Size and Value Effect:
Application of the Fama French Three-Factor Model in the Irish Stock Market

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Abstract

There are several studies of the Fama French three factor model in international capital markets. This study empirically examines the feasibility of the Fama French three factor model as an asset pricing model in the Irish stock market. According to Fama and French methodology, monthly returns of twenty-six stocks over the period of 2011 to 2015 is used to construct four portfolios based on market capitalisation (size) and book equity-to-market equity (value) ratio. A time series regression approach is employed using the ordinary least square method by regressing the excess return of the portfolios against three independent factors (excess return on the market, size and value). The findings show that there is evidence for excess return on the market and value factors in the Irish stock market and that the Fama French three factor model has a higher explanatory power than the capital asset pricing model (CAPM). The market risk factor is positive and the most significant among the three risk factors. However, the size factor is significant for portfolios containing both small and big or large capitalisation stocks. This suggests that the small capitalisation stocks did not realise higher premiums than the big or large capitalisation stocks. The value factor is positive and significant for portfolios containing high book equity-to-market equity stocks. This indicates that high book equity-to-market equity stocks outperform low book equity-to-market equity stocks. The results are partially consistent with those of the Fama and French (1993), this implies that the Fama French three factor model does not completely hold for the Irish stock market. The empirical evidence of this study can be a basis for further research of other factors that explain in more detail the variation in the average returns of portfolios in the Irish context.

Keywords: *Asset pricing, CAPM, Fama French three factor model, Irish stock market, regression analysis, stock returns, size premium, value premium.*

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List of Abbreviations

ADF	Augmented Dickey-Fuller
AMEX	American stock exchange
APT	Arbitrage Pricing Theory
BE/ME	Book equity-to-market equity ratio
CAPM	Capital Asset Pricing Model
C/F	Cash flow yield (Cash flow/ Price)
EMH	Efficient Market Hypothesis
E/P	Earnings yield (Earnings/Price)
FF	Fama French
HML	High Minus Low
ISE	Irish Stock Exchange (Euronext)
MRP	Market Risk Premium
NASDAQ	National Association of Securities Dealers Automated Quotations exchange
NYSE	New York Stock Exchange
P/E	Price Earnings ratio
SMB	Small minus Big

1 INTRODUCTION

The concept of risk, return and expected return are major components in portfolio management, corporate finance, investment analysis and valuation. Investors are faced with the challenge of selecting appropriate securities to maximize their returns and typically want to be compensated with a premium for holding 'risky' assets. A risky asset, for example a stock or a bond, is an asset with different levels of risk with a return that is uncertain. Therefore, asset pricing is a key aspect when making investment decisions.

The capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965) and Black (1972) based on Harry Markowitz's (1952) earlier work on diversification and mean-variance portfolio theory is the first asset pricing model. It implies that there is a positive linear relationship between the expected return on securities, and market risk beta of the single-factor model is enough to explain the variations in expected returns on stocks. CAPM is a simple and popular model widely used in practice till today (Hamid *et al.*, 2012) although some of its assumptions are not applicable in real world scenarios. Empirical evidence from several studies indicates that the single-factor model (CAPM) does not entirely explain variations in the average returns of stocks.

According to Banz (1981), evidence supports that CAPM does not apply on the New York Stock Exchange (NYSE) and finds that there is a size effect which explains the cross-sectional returns of stocks. Banz (1981) concludes that the size effect, in terms of market capitalisation, has been in existence for a long period and finds that average returns of small stocks are higher than large stocks. Rosenberg, Reid and Lanstein (1985) finds that firms with a high book equity-to-market equity (hereafter BE/ME) ratio have higher average stock returns than firms with a low BE/ME ratio. They called it the value effect. Reinganum (1981), Amihud and Mendelson (1991, 1986), Fama and French (1993) highlights that the CAPM is not an efficient

predictor of average stock returns. Fama and French (1993) added extra factors (size and value) to the market factor and found out that the two factors captured much of the variation in average stock returns. They found that during the period of 1963 to 1990, the simple relationship between market risk and average stock returns vanished.

Further studies by Downe (2000) describes that CAPM is not a reliable predictor of returns and the characteristics of the stocks explain better the variation in the average stock returns. Dempsey (2013) claims that CAPM has failed as a model for asset pricing and investors who choose to use the model do so on their own rationality and not the market's. Lai and Stohs (2015) illustrates that the CAPM market beta depends on the expected rate of return for an asset which is the opposite of the assumed relationship. Tests on the CAPM such as those carried out by Nikolaos (2009) and Dalgin, Gupta and Sraiheen (2012) on the British and Turkish markets respectively show that the model is not valid in its application of explaining stock returns.

Amanda and Husodo (2015) identifies that before making any investment decisions, it is important that investors know the factors that affects the expected average returns on assets so they can develop an optimal portfolio of assets. According to Griffin (2002), applying the wrong model or theory can introduce flaws in portfolio evaluation, capital budgeting, risk analysis and investment decisions and most of these models cannot always be efficient with varying financial markets. Fama and French (1993) reports that the three factors – market, size and value – explain to a considerable extent the variation in the average returns on stocks. The initial examination of academic literature and industry reports shows that an extensive amount of research and consideration has been given to the connection between stock returns and its fundamental variables in most countries, however, there is limited evidence of research on the Irish stock market.

Although there are many studies on the Fama French (hereafter FF) three factor model, the aim of this study is to add to existing theory and investigate the possibility and explanatory power of the FF three factor model as an asset pricing model on the Irish stock market and determine the size and value effect as characterised by the model. In other words, this study will assess and compare the strength of CAPM (single-factor model) and FF three factor model (multifactor model) in asset pricing on the Irish stock Exchange (hereafter ISE) between 2011 and 2015. Four portfolios are constructed namely:

- Low BE/ME and small capitalisation stocks (LS)
- Low BE/ME and big capitalisation stocks (LB)
- High BE/ME and small capitalisation stocks (HS)
- High BE/ME and high capitalisation stocks (HB)

After the analysis of the four portfolios, it is found that the market (R_m-R_f) and value (HML) factors are the important factors in explaining the variations in excess return of the portfolios which is partially consistent with the Fama and French (1993) result. However, the size (SMB) factor is not significant in the model.

The Irish Stock Exchange in Dublin is Ireland's only stock exchange and has been in existence since 1793. Euronext completed acquisition of the ISE on 27 March 2018. The ISE is run and managed by Euronext and joined Euronext federal model which operates under the trading name Euronext Dublin (Irish Stock Exchange, 2018). As of July 2019, ordinary shares of 54 companies were listed on Euronext Dublin with a total market capitalisation of approximately 184 billion euros.

The next chapter presents the literature review. This chapter provides a review of the single-factor and multifactor models. It also provides an in-depth review of the relevant literature. Chapter three explains the research questions. This chapter specifies the objectives of the study

focusing on the research hypotheses. Chapter four explains the research methodology and the approach used for the study. This chapter focuses on the data and its collection and the strategy used. Chapter five presents the analysis and findings of the three-factor model with respect to excess return on the market, size and value. Chapter six presents and discuss the results of the regression analysis. The final chapter is the conclusion which explains the limitations and recommendations related with this study.

2 LITERATURE REVIEW

2.1 Introduction to Literature

Market return is not the only factor related to asset returns, there are several asset pricing theories that are used to determine the return on assets. A characteristic or variable that is related to asset returns is called a factor. Multifactor models offer a better explanation and flexibility when compared to the single-factor model (CAPM). According to DeFusco *et al.* (2015), models that use several factors are used by investment professionals in portfolio construction and management, risk management, and in the assessment of the performance of a portfolio in comparison to a benchmark.

To provide a framework for this study, a brief discussion of the single-factor model (CAPM) and some multifactor models (Arbitrage pricing theory, The FF three factor model, and the Carhart model) are discussed below.

2.2 Capital Asset Pricing Model (CAPM)

The CAPM is the first, most popular and most commonly used asset pricing model (Cochrane, 2005). It is a powerful intuitive model that simplifies the measurement of the complex relationship between risk and expected return, that is, only one factor is used to price an asset or a portfolio (Fama and French, 2004). CAPM explains that the expected return on an asset is a linear relationship with the systematic risk measured by beta. Although CAPM is a simple model, its simplifying assumptions ignore the complexity of financial markets and the empirical record of the model is poor to effectively invalidate the way it's used (Fama and French, 2004).

According to Elton *et al.* (2009), some of the assumptions of the model are as follows:

- There are no transaction costs and taxes
- Assets are infinitely divisible
- Investors are risk averse
- Investors are rational individuals
- Markets are frictionless
- Investors cannot affect the price of a stock through buying and selling.
- Investors can continuously borrow and lend at the risk-free rate

Even though some of these assumptions are unrealistic, CAPM is still used widely used in the industry and serves as a benchmark for comparison of initial returns (Hamid *et al.* 2012).

2.3 Multifactor models

The increase in evidence against the validity of CAPM in explaining risk and variation in the average returns of stocks over the years spurred researchers to incorporate many sources of systematic risk for asset pricing models. According to Cochrane (2005), there are three steps that researchers use for constructing and testing asset pricing models. They are as follows:

1. They find a characteristic or factor that they think is related to average returns. The stocks are then sorted into portfolios based on those characteristic and any difference in the average returns of the portfolios is identified.
2. Slope coefficients for the portfolios are computed, the variation in average return is checked whether it is explained by the variation in the slope coefficients.
3. If not, there is an anomaly and more slope coefficients are considered.

There are several factors that have been used by authors to examine the relationship and model the variation of average stock returns, however, multifactor models are classified into three types: macroeconomic, fundamental and statistical factor models.

Macroeconomic factor models

According to DeFusco *et al.* (2015) the factors in the macroeconomic factor models are surprises in the macroeconomic variables that explain significantly the average returns of stocks. Connor (1995) describes that although they are the most intuitive and simplest multifactor model, the surprises affecting each stock return needs to be identified and measured. Several authors and researchers have used macroeconomic factors in their model. Cochrane (1996) used returns from physical investment as the macroeconomic factor in the investment-based asset pricing model. The production function equation was used to calculate the returns. Chen, Roll and Ross (1986) used interest rates, expected and unexpected inflation, industrial production and other variables to examine the performance of stocks and determine the sources of risks that are priced. Cochrane (2005) cited that Jagannathan and Wang (1996) and Reyfam (1997) used labour income as a factor to study the variation in the average returns of stock.

Fundamental factor models

The factors in the fundamental factor models are attributes of the stocks or companies which explain the cross-sectional variation in the average stock returns (DeFusco *et al.*, 2015). Fama and French (1993) used market capitalisation (size), book equity-to-market equity ratio (value) in their asset pricing model. Other common fundamental factors used are price-to-earnings ratio, earnings yield, dividend yield and financial leverage.

Gottwald (2012) defines price-to-earnings ratio as the ratio of a stock price and the last earning per share which illustrates how much investors wish to pay per earnings of the company. Earnings yield is the ratio of the most recent twelve-month earnings per share to the current market price. It is used by investors to determine if an asset is over-priced or under-priced and for optimal asset allocation (Mitchell, 2019). According to Chen (2019) dividend yield is the ratio of a firm's annual dividend to its share price.

Statistical factor models

Connor (1995) explains that statistical models such as Maximum Likelihood and Principal Component Analysis are used on historical stock returns to identify the persistent factors. The statistical factor model makes minimum assumptions, but the drawback according to DeFusco *et al.* (2015) is that relating a statistical factor with economic meaning may not be possible and it is generally difficult to interpret in comparison to the macroeconomic and fundamental factors.

The financial industry frequently uses macroeconomic and fundamental factor models because they are intuitive and do not entirely rely on data mining methods. However, statistical factor models are also used in real world scenarios (DeFusco *et al.*, 2015). Investors may be able to make better investment decisions using a multifactor model than a single-factor model (CAPM). Some multifactor models are discussed below.

2.3.1 Arbitrage Pricing Theory (APT)

The Arbitrage Pricing Theory (APT) is an alternative to the CAPM and was developed by Ross in 1976. The APT introduced a framework that is more general than the CAPM because it allows for the explanation of expected asset (portfolio) return with multiple risk factors capturing systematic risk. (Campbell *et al.*, 1998). Although the APT is also linear, the theory is more general than the CAPM and it does not indicate the identification or the number of risk factors. The risk factors can include inflation, changes in interest rates, exchange rates, production measures, investor confidence, market indices and so on (Ross, 1976). An analyst can decide on the number of risk factors for the individual asset or portfolio being analysed. According to DeFusco *et al.* (2015) the APT makes three key assumptions:

1. A factor model explains asset returns.
2. Investors can form well-diversified portfolio that eliminate unsystematic risk because there are many assets to choose from.
3. There are no arbitrage opportunities among well-diversified portfolios.

2.3.2 Fama French three factor model

Cochrane (2005) concludes that the FF three-factor model is a well-known and widely used multifactor model in empirical research. Fama and French (1992, 1993, 1996) in their academic studies concluded that the CAPM does not explain the variation in stock returns. They extended the CAPM which proposed that (i) expected returns are a positive linear function of beta (β) and (ii) beta (β) is the only explanatory factor to describe the variation of asset returns. The beta measures the sensitivity of the stock or portfolio to the market risk. It is the slope of the regression line of a stock's or portfolio return compared to the market's return.

Due to increasing empirical evidence from several studies such as Banz (1981), Basu (1983), Rosenberg, Reid and Lanstein (1985) amongst others which states that CAPM poorly explains stock returns, FF added *size* and *value* (book equity-to-market equity ratio) as explanatory factors in explaining the variation in stock returns. "Value" stocks are stocks that have higher book value than the market value while "growth" stocks have higher market value. According to Cochrane (2005), value stocks have given higher average returns than growth stocks and book value is a better divisor than dividend or earnings which can be negative.

Fama and French (1993) identifies that the return on a stock or portfolio is expressed as a linear function of the

- Market risk premium, MRP (excess return on the market portfolio),
- Size risk premium, SMB (premium earned by small stocks minus big stocks) and
- Value or Growth risk premium, HML (premium earned by high BE/ME ratio stocks minus low BE/ME ratio stocks)

According to the FF three-factor model, all the portfolios formed have betas close to one on the market portfolio, which proves that the market beta explains the difference in average return between stocks and bonds. They also show that the variation in the average return of the 25 size and BE/ME portfolios can be explained by varying SMB and HML loadings (Fama and French, 1993).

2.3.3 Carhart model

The Carhart model includes a momentum factor to extend the FF three factor model. Carhart (1997) presents a model based on mutual fund performance with three group of stocks and portfolios having higher average returns than those based on single-factor model (CAPM).

Based on the findings, four factors were able to explain the variation in the average returns of stocks. The four factors of the model are:

- Market risk factor (RMRF)
- Small minus big (SMB),
- High minus low (HML),
- Winners minus losers (WML)

These factors are explained as the market index factor, market capitalisation factor, book-to-market factor and momentum factor respectively. DeFusco *et. al* (2015) concludes that the three factors (size, value, and momentum) are the most popular and used in equity portfolio construction, active management risk decomposition and return attribution.

2.4 Empirical Evidence of Stock Returns and their Fundamental Variables

There have been several researches to show the relationship between stock returns, firm size, earnings yield (E/P), book-equity to market equity ratio (BE/ME), cash flow yield (CF/P), value or growth strategies and leverage amongst others. Basu (1983) illustrates the relationship between earnings yield, firm size and stock returns. The outcome confirms that average returns of high E/P firms are higher than low E/P firms, the E/P outcome is significant even after the effect of size is randomised across high and low E/P groups. Lakonishok, Shleifer and Vishny (1994) explains that stocks mispricing caused by growth strategies in which the investment decisions are based on the reaction to the news pertaining to the company leads to lower average returns. A further explanation is that the strategy is not inferior to value strategy, but investors are too confident about firms that did well in the past which pushes up the price and P/E ratio, thus, lowers the expected returns of the stocks.

Further work of Bhandari (1988) found that stock returns are positively related to leverage (the ratio of debt to equity). Stocks with a high degree of leverage earned a higher return relative to their market betas. In addition, the study by Chan, Hamao and Lakonishok in 1991 on the Tokyo stock exchange include delisted securities in the construction of their portfolios. Their findings show that the results are statistically significant; the three fundamental variables – BE/ME ratio, earnings yield and cash flow yield – were tested and found to have a significant impact on the stock returns, that is, a high ratio of cash flow yield predicts higher returns.

2.5 Evidence of Size or Value Premiums in International Markets

According to FF (1993), the market risk premium, MRP, is the difference between the market return and the risk-free rate; the size premium, SMB (small minus big) is the factor that measures the excess return of small stocks relative to big stocks. This premium is due to the high risk, less financial flexibility and lower diversified nature of stocks of small firms, that is, the premium compensates investors for investing in these small firms. The value premium, HML (high minus low) is the factor that quantifies the extra return of stocks with high BE/ME ratio. If the BE/ME ratio of a stock is high, it signifies the difference in the book value of the stock and the market value of the stock. This may be a result of low market expectation for the stock which could make investors demand additional compensation because of higher business and financial risk such firms face.

Aguenaou, Abrache and El Kadiri (2011) and Duc Hong Vo (2015) concludes that the FF three-factor model does not completely hold in the Moroccan and Australian stock market respectively. Evidence shows that in the Moroccan stock market, high BE/ME stocks outperform low BE/ME stocks and small capitalisation firms have a negative size premia. In

the Australian context, adoption of the FF three-factor model is not recommended because findings show that the HML factor is well priced and the SMB factor is not.

Rossi (2012) in the study of the Italian stock market found that market factor alone cannot explain the variation in the average stock returns, thus, confirming the Cavaliere and Costa (1999) study. Rossi (2012) concluded that both size and market portfolio explain the excess return on the portfolios of stocks. Eraslan (2013) study on the Istanbul stock exchange from 2003 to 2010 explains that the value premium does not completely hold since most of portfolios with low BE/ME ratio stocks perform better than the high BE/ME ratio stocks. They found that the size premium exists in portfolios with small and medium size stocks and conclude that the market risk factor has a wider and stronger effect on portfolio returns than the other two factors (size and value).

Dolinar (2013) describes that the FF three factor model is a valid pricing model for stocks in the Croatian market because it explains the cross section of average returns on the stocks better than the CAPM. The size and value factor are not always significant on all the portfolios, yet, they capture variations in stock returns that is missed by the market factor. However, they conclude that the value factor explains the variation in average stock returns better than the size factor. Fama and French (2012) included momentum as the fourth variable and discovered that in the joint test of four regions (North America, Europe, Japan and Asia Pacific), local models are less successful. They found that a value premium exists in the average stock returns and decreases with size except in Japan. A recent empirical study on the Indian stock market based on two types of assets – individual stocks and a portfolio of stocks, explains that the value effect is positive and distressed stocks (small stocks with high BE/ME ratio) outperform growth stocks (big stocks with high BE/ME ratio). The size effect of individual stocks is very low and there is a positive impact of size premium on the average return of stocks in most of the assets (Anwar and Kumar, 2018).

2.6 Application of the Fama French Three-Factor Model: International Evidence

A considerable amount of scholarly studies has focused on whether the FF three-factor model holds in individual (non-US) stock markets. Some of the international studies on the FF three factor model are presented. According to Connor and Sehgal (2001), they find evidence for market, size and value factors in the Indian stock market. They found that the mean returns are explained by the exposure of these factors and concluded that FF three-factor model does apply to Indian equities. Bundoo (2008) also agree that the FF three-factor model is a robust model for an emerging equity market. The size and book-to-market equity effects are statistically significant, and beta is less than one for the entire portfolio constructed from stocks on the Mauritius stock exchange.

Czapkiewicz and Skalna (2010) concludes that the FF three-factor model holds on the Warsaw stock exchange and the results satisfactorily explain changes in the returns of the portfolio. The SMB and HML factor risk premiums are significant and the adjusted R-squared, a measure of the explanatory power of the model is sixty-five percent. To further validate the FF three-factor model, in 2012, Hamid *et al.* presents that the FF three factor model explains most of the variation in returns on the monthly data of twenty banks listed on the Karachi stock exchange over the period of 2006 to 2010. The intercept (α) which represents the abnormal return earned on all the six portfolios were insignificant, and the performance of the model is adequate given the high adjusted R-squared value.

According to Al-Mwalla and Karasneh (2011), results from the Amman stock market in Jordan show that there is no evidence to support the single-factor model (CAPM). They found that CAPM is unable to predict variation in the returns between different portfolios. They conclude that the FF three-factor model is positive and has superior explanatory power over the single-factor model (CAPM). Alves (2013), attempts to compare the reliability of CAPM and FF

model by considering local, international and global premia. The research considers samples of firms from ten countries in the European monetary union (EMU) over the period of January 1990 to December 2003 where twenty-five Irish firms were considered. The FF model is preferred relative to CAPM for small firms and high BE/ME firms and models based on EMU factors gave the worst results when the CAPM and FF model were not considered.

Trinh, Karki, and Ghimire (2016) examines the validity of the FF three factor model as a determinant of stock returns after the financial crisis. The analysis was based on FTSE100 stock returns during the period of 2009 to 2013. They found that the FF three factor model is superior to the CAPM and the market risk premium is the dominant factor among the three factors.

In the context of China, Gan *et al.* 2013 finds that although the size effect is stronger than the value effect, the FF three factor model is a better asset pricing model than the CAPM. Xie and Qu (2016) demonstrates that using monthly data from the Shanghai stock exchange (SSE) A-share market between 2005 and 2012, size and value premiums are significant. Twenty-five portfolios based on size and BE/ME ratio and four sector portfolios was constructed. They found that the factor coefficients of size and value are robust even under different variable sorting and construction methods.

The FF three factor model has been tested in different countries using different time period and methodology. Some of the research done in several countries with their findings are illustrated in the table below:

2.7 Criticism of the Fama French Three Factor Model

Although the FF three-factor model achieved a high degree of support and attention in academic circles, there are several critics of the model. Black (1993) explains that the FF three factor model was not built on theory but relied heavily on data mining[1] which led to inaccurate estimation. This claim has been strongly supported by Kothari, Shanken and Sloan (1995). They contested that the data used for the FF three factor model is influenced by survivorship bias. The time series regression of the expected returns showed that there is a significant compensation for beta risk and there is no adequate evidence of a relationship between the value factor and the expected returns.

Daniel and Titman (1997) shows that using monthly data of stocks on the NYSE, American stock exchange (AMEX) and National Association of Securities Dealers Automated Quotations exchange (NASDAQ) over the period of July 1963 to December 1993 does not support the FF three-factor model. Daniel and Titman argues that there is no evidence of a separate distress factor and the return premium on small capitalisation and high BE/ME stocks is not as a result of the co-movements of the stocks and the extra two variables. They claim it is the characteristics of these firms and not the factor loading that explain the cross-sectional variation in stock returns. Davis, Fama and French (2000) dismissed the argument of the factor loading against the characteristics-based model and conclude that growth characteristics relate to the co-variation in returns. They claimed that the evidence of the characteristic model is due to a short sample period and the value premium, measured by the HML, in average stock returns is strong. The size effect, measured by the SMB, on the average stock returns is smaller and the three-factor model explains the value premium better than the characteristic-based model of Daniel and Titman (1997).

[1] Data mining is a process of examining past data in order to create new information.

However, Gregory, Tharyan and Christidis (2009) recommend that the characteristic-based model of Daniel and Titman (1997) should be used to analyse the variation of returns of UK stocks rather than the FF three-factor model. They expressed concern against the over-reliance on the factor models until a convincing model of UK asset pricing is established. Vo (2015) claims that the empirical evidence for FF three-factor model is conflicting and not consistent. They explain their concern about the validity of the HML factor in the Australian context and argue that this inconsistency may be due to 'data mining'. They conclude that there is no justification for the model to be applied - "the FF three factor model is interesting for research endeavour, the adoption of the model into policy is problematic and as such, not recommended".

2.8 Overview of the Fama and French three factor model

This chapter has attempted to provide a summary of literatures relating to different studies that highlight the differences between the CAPM and the FF three-factor model. However, some researches have shown that there is no consensus or pattern for the FF three factor model. Regarding the UK stock market, Strong and Xu (1997) found that the variation in the average returns is positively related to the three factors in the FF model while Morelli (2007) reports that size premium is not significant while market and value premium were found to be significant when determining the stock returns. An overview of the FF three factor model in different countries and their findings is presented in table one.

Table 1: Overview of literature on Fama and French three factor model

Study	Year	Country	Data and Methodology	Finding
Connor and Sehgal	2001	India	Monthly data of 364 stock prices with dividends and stock split over a period of ten years.	Fama French model is robust as an asset pricing model.
Gaunt	2004	Australia	Stock returns over a period of 1991 to 2000 on the Australian stock exchange.	Beta is significantly less than one and the value factor is significant for asset pricing.
Bundoo	2008	Mauritius	An augmented Fama French model was constructed using GARCH specification for stock returns over	The Fama French model holds for the Mauritius stock market.

			a period of 1997 to 2003.	
Taneja	2010	India	Monthly data of 187 companies from June 2004 to 2009.	Fama French model is efficient and a good predictor of stock returns.
Aguenaou *et al.*	2011	Morocco	Monthly data of share prices over a period of five years (2005-2009)	Evidence of market and value risk factors.
Al-Mwalla and Karasneh	2011	Jordan	Stock returns of data over 11 years from 1999 to 2010	CAPM does not completely explain the stock returns, FF three factor model performed better on the Amman stock exchange.
Rossi	2012	Italy	Used time series analysis of stock returns of 109 common stocks	Size and market factor show high explanatory

			over a fifteen-year period (1989-2004)	power when considered together.
Eraslan	2013	Turkey	Data of 274 stock returns over a period of 2003 to 2010 were sorted into nine portfolios	Size factor has no effect on portfolios containing big stocks and the value factor has an effect on all the portfolios.
Xie and Qu	2016	China	Monthly data from China's shanghai stock exchange (SSE) between 2005 and 2012 was used for the construction and sorting of twenty-five portfolios.	Size and value premium are significant on China's stock market.
Anwar and Kumar	2018	India	Returns of individual stocks and portfolios were used over	Fama French model could not capture the variation in the

			the period of 2009 to 2016.	individual stocks but had a significant effect on the portfolios of stocks.

Griffin (2002) examines the possibility of using the country-specific or global version of the FF three factor model in explaining the variation in international stock returns. Evidence shows that the country-specific model is superior in explaining the time series variation in the average stock returns than the global version of the FF three factor model. Griffin (2002) concludes that calculation of the cost of capital and performance evaluation which are applications of FF three factor model should be performed based on the country-specific model.

Although there has been a diverse result of the FF three-factor model when tested in different stock markets, at different periods, with different number of sample data; the diverse findings still make it important to study the Irish stock market in this context. The next chapter presents the research questions for this study on the FF three factor model.

3 RESEARCH QUESTIONS

Several asset pricing models have been developed for developed capital markets to date. There has been much discussion and literature on the FF three-factor model, and it is evident that the model has been tested in many international markets. To our knowledge there is little evidence of an academic study of the FF three-factor model on the Irish stock market. The objectives of this study are as follows:

i. To determine the feasibility and explanatory power of the FF three-factor model for a portfolio of stocks in the Irish stock market.
ii. To determine the size and value effect on the return of a portfolio of stocks as characterised by the FF three-factor model.
iii. To determine if the FF three-factor model can be used as an asset pricing model to explain the variation of stock returns on the Irish stock market.

3.1 Research Hypotheses

The FF three-factor model is specified by

$$\boldsymbol{R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i(SMB_t) + h_i(HML_t) + \varepsilon_{it}} \qquad \mathbf{1}$$

Where

$\boldsymbol{R_{it} - R_{ft}}$ is the excess return on a portfolio at time t,

$\boldsymbol{\alpha_i}$ is the intercept term or abnormal profit at time t,

$\boldsymbol{R_{Mt} - R_{ft}}$ is the excess return on the market at time t. It is also called market risk premium (MRP)

$\boldsymbol{SMB_t}$ (small-minus-big) is the size factor which measures the difference between returns on small and big portfolio at time t. It is also called size premium.

$\boldsymbol{HML_t}$ (high-minus-low) is the value factor which measures the difference between returns on portfolio with high BE/ME ratio and low BE/ME ratio at time t. It is also called value premium.

$\boldsymbol{b_i}$ measures the sensitivity to the excess return on the market (coefficient of market risk premium) at time t,

$\boldsymbol{s_i}$ measures the sensitivity to the risk factor related to firm size (coefficient of size premium) at time t,

$\boldsymbol{h_i}$ measures the sensitivity to the risk factor related to BE/ME ratio of the firm (coefficient of value premium) at time t and

$\boldsymbol{\varepsilon_{it}}$ is the error term at time t.

The following null hypotheses derived from FF three-factor model have been made and will be tested for the purpose of this study:

Hypothesis 1: There is no abnormal profit on the excess return of a portfolio, that is, $\alpha_i = 0$

The intercept term (α) represented in equation 1, which is a constant should be statistically insignificant for the portfolio return. If the intercept term is insignificant, it describes that there is no abnormal profit or return on the portfolio and the average stock returns are well explained by the other three factors (MRP, SMB and HML).

Hypothesis 2: There is no effect of market risk premium on the excess return of a portfolio, that is, $b_i = 0$

Hypothesis 3: There is no effect of size premium on the excess return of a portfolio, that is, $s_i = 0$

Hypothesis 4: There is no effect of value premium on the excess return of a portfolio, that is, $h_i = 0$

The three factor coefficients on the MRP, SMB and HML (b_i, s_i, h_i) represented in equation 1 should carry a positive sign and be statistically significant. This would mean that the three factors are positively correlated and contribute to the excess portfolio return. Thus, there would be evidence to support that small stocks and stocks with high BE/ME ratio have high risk which make investors demand for a higher premium for the risk (Fama and French, 1993). This chapter has described the objectives and hypotheses relating to this study, the chapter that follows presents the methodology used for the study.

4 RESEARCH METHODOLOGY

The purpose of this study is to identify if there is evidence of market, size and value factors on a portfolio of stocks in the Irish stock market. This will be accomplished through quantitative method using a time series regression approach with three independent variables (Fama and French, 1993). In applying regression analysis to financial data, violations of regression assumptions such as heteroskedasticity, autocorrelation, multicollinearity and the non-stationarity of data are taken into consideration. The coefficient of determination (adjusted R-squared) value reflects the explanatory power of the FF three-factor model. A high (low) value indicates that the model has a high (low) explanatory power.

According to Fama and French (1995 and 1996), monthly adjusted closing prices of the stocks and yearly (calendar) market capitalisation of the firms throughout the sample period are used. Data of firms with negative BE are excluded[2] when splitting the stocks to form the size-BE/ME portfolios. Stocks are categorised based on the firm's market capitalisation (closing price multiplied by shares outstanding) and the firm's value (BE/ME ratio at December of year t – 1). The BE/ME ratio at the end of year t, is the book value of common equity for fiscal year ending in t – 1 divided by the market value of the equity at the end of t – 1. According to O'Donnell and Baur (2009) the three-month Euribor rate is used as a proxy for the risk-free rate (R_f).

[2] Independent News & Media PLC (INM ID PLC) was excluded because it had negative BE during the period of study.

4.1 Data Collection

This study focuses on the stocks that are (or were) listed on the Irish stock exchange (Euronext Dublin) on a monthly basis over a period of five years from January 2011 to December 2015. The data analysed for the model was downloaded from Bloomberg L.P (Access date 04/07/2019). The data include the risk-free rate proxy, which is the three-month Euribor rate, closing stock prices from which returns were calculated, market return of the ISEQ 20 All Share Index, market capitalisation and book equity values.

Bloomberg L.P

Bloomberg L.P is a financial software, data, and media company that provides financial software tools to financial firms and corporations (Bloomberg, 2019). It provides current and historical financial and economic data, data analysis tools, news on markets and securities in several sectors including fixed income, equities, commodities, and currencies through its Bloomberg Professional Service (Lei and Li, 2012). Bloomberg terminals are not used solely by those who work in the financial companies, they are also used by researchers, analysts, university students and journalist for gathering information and data, analysis and more.

Sample Size:

Connor and Sehgal (2001), excluded the stocks of companies with missing share prices because some of the companies are just listed on the stock market on a later date than the initial date of the study period; we replicate this process and not all the stocks were chosen for the analysis. There were some restrictions on the stocks that traded during the period of study as described by Fama and French (1993), Gaunt 2004, Eraslan (2013), and Trinh *et al*. (2016). They are:

1. Stock should be ordinary common equity
2. Companies are listed on the ISE
3. Companies should have at least 12 months of trading history and 24 months of accounting data available before the period of study.

Twenty-six stocks were used for the construction of the portfolios and the restriction is similar to those listed above to ensure the reliability and validity of the data.

4.2 Research Strategy

According to Aguenaou *et al. (*2011), researchers are consistent about the methodology of how to test Fama-French three-factor model on individual stock or portfolio. The methodology used by Fama and French (1995 and 1996) for constructing portfolios requires that stocks are classified into three groups of portfolios; low, medium and high BE/ME ratio. However, Fama and French (1995) argued that splitting the stocks into three BE/ME categories is arbitrary and the test should be insensitive to this choice. Based on this argument and the small sample size of some international markets, some small variation exists in the methodology of how to test the FF three factor model as described in Bundoo (2008), Aguenaou *et al.* (2011) and Dolinar (2013). They classified stocks into two groups of portfolios (50% high BE/ME and 50% low BE/ME ratio) rather than three groups of portfolios. Given the small sample size of stocks on the ISE during the period of study, stocks are categorised into two size groups and two BE/ME ratio groups according to the method used by Bundoo (2008), Aguenaou *et al.* (2011) and Dolinar (2013).

4.2.1 Portfolio Formation (Size and Book-to-Market Equity Effect)

In order to analyse the data, Fama and French (1995 and 1996) require that the stocks be classified according to size (market capitalisation) and value (BE/ME ratio) for each year in consideration.

Classification by size: The twenty-six stocks on the ISE are categorised into two groups – small capitalisation stocks and big capitalisation stocks. The big capitalisation stocks are stocks above the median market capitalisation value and the small capitalisation stocks are those below the median market capitalisation value. All the twenty-six stocks used for the analysis are sorted such that the small and big capitalisation stocks each contain thirteen stocks.

Classification according to Book-to-Market Equity: The twenty-six stocks on the ISE are categorised into two groups of BE/ME ratio. The low BE/ME stocks (L) are those below the median BE/ME which are classified as 'growth' stocks, and high BE/ME stocks (H) are those greater than the median BE/ME which are classified as 'value' stocks. All the twenty-six stocks used for the analysis are sorted such that the low BE/ME stocks and high BE/ME stocks each contain thirteen stocks.

Stocks are then grouped into four portfolios as presented in table one:

- LS (portfolio including stocks with low BE/ME ratio and small capitalisation stocks),
- LB (portfolio including stocks with low BE/ME ratio and big capitalisation stocks),
- HS (portfolio including stocks with high BE/ME ratio and small capitalisation stocks),
- HB (portfolio including stocks with high BE/ME ratio and big capitalisation stocks).

Table 2: Classification into Portfolios

	Small Size	**Big Size**
Low Value	LS	LB
High Value	HS	HB

Four variables are used in the regression analysis of the FF three-factor model. The regression equation is stated below:

$$\boldsymbol{R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i(SMB_t) + h_i(HML_t) + \varepsilon_{it}}$$

Dependent variable used in the study

- Excess average return on portfolio ($R_{it} - R_{ft}$) is estimated as the difference between the total return on portfolio and the risk-free rate

Independent variable used in the study

- Market risk premium ($R_M - R_f$) which is estimated as the difference of the market return and the risk-free rate at time *t*,
- Size premium measured by SMB_t is the difference between the average returns of small stock portfolios and average returns of big stock portfolios at time *t* estimated by equation 2 and
- Value premium measured by HML_t is the difference between the average returns of high BE/ME ratio stock portfolios and average returns of low BE/ME ratio stock portfolios at time *t* estimated by equation 3.

$$\boldsymbol{SMB = \frac{HS+LS}{2} - \frac{HB+LB}{2}} \qquad \textbf{2}$$

$$\boldsymbol{HML = \frac{HS+HB}{2} - \frac{LS+LB}{2}} \qquad \textbf{3}$$

Fama and French used cross-sectional regression and time series regression for the analysis of the three-factor model in 1992 and 1993 respectively. However, Lam (1995) concludes that time series regression is a more powerful test of model validity. Therefore, time series regression is chosen for this study. The data analysis is carried out using Microsoft Excel for the descriptive statistics and EViews[3] for the time series regression. The analysis and findings of the FF three factor model are described in chapter five.

[3] EViews is a statistical software used for econometric analysis, forecasting, modelling and simulation of data. According to EViews (2019), it is the main macroeconomic forecasting and analysis tool used by academics, business and corporations, central banks, national banks and government agencies around the world.

5. ANALYSIS AND FINDINGS

In this chapter, we present the findings from the empirical analysis of the FF three factor model and the CAPM during the period of 2011 to 2015 in the Irish stock market in order to observe the applicability of the model and to achieve the objectives of the study. Most importantly, the period of study is after the global financial crisis when the stock prices were increasing and less volatile. This chapter is organised into three sections: the next section 5.1 presents the descriptive statistics of the returns for the four portfolios, excess market return, SMB and HML. Section 5.2 presents the diagnostics tests such as stationarity, autocorrelation, heteroscedasticity and multicollinearity tests. Section 5.3 presents and analyses the estimation results from the analysis of the FF three factor model and the CAPM.

5.1 Descriptive Statistics

Table three presents the number of shares in each of the four portfolios for each year. It shows that high BE/ME and small size stocks (HS portfolio) and low BE/ME and large size stocks (LB portfolio) account for the highest portion of stocks over the sixty-month period. This indicates that small and large companies listed on the ISE tend to have both high and low book-to-market values.

Table 3: Number of stocks in each portfolio

Year	LS	HS	LB	HB	Total
2011	4	9	9	4	26
2012	4	9	9	4	26
2013	5	8	8	5	26
2014	5	8	8	5	26
2015	5	8	8	5	26
Average	4.6	8.4	8.4	4.6	

The descriptive statistics of the mean return of the four portfolios and the three factors ($R_m - R_f$, SMB and HML) over the period of January 2011 to December 2015 are presented in table four. The dispersion of the mean returns of the portfolios and the three factors is high and fall within the range of approximately -3.78% and 1.75%. For example, the LB portfolio has a positive mean return of approximately 1.29% while the SMB variable has a negative mean return of approximately 0.066%.

Table 4:Descriptive statistics of returns for the portfolios, excess market return, SMB and HML

	LS (%)	HS (%)	LB (%)	HB (%)	Rm-Rf (%)	SMB (%)	HML (%)
Mean	1.747	-2.563	1.287	-1.971	0.959	-0.066	-3.784
Standard Error	0.755	0.970	0.716	1.667	0.507	0.917	0.973
Median	1.228	-2.248	0.857	-2.238	1.002	-0.955	-4.375
Standard Deviation	5.846	7.510	5.548	12.912	3.925	7.103	7.537
Sample Variance	34.181	56.397	30.780	166.717	15.403	50.458	56.813
Kurtosis	1.638	0.645	4.233	0.944	0.416	-0.429	0.524
Skewness	0.046	-0.396	-0.391	-0.575	-0.195	0.271	0.049
Range	34.459	37.123	37.960	63.496	21.372	31.482	39.244
Minimum	-14.015	-23.879	-20.759	-38.397	-10.606	-14.911	-21.559
Maximum	20.445	13.244	17.201	25.099	10.766	16.571	17.684

However, the standard deviation of return which measures the variation of the portfolios and the three factors from their mean is also high compared to the mean return. This indicates that high volatility of mean returns exists. The standard deviation falls within a range of approximately 3.92% and 12.91%. A general comment in investment analysis or portfolio management is that ‘a higher return is associated with a higher standard deviation’, our analysis further confirms this since each of the portfolio and the three factors have high returns. For example, the HB portfolio and the HML factor has a maximum return of approximately 25.10% and 17.68% respectively. Furthermore, the expected mean returns of the observed portfolios

and the three factors appear to be normally distributed because the mean and the median are similar.

5.2 Diagnostics tests

There are several approaches to time series regression, for our analysis with more than one independent variable ordinary least square multiple regression (OLS) is used. DeFusco *et al.* (2015) describes that when using OLS;

- Data should be stationary, that is, the expected value of the residual is zero and the variance of the residual is constant for all observations.
- Data should be homoscedastic, that is, the residuals are normally distributed.
- There should be no autocorrelation, that is, the residuals are uncorrelated across observations.
- There should be no multicollinearity, that is, the independent variables are not random and there is no relationship between two or more of the independent variables.

They concluded that financial data should satisfy all these assumptions of the multiple linear regression model before a valid interpretation can be made from it.

5.2.1 Stationarity Test

Time series data is stationary if its mean and variance do not change over time (Gujarati, 2004). Non-stationarity of data is also referred to as the data having a unit root. According to Trinh *et al*. (2016), Augmented Dickey-Fuller (ADF) unit root test carried out in EViews is used to test the stationarity of the variables for this study. The output is outlined in table five and the null and alternative hypotheses are stated below;

H_0: Time series data is non-stationary (has a unit root)

H_a: Time series data is stationary (does not have a unit root)

Table 5: Augmented Dickey-Fuller Test for the Dependent and Independent Variables

Variables	Augmented Dickey-Fuller test statistic		Test critical values		
	t-statistic	p-value	1%	5%	10%
Rm-Rf	-6.73385	0	-3.5461	-2.91173	-2.59355
SMB	-7.06807	0	-3.5461	-2.91173	-2.59355
HML	-5.37815	0	-3.5461	-2.91173	-2.59355
LS	-9.04405	0	-3.5461	-2.91173	-2.59355
HS	-7.83249	0	-3.5461	-2.91173	-2.59355
LB	-7.1114	0	-3.5461	-2.91173	-2.59355
HB	-6.12466	0	-3.5461	-2.91173	-2.59355

The results show that the p-value is greater than one percent level of significance for all the variables. This indicates that the ADF results are insignificant, therefore we reject the null hypothesis of non-stationarity and can infer that the time series is stationary.

According to Defucso *et al.* (2015) the plot of the series of the variables can be used to show if there is significant deviation from covariance stationary. Deviation from stationarity might include a linear trend, exponential trend seasonality or a change in the time series throughout the sample period. A plot of each variable is presented in figures one to seven (appendix 3) shows that the series looks covariance stationary. This indicates that the variables are good enough to model the FF three factor model.

5.2.2 Autocorrelation Test

DeFusco *et al.* (2015) defines autocorrelation as the "correlation of a time series with its own past values". According to DeFusco *et al.* (2015), the Durbin-Watson test statistic cannot be used for most time series models and Gujarati (2004) describes that the output of the Breusch-

Godfrey Serial Correlation LM test is preferred to that of Durbin-Watson test. We test to see whether the residual autocorrelation significantly differs from 0; the aim is *not* to reject the null hypothesis of no autocorrelation. Thus, the test was carried out in EViews according to Trinh *et al.* (2016) where the time series were modelled as Autoregression process [AR(p)], where p=1,2,3,4 are the lags. The null and alternative hypotheses are below;

H_0*: There is no autocorrelation in the residual*

H_a*: There is autocorrelation in the residual*

The results show that the p-values of AR(p) at p=1,2,3,4 for the HS and LB portfolios and LS and HB at p=1,2 are greater than 0.05. However, the p-values of AR(p) at p=1,2,3 for both LS and HB portfolios are greater than 0.05.

Table 6: P-values for the autocorrelation of the residual of the portfolios at different lags

Breusch-Godfrey serial correlation LM Test **Number of observations: 60**				
Variables	**Lag 1**	**Lag 2**	**Lag 3**	**Lag 4**
LS portfolio	0.1541	0.0589	0.0191	0.0073
LB portfolio	0.7056	0.5377	0.739	0.8521
HS portfolio	0.7056	0.5377	0.739	0.8521
HB portfolio	0.1541	0.0589	0.0191	0.0073

The p-values are presented in table six, for example, the p-value of AR (1) for LS portfolio is 0.1541 and the p-value of AR (3) for HS portfolio is 0.7390 (p-value is greater than five percent level of significance). However, we can infer that there is not enough evidence to reject the null hypothesis of no autocorrelation with two lags [AR(2)] at the five percent level of significance for all the portfolios, thus, autocorrelation does not exist in the time series data.

5.2.3 Heteroscedasticity Test

One of the violations of the assumptions of regression is heteroscedasticity; DeFusco *et al.* (2015) describes that heteroscedasticity occurs when the variance of the residuals varies and is not constant over time. Therefore, the F-test of the time series regression model and the regression coefficients will be unreliable. The Breusch-Pagan-Godfrey Heteroscedasticity test in EViews is used. The null and alternative hypotheses are stated below;

H_0: *Time series data are homoscedastic*

H_a: *Time series data are heteroscedastic*

Table 7: Heteroscedasticity diagnostics for times series data of the portfolios

Breusch-Pagan-Godfrey Heteroscedasticity Test **Number of observations: 60**		
Variables	**P-value**	**Prob. chi-square**
LS portfolio	0.1329	0.1293
LB portfolio	0.7926	0.7795
HS portfolio	0.7926	0.7795
HB portfolio	0.1329	0.1293

The result shows that the p-value of the chi-square for all the portfolios are greater than 0.05. The p-values are presented in table seven. Therefore, we cannot reject the null hypothesis at the five percent level of significance. In fact, we cannot reject the null hypothesis at one percent level of significance because the p-values are greater than 0.01. Thus, we can infer that the residuals of the time series data do not vary over time, that is, the time series data is homoscedastic.

5.2.4 Multicollinearity test

Multicollinearity occurs when two or more independent variables in a multiple regression are closely related but not perfectly related with each other (DeFusco *et al.*, 2015). The regression model can be estimated even in the presence of multicollinearity, but the coefficients of the model are not reliable, and any inference made from it is uncertain. According to Trinh *et al.* (2016), there are two main approaches to indicate multicollinearity – the variance inflation factor (VIF) and pairwise correlations among the independent variables. DeFusco *et al.* (2015) describes that a major detection of multicollinearity is a high R–squared (also known as the coefficient of determination) and significant F statistics even when the p-value of the coefficients are insignificant. Gujarati (2004) concludes that if the VIF of a variable is greater than 10, then it is highly collinear. Trinh *et al.* (2016) summarises that if the correlations among the independent variables are less than 0.8 and the VIF is less than 2, then multicollinearity does not exist. The higher the value of VIF, the more collinear the variable, thus economical or statistical inference made from the model are not reliable.

Table eight presents the result of the correlation and VIF test. Although excess return on the market portfolio is negatively correlated to the return of SMB portfolio, the correlation is not very strong. The return on SMB and HML portfolios are also weak and negatively correlated, thus, according to Trinh *et al.* (2016) we can infer that multicollinearity does not exist between the variables.

Table 8: Correlation between the three risk factors

	Correlation Test			
Variables	**Rm-Rf (%)**	**SMB (%)**	**HML (%)**	**VIF Test**
Rm-Rf (%)	1.000	-0.601	0.113	1.595
SMB (%)	-0.601	1.000	-0.351	1.796
HML (%)	0.113	-0.351	1.000	1.161

5.3 Estimation Results

Table nine presents the regression results of the Fama French (1993) three factor model using the excess return of the portfolios as the dependent variable and the excess return on the market, SMB, HML as the independent variables. The intercept term or abnormal returns (α) are negative and found to be insignificant for all the portfolios at one percent level of significance. For example, the intercept return for the LS portfolio is approximately -0.487% and -1.16% with a p-value of 0.5366 and 0.0123. However, the LB and HS portfolios are significant at the five percent level of significance. For instance, the LB portfolio is approximately -1.16% with a p-value of 0.0123. This suggests that there may be abnormal returns in the LB and HS portfolios at five percent level of significance.

Table 9: Results of the Fama French Three Factor model on the Irish Stock Exchange

$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i(SMB_t) + h_i(HML_t) + \varepsilon_{it}$				
Portfolio excess returns	**α coefficient**	**β coefficient**	**s coefficient**	**h coefficient**
LS portfolio	-0.4872	0.8667	0.2408	-0.0914
[p-value]	[0.537]	[0.000]	[0.066]	[0.3514]
LB portfolio	-1.1605	1.0565	-0.1358	-0.0929
[p-value]	[0.012]	[0.0000]	[0.066]	[0.100]
HS portfolio	-1.1605	1.0565	0.8642	0.9071
[p-value]	[0.012]	[0.0000]	[0.0000]	[0.000]
HB portfolio	-0.4872	0.8667	-0.7592	0.9086
[p-value]	[0.537]	[0.000]	[0.0000]	[0.000]

The coefficient of the MRP (β) for all the portfolios are positive and statistically significant at one percent level of significance. For example, the MRP coefficient for the LS and HS portfolios is 0.867% and 1.056% respectively with p-value of 0. This indicates that we can fail to accept the null hypothesis that there is no effect of MRP on the excess portfolio returns, that is, the effect of MRP on the excess portfolio return is present and it shows positive slope.

The SMB coefficient (s) is only significant for the high BE/ME portfolios. For example, the size premium for HS and HB portfolios is approximately 0.864% and -0.759% respectively with p-value of 0. This shows that the effect of size premium is present for the average excess returns of both HS and HB portfolio. However, the SMB coefficient (s) is insignificant for the low BE/ME portfolios. For instance, the size premium for the LS and LB portfolios is approximately 0.24% and -0.136% respectively with a p-value of 0.066. We can infer that there is no effect of size premium on the average excess returns of the LS and LB portfolios at the one and five percent level of significance.

The HML coefficient (h) is also significant for high BE/ME portfolios. For example, the value premium for HS and HB portfolios is approximately 0.907% and 0.909% respectively with a p-value of 0.000. This shows that the effect of the value premium is present on the average excess return of both HS and HB portfolios. However, the HML coefficient (h) is insignificant for the low BE/ME portfolios. For example, the value premium for the LS and LB portfolios is negative with approximately -0.091% and -0.093% with a p-value of 0.351 and 0.100 respectively. This suggests that we can infer that there is no effect of value premium on the average excess returns of the LS and LB portfolios.

Table ten illustrates the comparison of the CAPM and FF three factor model. Although the adjusted R-squared value of LS portfolio for the FF three factor model is low, the range of the FF three factor model is between 20.14% and 84.15% and that of CAPM is between 0.98% and

69.67%. This indicates that the FF three factor model outperforms the CAPM model, particularly the portfolios including high BE/ME (value) stocks. In other words, an average of 64.72% of the expected portfolio returns is explained by the FF three factor model while an average of 29.11% of the expected portfolio returns is explained by CAPM.

Table 10: Adjusted R-squared, F-statistic and p-values of CAPM and Fama French model

	Adjusted R-squared		**F-Statistic**		**p-value**		**α_{it}**	
	Fama French model	**CAPM model**	**Fama French model**	**CAPM model**	**Fama French model**	**CAPM model**	**Fama French model**	**CAPM model**
LS portfolio	20.14%	13.95%	5.958	10.565	0.001	0.002	-0.487	0.113
LB portfolio	70.97%	69.67%	49.072	136.531	0.000	0.000	-1.160	-0.923
HS portfolio	84.15%	0.98%	105.446	1.583	0.000	0.213	-1.160	-3.936
HB portfolio	83.63%	31.84%	101.442	28.555	0.0000	0.000	-0.487	-4.856

The F-statistic and p-values for FF three factor model and the CAPM for LS, LB and HB portfolios were found to be significant (even at 0.2 percent level of significance), while the CAPM for HS portfolio is insignificant (p-value is greater than five percent level of significance). This implies that FF three factor model can be applied in the Irish stock market during the period of study.

6. DISCUSSION

The study finds that the FF three factor model is superior at explaining the variation of the average portfolio returns than the CAPM. Although the CAPM model is found to be statistically significant for three portfolios, the average R-squared of the excess portfolio returns is 29.11%. This suggests that the CAPM model has a weak explanatory power when compared with the FF three factor model.

The null hypothesis for the intercept term (abnormal profit) should be statistically insignificant. According to the Fama and French (1993), if the intercept is insignificant, then the three-factor model is correct. If the intercept term is significant, there must be a return for risk. According to Eraslan (2013), the intercept term does not capture the risk premium, only the MRP, SMB and HML captures the risk premium in the FF three factor model, thus, the intercept term should be close to zero. The results of the regression analysis show that at the one percent level of significance all the portfolio terms are zero. This suggests that excess portfolio returns are well captured by the FF three factor model. The excess return of only LS and HB portfolios are explained by the FF three factor model at the five percent level of significance. Therefore, the FF three factor model has explanatory power on two portfolios out of the four at the five percent level of significance.

Figure 1: Market, Size and Value Premia For LS, LB, HS and HB portfolios

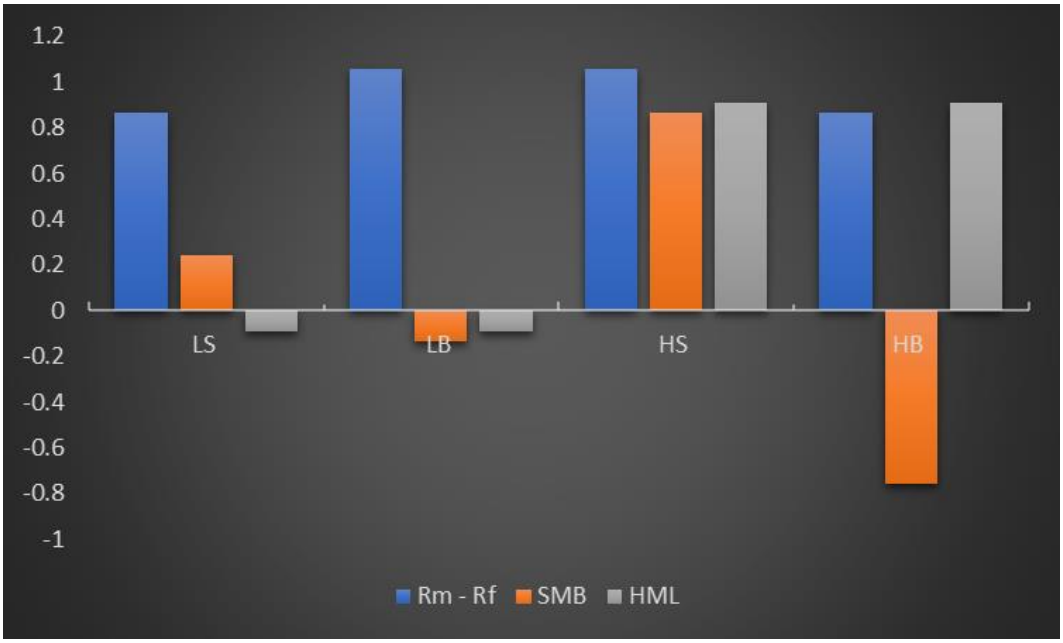

Figure one presents the premia for market, size and value for the LS, LB, HS and HB portfolios of the FF three factor model. Our findings for the MRP in the Irish stock market are slightly inconsistent with Fama and French (1993). In their study, they found that the MRP is positive and close to one and described that MRP less than one does not entirely capture the variation in the average return of the portfolio, thus, size premium and value premium explain part of the average return on the portfolio. However, in this study we found that the MRP for both the LB and HS portfolios is greater than one. The MRP is found to be positive and greater than the SMB and HML premia in all the portfolios. According to Anwar and Kumar (2018), we can infer that the market return and excess portfolio return are positively correlated, and we are rewarded positively for the opportunity lost by not investing in risk-free assets.

The SMB coefficient (s) is found to be statistically significant for both HS and HB portfolios and insignificant for LS and LB portfolios at the one and five percent level. The sign of the coefficient of the size premium (s) is consistent with the findings of Bundoo (2008), that is, negative for the big market capitalisation portfolios (LB and HB) and positive for the small capitalisation portfolios (LS and HS). However, the significance and insignificance of the size

factor for the HB and LS portfolios respectively is contrary to the presence of the small firm effect. This result shows that the size factor (SMB) affects the return of the portfolios and it plays an important role in explaining the average excess portfolio returns for both big and small portfolios.

The value factor captures the risk of the BE/ME effect on the average excess return on portfolio of stocks. The HML coefficient (h) is found to be statistically significant for high BE/ME portfolios (HS and HB) and insignificant for the low BE/ME portfolios (LS and LB) at the one and five percent level of significance. The findings indicate that the high BE/ME firms outshine the low BE/ME firms which is consistent with Fama and French (1993). The sign of the coefficient of value premium for all the portfolio is consistent with Bundoo (2008) and Aguenaou *et al.* (2011). Figure eight shows that it is negative for the low book-to-market equity portfolios (LS and LB) and positive for the high book-to-market equity portfolios (HS and HB). Thus, we can confirm the value effect in the in the case of HS and HB portfolios.

A summary of the main findings, limitations and recommendation for future research is provided in the next chapter.

7. CONCLUSION

This study explores the application of the FF three-factor model in the Irish stock market using monthly data over the period of 2011 to 2015. Four portfolios from twenty-six stocks were constructed based on size and book-to-market ratio as demonstrated by Bundoo (2008), Aguenaou *et al.* (2011) and Dolinar (2013). The study examines the significance and existence of the market, size and value factors, and shows if they can explain the variation in the excess portfolio returns as described by the FF three factor model. The MRP, SMB and HML were used as the explanatory variables. Our findings show that the possibility of using the FF three factor model in the Irish stock market is limited to the study period.

Size and Value Effect

The findings show that there is no evidence to support the size effect on only small size portfolios. For the four portfolios, the coefficients of the HS and HB portfolios have significant premiums, although the size premium for HB portfolio is negative. This supports the size effect in the case of the HS portfolio and is consistent with Fama and French (1993), but contrary to the LS portfolio. Therefore, we can conclude that the size effect does *not* hold in the Irish stock market during the period of study. The third factor, HML, is found to be positive and significant for the excess return of high BE/ME portfolios (HS and HB) out of the four portfolios. It shows a better risk representation than the size factor. This supports the presence of value premium as found by Fama and French (1993), Aguenaou *et al. (*2011) and we can summarise that the size effect does exist in the Irish stock market during the period of study.

The results show that the intercept term for both LB and HS portfolios are negative and significant which highlights that there is a negative abnormal return that can explain part of the excess return on those portfolios. The market risk factor has a stronger effect than the size and

value factor. It is found to have a high, positive effect and captures a large part of the excess return of the portfolios.

Feasibility and Explanatory Power of the Fama French Three Factor Model

Although the size premium does not hold during the period of study, the findings suggests that the FF three factor model explains the variation in the average returns of stocks sorted into portfolios better than CAPM. The performance of FF three factor model is superior to the CAPM in explaining excess portfolio returns in terms of the adjusted R-squared because it explains approximately sixty-five percent of the total systematic risk with statistically significant MRP.

Fama and French (1993) find that the three-factor risk-return relationship is a good model for explaining the variation in average returns of portfolio constructed on size and BE/ME ratio. This study tests whether asset pricing models built for developed markets such as the US stock market can be applied in the Irish context. The findings are partially consistent with Fama and French (1993) since the evidence supports for market and value risk factors in the Irish stock market. Thus, it proposes the possibility of using two factor (market and value) model instead of the FF three factor model in the Irish stock market.

7.1 Limitation of the Study

There are several limitations related to this study such as sample size, liquidity of the ISE and company size. The study by Fama and French (1993) used twenty-five portfolios because they had more than three thousand stocks from AMEX, NYSE and NASDAQ compared to four portfolios from twenty-six suitable stocks on the ISE during the period of study. In addition,

the exclusion of stocks traded on the ISE that do not have closing share prices during the sample period further decreased the sample size. There is lower liquidity on the ISE, the illiquidity leads to inefficiency in the market which largely pertains to stocks of small capitalisation firms that do not trade frequently. Also, companies listed on the ISE are mostly smaller than the companies listed in other developed markets.

7.2 Recommendation for further research

Based on this study, there are other possible areas suggested for future research.

- There appears to be some inefficiency and limited liquidity due to the small sample size in the Irish stock market that limit the possibility of the model. Can these drawbacks be incorporated and thought of as the starting point for further research?
- The FF three factor model use firm specific factors (size and value effect) as additional risk proxies to the market risk. Should other firm specific factors be used as proxies?
- The frequency of the returns of stocks used in the FF three factor model is monthly over a period of five years. Can the frequency of returns and period of study be modified in the Irish context? Should we use three years or ten years of daily returns instead of the monthly returns?
- The momentum effect discovered by Carhart (1997) is commonly used as the fourth factor in the FF three factor model. Can the momentum effect be used in the Irish stock market?
- The sorting of firms into small and big stocks is based on the median or a 'certain' percentile. Can the separation be improved on different variable sorting when defining the size and value factors?

- The most commonly used market ratio is the P/E ratio. Should we merge the P/E ratio as one of the risk proxies instead or in addition to the size factor?

This study has examined the possibility of applying the FF three factor model in the Irish stock market. The empirical evidence presented can offer some methodologies and strategies for further research into an asset pricing model that captures and explains effectively the variation in the average stock returns on the Irish stock exchange.

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APPENDICES

Appendix 1 - List of observed stocks

1	**ABBEY PLC**	**ABBY ID Equity**
2	**AIB GROUP PLC**	**AIBG ID Equity**
3	**AMINEX PLC**	**AEX ID Equity**
4	**BANK OF GRP**	**BIRG ID Equity**
5	**C&C GROUP PLC**	**GCC ID Equity**
6	**CPL RESOURCES PLC.**	**CPL ID Equity**
7	**CRH PLC**	**CRH ID Equity**
8	**DATALEX PLC**	**DLE ID Equity**
9	**DONEGAL INVESTMENT GROUP PLC**	**DQ7A ID Equity**
10	**FBD HOLDINGS PLC**	**FBD ID Equity**
11	**GLANBIA PLC**	**GLB ID Equity**
12	**IFG GROUP PLC**	**IFP ID Equity**
13	**KENMARE RESOURCES PLC**	**KMR ID Equity**
14	**KERRY GROUP PLC**	**KYG ID Equity**
15	**KINGSPAN GROUP PLC**	**KSP ID Equity**
16	**ORIGIN ENTERPRISES PLC**	**OGN ID Equity**
17	**ORMONDE MINING PLC**	**ORM ID Equity**
18	**OVOCA BIO PLC**	**OVG ID Equity**
19	**PERMANENT TSB GROUP HOLDINGS PLC**	**IL0A ID Equity**
20	**IRISH CONTINENTAL GROUP PLC**	**IR5B ID Equity**
21	**PETRONEFT RESOURCES PLC**	**PTR ID Equity**
22	**PROVIDENCE RESOURCES PLC.**	**PRP ID Equity**
23	**RYANAIR HOLDINGS PLC**	**RYA ID Equity**
24	**SMURFIT KAPPA GROUP PLC**	**SKG ID Equity**
25	**TOTAL PRODUCE PLC**	**TOT ID Equity**
26	**TULLOW OIL PLC**	**TLW ID Equity**

The sectors which the companies belong are:

- Banking (Allied Irish Banks (AIB) Group Plc, Bank of Ireland Group Plc, Permanent TSB Group Holdings),
- Building Materials and Construction (Abbey Plc, CRH Plc, Kingspan Group Plc),
- Recruitment (CPL Resources Plc),
- Airline (Ryanair),
- Retail and Food and Beverage (Glanbia Plc, Kerry Group Plc, Total Produce Plc),
- Oil and gas (Aminex Plc, Tullow Oil Plc, Petroneft Resources Plc, Providence Resources Plc),
- Mineral resources (Ovoca Bio Plc, Ormonde Mining Plc, Kenmare Resources Plc),

- Shipping and Transport (Irish Continental Group Plc, C & C Group Plc),
- Financial Services and Insurance (IFG Group Plc, FBD Holdings Plc, Donegal Investment Group Plc),
- Agri-Services (Origin Enterprises Plc),
- Packaging (Smurfit Kappa Group Plc),
- IT Services (Datalex Plc).

Appendix 2 - Results for the CAPM

Table 11: Test results for the CAPM

$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft})$			
Portfolio excess returns	**α coefficient**	**β coefficient**	**Adjusted R-squared**
LS portfolio	0.1128	0.5847	13.95%
[p-value]	[0.876]	[0.002]	
LB portfolio	-0.9226	1.184	69.67%
[p-value]	[0.027]	[0.000]	
HS portfolio	-3.936	0.312	0.98%
[p-value]	[0.000]	[0.2134]	
HB portfolio	-4.856	1.890	31.84%
[p-value]	[0.001]	[0.000]	

Appendix 3 - Stationarity of time series data

Figure 2: Stationary time series data for market risk factor

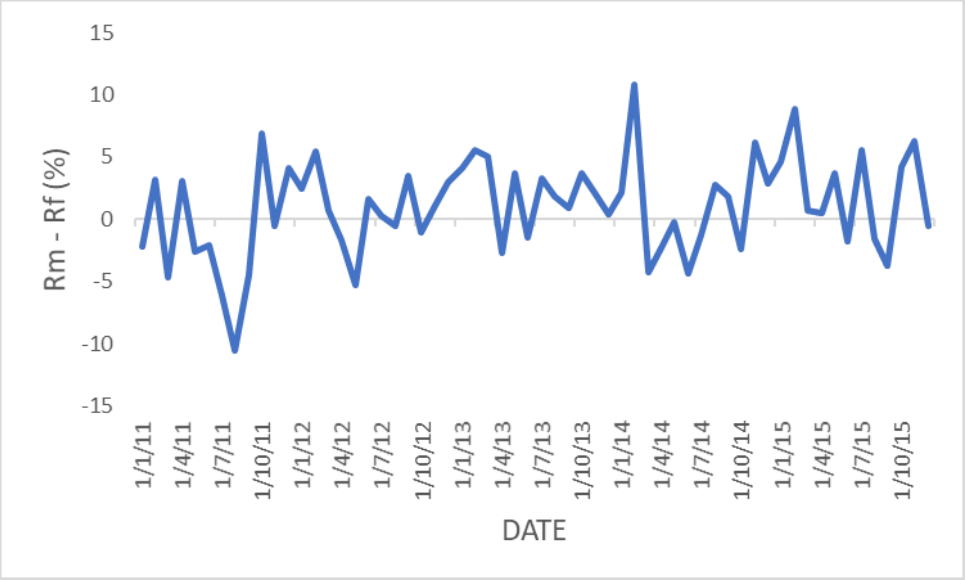

Figure 3: Stationary time series data for the SMB factor

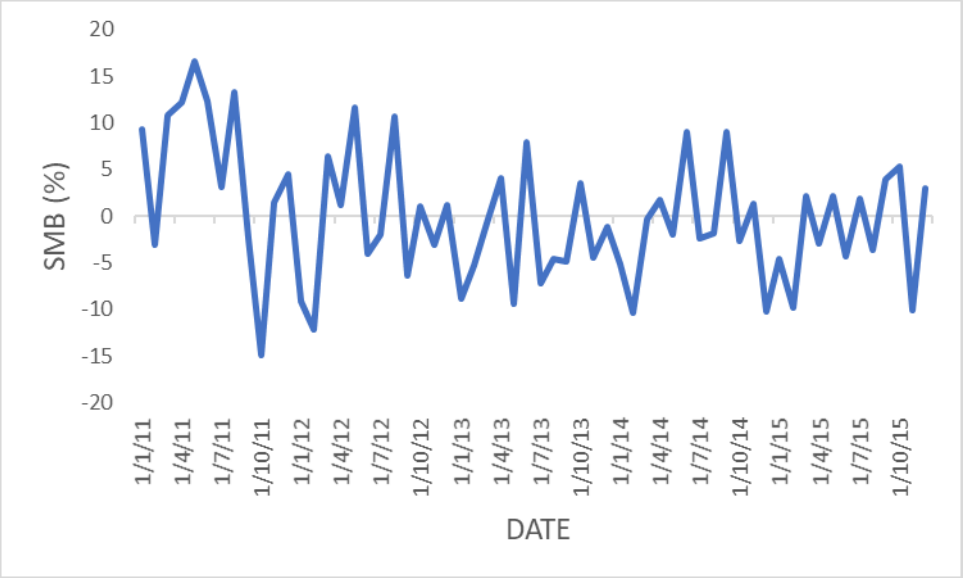

Figure 4: Stationary time series data for the HML factor

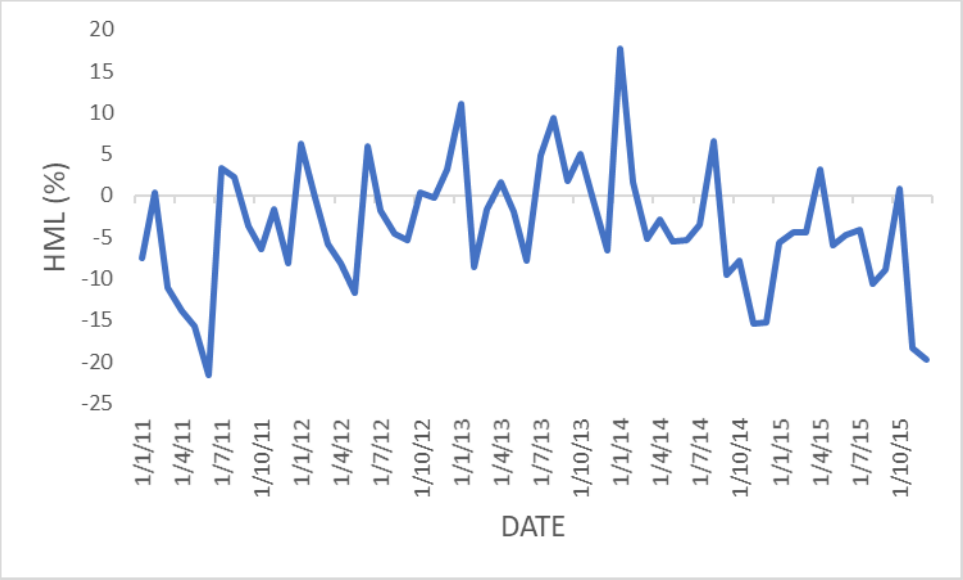

Figure 5: Stationary time series data for LS portfolio

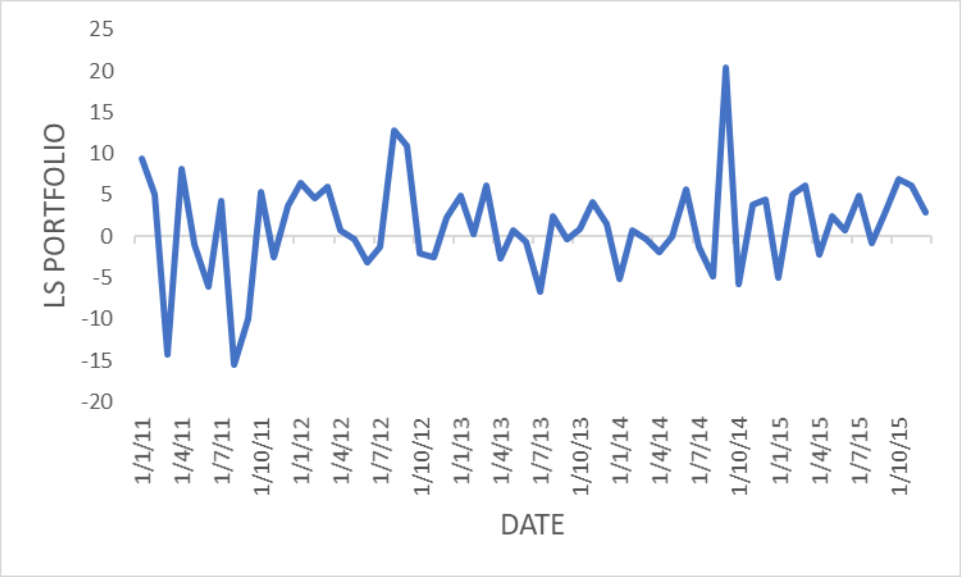

Figure 6: Stationary time series data for HS portfolio

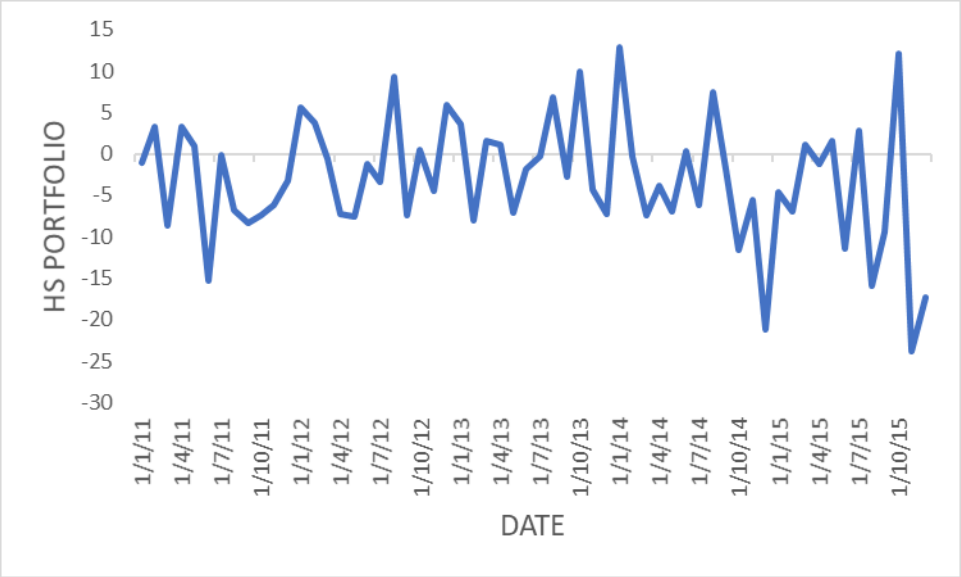

Figure 7: Stationary time series data for LB portfolio

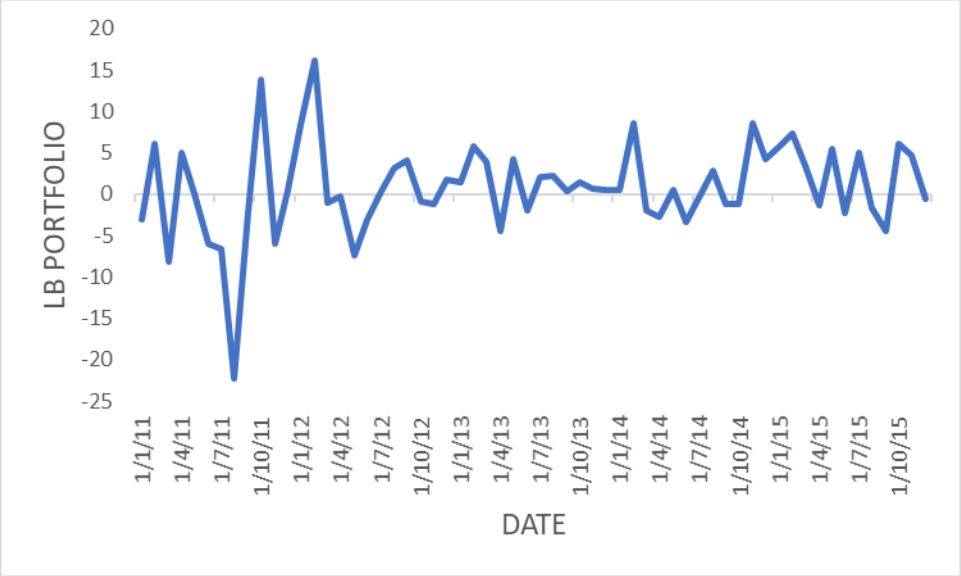

Figure 8: Stationary time series data for HB portfolio