summary statistic results for the six-factor model, including an ESG scores factor. Like the FF5F, the profitability factor and the investment factor still show insignificant results. The market premium factor also continues to show the highest correlation with expected returns, producing a positive coefficient of 2.802, significant at a 5% level of significance. The size factor subsequently produced greater correlation with market returns in the adjusted FF5F, displaying an increased positive correlation of 0.664 with expected returns on the JSE (0.447 in the FF5F). This correlation is significant at a 1% level of significance as it had a p-value of 0.00173. The profitability factor and the investment factor both displayed positive correlation with expected returns of 0.321 and 0.240, respectively. Both these correlations were insignificant at a 1%, 5% and at a 10% level of significance. Lastly, of particular interest, is the correlation produced by the ESG scores factor. This factor produced a negative correlation of 0.206. Interestingly, this indicates that a negative relationship exists between the ESG scores reported by JSE listed companies, and their expected returns. This result, however, is not significant at a 1%, 5%, nor at a 10% level of significance.

	Coefficients	*t Stat*	*P-value*
Intercept	0,598823	2,257	0,025
RmRf	2,802152	3,324	0,001
SMB	0,664936	3,197***	0,001
HML	-0,13377	-3,48	0,0006
RMW	0,321556	1,005	0,316
CMA	0,240872	1,33	0,185
ESG Score	-0,20691	-1,266	0,207
R Square	0,351629		

** Significant at 10% level, ** Significant at the 5% level, *** Significant at the 1% level*

Table 4 - summary statistics for the adjusted FF5F which includes an ESG scores factor.

Notably, the R-squared for the FF5 model with ESG scores was 0.352. This indicates that the inclusion of ESG scores does improve the predictability of the FF5 asset pricing model, although only marginally.

The market premium factor displayed positive correlation with JSE expected returns in both models. As previously discussed in the hypothesis development section in 2.6.1, this implies that improved market performance in the JSE market, resulted in an improvement in the performance of JSE listed stock prices. Although this finding is inconsistent with that of Muller and Ward (2011) and van Rensburg and Robertson (2003), it is in line with the results of Cox (2018), with timing and methodological differences possibly causing differences. Further, the adjusted FF5F displayed a slightly higher correlation between expected returns and the market premium in the JSE, both results are significant at a 5% level.

The value factor, which reflects the expectation that stocks with high book to market value (value stocks) outperform low book to market value stocks (growth stocks), was not observed on the JSE for both the FF5F and the adjusted FF5F. Interestingly, both models displayed statistically significant negative correlations between the value factor and JSE expected returns. The FF5F produced a stronger negative correlation of -0,935, compared to that of the adjusted FF5F of -0,133, both suggesting that expected returns on the JSE are inversely related to a firm's book-to-market value – i.e., growth stocks outperform value stocks, at least during the period sampled (between 2015 to 2019). This is contrary to the observations of van Rensburg and Robertson (2003) and Strugnell et al. (2011), who found evidence of the existence of a value premium. Van Rensburg and Robertson (2003) and Strugnell et al. (2011) constructed value and growth stocks based on price-to-earnings and earnings yield ratios, respectively. This could be the contributing cause to the differences identified as the factor specifications also play a role in their performance. Performing testing on the JSE over a 14-year period (1999 to 2021), Hammar (2014) found that value stocks predominantly outperformed growth stocks when defined by the price-to-earnings or by the price-to-cash flows ratio, however, growth stocks outperformed value stocks when the portfolios were based on price-to-book value and dividend yield on the JSE. As this research defined value and growth stocks by the book-to-market value – following Fama and French (2015) – the results may be a function of the model specification.

The size factor, defined by market capitalisation, reflects the excess return generated by small stocks relative to large stocks. The summary statistics for both models present statistically significant positive correlation results for the size factor. The adjusted FF5F displays a stronger correlation than the FF5F between the size factor and expected returns on the JSE (0,664 vs 0,447). This suggests that firms in the JSE did experience the 'size effect' in the sample period investigated. This result is consistent with the findings of Basiewicz and Auret (2009); Rensburg and Robertson (2003) and Strugnell et al. (2011).

The profitability factor, defined by operating profit divided by book value of equity, which represents the outperformance of stocks with weak-profitability by robust-profitability stocks, shows positive correlation with JSE expected returns which is not as strong as that of the market premium, size and value factors for both models. Although both models produce results that do indeed suggest that robust-profitability stocks out-perform weak-profitability stocks, little reliance can be placed on this postulation as both models display statistically insignificant results with the FF5F and the adjusted FF5F producing p-values of 0.362 and 0.316, respectively.

Similarly, the investment factor, defined as the growth in total assets from fiscal year end t-2 to fiscal year end t-1, displayed statistically insignificant positive correlation between JSE expected returns and the investment factor. Although the stocks of firms that pursue a conservative investment strategy were expected and observed to outperform those that pursue aggressive investment strategies, little reliance can be placed on this result due to its statistical insignificance.

Lasty, of particular interest for the purposes of the research is the observed interaction between ESG scores and expected returns on the JSE. The FF5F did not include an ESG factor, therefore no results were collected for this. The adjusted FF5F did produce some correlation with JSE expected returns, however, the direction of this correlation was surprising as ESG scores were seen to be inversely related to expected returns. In addition to this, these results had a p-value of 0,207, as this is above the 5% level of significance, the result is not statistically significant. Similarly, employing panel regression on the JSE over the 2012 to 2019 period, Ball (2021) investigated the relationship between ESG and corporate financial performance, and during this period, also found no statistically significant evidence of a relationship between the two. However, as the main objective of the research performed in this study is the investigation of the model itself, instead of individual factors, more importance will be placed on the model statistics results, and the statistical significance thereof.

4.3.3 Model statistics – FF5F

Tables 5 presents the summary statistics for the FF5F as a whole, excluding the ESG scores factor. Table 5 presents the R-squared, adjusted R-squared, and the number of observations observed for the regression performed.

As the objective of the research is to investigate whether the inclusion of the ESG scores factor in the FF5F model would improve the model’s predictability of expected returns on the JSE, the focus of the analysis below will be on the R-squared and the adjusted R- squared generated by the model in table 6. This will be compared to the R-squared and adjusted R-squared generated by the six-factor model which includes an ESG scores factor.

Regression Statistics	
R Square	0,343632
Adjusted R Square	0,315957
Observations	136

Table 5 – regression statistics for the FF5F

The FF5F produced an R-squared of 0.343, while the adjusted R-squared amounted to 0.315 out of 136 observations.

4.3.4 Model statistics – adjusted FF5F

Table 6 presents the summary statistics for the adjusted FF5F as a whole, which includes the ESG scores factor. This table displays information that is similar to that displayed by table 5 above.

Inclusion of the ESG scores factor in the five-factor model resulted in an R-squared and adjusted R-squared of 0.351, and 0.318, respectively. This is an improvement in both measures when compared to that observed on the FF5F of 0.343, and 0.315, respectively (see table 5).

Regression Statistics	
R Square	0,351629
Adjusted R Square	0,318999
Observations	136

Table 6 – regression statistics for the adjusted FF5F including an ESG scores factor.

The researcher mentioned in the assumptions, limitations, and delimitations section under section 1.5 that the purpose of the research is not to empirically test the validity of the FF5F in explaining returns, but rather, to investigate whether there is improvement in the predicting power of the model given an ESG scores factor inclusion. Therefore, although the above R-squared results from both models suggest that the models do not seem to capture most of the returns on the JSE, the results are acceptable for the purpose of answering the research question and addressing the aim of the study.

However, as there existed the possibility that the R-squared measure utilised in the study may have automatically, or spuriously increased as a result of adding an additional variable to the FF5F, i.e., the ESG scores factor, the final comparison of the FF5F and the adjusted FF5F was based on the adjusted R-squared. This was to ensure that both models are compared on an equivalent basis, with no bias against the model with less independent variables, i.e., the FF5F.

As was seen above, the FF5F resulted in an adjusted R-squared of 31.60%, thus explaining 31.60% of JSE expected returns, whereas use of the adjusted FF5 model resulted in a slightly improved adjusted R-squared of 31.90%. Therefore, this implies that the improvement observed in the adjusted FF5F model's R-squared is not the sole function of variable bias, but a genuine improvement in the predicting power of the model. These results are both statistically significant at a 5% level, having produced F-tests of overall significance of less than 0.05, for the FF5F and adjusted FF5F, respectively.

Based on the R-squared results from the summary statistics above, the FF5F model was able to explain 34.36% of expected returns on the JSE during the 5-year period examined, whereas the adjusted FF5F was able to explain a slightly improved 35.16% of the expected returns on the JSE. This conversely implies that 65.64% of the variation in expected returns on the JSE (the dependent variable in the research) are not explained by the FF5F. Likewise, 64.84% of the variation in JSE expected returns are not explained by the factors in the FF5F (which include the ESG scores factor). Thus, albeit a small difference, the adjusted FF5F was able to explain a greater portion of JSE returns than the FF5F, therefore, based on R-squared, the adjusted FF5F outperformed the FF5F.

Lastly, this study hypothesised that inclusion of an ESG scores factor in the FF5F would result in an improvement in the model's predictability of JSE expected returns. To test this hypothesis, a null hypothesis hypothesising that inclusion of an ESG scores factor in the Fama-French five-factor model would have no effect on the model's predictability of JSE expected returns was developed in the hypothesis development section. Based on the results discussed above, since the F-test of overall significance for the adjusted FF5F of 0,000000000176 is below alpha, i.e., the significance level of 0.05, the null hypothesis is rejected in favour of the alternative hypothesis. Therefore, inclusion of an ESG scores factor to the FF5F does result in the improvement of the model's predictability of expected returns on the JSE.

4.3.5 Summary of the results

This chapter presented and analysed the research results for 38 of the companies included in the JSE top 40 as at 31 October 2021. The primary aim was to compare the performance of the FF5F and the adjusted FF5F in the explanation of JSE returns. The secondary objective of this chapter was to observe and study the relationships between JSE expected returns, and the factor specifications of each of the models given the understanding established in the hypothesis development section.

To varying degrees, both models exhibited similar relationships between JSE returns and their respective factors. Although both the FF5F and the adjusted FF5F displayed positive correlation with JSE expected returns for the profitability and investment factor, this correlation was found to be statistically insignificant. Statistically significant evidence of the market premium and size effects was also found in both models, with the adjusted FF5F displaying a stronger correlation in both. Contrary to the findings of Fama and French (1993; 2015), however, no evidence was found of the value effect, in fact, growth stocks seemed to outperform value stocks on the JSE during the sample period studied. These results were found to be statistically significant. Interestingly, ESG scores show a negative and insignificant relationship with returns. This is an intriguing finding and warrants further research. In summary, except for the ESG scores factor, both the FF5F and the adjusted FF5F seem to capture the relationships between JSE returns and the factors in a similar way.

The focus of the research, however, was on the comparative performance of the FF5F and the adjusted FF5F. The results produced by the research provided statistically significant findings that suggest that the adjusted FF5F is an improvement to the FF5F. However, this was only a slight improvement, and as such, this result may indicate that, although investors may care about ESG, this does not materially influence their investment decisions and that ESG performance is not significantly priced by the JSE market.

5 SUMMARY, CONCLUSIONS, RECOMMENDATIONS, AND AREAS FOR FURTHER RESEARCH

Asset pricing models have long been a focus area for researchers in finance. Work on this area of finance has been the source of several Nobel Prizes. In addition to this, asset pricing models are commonly used by investors for portfolio selections, determining return rates, performing valuations, etc. Work done on asset pricing models usually aims to understand the risk factors that drive share prices. The most popular of these models include the Capital Asset Pricing Model (CAPM), the Fama and French three-factor model (FF3F), and the Fama and French five-factor model (FF5F). Building on the work of Markowitz (1952) on mean-variance theory, the CAPM became a seminal model that laid the foundation for asset pricing theory. It suggested that the only priced risk factor in determining share prices in markets is the systematic risk of the share of portfolio. Following empirical shortcomings identified by scholars, Fama and French (1993;2015) added additional risk factors that were observed to have a correlation with expected returns. These were the size, value, profitability and investment factors. The addition of these factors resulted in the Fama and French three-factor and the five-factor model, respectively. Although these models proved to be an improvement to the CAPM on empirical tests conducted on most markets, there were still some returns left unexplained by the models. This created scope for additional research to suggest new risk factors that may better capture returns in the markets.

This research was a response to this call. The aim of the research was to discover whether the inclusion of ESG scores in the FF5 would improve the model's predicting power of expected returns on the JSE. To achieve this, an ESG scores inclusive six-factor model (the adjusted FF5F) was developed and the performance of the model in explaining expected returns on the JSE was compared to that of the FF5F using regression analysis. Additionally, the study also looked at the relationships that the factors included in both models share with the expected returns on the JSE to determine if they are in line with prior research.

The results of the research find evidence of the risk premium and the size effect for both models; however, the value effect was not observed on neither of the models. In fact, it seems there is a 'growth effect', in other words, contrary to the findings of Fama and French (1993; 2015), JSE listed growth stocks seem to outperform value stocks in the sample period studied. Although profitability and investment effects were observed for both models, they were found to be statistically insignificant. More interestingly, however, the ESG scores displayed a negative and insignificant relationship with returns. This is an intriguing finding and warrants further research.

Further research could use longer sample periods to investigate the relationship between JSE expected returns and ESG scores further. Alternatively, as stated in the limitations and delimitations section, ESG scores tend to be subjective and dependent on the respective databases ratings approach, thus, employing a different database may also provide more insight on the relationship between ESG scores and JSE expected returns. Lastly, the research could be replicated with the use of ESG disclosure scores as opposed to ESG performance scores as used by this research.

The main objective of the research, however, was the comparative performance of the FF5F and the adjusted FF5F. It was found that although the adjusted FF5F captured more returns than the FF5F, there was only a slight improvement in the predicting power of the model. However, given the fast-growing interest and focus on ESG in the world and the increase in sustainability-related regulation, the researcher suggests that this improvement in predicting power of the model is likely to grow as ESG becomes more integrated in investments by investors. The researcher is of the idea that there is scope for further research on the addition of ESG factors in the development of asset pricing models in the future, especially during and post the COVID-19 period as the world continues to embrace and build momentum around ESG.

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APPENDIX

Table 1: ESG scores conversion between percentage and letter grades

Score range	**Grade**	**Description**
0.0 <= score <= 0.083333	D -	'D' score indicates poor relative ESG performance and insufficient degree of transparency in reporting material ESG data publicly.
0.083333 < score <= 0.166666	D	
0.166666 < score <= 0.250000	D +	
0.250000 < score <= 0.333333	C -	'C' score indicates satisfactory relative ESG performance and moderate degree of transparency in reporting material ESG data publicly.
0.333333 < score <= 0.416666	C	
0.416666 < score <= 0.500000	C +	
0.500000 < score <= 0.583333	B -	'B' score indicates good relative ESG performance and above-average degree of transparency in reporting material ESG data publicly.
0.583333 < score <= 0.666666	B	

Source: Refinitiv (2021)

Table 2 – Constituents of the JSE Top 40 and their respective market capitalisation

FTSE/JSE SA Top 40 Companies Index | Index Constituents Analysis

Name	RIC	Mcap

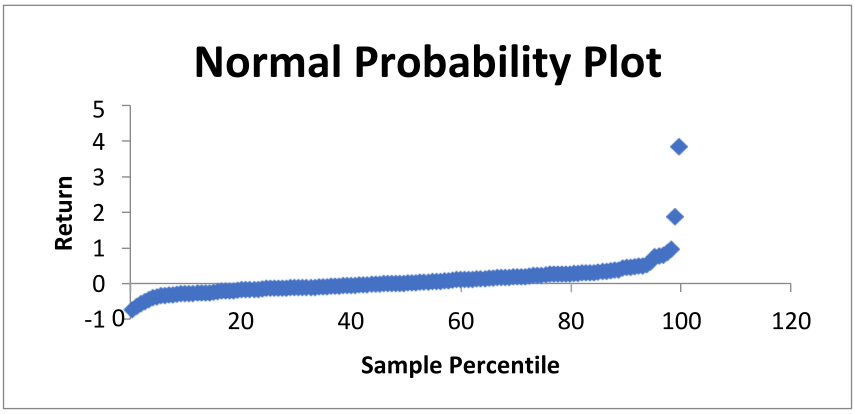
BHP Group Ltd	BHGJ,J	R 158,37	2 785 075 628
Anheuser Busch Inbev SA	ANHJ,J	R 775,66	1 666 644 915
British American Tobacco PLC	BTIJ,J	R 579,95	1 528 175 498
Prosus NV	PRXJn,J	R 867,94	1 493 291 209
Glencore PLC	GLNJ,J	R 332,85	1 292 659 842
Compagnie Financiere Richemont SA	CFRJ,J	R 245,51	1 015 846 860
Anglo American PLC	AGLJ,J	R	986 811 924 061,48
Naspers Ltd	NPNJn,J	R	642 043 467 035,34
Anglo American Platinum Ltd	AMSJ,J	R	499 035 862 862,48
FirstRand Ltd	FSRJ,J	R	394 347 250 709,53
MTN Group Ltd	MTNJ,J	R	324 829 263 581,62
Standard Bank Group Ltd	SBKJ,J	R	290 654 751 617,48
Vodacom Group Ltd	VODJ,J	R	271 781 448 826,44
Capitec Bank Holdings Ltd	CPIJ,J	R	249 042 605 692,72
Sasol Ltd	SOLJ,J	R	243 392 622 582,72
Gold Fields Ltd	GFIJ,J	R	196 483 681 340,72
Impala Platinum Holdings Ltd	IMPJ,J	R	189 005 893 490,15
Sibanye Stillwater Ltd	SSWJ,J	R	164 976 726 742,30
Sanlam Ltd	SLMJ,J	R	154 307 056 730,32

Mondi PLC	MNPJ,J	R	146 687 121 871,42
Absa Group Ltd	ABGJ,J	R	142 803 601 877,55
AngloGold Ashanti Ltd	ANGJ,J	R	140 457 164 512,14
Shoprite Holdings Ltd	SHPJ,J	R	139 023 681 820,20
Nedbank Group Ltd	NEDJ,J	R	113 184 894 811,20
Discovery Ltd	DSYJ,J	R	111 047 936 186,00
Bid Corporation Ltd	BIDJ,J	R	110 475 439 348,56
Sasol Ltd	SOLBE1	R	240 842 930 966,32
Pepkor Holdings Ltd	PPH	R 324,54	80 855 871
Aspen Pharmacare Holdings Ltd	APNJ,J	R 897,34	80 436 510
Exxaro Resources Ltd	EXXJ,J	R 957,60	79 571 699
Remgro Ltd	REMJ,J	R 579,76	77 096 333
Clicks Group Ltd	CLSJ,J	R 419,66	76 377 126
Rand Merchant Investment Holdings	RMI	R 827,30	40 577 587
Bidvest Group Ltd	BVTJ,J	R 707,36	75 595 348
Reinet Investments SCA	RNIJ,J	R 819,69	66 016 936
Woolworths Holdings Ltd	WHLJ,J	R 406,46	61 578 358

NEPI Rockcastle PLC	NRPJ,J	R 613,63	58 518 320
Old Mutual Ltd	OMUJ,J	R 346,21	57 868 124
Kumba Iron Ore Ltd	KIO	R	163 200 963 025,80
South32 Ltd	S32	R	255 076 180 840,24
FTSE/JSE SA Top 40 Companies Index			16705698644392,60
Total of included firms			15073033242586,50
FTSE/JSE SA All Share Index			18 253 809 964 106,20
% of JSE main board (included firms only)			82,57
% of JSE main board (included and excluded firms)			91,52

Source: Refinitiv workspace database and researcher's own computations

Figure 2 – Normal probability plot of data sample percentile and returns.



Source: Researcher's regression results