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2022 **Shuhong Lu**

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Can a Dual-beta Five-Factor Model Explain Stock Market Variation in CEE?

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Abstract

The study applies a dual-beta five-factor model to investigate how return is correlated with market factor, size, value, profitability and investment factors in the CEE region. Dual betas are employed in a pooled regression to account for different behaviour in different market conditions. The results show that market factor is significant across the sample period from 2003 to 2017, and the coefficient of the market factor is lower in bearish market and higher in bullish market. By employing dual betas, the explanatory power of a model has increased. However, the effect is limited, and we do not recommend using the dual-beta model due to the loss of simplicity. Post-regression diagnosis has confirmed the appropriateness of using our model by checking the key assumptions of Ordinary Least Square. Limitations are presented at the end to suggest future study.

Keywords

CAPM, five-factor model, dual-beta, CEE

Declaration of Authorship

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

2. The author hereby declares that all the sources and literature used have been properly cited.

3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

25.07.2022 **Shuhong Lu** Shuhong Lu

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Short description of the topic: The study applies a dual-beta five-factor model to investigate how return is correlated with market factor, size, value, profitability and investment factors in Central and Eastern Europe
Proposed structure: Introduction, Literature Review, Methodology, Result Discussion, Conclusion
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Contents

1. Introduction

Market participants have been searching for a better alternative of the capital asset pricing model (CAPM) for several decades. CAPM only measures systematic risk because it assumes that market participants are rational and capable to diversify idiosyncratic risks. Therefore, systematic risk should be the only priced risk for an asset. Evolvement of capital asset pricing model includes multi-factor models such as Fama-French Five Factor Model and the Arbitrage Pricing Model. These models take other risk factors such as company size into account and price those factors accordingly. Portfolios with a higher exposure to a risk factor should have a higher return to compensate the portfolio holders, assuming portfolio holders are risk adverse. Some other study criticizes the use of beta as a single source of measurement of market risk. Thus, they have been looking for a non-constant beta. Consequently, research on dual-beta model has increasing popularity as well (Pettengill et al., 2002). However, their focus is primarily on the US and the UK market (Fletcher, 1997; Maheu and McCurdy, 2000). Other economies lack the attention of both theoretical and empirical research in those relatively new areas. Central and Eastern Europe, an important geographical area to study transition economies, has attracted surprisingly small number of researches, which is not proportionate to the value that CEE countries can provide for understanding asset pricing. In this study, we are going to study asset pricing models, particularly with dual betas, in CEE. This study is one of the few researches that combines Fama-French Five Factor model and the dual-beta model in the application of CEE region, aiming to shed lights on portfolio management.

CEE is defined as the region encompassing those countries that are in the Central, Eastern, Southeast Europe, and Baltic. They are primarily member state of the European Union (expect Albania) that were former communist countries which were part of the Eastern Bloc. Majority of the CEE countries were transition economies which now have completed the transition process (IMF, 2000), which makes them one of the best focuses to study transition economies. There are 12 countries included in CEE, which are Albania, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic and Slovenia (OECD, 2001). The 12 countries share similarities and differences, and they provide valuable information on transitional economies which has not been paid sufficient attention before. However, not every country has sufficient data points for analysis to identify a valuable pattern. In our case, there is no satisfactory number of observations for Albania and Lithuania between the period from 2003 and 2017, including each sub-period we are going to analyze. Therefore, we will only be studying 10 out of 12 CEE countries, which are Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Poland, Romania, the Slovak Republic and Slovenia.

From the theoretical perspective, the study will analyze the Efficient Market Hypothesis as a starting point, which then leads to the CAPM, Three Factor Model, and the Five Factor Model. Following on that, we introduce the Dual Beta Model which is relatively new. From the empirical perspective, our study builds on the Fama-French Five Factor Model and introduces additional beta to differentiate a portfolio's reaction to the market as a whole, aiming to provide additional insights into the financial market in the CEE region. We obtain our data set from the Kenneth R. French Data Library and Refinitiv, which are considered to be reliable data sources. To ensure an appropriate model is applied in the panel data, a model comparison has also been employed to determine whether a fixed effect, random effect, or a pooled model is more appropriate. The result shows that a pooled model is the appropriate regression model.

The key question of this study is to answer if a dual beta model helps explain stock market variation. When attempting to answer the question, some insights on the other two questions are available. Since we are running the samples from 2003 to 2017 with 5-year interval as a sample breakpoint, we may be able to identify if different market behaviour may exist in different time periods. For example, did the Five Factor model perform better in the 2008 Global Financial Crisis? Furthermore, the other question that may be able to answer is the significance of the Five Factors. If some of the factors have been insignificant across all periods, it may be sensible to apply a more simplified model with fewer variables. These two questions along with the main question form the basis of this paper.

Our hypothesis on the dual-beta model is that it improves the explanatory power of a multi-factor model because it allows the beta to be different in different market conditions. We also hypothesize that the model should behave similarly across different time periods, and the five factors should be significant in most cases. The results show that dual-beta model is useful in predicting stock market returns variation, although the effect is minor. This is in line with our hypothesis that dual-beta improves the explanatory power of Fama-French Five Factor Model. We also found that betas have been consistently higher in the down-market conditions where the market excess return is negative, which corresponds to the findings of Teh and Lau (2017). According to the regression models, beta as the coefficient of market factor is always significant. However, this is not always the case for SMB the size factor, HML the value factor, CMA the investment factor, and RMW the profitability factor. This rejects our previous hypothesis. Based on our results, we support the continued use of single beta Five-Factor model because the relatively small benefit of using dual betas fails to justify the complexity of introducing new variables. It is, however, beyond the scope of this study to investigate the use of a multi-factor model over a single-factor model such as CAPM.

The study is relevant to understand the behaviour of introducing a second beta in the Five Factor Model in the CEE region. It helps identify an alternative to the traditional asset pricing model. The analysis hopes to provide insight for market participants in explaining the stock market returns. It should be noted that the results are based on the samples from CEE countries between 2003 and 2017 and should not be over-extrapolated into other developed or developing economies. Further research is required to confirm its validity in other regions.

The following sections include Literature Review on EMH, CAPM, five-factor model and dual betas, Methodology on how data is collected and processed, Results on the regression models, and finally Conclusion.

2. Literature Review

The literature review section aims to provide an overview of the extant theories and empirical evidence related to development from the capital asset pricing model to the dual beta five-factor model, mainly since 1950s. To understand the reasons to introduce a second beta and our model limitations, we will also discuss the efficient market hypothesis, which provide insights on how and why assets move in line with the market in different market conditions.

2.1 Efficient Market Hypothesis

The exploration of the 'correct' model to predict stock returns is mostly based on the belief that market is somewhat efficient. If a stock deviates too much from its true value, the price gap will be reduced by the act of arbitragers. The efficient market hypothesis (EMH) asserts that a market is efficient if the prices reflect the information set such that it is not possible to earn economic profits (Jensen, 1978). In other words, the market value of a stock moves in line with the company's intrinsic value. Hence, a firm's shares should be valued by the future cash flows discounted by the firm's cost of capital, and irrelevant information should not affect the share price. The EMH suggests that the best strategy for investment is to buy a broad index fund including all the stocks in the market. Even if some fund managers are able to generate consistent excess returns (difference between asset returns and risk-free rate) for their funds over a long period of fund, this does not affirm market is inefficient. With such a large number of funds all over the world, the probability suggests there will be a couple of funds that stand out purely by chance. However, whether the prices fully reflect the information is almost untestable. Therefore, a redefinition of what 'fully reflect' means is needed within the context of a model that specifies market equilibrium, for instance, the submartingale model and the random walk model (Fama, 1970). According to the EMH, the equilibrium price of an asset should be equal to the current price plus the expected return based on present information (Fama, 1970), regardless of the model adoption. But what drives the market to be efficient? It is generally believed there are two key factors. Firstly, the participants in the market are at least partially rational. They are profit maximizing and expect stock prices to rise following the announcement of positive news and vice versa. Secondly, when the market participants' behaviors appear to random or irrational, that randomness cancel out each other, leaving the overall effect on the stock price to be neutral. Koller et al. (2010) suggests that intrinsic value investors are the major determiners of stock price because their trading volume is relatively large, and the trading activity is concentrated. On the other hand, the impact of irrational investors is negligible and quickly exploited by more sophisticated market participants for risk-free profits.

There are three levels of market efficiency: weak form, semi-strong form, and strong form (Fama, 1970). In weak form market efficiency, past information such as historical price trend and trading volume is already incorporated in the stock price and do not influence how the market moves. It suggests that the stock market behaves like a random walk model and price changes in the next period are independent of the price changes at the current period (Kendall, 1953; Samuelson, 1965). Therefore, it is ineffective to apply technical analysis to explore stock price patterns. However, fundamental analysis to evaluate a company's performance by researching its financial statements can help increase the chance of earning excess return. The weak form efficiency has been one of the important assumptions in stock valuation in the literature (Degutis and Novickyte, 2014). Although this form market efficiency is often recognized to be true in developed countries, observations such as momentum generates numerous discussions on whether it holds in practice. Semi-strong market efficiency states that stock price reflects all public information in an unbiased manner, indicating nor fundamental analysis or technical analysis is useful in earning consistent abnormal stock returns. If new information becomes available, for example, unexpected dividend announcement, there should be an instantaneous adjustment of the share prices. In other words, no continuous trend after the initial announcement can be observed. In strong market efficiency, all public and private information have been fully reflected in the prices, which means no one is capable of obtaining abnormal returns. This form of market efficiency is a strong assumption, and it is less likely to be found in practice compared to the other two forms of market efficiency. Laws and regulation usually prevent insider trading, thereby limiting price adjustments to private information.

The discussion of EMH has undergone several stages since 1960s. The majority of arguments support the EMH in the early stage, especially in weak forms (Malkiel, 1962; Fama, 1965). Fama (1970) argues that the early research on asset prices were more related to a general ‘fair game’ model: a speculator’s expected gains or losses should be zero. The author claims only after the research of Samuelson (1965) and Mandelbrot (1966) that the relationship between the expected return model and the random walk theory start to be rigorously analyzed, because early study lacks consideration of the stochastic process. The semi-strong form of market efficiency is also widely supported in academics during the same period. Fama et al. (1969) claim that share split information which indicates future stock dividend is reflected in the stock price at the time of splitting. Additionally, Ball et al. (1970) yielded similar results by studying the effects of initial public offering, secondary equity offering and earnings announcement, which indicates the presence of semi-strong market efficiency. In terms of strong form efficiency, it has been suggested that specialists of major exchanges and corporate insiders are the only group of investors who have monopolistic access to information (Niederhoffer and Osborne, 1966; Scholes, 1969). However, there is no indication that this monopolistic access has led to inconsistency of the strong form efficiency for other investor groups, who account for the majority of investment. Consequently, the strong form efficiency is also regarded as a reasonable first approximation to reality (Fama, 1970). Since late 1970s, mixed evidence started to emerge. Jensen (1978) states that while there is solid evidence supporting the EMH, there are inconsistent phenomena that cannot be ignored, which casts doubt on the validity of the theory. In the same year, Ball (1978) examined the post-announcement stock price reaction and found non-zero excess return, thus rejecting the semi-strong form market efficiency. Watts (1978) applied the methodology by Ball (1978) in different empirical data set and concludes similar result that market is inefficient. Furthermore, Koller et al. (2010) suggest that the differences of awareness across investors and the uneven transaction costs are the main reasons that market prices do not instantly reflect fundamental value changes. Difference of awareness is even more significant when there is a lack of experience such that a rational decision can be based on, e.g., the collapse of Lehman Brothers. Haugen (1995) argues that investors are likely to overreact to past successes and failures, leading to opportunities of consistently outperforming the market. Similarly, according to Koonce (2001), the assumption underlying the EMH that investors' irrationality cancelling out each other is weaker than generally believed, leading to deviations from the asset's fundamental value. Barberis and Thaler (2003) argues those deviations can be substantial and long-lasting. In addition, Hong and Stein (1999) claims some assumptions of EMH are not an accurate reflection of reality. For example, market participants do not have access to all information, and they do not have the capability to process all information. Even if they do, different sentiments for different market participants about the same information may also cause the market to behave inefficiently. We mentioned above that arbitrageurs are an important part that helps the market to achieve efficiency; however, according to Abreu and Brunnermeier (2003), sometimes arbitrageurs wait for market inefficient before taking action in order to gain a greater profit. Nevertheless, not every scholar thinks that market is inefficient. Charest (1978) analyzed the share performance after stock split and dividend change event from 1947 to 1967 in NYSE, and the author argues the presence of non-zero abnormal returns are caused by different estimation procedures and the time interval. It appears that more research is needed to conclude whether the market is efficient. Hence, Ball (1994) raised a neutral view regarding the EMH: it is limited but provides valuable insights to stock market behavior.

The observations on EMH also differ across countries. It is generally believed that developed markets are more efficient than developing countries, both in the stock market or the sovereign debt market (Zunino et al., 2012). Even for neighboring economies, there is perceived difference in market efficiency. Fakhry and Richter (2016) studied the GIPS (Greece, Italy, Portugal, Spain) markets using a GARCH variance bound test, and they found that only Greece and Portugal are the only two markets that the null hypothesis of inefficiency can be rejected. Furthermore, this efficiency is not permanent because the two markets also show signs of inefficiency in the financial crisis. The authors suggest asymmetrical effects can be affecting market efficiency. The discussion on EMH also varies across time, especially after the financial crisis in 2008. If prices should have reflected all the available information, why a disruption of financial market was observed in the crisis? Fakhry (2016) claims that the EMH theory leads market participants to falsely believe that assets are secure, and the prices are accurate reflection of discounted future cash flows. Those consistent deviation brings economic bubbles, and investors do not realize the existence of bubbles until they burst. More financial regulation was introduced as a result of growing concerns of market failure since the 2008 Global Financial Crisis.

Overall, EMH has received a great amount of doubt and criticism. Because there is no single definite way to determine prices or returns, it is difficult to test and verify EMH empirically (Timmermann and Grandger,2004). However, it provides guidance on asset valuation models based on which we are able quantify and measure the required rate of return for an asset or a portfolio. It remains one of the most important assumptions in the financial market, which allows us to propose the capital asset pricing model and its extensions.

2.2 Capital Asset Pricing Model and the Five-Factor Model

Investors and academia have long been trying to identify a simple and reliable stock valuation model. The capital asset pricing model (CAPM) is one of the most important theoretical frameworks to establish a stock's required rate of return, and it is still widely used in today's financial world. It provides a reasonable definition of asset risk with respect to the market portfolio, as follows:

$$E\,(R_i) = R_f + \beta_i\,(R_m - R_f) \quad (1)$$

where $E\,(R_i)$ represents the expected return of asset *i*. R_f is the risk-free rate, which has been commonly approximated by one-month US Treasury bill; R_m is the market return, therefore, $R_m - R_f$ represents the market excess return, also the risk premium. β_i represents the coefficient and the beta of asset *i* with respect to the market.

The CAPM suggests only systematic risk matters in pricing an asset: a higher return is required to compensate higher systematic risk (Lakonishok and Shapiro, 1986) because investors are assumed to be risk averse. It is assumed that investors will diversify their portfolio by investing a range of stocks and bonds, thus a company's idiosyncratic risk should not be priced into the stock. In addition, asset excess return is expected to have a positive linear relationship with the market risk premium, with the coefficient being the asset's beta. The beta can be expressed by dividing the covariance between the measured security and market return by the variance of the market returns, i.e.,

$$\beta_i = \frac{cov\ (R_i, R_m)}{var\ (R_m)} \tag{2}$$

where $cov\ (R_i,\ R_m)$ is the covariance of the stock and the market, and $var\ (R_m)$ is the market variance.

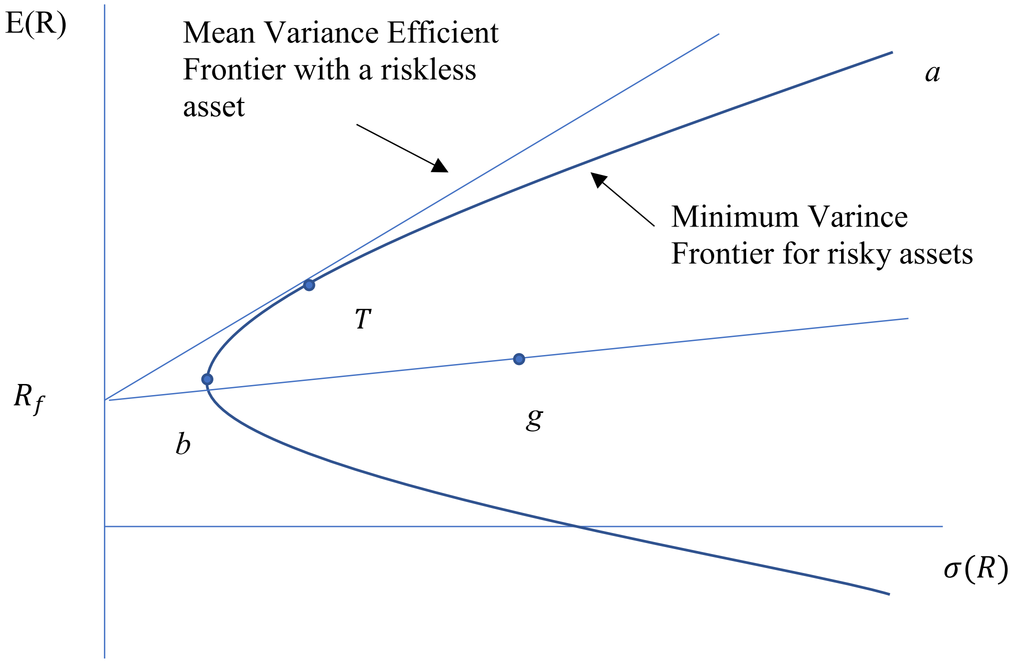
Unlike the semi-variance model to be discussed later, the CAPM assumes a person is only concerned about the mean and variance of the equity return for a one-period investment. Given equity variance, the investor demands for mean return maximization; on the other hand, the investor would like to minimize price fluctuation, i.e., the variance, given expected stock return. If depicted on the graph where the y-axis is the expected return and x-axis is the standard deviation, the combination of portfolios of risky assets that minimize the variance at a given level of expected return is illustrated by the curve line *abc* in Figure 1. The curve shows the trade-off between lower volatility and higher expected return. To obtain a higher return investor should accept more volatility. For example, moving from Point *b* to Point *a* requires taking more risk. If borrowing and lending are not allowed, the points on the curve above Point b would be efficient because they have the minimum variance at a given return. However, if borrowing and lending are allowed, at a point (Point *T* in Figure 1) in the frontier, the line that connects the risk-free rate and the point will have a largest slope. The slope of this line measures the market price of risk, in other words, how much extra return is required for taking one marginal unit of risk. The Sharpe ratio (Sharpe, 1998) on this line is largest because the compensation for undertaking additional risks is the highest. It is also possible to go beyond point *T* by borrowing at the risk-free rate and buy portions of risky assets. The mean-variance efficiency behavior means that every investor will choose their portfolio on this line, depending on their risk preference. If market is efficient, this mean-variance model approach determines the price of an asset: higher-risk assets appear to be less attractive, and thus have lower demand, lower price and higher return. There are two key assumptions developed by Sharpe (1964) and Lintner (1965). Firstly, investors are able to borrow and lend any amount at the risk-free rate. Secondly, every individual has homogeneous expectation on the rate of return in the next period. In other words, they have total agreement on the return distribution. These two assumptions with the other assumptions developed by Markowitz (1952), therefore, form the basis of CAPM assumptions, which are

(1) Investors are assumed to be risk averse and utility maximizing. Each individual will have his or her own utility function and preference of risk-award trade-off, which will determine the position of the efficient frontier that the investor takes;
(2) Investors hold homogeneous expectations;
(3) Investors are able borrow and lend at the risk-free rate, and the interest rate will not change by the amount borrowed or lent;
(4) There is no restriction on purchasing or selling portfolios or a portion of the shares;
(5) No transactional costs or tax implication;
(6) Constant interest rate and no inflation;

(7) Investments are held for one-period of time, which is the same for all investors;

(8) Equilibrium capital market, and individual investors are not able to influence the price in the market (Elbannan, 2015).

Figure 1: Opportunities of Investment



Note. Adapted from Fama and French (2004).

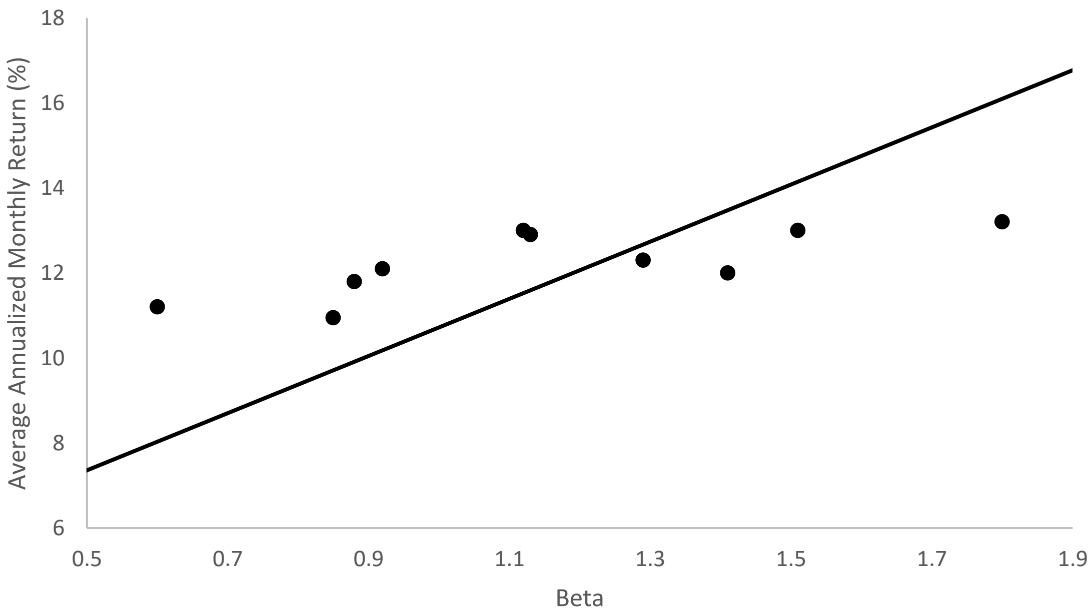
From CAPM, it can be inferred that all investors hold a combination of risk-free assets and a market portfolio which contains all risky assets. The weight of risky assets in the portfolio is determined by the ratio of their market capitalization and total market value. In most circumstances, the returns will not be exactly the same as that predicted by the CAPM formula. A consistent outperformance or underperformance is captured by the 'Jensen's alpha'. According to the market efficient hypothesis, the expected value for Jensen's alpha is zero. However, phenomenon such as consistent abnormal returns can also be observed in the stock market, suggesting a non-zero Jensen's alpha. These anomalies bring discussion on incorporating more variables to account for 'risk' that is missed in the capital asset pricing model. For example, the Three Factor model includes the size effect and the book value premium, which will be examined later in this study. Some argue that these discrepancies may also come from the assumptions of the CAPM. Friend and Blume (1970) suggest that the disparity between the rate of borrowing and lending is one explanation of why those discrepancies exist. Typically, the rate of borrowing is higher than that of lending, and this rate may vary across different investors. This means that not every investor will have the option to increase the portfolio's return above point T in Figure 1 by borrowing at the risk-free rate and using it to finance additional stocks. If this assumption is relaxed, there will be two separate lines passing to the market portfolio (Reilly and Brown, 2003). However, Black (1972) suggests that even with no riskless borrowing, the expected return remains a linear function of β by allowing short sales of risky assets. The other assumptions of CAPM have been challenged as well. If investors do not have homogenous expectation, the capital market line and the security market line will be different. Graphically, these are portrayed by a collection of parallel lines whose distance will be closer if investors have a more aligned expectation (Elbannan, 2014). Similarly, while the no-tax assumption helps simplify the CAPM calculation and comparison between countries with different tax rates, it may lead to preference for capital gains over dividend pay-out because of higher tax burden (Miller and Scholes, 1982), thus a greater return is required for dividend-paying stocks to compensate the additional tax paid. The actual return for individuals after taking tax effect into account, therefore, are:

$$R_{after\ tax} = \frac{1}{P_0}\left(\left(1 - T_{capital}\right) * \left(P_t - P_0\right) + Div * \left(1 - T_{income}\right)\right) \qquad (3)$$

Where $R_{after\ tax}$ represents the after-tax return; P_0 is the price at the starting period, or the purchase price; P_t is the price at the ending period, or the selling price; $T_{capaital}$ is the tax levied on capital while T_{income} represents the income tax on dividend; Div is the dividend pay-out. Another assumption that may have caused the distortion in CAPM is the transaction costs. If there is no transaction cost, mispriced assets will eventually move to the security market line. However, transaction costs exist, which leads to a range of security market lines instead of only one line.

Early empirical research on CAPM focuses on regressing on individual asset returns to estimate the beta, with the intercept being the risk-free rate and the coefficient being the asset's beta. However, this creates potential problems. Not only the beta coefficient created this way is inaccurate, but also the residuals from the regression share the same origins of systematic variations (Fama and French, 2004); for example, overall market effect. Fama and French (1997) claimed that inaccurate risk loadings of industries and uncertainty about the risk premium of true factors were the two reasons why it occurred. Later work uses portfolios rather than single asset to improve the model precision because CAPM can also be used to predict portfolio returns. Grouping the assets together as a portfolio mitigates the impacts of measurement errors that may occur when estimating single beta; however, it also reduces the statistical power. Thus, the portfolios are usually formed on sorting betas from lowest to highest in today's literature to mitigate such impacts. While CAPM has performed relatively well in the early days, the relationship has become weaker since the mid-1960s (Campbell and Vuolteenaho, 2004). Bartholdy and Peare (2005) found that the CAPM accounted for only three percent of differences in returns on average. Fama and French (2004) also found the lack of explanatory power by CAPM. The authors drew data for all stocks in NYSE, AMEX and Nasdaq. Portfolios are then formed based on previous year betas. Those portfolios' next year returns are then plotted against their estimated betas derived from prior years. Figure 2 demonstrates the findings. The straight line was constructed using one-month US Treasury and the average market excess return. Two things were noted. Firstly, the intercept, which indicates the risk-free rate, is higher than the returns estimated by the CAPM. Secondly, the compensation for additional risk taken (beta) is not as strong as the CAPM predicts, resulting a flatter line than predicted. The phenomenon that the fitted observation appears to be flatter than it should be is also evidenced in other literature (Blume and Friend, 1973; Stambaugh, 1982), suggesting this observation is not isolated. However, the relationship between the mean returns and portfolio beta appear to remain linear, which is consistent with the theory and the findings of Fama and MacBeth (1973). The authors included the square of market betas as an additional variable to test the hypothesis that the relationship is linear, and they found no extra explanatory power contributed by squared beta, which confirms the linear relationship.

Figure 2: Realized monthly return vs. Portfolio Beta



Note. Adapted from Fama and French (2004).The points represent the actual observations for average monthly return in percentage based on prior year's beta. The straight line represents the average annualized return that is predicted by the Capital Asset Pricing Model.

While efforts have been made trying to predict how stocks move, a great number of anomalies which cannot be explained by CAPM still exist. The presence of such anomalies has made a more thorough model desirable. For example, it is found that small stocks tend to outperform large stocks, after isolating market risk. Banz (1981) examined how NYSE common stock returns was related to their market values and found a higher risk-adjusted return for smaller firms. Furthermore, firms with high book-to-market values tend to outperform those with low values. Basu (1983) identified that return for common stocks are positively correlated with the earnings' yield represented by the earnings-to-price ratio (E/P). Interestingly, the author also shows the E/P effect is not completely independent of the firm size effect. Other literature also documents the existence of this value premium anomaly (Fama and French, 1992; Lettau and Ludvigson, 2001; Bansal and Yaron, 2004). Consequently, a different perspective other than the capital asset pricing model is presented by Fama and French (1993). The aim is to explain excess return by the two additional factors described above – size effect and value premium. The authors use two constructed factors to represent the size and value premium, which are small minus big (SMB) and high minus low (HML). SMB accounts for the size premium. It measures the extra returns that market participants receive for investing in companies with a small market capitalization. Fama and French (1992) found the return for the SMB factor is about 1% on average by studying the equal-weighted and value weighted portfolios in New York Stock Exchange from 1963 to 1990. HML accounts for the value premium. It measures the additional return that market participants receive by investing relatively high book-to-market (B/M) companies. The average return for the HML factor during 1963 and 1990 is about 1.5% (Fama and French 1992). Fama and French (1995) found the Three Factor model can better capture the cross-sectional average return of US stock market. The study is further supported by Fama and French

(1996) claiming that the market anomalies mostly disappear after the application of the Three Factor model.

Like many other models, the Three Factor model also has limitations. Daniel and Titman (2005) estimated the model on indexes such as NASDAQ over the 30-year period from mid-1960s. Their result does not support the use of additional variables. Furthermore, Rechman and Baloch (2016) evaluated Pakistan's mutual fund performance from 2009 to 2015 and concluded that the CAPM is a preferred model. Allen and McAleer (2019) questioned the Three Factor model may be subject to endogeneity after studying monthly US market from 1926 to 2018. The authors argue the methodology used by Fama and French (2018) to screen factor relevance is questionable because the standard errors are "sensitive to the correct model specification". Some study also suggests that the variables *per se* are not direct contributors to return, instead, they are proxy for true risk factors. Chan and Chen (1988) claim that firm size is an instrumental variable for risk and that firm-size proxy does not have explanatory power for returns. Using the same procedures but with sets of portfolios constructed to have low cross-sectional correlations, Jegadeesh (1992) shows contradicting results with Chan and Chen (1988), suggesting that size effect cannot be explained by the betas. To mitigate the impacts of firm size, more recent study tends to use size-based portfolios. Aleati et al. (2000) claimed that the effects of size and the book-to-market ratios depends on the procedures and period applied.

Whether the variables themselves are true factors affecting asset returns, or they happen to correlate to risk measurement remains inconclusive. It is noted that the Three Factor model is concerned with regressing with past data and may only represents historical evidence that stock returns are associated with size and value premium. So, why the Three

Factor model is still being widely used? The simple answer is that it provides the greatest predictive power compared to other variables. The R square of most empirical tests are high, and theoretical explanations for these risk factors appears to be plausible. Small firms are expected to be riskier because of their reduced capability to absorb adverse events, such as industry competition. Same for the HML factor. Growth stock can be deemed riskier than value stock, and thus, investors required a higher return.

The research on multi-factor model does not stop at three factors. Fama and French (2015) found two additional variables that seem to provide extra explanatory power in asset returns. The first factor is profitability. This is due to the observation that firms with a high operating profitability tend to perform better on average. The authors use robust minus weak (RMW) to represent the profitability factor. It measures the return spread of relatively more profitable companies and those that are not. The second factor is an investment factor. The investment factor accounts for the observation that high total asset growth is likely to be negatively associated with averaged return, which is measured by the factor conservative minus aggressive (CMA). Fama and French (2015) found the Five Factor model performed better than the Three Factor model and the result was not sensitive to how the factors were defined. However, the Five Factor model also comes with limitations. Firstly, more factors mean increased difficulty in estimation. One of the reasons that CAPM is popular is because of its simplicity and predictability. Consequently, whether a Five Factor model can be justified remains a question to answer. Secondly, as suggested by Asness (2014), momentum is not included in the model, even if the momentum effect has been widely observed for about two decades. Last but not least, it is found that correlation exists between factors. Fama and French (2015) claimed that the addition of new factors made the value factor (HML) redundant.

2.3 Dual beta Model

It is discussed above that markets may deviate from being efficient. To mitigate the impacts of the market inefficiency, scholars have tried to incorporate behavioral finance into the asset pricing models (Kourtidis et al., 2011). In the models discussed above, the market beta is constant regardless the periods analysed, and there is no mechanism to address the possibility of different reactions in different market conditions. However, according to Roy (1952), individuals appear to care differently about gains and losses. Safety is a key consideration in asset management, and thus investors may intend to minimize expected portion of loss occurrences instead of maximizing the expected return. Likewise, Hofschire et al. (2013) suggest asset managers are increasingly looking for capital preservation. In such cases, a modification of the valuation model to allow asymmetric betas can help understand investors' reaction to different market environments. One way is to use the dual beta model. It introduces a second beta in additional to the Sharpe-Linter-Black model, which allows for differentiation of upside participation and downside conservation. It is observed that assets with high downside betas are often associated with higher returns (Ang et al., 2006). By allowing more than one beta, it is possible to model preferences over different market conditions. Javid and Ahmad (2011) illustrate that betas increase in bullish market and decrease in bearish market, rejecting the use of one constant beta. Teh and Lau (2017) claims the dual beta model provides a superior measure for risk assessment than the conventional single beta model.

However, the use of downside betas also comes with limitations. Research has shown that introducing downside betas does not necessarily improve the model (Jahankhani, 1976; Harlow and Rao, 1989). Fabozzi and Francis (1977) conducted an empirical test to investigate the stability of the single-index market model, and they found both regression coefficients were not significantly affected by different market status. Kim and Zumwalt (1979) extend the analysis applied by Fabozzi and Francis (1977) to investigate if investors respond differently to bullish and bearish market. The authors analyzed a total of 322 securities and found contrasting results: investors pay a premium for upside movement and receive a premium for downside fluctuation. Therefore, Kim and Zumwalt (1979) suggest downside beta as a more appropriate risk measure. Nonetheless, their research is being criticized for potential problems of heteroskedasticity and multi-collinearity (Chen, 1982).

The higher sensitivity to downside risks can also be measured using different approaches. Compared to the traditional capital asset pricing model, which is static, a conditional CAPM assumes a time-varying betas and market risk premium by allowing a non-zero covariance. The results of using conditional CAPM is mixed. Jagannathan and Wang (1996) found that conditional CAPM explains cross-sectional averaged returns well. On the other hand, Lewellen and Nagel (2006) argued that conditional CAPM does not perform better than the static model, making the use of conditional CAPM unnecessary. In addition to conditional CAPM, Estrade (2007) proposes an alternative behavioural hypothesis by redefining ‘risk’. The author states that the traditional beta as a measure of risk stems from a mean variance behaviour exhibited by investors, i.e., their utility functions depend on the mean and variance of the portfolio’s returns. Estrade (2007) argues that the semi-variance of returns provides a more credible evaluation of risks because the semi-variance is more effective in addressing the asymmetric distribution of returns. While it is too soon to conclude its effectiveness, the use of different risk measurement approaches brings practical insights to how we can improve a model’s predictability and validity.

To conclude, the theory and empirical tests on the asset pricing models have developed from the unconditional single factor capital asset pricing model to numerous extensions of multi-factor model. There is not a definite way to proclaim which model outweighs the others because each model has its own benefits and limitations. For example, having a more precise model often comes with sacrificing the benefits of simplicity. The exploration of the correct model is probably never possible. However, we can approximate what the majority investors agree upon. According to Keynes (1936), investors do not necessarily price assets based on their own belief of the asset's underlying value. Instead, they price assets by speculating other individuals' belief, i.e., investors guess what others think about the price of asset and act according to that. This concept is called Keynesian beauty contest in which a judge does not select the candidate that him/herself finds the most beautiful but the one he/she thinks the most popular among all the remaining judges. Consequently, the correct model to predict stock price fluctuation may be less necessary than the public believes. On the contrary, a pricing model that agrees with what most people think may be sufficient to explain stock price fluctuation.

3. Methodology

This section applies relevant methodologies for the whole period and the three sub-periods from January 2003 to December 2017 to answer if a dual-beta five-factor model explains stock-market variation better than a single beta Five Factor model in the CEE region. We will also investigate if the valuation model changes across different periods and whether or not the Fama-French five factors are robust. 95% confidence level will be employed throughout the analysis. The remaining section will introduce the data collection, data description and model comparison.

3.1 Data Collection

The objective of the study is to identify if potential return patterns exist in bullish and bearish market, and to compare if a dual beta model provides better explanatory power than a conventional model. The performance of an asset can be measured by the difference of the realized asset return and the risk-free rate in the same period. In this study, instead of a single asset, we analyze the market portfolio's return for each CEE country to investigate the existence of the above discussed relationship. The return of the market portfolio will be used as the dependent variable and regressed against market factor, size factor, value factor, profitability factor, and investment factor. To have a reasonable proxy of the market portfolio that contains all risky assets, the primary market index return of the 12 CEE counties will be used to approximate the broad selection of stocks. However, not every CEE country has sufficient data points covering from our study period from 2003 to 2017. Those countries will then be removed from the list of countries studied to avoid bias in results. We have excluded Albania and Lithuania as a result of lack of data observations. Therefore, we will be analyzing 10 of the 12 CEE market portfolios, which are those of Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Poland, Romania, the Slovak Republic and Slovenia.

The analysis covers a 15-year period between 2003 and 2017, and thus, the total observation should be 1,800 (10*15*12). However, Slovenia market index return was not available until May 2006, which leads to 40 missing points. The total sample is, therefore, 1,760. The chosen 15-year length gives sufficient data observations while ensuring the relevance of conclusions derived from the data. Three sub-periods (2003 – 2007, 2008 - 2012, 2013 – 2017) were further divided to analyze the impacts of significant financial events on the behavior of valuation models. The Global Financial Crisis in 2008 has caused severe economic recession, which led to the introduction of Basel III. However, it is argued that those regulations have also elicited excessive lending and borrowing for the governments, leading to the start of the European sovereign debt crisis (Johan, 2012). Both the impacts of the Global Financial Crisis and the Sovereign Debt Crisis in Europe has lasted several years, and it was not until 2012 that the economies started to recover. Therefore, we define the period between 2008 and 2012 as the crisis period in this study. During this period, the CEE economies were severely traumatized. In addition, low economic growth or even negative economic growth were observed. We separate this period to evaluate whether a pessimistic view on the market will increase or decrease the explanatory power of the Fama-French Five Factor model. The crisis period acts as a milepost which we use to define pre-crisis period (2003-2007) and post-crisis period (2012 -2017) within our total period studied. By comparing different periods with the same model, we will be able to get a heuristic view on the model performance in different market conditions, and thus enabling us to have a better prediction in the future.

This study employs the Five Factor model (Fama and French, 2015) to take size, value, profitability and investment into account. The formula is as follows:

$$R_{it} = \alpha_i + R_f + b_i (R_{Mt} - R_{ft}) + s_i (SMB_t) + h_i (HML_t) + r_i (RMW_t) + c_i (CMA_t) + e_{it} \quad (4)$$

Where R_{it} represents the return of asset i at time t. α represents the Jensen's alpha indicating the abnormal return above the expected return, and α can either be positive or negative showing if the asset is overperforming or underperforming. R_{ft} is the risk-free rate at time t; R_{mt} is the market return, therefore, $R_m - R_f$ represents the market excess return, also the risk premium. b_i represents the coefficient and the beta of asset i with respect to the market. Similarly, s_i, h_i, r_i and c_i are the estimated parameters for size, value, profitability, and investment factors, respectively. e_{it} is the error term.

Formula (4) produces a benchmark model for the dual beta model. It also acts as a control when testing if the introduction of a dual beta model produces a better explanation of return variation. The regression for the dual beta model is produced below:

$$R_{it} = \alpha_i + R_f + b_i^+ (R_{Mt} - R_{ft})D + b_i^- (R_{Mt} - R_{ft}) * (1 - D) +$$
$$s_i (SMB_t) + h_i (HML_t) + r_i (RMW_t) + c_i (CMA_t) + e_{it} \quad (5)$$

Where b_i^+ and b_i^- are the coefficients for bull market and bear market, respectively. If the return of a portfolio does not change relative to the overall market in different market conditions, i.e., there is no beta asymmetry, then b_i^+ and b_i^- will be identical. D is the dummy variable which takes different value in different market conditions. D equals to one when market excess return is greater than zero and takes the value of zero when the market excess return is smaller or equal to zero.

We have derived the market portfolio's return for the selected 10 CEE countries from Refinitiv, which is a financial market data and infrastructure provider. The market portfolio is represented by the country's primary market index. We consider market index as a reasonable proxy for a well-diversified market portfolio. The frequency of the data is monthly. Using monthly data mitigate the issues of frequent fluctuation and systematic biases. In addition, monthly returns data also gives sufficient data points to search for potential patterns in stock valuation. The total data observations available is 1,760 across the 15-year time span. On the other hand, data of the five factors are derived from the Kenneth R. French data library (French, 2021). The frequency of the data is consistent with the return of market portfolios, which is monthly. Since the paper's focus in on the CEE region, Fama-French European five factors from the Kenneth R. French data Library were chosen to approximate the actual five factors in the CEE region . Those factors are constructed in June every year. Table 1 summarizes the calculation method for each factor.

Table 1: Fama-French Five Factors Calculation

	Market Factor	High Minus Low	Robust Minus Weak	Conservative Minus Aggressive	Small Minus Big
Calculation	European Market Premium	½ (SV+BV) – ½ (SG + BG)	½ (SR + BR) - ½ (SW + BW)	½ (SC + BC) - ½ (SA + BA)	1/3 ($SMB_{B/M} + SMB_{OP} + SMB_{INV}$)

Note. Adapted from Kenneth R. French data library (French, 2021), where S is small, B is big, V is value, G is Growth, R is robust, W is weak, C is conservative, A is aggressive. The formula of the small minus big formula consists of three parts. $SMB_{B/M}$ = 1/3 * (SV + SN + SG) - 1/3 * (BV + BN + BG) , SMB_{OP} = 1/3 * (SR + SN + SW) - 1/3 * (BR + BN + BW), SMB_{INV} = 1/3 * (SC + SN + SA) - 1/3 * (BC + BN + BA), where N is neutral.

Table 2 summarizes the variables used in this analysis, including a brief description of the variable and where the data is obtained. The variables form the basis of the regression model. In the next section Data Description, we will demonstrate a graphical presentation and descriptive statistics of the data.

Table 2: Variable Description

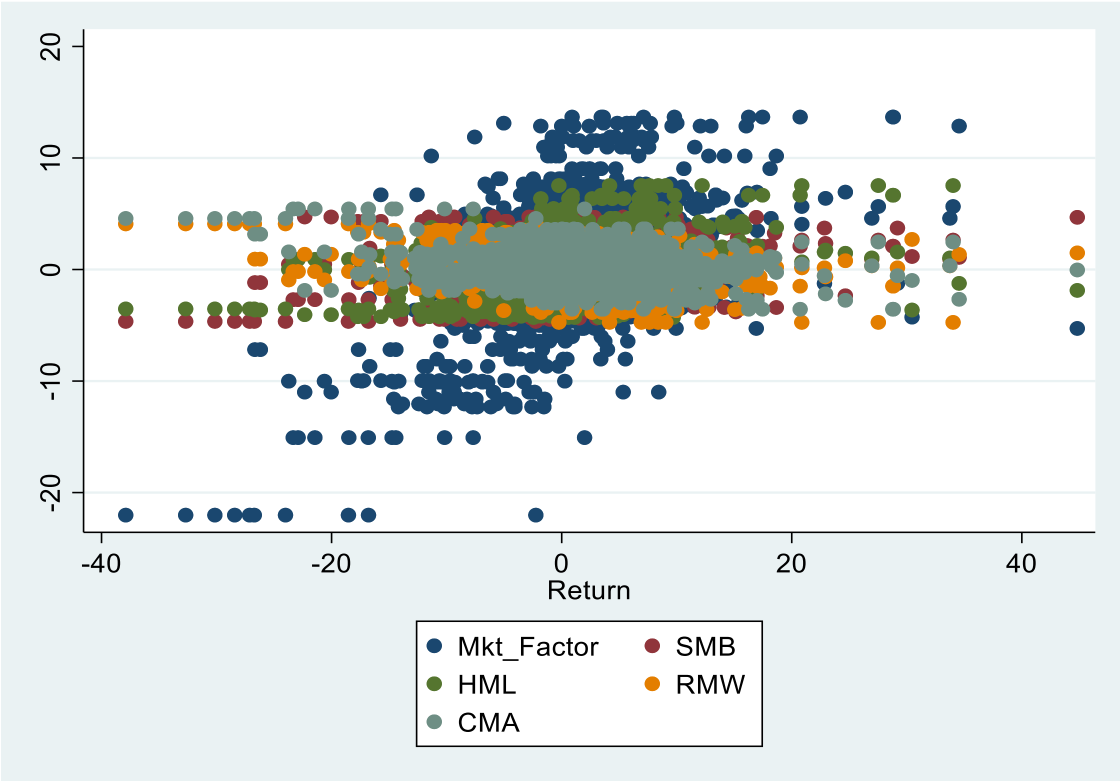
Variable	Description	Data Source
Portfolio Return	The market portfolio's realized return. Approximated by the market index monthly returns for each CEE countries from 2003 to 2017. Also the dependent variable for the regression.	Refinitiv
Market factor	Expressed by European excess market return; also called market premium. The coefficient of market factor is beta. One of the independent variable for the regression model.	Kenneth R. French Data Library
SMB	Small minus big. The size factor in the Five Factor model. One of the independent variables for the regression model.	Kenneth R. French Data Library
HML	High minus low. The value factor in the Five Factor model. One of the independent variables for the regression model.	Kenneth R. French Data Library
RMW	Robust minus weak. The operating profit factor in the Five Factor model. One of the independent variables for the regression model.	Kenneth R. French Data Library

CMA	Conservative minus Low. The investment factor in the Five Factor model. One of the independent variables for the regression model.	Kenneth R. French Data Library

3.2 Data Description

Data obtained from different sources may present different characteristics. To get a comprehensive view of the data, a scatter plot (Figure 3) is produced to identify if potential issues exist. The portfolio’s return is plotted on the x-axis and the five factors are plotted on the y-axis. The units of the variables have been transformed to percentage. For instance, the number 20 on the x-axis represent +20% monthly return. The first observation from the diagram is that most data points are clustered around 0. There is no apparent linear relationship except that market factor appears to be positively associated with portfolio returns, but this should be confirmed with the regression model. Apart from market factor, the values for other risk factors are generally centered between -10 and 10 with little variation. Few extreme data points of the market factor are below -20. Severe market recession could have caused that. The risk-free rate is relatively stable in short-term, therefore, extreme market condition when market return fluctuates by a large extent may lead to deviation from the average value. Additionally, the variances of the independent variables do not appear to be non-constant as the dependent variable changes. Therefore, the dataset should not possess the problems of heteroscedasticity.

Figure 3: Scatter Plot for Realized Returns and Five Factors



Note. Units are transformed to percentage points on both axes.

To avoid the issue of multicollinearity, a pairwise correlation is produced to check the correlation between each factor. Table 3 illustrates the results of correlations. The upper part of the correlation table is removed to avoid duplicates. From Table 3, The profitability factor (RMW) appears to be highly correlated with the value factor (HML), which is consistent with the findings of Fama and French (2015) stating that the introduction of RMW and CMA may lead to the HML being redundant. However, other factors do not present a high correlation between each other. The next highest pairwise correlation is between portfolio's return and market factor, which has a value of 0.5143. The third highest correlation is between HML and the market factor, which is 0.5082. Those correlation values are considered to be reasonable.

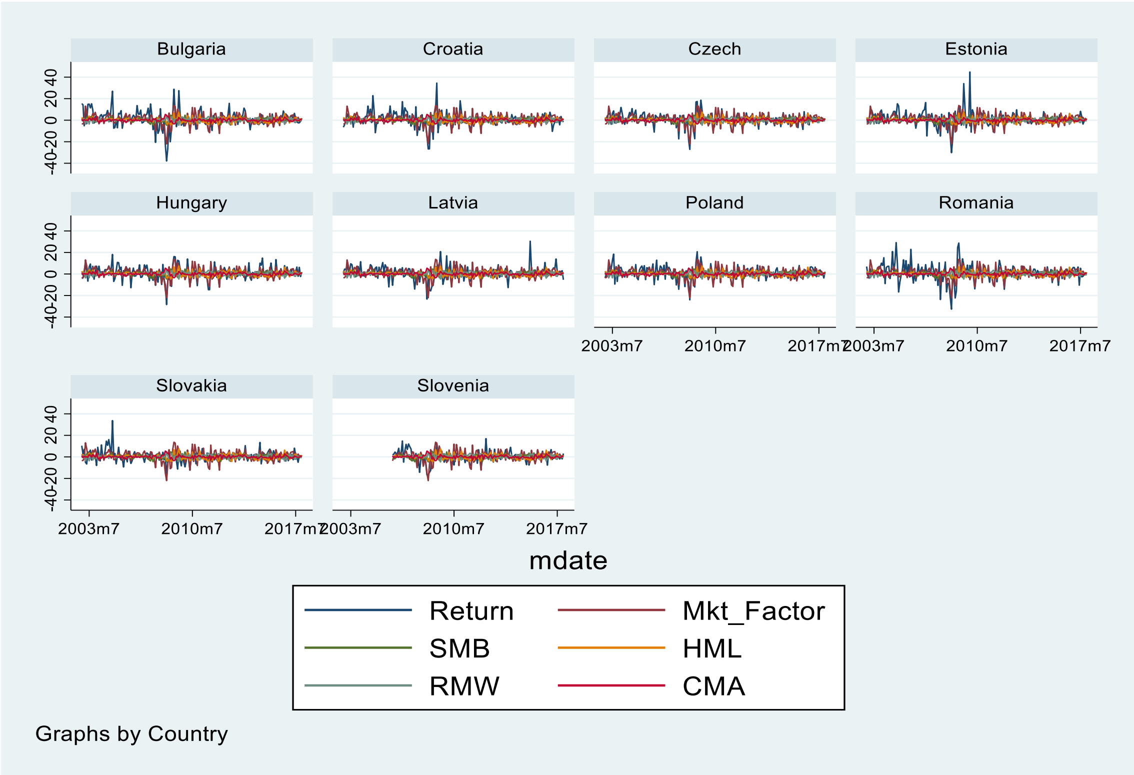
Table 3: Pairwise Correlation

	Return	Market Factor	SMB	HML	RMW	CMA
Return	1.0000					
Market Factor	0.5143 *	1.0000				
SMB	0.1752 *	-0.0248	1.0000			
HML	0.3519 *	0.5082 *	0.0272	1.0000		
RMW	-0.2567 *	-0.4311 *	-0.0867 *	-0.8037 *	1.0000	
CMA	-0.2120 *	-0.2314 *	0.1545 *	0.2855 *	-0.3047 *	1.0000

Note. * Significant at 95% confidence level

To examine the panel data from all countries covering the 15-year period, a matrix of line plots that show the variation is depicted in Figure 4. Slovenia's data did not start until May 2006. It can be observed that the return data do not show structural breaks or trend in the graphs, indicating no non-stationarity is present. Similar patterns are observed across all countries, where highly positive and negative returns took place around the same period. Figure 4 gives a more detailed description of Figure 3 in terms of when and where the influential points occurred. The graphs, however, do not indicate the potential relationship between factors, which is the reason that additional analysis is needed.

Figure 4: Panel Data Line Plot



Note. X-axis shows the time span for the analysis. Y-axis shows the values for the studied variables in percentage points.

Table 4 presents the summary statistics of the variables. The first column shows the number of observations for the variables. All variables have 1,760 observations, which means no additional missing data apart from the ones discussed in Data Collection section. The averages for all variables are all positive and below 1. Considering the values of the means, the standard deviations are relatively large, ranging between 1.32 to 6.62. The market portfolio's return has the highest standard deviation, which corresponds to Figure 4 where the return variable has the greatest fluctuation. The minimums for all variables are below 0, while the maximums are above 0. For instance, the minimum monthly return for all sample countries is -37.89%, while the maximum monthly return across all sample countries is 44.82%.

Table 4: Summary Statistics Table

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Return	1,760	0.86	6.62	-37.89	44.82
Market Factor	1,760	0.77	5.26	-22.02	13.67
SMB	1,760	0.28	1.79	-4.65	4.71
HML	1,760	0.11	2.16	-4.30	7.53
RMW	1,760	0.30	1.54	-4.74	4.09
CMA	1,760	0.12	1.32	-3.56	5.43

To sum up, the data obtained from Refinitiv and Kenneth R. French data library presents reasonable data quality. The data covers a 15-year period with sufficient data observations to identify a potential pattern. Each panel also contains the same number of observations. The analysis applied in this study employs Fama-French Five Factor model, which should present a more comprehensive view of the asset valuation. However, there are also deficiencies by applying the methodology. For example, the correlation between RMW and HML may be high, which may cause multicollinearity.

3.3 Model Comparison

To determine the appropriate model for the panel data, we run two tests to assess the suitability of a pooled model, fixed effect model, or random model. The first step is to determine if a random effect model is more appropriate than a fixed effect model. Hausman test is employed in this scenario. The Hausman test, also named as the Hausman specification test, recognize endogenous independent variables (Hausman, 1978). That is to say, the test identifies if a variable may be determined by another variable in the model. If endogenous independent variable exists, the ordinary least squares model will no longer be accurate. It is, therefore, often used to identify model misspecification by checking whether or not the differences in coefficients are systematic. Hausman test helps evaluate the model and check if it corresponds to the data. The null hypothesis is that the there is no systematic difference in the coefficients, and a random effect model is preferred over fixed effect. On the other hand, the alternate hypothesis states that there is endogenous variable, and a fixed effect is more appropriate. Appendix 1 details the full result of the Hausman test. The chi-squared value is 0.69, and the p-value is 0.9835. At a 5% significant level, the null hypothesis cannot be rejected, i.e., we believe that a random effect model is more appropriate than a fixed effect model.

Since a random effect model is preferred over a fixed effect model, the second step is to determine if a random effect is more appropriate than a simple pooled model by running a Breusch-Pagan Lagrangian multiplier test (Breusch and Pagan, 1979). The test examines whether the variance of residual errors is independent of independent variables, and therefore, it tests conditional heteroscedasticity. The null hypothesis is that the variance of error is not statistically different from 0. Consequently, if the null hypothesis is rejected, a random effect model is more appropriate. On the other hand, if we cannot reject the null hypothesis, a pooled model is more appropriate. The result of the test is reproduced in Appendix 2. Here we only summarize the key insight of the findings. The chi-squared value is 0.00 and the p-value for the test is 1.0000. Therefore, we cannot reject the null hypothesis at 5% significant level, which means a pooled model is preferred than a random model in this situation.

After selecting the appropriate model, we also need to check on the stationarity assumption before running the regression. Figure 3 and 4 gives some preliminary insights. It is likely that there is no presence of non-stationarity. However, this should be confirmed with the Im Pesaran Shin test for unit roots (Im et al., 2003). Each Im Pesaran Shin test should be run for each variable. There is one dependent variable and five independent variables in this analysis, and thus, we should run six Im Pesaran Shin tests. The results of the tests are produced in Appendix 3. Examining the statistics and p-value finds no non-stationary variables because all p-values are lower than 0.05, which means that we reject the hypothesis that the panel contains unit roots, i.e., the panel is stationary. This finding confirms our observation from Figure 3 and 4. Because the panels are stationary, the process of generating a time series does not change, which means that the statistical properties do not change (Palachy, 2019). The other assumption of regression that may invalidate the results is heteroscedasticity. If heteroscedasticity is present, the t-stat and the p-value for a regular regression will not be an accurate reflection, and a robust regression should be run instead. We employ the Breusch-Pagan and Cook-Weisberg test for detecting the presence of heteroscedasticity. The null hypothesis is that the variance is homoscedastic, i.e., constant expected variance for each observation. The full result is shown on Appendix 4. The value of the Chi square is 0.38 and the p-value is 0.54, suggesting heteroscedasticity is not an issue in this case since we do not reject the null hypothesis.

It is, therefore, reasonable to apply pooled regression model to obtain the results. As discussed in the Data Collection section, there are three sub-periods for analysis. Therefore, regressions will be run on the whole period from January 2003 to December 2017, the pre-crisis period from January 2003 to December 2007, the crisis period from January 2008 to December 2012, and the post-crisis period from January 2013 to December 2017. The separation of time periods allows for comparison across time to evaluate if different period may produce different results. For example, do the significance for the five factors vary in time of crisis. In addition, this separation also acts as a robustness check. Within each time period, the traditional Fama-French Five Factor model is compared with the dual beta Five Factor model. This allows for model comparison to examine if the introduction of a second market beta helps explain the return variation. The adjusted r-squared and the significance of second beta will be examined. In the traditional Five Factor model regression, we regress for the whole sample within each time period. On the contrary, in the dual beta regression, we separate the samples according to market premium (Chong et al., 2011). If the realized market premium is positive, the sample will be categorized to the section where the market dummy is 1 (D =1 in Equation 5). On the other hand, if the realized market premium is negative, the sample will be categorized to the section where the market dummy is 0.

To sum up, this section confirms the appropriateness to use a pooled model for regression by applying a Hausman test and a Breusch Pagan LM test. The assumptions of stationarity and heteroscedasticity in the regression are also checked. The results in the next section are produced by regressing the sample countries' index returns with the five factors: market, SMB, HML, RMW, CMA. A conventional Five Factor model and the dual beta model are performed within each 5-year time frame of the 15-year time span.

4. Result Discussion

This section will summarize the results of the methodology applied in Section 3. We will discuss the key findings and their implications, along with the limitation of this study. This section is divided into four sections: Regression Table, Post-regression Diagnosis, Result Summary, and Limitations.

4.1. Regression Tables

The units of the data used to derive the regression tables are expressed in %. Consequently, the interpretation of the data should also be in percentage. For example, a coefficient of 0.5 means that if the independent variable increases by 1 percentage point (1%), the dependent variable is expected to increase by 0.5% rather than 50%.

4.1.1. Whole Observation Period

The section focuses on the total observation period from 2003 to 2017 as a whole. The regression result is illustrated in Table 5 and Table 6. The standalone Five Factor has a F-test of 172.34 with a p-value less than 0.05, which suggests that at least one model parameter is significant. This is further confirmed by individual t-test that will be discussed later. Furthermore, the value of the R square is 0.3294 and the adjusted R square is 0.3275, meaning that the regression model is able to explain around 33% of the variations in the dependent variable, realized market portfolio return. The p-values for each of the factor is statistically significant at 95% confidence level, suggesting that all factors are statistically different from 0. The coefficients for market factor, SMB, HML, RMW, CMA are 0.49, 0.61, 0.82, 0.42 and -0.72, respectively. It is noted that only the CMA factor has a negative sign while the other four have a positive sign. One percentage unit increase of the CMA factor leads to 0.72% decrease in the return for the selected

CEE market portfolio. On the other hand, one percentage increase of the market, SMB, HML, RMW factor increases the portfolio return by 0.49%, 0.61%, 0.82%, 0.42%, respectively. Although the constant term is positive at 0.17, it is not statistically significant.

Table 5: Whole-period Five Factor Regression

Source	Sum of Squares	Degree of Freedom	Mean Squared Errors	
				Number of observation = 1,760
				F-statistic (5, 1754) = 172.34
Model	25378.0088	5	5075.60175	Probability > F-stat = 0.0000
Residual	51657.3033	1,754	29.4511422	R square = 0.3294
				Adjusted R square = 0.3275
Total	77035.3121	1,759	43.7949472	Root Mean Squared Error = 5.4269

Return	Coefficient	Standard Error	t-stat	P>|t-stat|	Lower 95%	Upper 95%
Market	.49269	.03275	15.04	0.000	.42846	.55693
SMB	.60648	.07495	8.09	0.000	.45948	.75348
HML	.82157	.10842	7.58	0.000	.60893	1.0342
RMW	.42195	.14484	2.91	0.004	.13788	.70603
CMA	-.71619	.12025	-5.96	0.000	-.95204	-.48035
constant	.16766	.14845	1.13	0.259	-.12351	.45882

Table 6: Whole-period Dual-beta Five Factor Regression

Source	Sum of Squares	Degree of Freedom	Mean Squared Errors	
				Number of observation = 1,760
				F-statistic (5, 1754) = 155.14
Model	26718.5081	6	4453.08469	Probability > F-stat = 0.0000
Residual	50316.804	1,753	28.7032538	R square = 0.3458
				Adjusted R square = 0.3446
Total	77035.3121	1,759	43.7949472	Root Mean Squared Error = 5.3575

Return	Coefficient	Standard Error	t-stat	P>|t-stat|	Lower 95%	Upper 95%
Market						

0	.75838	.05057	15.00	0.000	.65921	.85756
1	.24125	.04898	4.93	0.000	.14518	.33732
SMB	.55104	.07444	7.40	0.000	.40505	.69703
HML	.79599	.1071	7.43	0.000	.58594	1.0061
RMW	.42748	.14299	2.99	0.003	.14704	.70793
CMA	-.57592	.12047	-4.78	0.000	-.81221	-.33964
constant	1.2028	.21077	5.71	0.000	.78945	1.6162

The dual beta Five Factor regression shows a similar pattern but with a higher predictive power. After considering increased number of variables due to the market dummy, the adjusted R square still increase from 0.3275 to 0.3446, which suggests that the dual beta model is better at capturing the deviation of returns. All the five factors remain significant with a p-value of less than 0.05. The signs of the factor do not change. The coefficient for each factor changes slightly. For example, the value of RMW coefficient increases by 0.005, and the value of HML coefficient decreases by 0.03. In terms of market beta, a distinct pattern is observed in different market conditions. Market beta is notably higher in bear market where the market premium is negative, while the beta is lower in bull market where the market premium is positive. In bearish market, the market beta increase from 0.49 to 0.76, while the market beta decrease to 0.24 in bullish market. This observation is not a single and independent phenomenon. Teh and Lau (2017) documented this observation by studying the Malaysian stock market from 2001 to 2015. They found that most stocks experience a higher beta in the downtrend market. One possible explanation is that investors required a risk premium for holding assets in the bear market, while they pay to remain in the market when the market condition is good, reflecting a negative premium. The risk perception thereby plays an important role in determining asset pricing. We will look into the different behavior of betas in different market conditions in more details in separate division period.

Another observation is that the constant also becomes significant, which is different from the conventional Five Factor model. The constant term represents the interception of the regression model, also the sum of Jensen's alpha and risk-free rate. If all five factors have the value of 0, then the return of the market portfolio should be 1.2% according to the table.

4.1.2. Pre-crisis Period

The pre-crisis period is between 2003 and 2007 in our definition. It is before the 2008 Financial Crisis and the following European Sovereign Debt. The risk attitudes were considerably different than that in the crisis. The tendency to risk-loving, excess borrowing and lending, and lack of regulations together shaped a different landscape. More retail investors and more judgement rather than science used in investment have made valuation model less stable. Table 7 shows the results of regressing only the pre-crisis samples.

Table 7: Pre-crisis Period Five Factor Regression

Source	Sum of Squares	Degree of Freedom	Mean Squared Errors
Model	3422.54265	5	684.50853
Residual	17530.7252	554	31.643908
Total	20953.2679	559	37.483485

Number of observation	560
F-statistic (5, 1754)	21.63
Probability > F-stat	0.0000
R square	0.1633
Adjusted R square	0.1558
Root Mean Squared Error	5.6253

Return	Coefficient	Standard Error	t-stat	P>|t-stat|	Lower 95%	Upper 95%
Market	.47631	.08015	5.94	0.000	.31887	.63376
SMB	.37629	.15444	2.44	0.015	.07302	.67957
HML	1.8371	.33116	5.55	0.000	1.1866	2.4876
RMW	.97017	.30833	3.15	0.002	.36453	1.5758
CMA	-.58024	.26073	-2.23	0.026	-1.0923	-.06809
constant	.57634	.34766	1.66	0.098	-.10654	1.2592

Although the overall model is significant signified by F-test, the R square drops to only about 16% compared to 33% in the whole period. The five factors remain significant at 5% level. Similarly, the constant term is insignificant for the conventional model. The coefficients for market factor, SMB, HML, RMW, CMA are 0.48, 0.38, 1.84, 0.97, and -0.58, respectively. Same with the total period, only the CMA factor has a negative sign while the other four have a positive sign.

On the other hand, Table 8 shows the result for applying dual betas in the modelling. The R square increases slightly from 16% to 17%, and the adjusted R square increases by less than 1%. The signs of the factor have not changed when applying two betas. The coefficient for size factor, value factor, profitability and investment factor change by a small portion. For example, the value of SMB coefficient decreases by 0.04, and the value of HML coefficient decreases by 0.13. Similar pattern for market beta can be observed. The market beta is higher in down market (0.94) and lower in up market (0.28), and both are significant. It can also be observed that the constant term becomes 1.5 and is now significant in the dual beta Five Factor model.

Table 8: Pre-crisis Period Dual Beta Five Factor Regression

Source	Sum of Squares	Degree of Freedom	Mean Squared Errors	
				Number of observation = 560
				F-statistic (5, 1754) = 18.87
Model	3561.21484	6	593.53581	Probability > F-stat = 0.0000
Residual	17392.0531	553	31.450367	R square = 0.1700
				Adjusted R square = 0.1610
Total	20953.2679	559	37.483485	Root Mean Squared Error = 5.6081

Return	Coefficient	Standard Error	t-stat	P>|t-stat|	Lower 95%	Upper 95%
Market						
0	.94002	.23484	4.00	0.000	.47872	1.4013
1	.28494	.12121	2.35	0.019	.04685	.52302
SMB	.33229	.15534	2.14	0.033	.02716	.63743
HML	1.7012	.33642	5.06	0.000	1.0404	2.3621
RMW	.79927	.31798	2.51	0.012	.17467	1.4239
CMA	-.58447	.25994	-2.25	0.025	-1.0950	-.07388
constant	1.4567	.54399	2.68	0.008	.38822	2.5253

4.1.3. Crisis Period

Table 9 and 10 reproduce the results of the regression for the samples from January 2008 to December 2012 when the Global Financial Crisis and the European Sovereign Debt Crisis were at their peaks.

Table 9: Crisis Period Five Factor Regression

Source	Sum of Squares	Degree of Freedom	Mean Squared Errors	
				Number of observation = 600
				F-statistic (5, 1754) = 106.80
Model	20465.9405	5	4093.18811	Probability > F-stat = 0.0000
Residual	22766.5012	594	38.3274432	R square = 0.4734
				Adjusted R square = 0.4690
Total	43232.4418	599	72.1743603	Root Mean Squared Error = 6.1909

Return	Coefficient	Standard Error	t-stat	P>|t-stat|	Lower 95%	Upper 95%
Market	.53004	.05153	10.29	0.000	.42883	.63125
SMB	.77837	.13308	5.85	0.000	.51700	1.0397
HML	.77663	.17993	4.32	0.000	.42325	1.1300
RMW	.36471	.26208	1.39	0.165	-.15000	.87943
CMA	-.83003	.18936	-4.38	0.000	-1.2019	-.45812
constant	-.6748	.28781	-2.34	0.019	-1.2400	-.10956

Table 10: Crisis Period Dual Beta Five Factor Regression

Source	Sum of Squares	Degree of Freedom	Mean Squared Errors	
				Number of observation = 600
				F-statistic (5, 1754) = 92.30
Model	20876.9665	6	3479.49441	Probability > F-stat = 0.0000
Residual	22355.4753	593	37.6989466	R square = 0.4829
				Adjusted R square = 0.4777
Total	43232.4418	599	72.1743603	Root Mean Squared Error = 6.1399

Return	Coefficient	Standard Error	t-stat	P>|t-stat|	Lower 95%	Upper 95%
Market						
0	.69713	.07192	9.69	0.000	.55588	.83838
1	.30491	.08521	3.58	0.000	.13755	.47226
SMB	.73733	.13257	5.56	0.000	.47696	.99769
HML	.85469	.18001	4.75	0.000	.50116	1.2082
RMW	.43413	.26077	1.66	0.096	-.07802	.94627
CMA	-.75497	.18918	-3.99	0.000	-1.1265	-.3834
constant	.47315	.44982	1.05	0.293	-.41029	1.3566

The R squares from both regressions are notably higher than the pre-crisis period, increasing from around 16% to 48%, which is about three times the pre-crisis values. Again, the adjusted R square for dual beta has improved compared to the Five Factor regression, although only with small value. The values mean that the linear regression was able to explain close to 50% of the return variation from 2008 to 2013, which is considered a very high number. During the crisis period, the RMW profitability factor becomes insignificant, while the other four factors remain significant. In addition, the CMA investment factor continues to be negative. One percentage increase of the market, SMB, HML and CMA factor increases the portfolio return by 0.53%, 0.78%, 0.78%, and -0.83%, respectively.

Without applying dual betas, the constant is negative at -0.67 during crisis. This implies portfolios have been performing under expectations, or the risk-free rate is very low or negative. Furthermore, the beta in the bearish market is 0.70 compared to that of 0.30 in the bullish market. The signs of all factor have not changed in the dual beta model. The coefficient for size factor, value factor, profitability and investment factor change by only a small portion. For example, the value of SMB coefficient decreases by 0.04, and the value of HML coefficient increases by 0.07.

4.1.4. Post-crisis Period

Table 11 and 12 show the results from post-crisis period from January 2013 to December 2017 by applying the same methods in the previous sections. This period marks the graduate recovering process from the crises. R squares have again fallen to the pre-crisis level, and this is the only case where the adjusted R square is smaller in the dual-beta model. Furthermore, size, value, profitability and investment are no longer significant, which leaves market factor the only significant factor in both cases. The market beta can be observed to be higher in bearish market with a value of 0.32 where the market premium is negative, while the market beta is lower in bullish market with a value of 0.30.

Table 11: Post-Crisis Period Five Factor Regression

Source	Sum of Squares	Degree of Freedom	Mean Squared Errors
Model	884.496935	5	176.89939
Residual	8446.20254	594	14.219196
Total	9330.69947	599	15.577127

Number of observation	600
F-statistic (5, 1754)	12.44
Probability > F-stat	0.0000
R square	0.0948
Adjusted R square	0.0872
Root Mean Squared Error	3.7708

Return	Coefficient	Standard Error	t-stat	P>|t-stat|	Lower 95%	Upper 95%
Market	.30705	.05298	5.80	0.000	.20300	.4111
SMB	.10396	.11268	0.92	0.357	-.11734	.32525
HML	.00308	.17253	0.02	0.986	-.33576	.34193
RMW	-.18939	.20625	-0.92	0.359	-.59447	.21568
CMA	.03549	.19956	0.18	0.859	-.35644	.42743
constant	.59271	.18514	3.20	0.001	.22910	.95632

Table 12: Post Crisis Period Dual Beta Five Factor Regression

Source	Sum of Squares	Degree of Freedom	Mean Squared Errors
Model	884.720926	6	147.45349
Residual	8445.97854	593	14.242797
Total	9330.69947	599	15.5771277

Number of observation	600
F-statistic (5, 1754)	10.35
Probability > F-stat	0.0000
R square	0.0948
Adjusted R square	0.0857
Root Mean Squared Error	3.774

Return	Coefficient	Standard Error	t-stat	P>|t-stat|	Lower 95%	Upper 95%
Market						
0	.32007	.11661	2.74	0.006	.09106	.54909
1	.29943	.08066	3.71	0.000	.14101	.45785
SMB	.10589	.11381	0.93	0.353	-.11764	.32941
HML	.00472	.17317	0.03	0.978	-.33537	.34481
RMW	-.18457	.20997	-0.88	0.380	-.59695	.22781
CMA	.04278	.20801	0.21	0.837	-.36575	.45131
constant	.61817	.27488	2.25	0.025	.07831	1.1580

4.2. Post-regression Diagnosis

We conduct post-regression diagnosis, including normality check and robustness check, to ensure that our results are valid and robust.

A normality check is applied to examine whether the residual errors from the regression are normally distributed. If not, the assumption of regression model is not complied, and the regression result will not be stable. The residuals after regressing the pooled model are plotted against the probability density of each error happening. Appendix 5 represents the histogram of the results. This visual representation indicates that the error terms are roughly normal distributed, which is also confirmed by the White's Test (White, 1980). The details of White's Test are shown on Appendix 6. The p-values for heteroscedasticity, skewness, and kurtosis are 0.6916, 0.3959, and 0.2568, respectively. They are all greater than 0.05, which means that we do not reject the hypothesis that the residuals are normally distributed. We, therefore, do not believe the error term is associated with the independent variables, and the normality check is passed.

We also employ an additional variable to confirm the current regression we use is appropriate. The additional variable that we use is the square of market factor. There are two benefits of using the square of market factor. Firstly, it checks if the inclusion of the additional variable affects the other variables which were previously included in the model. We want the previous variables (market factor, SMB, HML, RMW, CMA) to be consistent and robust, which should not be influenced by the introduction of the square of market factor. On the other hand, if the results have significantly changed due to the additional variable, it may suggest the presence of endogenous variables. If that is the case, we may need to replace the endogenous variable with an instrumental variable. Secondly, by checking the significance of the square of market factor, we hope to confirm that portfolio's return is not correlated with the square of market factor, i.e., the relationship between portfolio's return and the market factor is linear. For simplicity, this study does not check every model within different sub-periods. Instead, the last model (post-crisis dual-beta model) is checked, which is Table 12. The result of introducing the square of market factor is produced in Appendix 7. Comparing Table 12 and Appendix 7 give two important observations. Firstly, the R-squared and adjusted R-squared hardly change. This suggests that this additional variable does not help explain the variation in returns and our previous model is stable, confirming the robustness of our regression model. Secondly, the square of market factor is insignificant, indicating that the relationship between return and market factor is likely to be liner, and there is no need to include the square of market factor.

4.3. Result Summary

Some similarity and differences have been observed across different time periods by applying the pooled model, which are summarized in Table 13.

Table 13: Regression Result Summary

	Whole		Pre-Crisis		During-Crisis		Post-Crisis	
	Five Factor	Dual Beta	Five Factor	Dual Beta	Five Factor	Dual Beta	Five Factor	Dual Beta
Adjusted R-square	32.75%	34.46%	15.58%	16.10%	46.90%	47.77%	8.72%	8.57%
Market	✓	✓	✓	✓	✓	✓	✓	✓
SMB	✓	✓	✓	✓	✓	✓		
HML	✓	✓	✓	✓	✓	✓		
RMW	✓	✓	✓	✓				
CMA	✓	✓	✓	✓	✓	✓		

Note. The ticks represent whether or not the factor is statistically significant for the selected time period and selected model.

By comparing the dual beta with the Five Factor model, the R square has generally increased, except for the case for the post-crisis period. However, the increment in model fit has been relatively small, all within 2%. This means dual beta has been able to increase the model fit only with a small margin, which confirms our hypothesis about the impact of dual-beta model. The cross-period comparison has identified that the regression model fit is the greatest in the crisis period, with a R square of about 47%. On the other hand, the post-crisis period has the weakest explanatory power out of all sample periods, with a R square of about 9%. This result rejects our hypothesis that the same model should behave similarly across time. One explanation of the increased R square may be due to systematic return variation across the CEE region in the crisis period, i.e., they all experienced similar degree of market downturn. In terms of answering if the Fama/French factors are important, it is inconclusive from the table. The significance of the factors may vary depending on the period in which the model is run. For example, the HML value factor has been significant in the pre-crisis and during-crisis period, but insignificant in the post-crisis period. However, the market beta is always significant no matter which period and whether it is a dual beta or not. Removing the insignificant factors in the post-crisis period will result in a single factor model, i.e., the CAPM. Another observation that has not been displayed on Table 13 is the value of beta in different market conditions. From the data points within each three-year sub-period, the beta in the down market was notably higher than that in the up market. The observation is not likely to be a coincidence given the size and consistency of the value change.

To conclude, the dual beta model has been useful in explaining the variation in returns, with a small margin. Given the complexity to separate samples based on excess market return and to introduce one more variable, the benefit of using dual betas is hardly justified. It is, therefore, not recommended to apply dual-beta model based on the samples in the CEE region. Hence, this study advocates the continued use of single beta model. The study also found that the same model can behave considerably differently in different periods, particularly when in crisis. This may be caused by systematic variation across the CEE region. However, this study alone will not be able to tell if a five-factor model is better than the three-factor model or single factor model. More focused study on the CEE region to investigate the behavior of different models, which is beyond the scope of this paper, is thereby needed.

4.4. Limitations

The analysis, however, is not without limitations. In this section we will analyze the limitations of the study from the data quality and methodology perspectives.

The quality of this study is significantly associated with the quality of sample data. In our study, a country's market index return is treated as a single portfolio and as the dependent variable. We have not characteristic-sorted the portfolios, which may affect our judgement on the significance of five factors. Additionally, the five factors were obtained from the European Five Factors in Kenneth R. French Data Library. There is no data directly related to the CEE region. European Five Factors are the closest possible dataset from Kenneth R. French Data Library. The relevance of the data points may thereby be compromised.

From the methodology perspective, we used R square to measure the goodness of fit, i.e., how well the model predicts the realized returns. However, goodness of fit is more than just R square. If we use R square alone to determine which model is better, the results can be biased. Maydeu-Olivares and Garcia-Forero (2010) argue that relative model fit to compare discrepancy between models should be used along with absolute model fit to examine the discrepancy between the expected and the actual data. To evaluate whether or not the introduction of a second beta is useful, other tests such as Kolmogorov-Smirnov test (Massey, 1951) can be employed. Additionally, the study is limited to the Fama-French Five Factor model, and the effects of using five factors are far from conclusive. Although a great number of research has indicated the significance of using profitability and investment factors, doubts on using all five factors still exist (Asness, 2014), and more research on this topic is needed to have a deeper understanding on asset pricing.

5. Conclusion

Aiming to provide insights on alternative asset pricing model, the paper investigates different perspectives on applying dual-beta five-factor model. The analysis reviews the theoretical background of the Efficient Market Hypothesis that plays an essential role in determining asset pricing. Then the evolution from the single factor asset pricing model CAPM to the Dual Beta Five Factor model is discussed. The pros and cons of each model is also briefly discussed. The methodology section explains the sources of data, as well as an assessment of data quality. In addition, the methodology section explains the appropriate model for our panel data by applying the Hausman Test and the Breusch-Pagan LM Test. Both tests combined together suggest that a pooled model is the preferred option for the regression. We also checked the assumptions of Ordinary Least Square to ensure that our results are appropriate, including that regression model should be linear in the coefficients and that error term should be uncorrelated with each other.

The results for each 5-year period (2003 – 2007, 2008 – 2012, 2013 – 2017) and the total sample period (2003 – 2017) are assessed. R square have changed significantly for different time period tested, and it is observed that during period of crisis the R square has been the highest. This may suggest that asset pricing model works best in period of distress. Regardless of the period or model chosen, the market factor has always been significant at 95% confidence level, which suggests that market factor is a significant determinant of asset's return. This is consistent with academic research that market factor is frequently treated as the single most important determining factor of asset pricing. On the other hand, other factors, including the size, value, profitability and investment factors, are not always consistent across different periods. SMB, HML, CMA were significant in pre-crisis and during-crisis period, while RMW had only been significant in pre-crisis time. Additionally, dual beta model shows a small-scale increase in model prediction, with a higher beta in down market and a lower beta in up market. Considering the trade-off between simplicity and model prediction, it is recommended to continue using the single beta model.

One of the post-regression diagnoses is the robustness check. We introduced the square of market factor to examine a): if the relationship between asset's return and market factor is linear and b): if the regression model is robust by introducing more variables. The results confirm that our regression model passes the robustness check, and there is no non-linear relationship between asset's return and market factor. However, the analysis also has limitations inherited from the data and the methodology applied. We adopted the European Five Factor from the Kenneth French Data Library to approximate the actual five factors in the CEE region. The data from which we derive the five factors may therefore differ from the actual factors in our selected countries. Furthermore, other measures of goodness of fit can be applied to improve the model comparison to determine if a second beta is useful in determining portfolio's returns.

The paper is one of the few papers that combines the dual betas and five factors together in an attempt to better understand how returns move based on other quantifiable factors. We conclude that the dual beta model is useful in explaining stock market variation, but with limited value. The study is relevant for investors in the CEE region as it has potential implications on portfolio management. It is recommended that market participants take the different behavior of beta in different market conditions into account. In period of general market downturn, an asset should move relatively more in line with the market, represented by the higher beta value and higher R square in bearish market. Overall, this topic is an important research area under the field of asset pricing. Further research can focus on justifying the use of Fama-French Five Factor Model, and if other factors such as momentum are effective in explaining the price mechanism in the stock market.

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List of appendices

Appendices

Appendix 1: Hausman Test for fixed effect and random effect

Factor	b Fixed Effect	B Random Effect	b-B Difference between fixed and random	Standard Errors
Market	0.0049258	0.0049269	-1.13e-06	0.0000145
SMB	0.0060448	0.0060648	-0.00002	0.0000365
HML	0.0081974	0.0082157	-0.0000182	0.00005
RMW	0.0042245	0.0042195	4.95e-0.6	0.0000642
CMA	-0.0071535	-0.007162	8.46e-06	0.0000536

Note: b is derived from the xtreg regression and is consistent across the null and alternate hypotheses. B is derived from the xtreg regression, efficient under null hypothesis and inconsistent under alternate hypothesis.

Ho: None systematic differences for the coefficients

Chi squared (5) = 0.69

Probability > Chi squared = 0.9835

Appendix 2: Breusch-Pagan Lagrangian-Multiplier Test for random effect and pooled model

	Variance	Standard Deviation
Return	0.0043795	0.0661778
e	0.0029509	0.054322
u	0	0

Null hypothesis: Variance of u is zero

Chi squared test (01) = 0.00

Probability > Chi squared = 1.0000

Appendix 3: Im Pesaran Shin Test for Stationarity

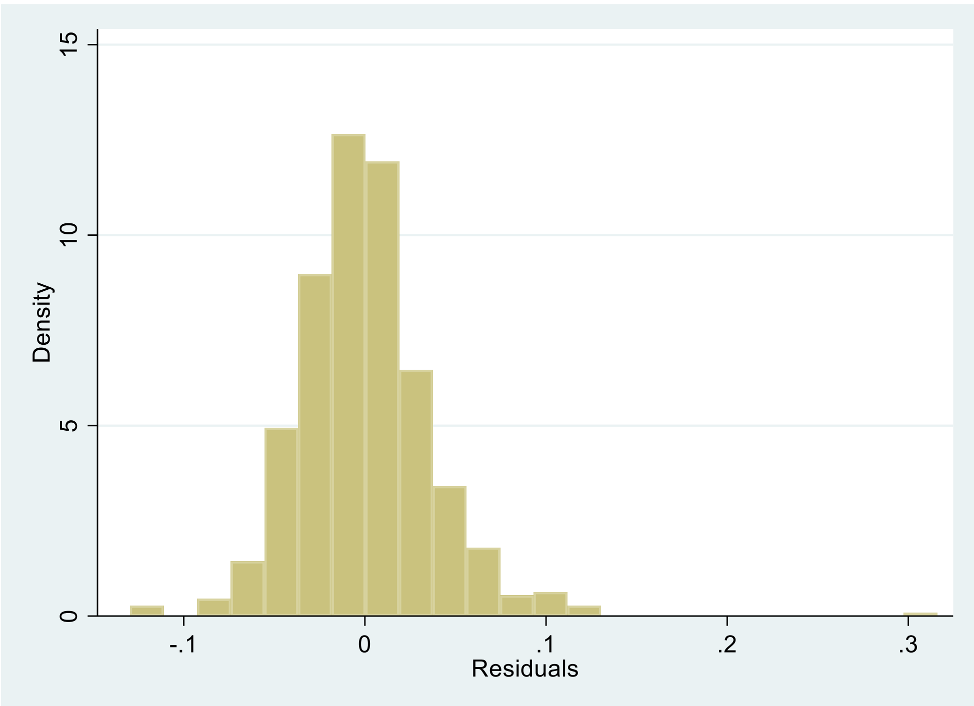
	w-t-bar statistics	p-value
Return	-34.5471	0.0000
Market Factor	-34.6469	0.0000
SMB	-30.3974	0.0000
HML	-35.4930	0.0000
RMW	-36.0382	0.0000
CMA	-32.3327	0.0000

Note: Panel means are included; time trend is not included. Augmented Dicky Fuller regressions have zero lag.

Appendix 4: Heteroscedasticity Test for Constant Variance

Null Hypothesis	The variance is constant
Alternate Hypothesis	The variance is not constant
Value of Chi squared	0.38
Probability > Chi squared	0.5400

Appendix 5: Residual Plot for Normality



Note: X-axis is the residuals after regressing the pooled model for the post-crisis period (2008-2017); Y-axis is the probability density of residuals

Appendix 6: White's Test

Source	chi_2	degree of freedom	p-value
Heteroscedasticity	16.40	20	0.6916
Skewness	5.17	5	0.3959
Kurtosis	1.29	1	0.2568
Total	22.85	26	0.6413

Appendix 7: Robustness Check for Additional Variable

Source	Sum of Squares	Degree of Freedom	Mean Squared Errors
Model	884.969353	7	126.42419
Residual	8445.73012	592	14.266444
Total	9330.69947	599	15.577128

Number of observation = 600
F-statistic (5, 1754) = 8.86
Probability > F-stat = 0.0000
R square = 0.0948
Adjusted R square = 0.0841
Root Mean Squared Error = 3.7771

Return	Coefficient	Standard Error	t-stat	P>|t-stat|	Lower 95%	Upper 95%
Market						
0	.34956	.25205	1.39	0.166	-.14548	.84459
1	.26397	.28054	0.94	0.347	-.28700	.81495
Mkt_sq	.00504	.03821	0.13	0.895	-.07000	.08009
SMB	.10503	.11409	0.92	0.358	-.11905	.32910
HML	.00504	.17333	0.03	0.977	-.33537	.34545
RMW	-.1892	.21306	-0.89	0.375	-.60765	.22924
CMA	.03805	.21125	0.18	0.857	-.37684	.45294
constant	.65133	.37258	1.75	0.081	-.08041	1.3831