ISSN: 2958-2326

African Journal of Commercial Studies

Publisher's Home Page: https://ijcsacademia.com/

Research Paper | Peer Reviewed | Open Access

Comparing the Explanatory Power of the Fama–French Five-Factor and Carhart Four-Factor Models in a Frontier Equity Market: Evidence from the Lusaka Securities Exchange (LuSE)

Danicious Kalenga[1]*, Benjamin Kaira[1], Jackson Sishumba[1], Lukundo Willy Siwilanji[2]

[1]*Graduate School of Business, University of Zambia*
[2]*School of Humanities and Social Science, University of Zambia*
* Corresponding Author

Article Info

Volume 7, Issue 3

***Publication history*:**
Accepted on 3 May 2026;
Published: 10 June 2026

***Key Words*:**
Frontier Markets; Asset Pricing; Lusaka Securities Exchange; Zambia; Fama-French Five-Factor Model; Carhart Four-Factor Model; CAPM; Momentum Effect; Profitability Factor

***Article Doi*:**
10.59413/ajocs/v7.i3.56

Abstract

Purpose: This study aims to test the explanatory power of the Carhart Four-Factor Model (C4FM) and the Fama-French Five-Factor Model (FF5FM) in the Lusaka Securities Exchange (LuSE), a frontier market that is characterized by low liquidity, thin trading, information asymmetry and market inefficiency where the CAPM has been found to perform poorly in explaining stock returns. The study uses standard Fama-French and Carhart portfolio formation procedures.
Methodology: This study employed a deductive quantitative research design and collected data on the return of the 20 LuSE listed firms (listed on the main board) on a monthly basis between January 2022 and December 2025 (48 months). Data are sourced from LuSE, company reports and Bank of Zambia. The explanatory power of the factors (market, size, value, profitability, investment and momentum) is tested using time series OLS regressions. The two factor models (FF5FM and C4FM) are compared based on regression intercepts, mean absolute price error, GR S tests and modified R-squared.
Results: The Fama French Five-Factor Model (FF5FM) exhibits better overall explanatory performance over the Carhart Four-Factor Model (C4FM) with a slightly higher average adjusted R-squared of 0.931, a minimum average absolute pricing error of 0.39% and a statistically non-significant intercept at the 5% level of significance for all types. The C4FM performed pretty well with a mean adjusted R-squared of 0.924 and a mean error of 0.44% which indicates that both frameworks have strong explanatory power in the setting of the LuSE frontier market.
Unique contribution: The unique contribution of this study is the investigation of asset pricing in frontier markets and being one of the few studies that directly compare the FF5FM and the C4FM, especially in the African market. Information and Policy Implications for Investors, Portfolio Managers and Development of Zambia's Capital Markets.

1. Introduction

The trade-off between risk and return, or the estimated return investors would receive in exchange for taking on greater risk, is the central preoccupation of most finance practitioners and theorists. The reasons why some securities regularly produce higher returns than others have been the subject of much research by financial economists. Sharpe (1964), Lintner (1965), and Mossin (1966) created the Capital Asset Pricing Model (CAPM) to solve this. According to the concept, a security's expected return can be explained only by its systematic market risk (beta). As a result, a security's expected return is equal to the risk-free rate plus its market beta times the market risk premium. Numerous other researchers found evidence that the CAPM was insufficient to explain the performance of many equities after these groundbreaking investigations (Fama & French, 2004).

Because of this, multifactor models have developed over time to enhance the CAPM's capacity for explanation. A significant advancement was the three-factor model by Fama and French (1993), which adds the size and value factors to the market factor. Subsequent studies, however, revealed the presence of a momentum factor—that is, stocks that did well in the past continue to do well in the next period (Jegadeesh & Titman, 1993). Carhart (1997) created the Carhart four-factor model (C4FM) by incorporating a momentum factor into the Fama and French framework. The Five-Factor Model, or FF5FM, was developed by Fama and French (2015) by including an investment factor and a profitability factor. They demonstrated that companies with robust profitability and cautious investment strategies have greater projected returns.

These multifactor models have been widely tested on stocks in developed markets, with a less clear picture of their performance on stocks listed in emerging and frontier markets. Mixed results obtained from testing multifactor models in Morocco, China, Vietnam, Nigeria and various other emerging markets reflect variations in liquidity, investor behavior, quality of institution, accounting standards and market efficiency, while momentum factors appear to support the C4FM in some of the countries tested but FF5FM in others (Foye, 2018; Cox & Britten, 2019; Dirkx & Peter, 2020). Frontier markets are particularly challenging for asset-pricing models as factors such as high transaction costs, low liquidity and thin trading can cause the pricing models (tested in mature markets) to be inadequate (Asness et al., 2019; Foye & Valentini, 2020).

The Lusaka Securities Exchange (LuSE) was established in 1994 and is one of Africa's frontier markets. Despite steady growth over the years, it still reflects thin trading, market concentration, low liquidity and low trading volumes. Research carried out in Zambia focused on testing CAPM and the FF5FM in isolation with conflicting results suggesting that FF5FM does better than CAPM in explaining stock returns. However, there are few direct comparisons between the FF5FM and the C4FM within Zambia.

Based on this background, this paper pits the FF5FM and the C4FM against each other within the context of the LuSE to investigate whether profitability-investment or momentum factors explain stock returns on a frontier market such as Zambia. By employing month-by-month LuSE-listed stock returns of twenty firms listed on the main board from January 2022 to December 2025 (48 months) and applying standard Fama-French and Carhart methodology to portfolio formation procedures, it tests the models by performing time-series regressions on cross-sectional size sorted portfolios. This study contributes to the literature on modern asset pricing research and specifically to testing a frontier African equity market. Additionally, it is one of the few studies in the African region that compares the FF5FM with C4FM.

Table 1. Theoretical Comparison of the Two Asset Pricing Models

Asset Pricing Model	Key Factors Captured	Primary Theoretical Focus	Relevance to LuSE (Frontier Market)
Carhart Four-Factor Model	Market, Size, Value, Momentum	Firm pricing anomalies stem from investor psychology, trend-following and short-term price continuation.	High Relevance: LuSE's frontier-market status makes it susceptible to herding, sentiment-driven trading and information asymmetry.
Fama–French Five-Factor Model	Market, Size, Value, Profitability, Investment	Firm fundamentals and intrinsic value drive returns; profitable firms yield higher returns.	Context-Dependent: Tests fundamental strength. LuSE's lower liquidity and thin trading can sometimes obscure the true pricing of these fundamental factors.

Source: Author compilation based on Carhart (1997) and Fama & French (2015).

2 Literature Review

The Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965) and Mossin (1966) provided the foundation for asset-pricing theory. The CAPM showed the relationship between risk and expected return. However, the empirical studies soon proved that the market beta was not enough to explain the stock returns for the firm-level differences and portfolio returns (Fama & French, 2004). The multi factor models were supposed to have better explanatory power than a single factor CAPM. Fama & French (1993) added size and value elements to the Three-element Model. Carhart (1997) added a momentum element. Fama & French (2015) extended their model to the Five-feature Model to better model firm fundamentals by adding an investment and profitability factor.

More recent studies from 2021 to 2025 suggest that no model is consistently outperforming the others across all markets. Claesson (2021) observed that models or facts have an explanation capacity that depends on the markets themselves and not necessarily explicable by the financial theory. Mosoeu (2022) found that there was a profitability factor driving stock returns in emerging markets, providing support for the Five-Factor Model in emerging economies. Hossain (2022) mentioned that empirical data from underdeveloped countries are less credible than those from industrialized economies, but found that the factors of profitability and investment are more relevant.

The literature has also been more heated after 2021 about the debate over which explanations of stock returns, momentum-based or profitability-investment-based, are more reliable. The Carhart Model performs better when prices are highly persistent but the Five-Factor Model still fails to explain momentum anomalies (Adegoke et al., 2024). Kamstra et al. (2024) argue that models should be evaluated by their pricing errors, intercept tests, and ranking procedures, rather than exclusively relying on the modified R-square value. The momentum effect in Malaysia and India is intensified by market inefficiencies, excessive volatility, and low information flow from stock price swings (Atodaria, 2025).

Research on African and frontier markets is rare but useful data have been produced. The momentum factor was not statistically significant which indicated that Morocco performed better under the Fama-French framework than the Carhart model (Tazi & Abrache, 2022). On the other hand, Five-Factor Model performed better than CAPM in explaining stock returns on Lusaka Securities Exchange with an adjusted R-squared value of 0.90 compared to 0.13 of CAPM (Musawa, Kapena & Shikaputo, 2018). These two results suggest that in some frontier markets the momentum might be driven by investment and profitability factors.

The literature includes three key discussions. Some factors are ineffectual in certain markets, and experts disagree that adding more factors boosts explanatory power (Hou, Xue & Zhang, 2020). It is an open topic to what extent the relative performance of momentum vs profitability-investment based explanations under the Carhart and Five-Factor models, respectively, persists. Asness et al. (2019) and Foye & Valentini (2020) argue that asset pricing models can be useful, but only in certain markets where liquidity, investor behaviour, market depth, institution quality and informational efficiency are relevant variables.

The literature shows a clear progression from CAPM to multi-factor models. However, recent study reveals that there are qualities that are better based on the market in question rather than a single superior model. This research intends to fill the gap of comparing the FF5 to the Carhart 4-Factor model of the Zambian frontier stock market. Previous research have mainly compared the FF5 model with CAPM, in terms of assessing whether stock returns on the LuSE are better explained by momentum or profitability and investment considerations.

3 Research Methodology

3.1 Research Design and Data Sources

The study employs a quantitative asset pricing approach to assess the ability of the Fama-French Five-Factor Model (FF5) and the Carhart Four-Factor Model (C4F) to explain stock returns on the Lusaka Securities Exchange (LuSE) for the period January 2022 to December 2025 (T=48 months). The research is based on empirical methodologies comparable to those used by Fama and French (1993, 2015) and the extension of Carhart (1997). The sample of corporations consists of the 20 listed companies on the main board of the LuSE and is drawn from the finance, consumer-goods, basic-materials, industrial, telecommunications, oil-and-gas, utilities and consumer-services sectors. The panel consists of month-end stock prices, the LuSE All-Share Index (LASI) and audited firm-level accounting data, and we use the Bank of Zambia 91-day Treasury-bill yield as a proxy for the risk-free rate. Firm-level metrics are market capitalization, book equity, operating profitability and investment levels based on the last annual financial statements disclosed prior to each portfolio creation date. The information in this dataset is important for analyzing corporate returns, studying market patterns, and the assessment of investment strategies over a long period of time.

Data Construction and Treatment of Missing Observations

For the 2024-2025 period, a few firm-level accounting observations and monthly stock price data points from publicly accessible sources were not available in a machine-readable format. Missing observations were carefully interpolated using publicly available benchmark values from the Lusaka Securities Exchange (LuSE), corporate annual reports and Bank of Zambia publications to ensure dataset continuity and sustain a balanced sample for factor estimation and portfolio construction.

Specifically, the interpolation was done using observable market and macroeconomic reference points that included LuSE All Share Index (LASI) year-end values of 6,194 (2021), 8,043 (2022), 10,855 (2023), 15,441 (2024) and 25,920 (2025) and reported Bank of Zambia 91-day Treasury Bill yields of 34.5 percent in May 2021 and 11.5 percent in October 2025. Where required, the interpolation procedure was further informed by sector classifications and firm-specific market capitalization data from the LuSE Listings Register.

The conservative interpolation process did not use whole data series, but just isolated missing observations. The goal was not to manufacture fake trends, but to maintain continuity of the economic and financial qualities underlying the data collected. The percentage of interpolated observations was also considered insufficient to materially alter the cross-sectional and time-series features of the sample. It was a tiny subset of the whole data.

Robustness and sensitivity analyses were performed to examine the potential impact of interpolated observations on the empirical results. The results were consistent throughout the varied specifications. It is comforting that the interpolation technique did not impact the study's conclusion on the relative performance of the Carhart Four-Factor Model and the Fama-French Five-Factor Model.

3.2 Portfolio Construction

The portfolio design methodology used in this study is based on the fundamental asset pricing principles proposed by Fama and French (1993, 2015) and Carhart (1997). To estimate the Fama-French Five-Factor and Carhart Four-Factor Models, we use standard methodologies to sort the companies into size and characteristic-based portfolios to generate the factor-mimicking portfolios. The methodology is also adapted to the context of the frontier market of Lusaka Securities Exchange by referring to the empirical applications of Aguenaou et al. (2011) and Nwani (2015) whose study used comparable portfolio creation strategies in relatively small and less developed equity markets.

The study constructs four sorts of portfolios: size and book-to-market, size and profitability, size and investment and size and momentum. The empirical studies confirm the explanatory capacity of the Fama-French Five-Factor Model and the Carhart Four-Factor Model by taking the expected returns on these portfolios as dependent variables.Factor imitating portfolios are constructed utilizing data from the Lusaka Securities Exchange (LuSE) and tested asset pricing models of Fama and French (1993, 2015) and Carhart (1997).

All the listed companies are first grouped into two size groups according to their median market valuation at the end of each year. Market capitalization is defined as the market value of the firm and is calculated as the market price of the stock times the number of stocks outstanding. Firms with a market capitalization value above the median are labeled Big (B) and firms with a market capitalization value below the median are labeled Small (S).Firms are classified independently on four important firm characteristics, utilizing the 30th and 70th percentile breakpoints. In the Book-to-Market (B/M) factor, firms are sorted into three groups: High (H), Neutral (N), and Low (L). These are value firms with high B/M ratios, firms with average B/M ratios, and growth firms with low B/M ratios, respectively.

The Profitability factor separates enterprises into Robust (R), Neutral (N) and Weak (W). Strong companies are tremendously profitable. The profits in medium-sized firms are moderate. Poor companies are less profitable. Investment factor: Firms are Conservative (C), Neutral (N), or Aggressive (A). Asset growth Conservative firms have low asset growth, neutral firms have medium asset growth, while aggressive firms have high asset growth. Companies are categorized as winners (W), neutrals (N) or losers (L) depending on their Momentum factor. Winner stocks have the highest past return and neutral stocks have average past return. Loser stocks have the lowest past returns.

The double-sorting procedure (Size × Factor sorting) combines independent size and factor sorts to create six portfolios for each factor category. More specifically, the categories Size-Book-to-Market, Size-Profitability, Size-Investment and Size-Momentum make up six portfolios. The portfolios are then utilized for the estimation of the Carhart Four-Factor Model and the Fama French Five-Factor Model which explain return differences in LuSE market based on size, value, profitability, investment and momentum.

The choice of this portfolio construction process is mainly owing to the small sample size and the number of listed businesses on the Lusaka Securities Exchange. We use two size groups and three factor-based classifications as a practical and statistically adequate way of generating suitably diversified portfolios while having sufficient observations to correctly estimate and compare competing asset pricing models.

3.3 Explanatory Variables

In this paper, six kinds of risks typically employed in empirical asset pricing research are developed to explain the variability of stock returns. Examples are the market risk premium (MKT_RF), size factor (SMB), value factor (HML), profitability factor (RMW), investment factor (CMA) and momentum factor (MOM). These factors collectively capture the important dimensions of market risk, firm size, valuation, profitability, investment behavior and price momentum and are compared in terms of their explanatory power on the Lusaka Securities Exchange (LuSE) using the Carhart Four-Factor Model and the Fama-French Five-Factor Model.

Fama-French five factors model

Market Risk Premium (MKT_RF)

The market risk premium (MKT_RF) is the excess return investors receive for holding a market portfolio instead of a risk-free asset. It is obtained by subtracting the risk-free rate (R_f) from the market portfolio return (R_m). The yield on the Bank of Zambia's 91-day Treasury Bill represents the risk-free rate and the monthly return on the Lusaka Securities Exchange All Share Index (LASI) is utilized as a proxy for market return in this study. Hence, the market risk premium is given by:

$$MKT_{RF} = R_m - R_f$$

where (R_m) is the monthly return on the LASI and (R_f) is the risk-free rate equivalent to the period of investment. The market risk premium is the primary systematic risk component and is the reward investors require for taking on the market-wide risk.

Size Factor (SMB)

The small minus big (SMB) factor is a measure of the size effect that captures the difference between the returns on stocks of firms with little and high market capitalization. The SMB factor is produced following the approach of Fama and French (1993, 2015) as the average difference in returns between portfolios of small and large stocks, sorted on book-to-market, profitability, investment and momentum. A negative SMB value means big companies do better, and a positive SMB value means small companies perform better than big companies over a time period. The SMB factor is important in multifactor asset pricing models as it reflects the return premium associated with company size in stock returns.

$$SMB = \frac{SMB_{\frac{B}{M}} + SMB_{OP} + SMB_{INV} + SMB_{MOM}}{4}$$

Where: $\boldsymbol{SMB_{\frac{B}{M}}} = SMB\ from\ the\ Size - Book - to - Market\ portfolio$

$\boldsymbol{SMB_{OP}} = SMB\ from\ the\ Size - Profitability\ portifolios$

$\boldsymbol{SMB_{INV}} = SMB\ from\ the\ Size - Investment\ Portifolio$

$\boldsymbol{SMB_{MOM}} = SMB\ from\ the\ Size - Momentum\ Portifolio$

Value Factor (HML)

The High Minus Low (HML) factor represents the value premium by taking the difference between returns of companies with high book-to-market ratios (value stocks) and returns of companies with low book-to-market ratios (growth stocks). The HML factor is calculated as the average return on the high book-to-market portfolios minus the average return on the low book-to-market portfolios, using the technique of Fama and French (1993, 2015):

$$\text{HML} = \frac{(SH + BH)}{2} - \frac{(SL + BL)}{2}$$

(SH), (BH) are returns on small and big firms with high book-to-market ratio accordingly and (SL), (BL) are returns on small and big companies with low book-to-market ratio correspondingly. When the HML value is positive, value stocks outperform growth companies and when the HML value is negative, growth stocks seem to provide larger returns. Hence, the HML factor captures the return premium associated with firms with relatively high book-to-market ratios.

Profitability Factor (RMW)

The robust minus weak (RMW) factor quantifies the profitability premium as the difference between the returns of enterprises with robust and weak operating profitability. The RMW factor is computed as the difference in average return between portfolios of high profitability firms and portfolios of low profitability firms following the approach of Fama and French (2015):

$$\text{RMW} = \frac{(SR + BR)}{2} - \frac{(SW + BW)}{2}$$

where (SR) and (BR) represent the returns on small and big businesses with strong profitability, while (SW) and (BW) represent the returns on small and large enterprises with weak profitability. A positive number of RMW indicates that high profitability firms outperform low profitability firms, whereas the opposite is true for a negative value of RMW. Therefore, in the Fama-French Five-component Model, the RMW component is important in explaining expected stock returns, as it captures the extent to which profitability is rewarded in the markets.

Investment Factor (CMA)

The Conservative Minus Aggressive (CMA) factor represents the investment premium, and is measured as the difference in returns between firms with conservative investment policies and firms with aggressive investment plans.

The CMA factor is the average return on portfolios of companies with conservative investment behavior minus the average return on portfolios of companies with aggressive investment activity. The calculation follows the suggestion of Fama and French (2015):

$$\text{CMA} = \frac{(SC + BC)}{2} - \frac{(SA + BA)}{2}$$

where (SC) and (BC) are returns on small and large businesses with cautious investment policies, while (SA) and (BA) are returns on small and large enterprises with aggressive investment plans. A negative CMA value indicates that firms with aggressive investment policies produce higher returns, whereas a positive CMA value indicates that firms with conservative investment policies have superior returns than firms with aggressive investment strategies. Thus, the CMA factor is the investment-related risk premium in the Fama–French Five-Factor Model and it measures the extent to which corporate investment behavior influences stock performance.

Carhart four factors model

Momentum factor (MOM).

The Carhart Four-Factor Model adds a momentum factor to the Fama–French Three-Factor Model to account for patterns in stock returns that are associated with continuing trends in price. In addition to the market risk premium (MKT_RF), size factor (SMB), and value factor (HML), the model also includes a momentum element, commonly known as Winner Minus Loser (WML) or Momentum (MOM).The momentum factor captures the tendency for firms that have recently outperformed to continue doing so, whereas those that have failed tend to continue underperforming over time. As in Carhart (1997), the momentum factor is calculated as the difference in the average returns of the winning and losing portfolios:

$$\text{MOM} = \frac{(SW + BW)}{2} - \frac{(SL + BL)}{2}$$

where (SL) and (BL) are the returns on small and large loser portfolios, and (SW) and (BW) are the returns on small and big winner portfolios correspondingly. A positive momentum factor indicates winner stocks outperform loser stocks during the time of interest, whereas a negative number indicates the opposite.

The addition of the momentum factor allows the Carhart Four-Factor Model to now account for return patterns related to investor behavior, market mood, and price continuation effects that might not be fully described by market, size, and value factors alone.

3.4 Dependent Variables

The dependent variables are the monthly excess returns of the 24 test portfolios formed by the intersection of size and firm-specific attributes using the portfolio generation methods in this study. In particular, each of the four unique sorting procedures generates six portfolios: Size–Book-to-Market (S/L, S/N, S/H, B/L, B/N, B/H), Size–Profitability (S/W, S/N, S/R, B/W, B/N, B/R), Size–Investment (S/A, S/N, S/C, B/A, B/N, B/C), and Size–Momentum (S/L, S/N, S/W, B/L, B/N, B/W).

Portfolio excess returns are measured as the difference between the monthly portfolio return and the risk-free rate proxied by the yield on the Bank of Zambia's 91-day Treasury Bill. The excess returns are the dependent variables in the time-series regression experiments used to test the explanatory power of the Carhart Four-Factor Model and the Fama-French Five-Factor Model on the Lusaka Securities Exchange (LuSE). Using numerous test portfolios allows for a thorough evaluation of how well the alternative asset pricing models account for the cross-sectional differences in stock returns related to size, value, profitability, investment, and momentum characteristics.

3.5 Statistical Model

Fama-French five factors model

As per Fama and French (1993), the linear regression model is as follows:

$$\boldsymbol{R_{it} - R_{ft} = \propto_i + \beta_i(R_m - R_f) + s_i SMB + h_i HML + r_i RMW + c_i CMA + \varepsilon_{it}}$$

Where:

RMW=profitability factor

CMA=investment factor

The remaining variances are defined above

Carhart Four-Factor Model

As per Carhart (1997), the linear regression model is as follows:

$$\boldsymbol{R_{it} - R_{ft} = \propto_i + \beta_i(R_m - R_f) + s_i SMB + h_i HML + m_i MON + \varepsilon_{it}}$$

Where: $R_{it} - R_{ft} = excess\ return\ on\ portfolio\ i$

$R_m - R_f = market\ risk\ premium$

$SMB = size\ factor$

$HML = value\ factor$

$MOM = momentum\ factor$

$\propto = abnormal\ return$

$\varepsilon = error\ term$

3.6 Factor Definition and Formulation

The six systematic risk factors used in this study are drawn from the Fama–French Five-Factor and Carhart Four-Factor asset pricing models. Market risk premium (MKT_RFF) is the excess return on the Lusaka All Share Index (LASI) over risk free rate as measured by the 91-day Treasury Bill yield. The size premium (SMB) is the disparity in average returns between small and big firms and is defined as the equally-weighted average of the small-minus-big return spreads across all forms of portfolios. The value factor (HML) is the return premium for value stocks, defined as the difference in returns between high and low book-to-market portfolios within both size classes. The profitability factor (RMW) is similarly generated based on operating profitability categories that evaluate the excess returns of enterprises with strong profitability relative to firms with weak profitability. The investment factor (CMA) measures the investment premium by capturing the difference in returns between firms that invest conservatively and firms that invest aggressively. Finally, the momentum factor (MOM) evaluates the persistence of trends in stock prices and is computed as the difference in returns between portfolios of previous winners and past losers. Together these criteria are meant to describe the main characteristics of systematic risk that affect stock returns on the Lusaka Securities Exchange (LuSE).

3.7 Data Analysis Techniques

We estimate the link between stock returns and the variables of the respective asset pricing models by use of ordinary least squares time-series regression. We compare three models on all the 24 test portfolios: the single factor CAPM, Carhart Four-Factor model and Fama-French Five-Factor Model. Explanatory ability is based on R-squared and significance, the value of and the respective t-statistic, the GRS statistical test for zero pricing errors, F-statistics and mean absolute pricing errors. The preferred model is selected on the basis of greater R-squared, lower pricing mistakes and a statistically negligible intercept.

3.8 Diagnostic Tests

Several post-estimation diagnostic tests were carried out to improve the empirical findings' robustness and believability. Potential multicollinearity between the independent variables was evaluated using the Variance Inflation Factor (VIF). The assumption of constant error variance was tested using the Breusch–Pagan and White heteroskedasticity tests. The residuals were tested for first-order serial correlation using the Durbin–Watson statistic and for normality using the Jarque–Bera test. For hypothesis testing and inference, the outcomes of these diagnostic tests offer crucial proof of the suitability of the model specification and the dependability of the predicted coefficients.

3.9 Ethical Considerations

This study uses secondary data that is publicly available, collected from sources such as the Lusaka Securities Exchange (LuSE), company annual reports and the Bank of Zambia; therefore, there are no human subjects, personal data or confidential information that require formal ethical clearance. However, the study follows accepted norms of research ethics, as it properly cites and acknowledges all sources of data, preserves the data obtained, and reports its conclusions in a transparent, objective, and unbiased manner.

Every effort was made to prevent data manipulation, selective reporting or misrepresentation of results thereby maintaining the standards of academic honesty, trustworthiness and scholarly rigor.

4 Results and Empirical Analysis

4.1 Descriptive Statistics of Factor Returns

Table 2 Panel A provides the descriptive statistics of the six built factors for the sample period of 48 months (Jan-2022 – Dec-2025). The average market risk premium (MKT_RFF F) is 2.77% every month or about 33.2% per year. This is the very good performance accumulated by LASI in the sample period, in which it jumped from roughly 8,043 in the beginning of the study period (end-2022) to 25,920 in the end of the period (end-2025). The average market value size premium (SMB) and book-to-market value premium (HML) are 0.73% and 0.65% every month, respectively. These numbers are in line with the standard Fama-French relation.

Crucially, all average returns for the profitability (RMW), investment (CMA) and momentum (MOM) categories are negative. These are -0.62%, -0.53% and -0.61% a month correspondingly. None of the factor mean returns is statistically different from zero at conventional significance levels, which reflects the limited statistical power available with twenty firms and forty-eight monthly observations. The negative realised RMW and CMA premia particularly mirror Foye (2018) and Mosoeu (2022) who find that profitability and investment considerations do not systematically price equities in less-developed markets. The negative MOM premium is in line with Tazi and Abrache (2022) in Morocco who discover an insignificant and sometimes negative momentum factor in a similar North African frontier market.

Table 2. Descriptive Statistics of Constructed Factor Returns (January 2022 – December 2025)

	MKT_RF	MOM	SMB	RMW	HML	CMA
Mean	0.02767570...	-0.0060649...	0.00732916...	-0.0061641...	0.00650033...	-0.0052600...
Median	0.0159685	-0.0065369...	0.011344	-0.0134415	0.008197	-0.00203
Maximum	0.465327	0.083568	0.084735	0.121516	0.100913	0.093525
Minimum	-0.285236	-0.112596	-0.0718300...	-0.094027	-0.127484	-0.12909
Std. Dev.	0.12942018...	0.04772264...	0.03950599...	0.05232254...	0.04620740...	0.04947144...
Skewness	1.32019112...	-0.2288351...	-0.0890732...	0.44314337...	-0.2724948...	-0.3067306...
Kurtosis	7.14620046...	2.30018546...	2.02015090...	2.75652491...	3.31873925...	2.78038530...
Jarque-Bera	48.3251933...	1.39840494...	1.98368083...	1.68956867...	0.79721691...	0.84913080...
Probability	3.20861485...	0.49698150...	0.37089346...	0.42965000...	0.67125347...	0.65405397...
Sum	1.328434	-0.291118	0.35179999...	-0.2958789...	0.312016	-0.2524830...
Sum Sq.	0.82399584...	0.10880581...	0.07593241...	0.13049335...	0.10237906...	0.11635701...
Sum Sq. Dev.	0.78723049...	0.10704019...	0.07335401...	0.12866951...	0.10035085...	0.11502893...
Observations	48	48	48	48	48	48

4.2 Multicollinearity Diagnostics

Table 3 presents the variance inflation factors for the Five- Factor and Carhart specifications. All VIF values are significantly below the commonly used criterion of 5 (and much below the stricter criteria of 10), with the highest VIF of 1.538 for MKT_RFF in the FF5 specification. Hence multicollinearity is not a serious problem and suggests that the built factors capture essentially independent variance even though they are constructed from overlapping portfolio sorts.

4.3 Stationarity of Factor Series

We examine these factor series for stationarity in order to justify the use of time-series regression techniques. We use the Augmented Dickey-Fuller (ADF) test for the unit-root null, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for the stationarity null. These two tests provide corroborating evidence and we conclude the series is I(0) (integrated of order zero) if the null hypothesis of the ADF unit root test is rejected and the null hypothesis of the KPSS stationarity test is not rejected.

Table 4.2 shows that all the six components are stationary at the 5 percent significance level. The p-values on the ADF test of the unit root null are between below 0.001 (MKT_RF, SMB, HML, RMW, CMA) and 0.033 (MOM), and the KPSS test statistics are all below their respective critical values. We consequently infer that the OLS regression of the time-series factors are free from spurious-regression bias.

Table 3. Unit-Root and Stationarity Tests on Factor Series

Factor	ADF statistic	ADF p-value	ADF 5% critical vaalue	ADF conclusion	KPSS statistic	KPSS p-value	KPSS conclusion Column1
MKT_RF	-9.0338	0	-2.9253	Reject I(1) > stationary	0.3832	0.0844	Cannot reject I(0) > stationary
SMB	-6.7427	0	-2.9253	Reject I(1) > stationary	0.1165	0.1	Cannot reject I(0) > stationary
HML	-4.4129	0.0003	-2.9435	Reject I(1) > stationary	0.0401	0.1	Cannot reject I(0) > stationary
RMW	-7.1633	0	-2.9253	Reject I(1) > stationary	0.167	0.1	Cannot reject I(0) > stationary
CMA	-7.634	0	-2.9253	Reject I(1) > stationary	0.1733	0.1	Cannot reject I(0) > stationary
MOM	-3.0251	0.0326	-2.9315	Reject I(1) > stationary	0.2188	0.1	Cannot reject I(0) > stationary

Note: ADF test conducted with constant, lag length chosen by AIC. KPSS test with constant only and automatic bandwidth selection. ADF null = unit root (non-stationary). KPSS null = stationarity (no unit root).

4.4 Factor Correlation Structure and Multicollinearity

Table 4 reports a Pearson correlation matrix with significant markers showing the link between the six factor returns. The market factor (MKT_RF) is favorably associated with the other five elements. The positive correlations vary from 0.25 (for RMW) to 0.41 (for CMA) indicating that the LuSE factor portfolios are subject to common underlying market risk. The correlation between the small-cap (SMB) and value (HML) factors is slightly negative (−0.14), consistent with Fama and French's (1993, 2015) finding that tilts toward value and small size are not entirely offsetting. The maximum absolute pairwise correlation is 0.41 for MKT_RF and CMA, which is significantly below the widely recognized threshold of 0.80.

Table 4: Correlation

Covariance Analysis: Ordinary
Date: 05/25/26 Time: 04:31
Sample: 2022M01 2025M12
Included observations: 48

Correlation t-Statistic	BM_BH	MKT_RF	SMB	CMA	MOM	RMW	HML
BM_BH	1						

MKT_RF	0.95786858...	1					
	22.61986686652549	-----					
SMB	0.11970155...	0.26438976...	1				
	0.817735007515 9055	1.85934163...	-----				
CMA	0.35074003...	0.40846726...	0.12850935...	1			
	2.540206728565799	3.03510281...	0.87888025...	-----			
MOM	0.22480700...	0.25869013...	0.28958147...	0.05868476...	1		
	1.564768183230193	1.81634972...	2.05195650...	0.39870657...	-----		
RMW	0.30181228...	0.24804295...	-0.0499876...	0.00426799...	0.33501519...	1	
	2.147116189542593	1.73657894...	-0.3394570...	0.02894721...	2.41153990...	-----	
HML	0.49116965...	0.35970184...	-0.1403909...	0.31286355...	0.04903137...	0.10390968...	1
	3.824374522102316	2.61462021...	-0.9617021...	2.23409999...	0.33294741...	0.70858551...	-----

Note: Significance markers: $p < 0.10$, $p < 0.05$, $p < 0.01$.

We then provide the variance inflation factors and condition number of the design matrix in Table 4.4 for both the Five-Factor and the Carhart model specifications. The highest VIF in either the Five-Factor or the Carhart model specification is 1.54 (MKT_RFin the Five-Factor model), which is considerably below the conventional warning threshold of 5. The condition number of about 31 in both models falls comfortably below the 'mild concern' range of 30 to 100. Consequently, multicollinearity is not a matter of concern for the forthcoming estimations.

Table 5. Variance Inflation Factors for FF5 and Carhart Regressors

Model	Regressor	VIF
FF5	MKT_RF	1.5380
FF5	SMB	1.1770
FF5	HML	1.2890
FF5	RMW	1.0950
FF5	CMA	1.2700
Carhart	MKT_RF	1.3400
Carhart	SMB	1.2200
Carhart	HML	1.2330
Carhart	MOM	1.1360

4.5 Time-Series Regression Results across All Test Portfolios

Table 6 reports the central comparative result: model performance averaged across all 24 test portfolios. In comparison to the Carhart Four-Factor Model (0.924), the Five-Factor Model has a marginally higher mean adjusted R-squared (0.931). The difference between the two models is rather small, suggesting that both models explain a significant percentage of return variation across LuSE portfolios, even though this shows a modest comparative advantage for the FF5 specification. Both significantly outperformed the single-factor CAPM, which nevertheless achieves a reasonable mean adjusted R-squared of 0.890. This outcome reflects the highly concentrated and market-co-moving nature of the LuSE, where the majority of index fluctuation is driven by a small number of large stocks.

The Five-Factor Model also produces the smallest mean absolute pricing error at 0.39 percent per month, compared with 0.44 percent for Carhart and 0.48 percent for CAPM. Notably, the Five-Factor Model produces zero portfolios with intercepts statistically significant at the 5 percent level, against one each for CAPM and Carhart. The mean Durbin The Five-Factor Model marginally edges out the Carhart ModelWatson statistic of approximately 2.1 across all three specifications suggests that first-order autocorrelation in the residuals is not problematic. The Breusch–Pagan test fails to reject homoskedasticity in roughly 83 to 88 percent of portfolios, indicating that residual variances are broadly well-behaved.

Table 6. Cross-Portfolio Summary of Model Performance (24 Test Portfolios, T = 48)

Model	No. Portfolios	Mean Adj. R²	Median Adj. R²	Min Adj. R²	Max Adj. R²	Mean |α|	# α sig. 5%	# α sig. 10%	Mean DW	Share BP > 0.05
CAPM	24	0.8899	0.9011	0.7733	0.9534	0.0048	1	2	2.0898	0.8333
FF5	24	0.9307	0.9358	0.8518	0.9630	0.0039	0	1	2.1543	0.8333
Carhart	24	0.9242	0.9300	0.8310	0.9634	0.0044	1	2	2.1236	0.8750

Note: |α| is the mean absolute value of the intercept across portfolios. BP = Breusch–Pagan test for heteroskedasticity. DW = Durbin–Watson statistic.

4.6 Time-Series Regression Estimates

We estimate the following time-series regression model:

Rp,t Rf,t = p + p,M MKT_{RF} + p,S SMB + p,V HML + p,P RMW + p,I CMA + p,t

for each of the 24 test portfolios along with the single-factor CAPM model and the Carhart specification. The quality of estimates for two exemplary test portfolios-the Big-Winner momentum portfolio (EXCMOMBH) and the Big-Loser momentum portfolio (EXCMOMBL)-can be evaluated from the EViews output below:

Table 7. Illustrative EViews Output - FF5 Estimates for Selected Portfolios

Statistic	EXC MOM BH	EXC MOM BH t-stat	EXC MOM BL	EXC MOM BL t-stat
Intercept (α)	-0.0037	-0.5500	0.0021	0.4200
MKT_RF (β_M)	1.0720	17.5700	0.9776	22.0400
SMB (β_S)	-0.4871	-2.7900	-0.5632	-4.4300
HML (β_V)	0.0791	0.5100	-0.1157	-1.0200
RMW (β_P)	0.2401	1.8900	-0.0751	-0.8100
CMA (β_I)	-0.0734	-0.5100	-0.2058	-1.9500
R²	0.9188	–	0.9372	–
Adjusted R²	0.9092	–	0.9297	–
F-statistic	95.0700	–	125.3000	–
Prob(F-stat)	0.0000	–	0.0000	–
Durbin-Watson	2.1005	–	2.6242	–
S.E. regression	0.0436	–	0.0317	–

Note: Output reproduced from EViews 14 estimation, sample 2022M01-2025M12, 48 observations. EXCMOMBH = excess return on Big-Winner portfolio; EXCMOMBL = excess return on Big-Loser portfolio.

The loadings on the market factor are significant for both types of portfolio (M = 1.07 and 0.98, both t-statistics > 17) suggesting that they are very sensitive to the broader LuSE market, as expected of portfolios based on market-wide performance rankings. For Big portfolios, SMB loadings are significantly negative (S = −0.49 and −0.56, both t-statistics < −2.7). This makes theoretical sense because the Big portfolios should have opposite size exposure to the SMB factor (small-minus-big). Interestingly, the Big-Winner portfolio has marginally significant positive loading on the profitability factor (_P = 0.24, t-statistic=1.89, p-value=0.066), suggesting that highly profitable firms may excel in terms of momentum in the LuSE. This result provides empirical support for the theoretical explanations of Fama & French (2015) and Asness et al. (2019) that momentum is affected by firms' profitability. The Adjusted R-squares of 0.91 and 0.93 show that the FF5 model can account for a considerable part of the return variations in these two portfolios. Importantly, the intercepts for both Big portfolios are not statistically different from zero (p-values = 0.587 and 0.676 respectively), suggesting that both Big-Winner and Big-Loser portfolios are properly priced by the FF5 model.

4.7 Joint Test of Pricing Errors (GRS)

Table 8 reports the Gibbons, Ross and Shanken (1989) joint test for the null hypothesis that all intercepts are zero for the 24 test portfolios. The GRS F-statistic is tiny for all three models and the p-value associated with it is far above the traditional significance levels. This means that the Five-Factor Model has the lowest mean absolute intercept (0.39 percent each month) and the highest p-value (0.996) and the most conclusive fail-to-reject result of the three models, which shows that none of the three models have jointly significant unexplained pricing flaws.

Table 8. Gibbons–Ross–Shanken Joint Test of Zero Pricing Errors

Model	N portfolios	T obs	K factors	GRS F-stat	p-value	Mean |α|	Mean |α| (% / month)
CAPM	24	48	1	0.5807	0.9033	0.0048	0.4799
FF5	24	48	5	0.3174	0.9956	0.0039	0.3890
Carhart	24	48	4	0.3827	0.9869	0.0044	0.4398

Note: H0 is that α_p = 0 for all p = 1,...,N. A large p-value supports the null of no systematic mispricing.

4.8 Decomposition of Pricing Errors by Portfolio Sort

Table 9 shows model performance by type of sort that forms the test portfolios the most diagnostic comparison between the two multi-factor frameworks. Three patterns are shown.

First, the two models are almost indistinguishable for the Size × Book-to-Market sort. The Five-Factor Model and Carhart Model provide almost the same adjusted R-squares (0.937 and 0.937) and price mistakes (0.32 percent and 0.38 percent). Such resemblance is predicted, given that both models share the size and value factors common to the Fama–French three-factor backbone.

Second, the Five-Factor Model strongly dominates the Size × Operating Profitability and Size × Investment types. For size-OP sorting, mean pricing mistakes decline to 0.18 percent per month for FF5 against 0.20 percent for Carhart, with adjusted R-squared of 0.945 versus 0.919. Again, on the size–INV sort, FF5 beats Carhart with a price inaccuracy of 0.47 percent vs 0.60 percent. The Carhart Model does not contain specific RMW and CMA parameters, and hence cannot explain the entire cross-sectional variation along these dimensions.

Third, and more importantly, the Carhart Model slightly outperforms the Five-Factor Model on the Size × Momentum sort with an adjusted R-squared of 0.929 compared to 0.911 for FF5, but mean absolute price mistakes are nearly comparable (0.59 percent for FF5 and 0.59 percent for Carhart). This is exactly the cross-section for which Carhart's momentum factor was created and the outcome is evidence that momentum has some incremental explanatory power for LuSE results sorted on prior performance.

Table 9. Pricing Errors and Adjusted R^2 by Portfolio Sort

Sort	Model	Mean |α|	Mean Adj. R^2
BM	CAPM	0.0032	0.8987
BM	FF5	0.0032	0.9368
BM	Carhart	0.0038	0.9377
OP	CAPM	0.0043	0.8899
OP	FF5	0.0018	0.9450
OP	Carhart	0.0020	0.9187
INV	CAPM	0.0049	0.8834
INV	FF5	0.0047	0.9305
INV	Carhart	0.0060	0.9115
MOM	CAPM	0.0068	0.8875
MOM	FF5	0.0058	0.9106
MOM	Carhart	0.0059	0.9288

Note: Sort BM = Size × Book-to-Market; OP = Size × Operating Profitability; INV = Size × Investment; MOM = Size × Momentum (six test portfolios per sort).

4.9 Discussion

Three fundamental findings emerge from the empirical evidence, Second, we find that market movements explain most of the firm-specific return variance in the frontier markets. Thus, multi-factor models are useful to improve the performance of the CAPM but do not fully explain the efficiency of the LuSE. The Five-Factor Model increases the mean adjusted R-squared by around four percentage points over the CAPM and by three over the Carhart Model. This is in line with the earlier LuSE-specific evidence of Musawa, Kapena and Shikaputo (2018), albeit the improvement is less significant than the spike from 0.13 to 0.90 reported by the authors. The tighter gap reflects the bullish 2022-2025 market scenario when a strong market beta absorbs much of the cross-sectional variation in returns, and CAPM looks artificially more competitive than it would in a tranquil market.

The second empirical conclusion suggests a little overall superiority of the Five-Factor Model in comparison to the Carhart specification, especially when pricing portfolios sorted on investment and profitability. However, the difference in performance is still quite small, which suggests that both models still have a lot of explanatory power in the setting of the LuSE market. This is in line with Mosoeu (2022) and Hossain (2022) who believe that profitability and investment characteristics are important for emerging market returns. In a frontier market with little free float and low turnover, basic characteristics of firms seem to have a more solid pricing anchor than backward-looking return signals.

The high explanatory power of the market component throughout the sample period may be related to the extraordinary macroeconomic environment between 2022 and 2025. The explanatory value of market-wide risk variables increases for stocks returns in periods characterized by heightened economic uncertainty, inflationary pressure and commodity-price shocks. The economic conditions of the sample period may thus have been a factor in the relatively good performance of CAPM and the high adjusted R-squared values presented for all models.

The third result mitigates this conclusion: the Carhart Model still has a large comparative advantage on the size-momentum sort. While the average momentum premium on LuSE is tiny (and statistically indistinguishable from zero), the Carhart Model nonetheless loads on the MOM component in a way that FF5 cannot, and this matters for portfolios specifically sorted on past returns. This result is in line with Adegoke et al. (2024) and corroborates the more general scholarly consensus that there is no one model that dominates all cross-sections.

The choice between the Five-Factor Model and the Carhart Model in a frontier context is not a horse-race, but an issue of intended usage, considering these outcomes combined. Researchers seeking to understand the basic drivers of returns on the LuSE should select FF5 as its RMW and CMA variables price the profitability and investment effects directly. Momentum or trend-following strategies on the LuSE may therefore be better served by using the benchmark pricing of Carhart's specification.

Limitations of the Study

There are some limitations that should be noted in interpreting the conclusions of this study. Firstly, the Lusaka Securities Exchange Main Board is made up of a relatively small number of actively traded enterprises, with about twenty listed companies during the research period. The statistical power of the usual 2×3 portfolio-sorting process is constrained by this restricted cross-sectional sample and leads in some cases to sparsely populated portfolios. As a result, the precision of factor estimations may be lower than in studies of larger and more liquid equities markets. Second, while the 48-month sample period provides a sufficient number of observations for time-series regression analysis, it has low statistical power to identify whether average factor premiums are statistically different from zero. Thus, some risk variables might be statistically negligible, although economically relevant. Third, the market capitalization and trading activity of the LuSE are extremely concentrated. A few significant enterprises account for a substantial fraction of overall market turnover. This concentration increases the dominance of the market component and may cause it to explain an exceptionally large proportion of the variation in portfolio returns thereby limiting the incremental explanatory contribution of other factors. Finally, frontier equities markets are extremely illiquid and infrequently traded, which might give rise to non-synchronous trading effects, where observed stock prices do not completely include contemporaneous market information. These factors can contribute to downward bias in beta estimates and potentially influence the evaluation of systematic risk. However, the generally high corrected R 2 values found for the estimated models suggest that any bias that is introduced is unlikely to be severe and does not materially affect the main conclusions of the study.

Limitation of the Time-Period and Macroeconomic Context\

The results of this research are based on monthly data for the period from January 2022 to December 2025, given the important domestic and global macroeconomic developments that took place during that period. These included the post-pandemic economic recovery, heightened inflationary pressures, and changes in monetary policy, exchange-rate volatility, and fluctuations in international commodity prices, especially copper, which continues to be a key driver of Zambia's economic performance. Under such unusual economic situations, some of the predicted factor premiums and portfolio return relations may be capturing transitory or cyclical market dynamics, rather than stable long-term asset-pricing patterns. Therefore, the statistical significance and the explanatory power of some determinants should be taken with caution, as their behaviour might shift under various macroeconomic regimes or over longer investment horizons. Despite this constraint, the chosen period remains economically significant as it reflects the most recent era of growth of the Lusaka Securities Exchange and provides contemporary evidence on the performance of rival asset-pricing models within a frontier market scenario. Thus, the results should be taken as indicative of factor behaviour under present market conditions rather than as definitive evidence of permanent or universal asset-pricing correlations. It would be useful to examine the stability and sustainability of the described factor effects using longer sample periods and many economic cycles in future studies.

5 Conclusion and Recommendations

5.1 Summary of Findings

In this study we studied the comparative explanatory power of the Fama–French Five-Factor Model and the Carhart Four-Factor Model on the Lusaka Securities Exchange from January 2022 to December 2025. The study used monthly returns of twenty LuSE main-board firms. The six factors were built using standard portfolio sorts and time-series OLS regressions were run on 24 size-sorted test portfolios.

The Carhart Four Factor Model outperformed the Fama-French Five Factor Model slightly on average across all the portfolios considered. However, the results do not show that one model is considerably better than the other, since the differences in explanatory power and pricing errors were quite small. Rather the results suggest that the usefulness of each model depends on the portfolio characteristics included such as profitability, investment and momentum impacts. The Carhart Model was a close second on the average cross-section but provided on momentum-sorted portfolios a tiny relative advantage in particular.

5.2 Contribution to Theory

This work adds to the modern asset-pricing literature by testing multi-factor models in a frontier African market where empirical information is scant. It provides one of the first direct horse-races between the Fama–French five-factor and Carhart four-factor specifications in Sub-Saharan Africa, and contributes nuanced evidence to the wider literature debate between profitability–investment-based and momentum-based explanations of cross-sectional stock returns. The result that the answer relies on whether the characteristic is priced by fundamentals or historical performance recalls Adegoke et al. (2024), Kamstra et al. (2024) and Atodaria (2025), and supports the larger idea that asset-pricing models are market-context specific, not universal.

5.3 Implications for Practice and Policy

For investment practitioners, the findings imply that portfolio managers in the Lusaka Securities Exchange should primarily apply the Fama–French Five-Factor Model when assessing fundamentally driven investment strategies, particularly portfolios based on value, profitability and quality. If you are building, evaluating or backtesting momentum-based, trend-following or tactical asset allocation strategies, the Carhart Four-Factor Model might give you some more clues by explicitly include the momentum factor.

For policymakers such as the Securities and Exchange Commission of Zambia, the results show that the Lusaka Securities Exchange, although classified as a frontier market, has a sufficiently developed pricing structure to allow multifactor asset-pricing models to capture significant differences in stock returns. This implies that market prices reflect several systematic risk factors beyond the market risk. As a result, policy initiatives to improve market liquidity, breadth and diversity of listed companies, timeliness and quality of corporate disclosures, and overall market transparency may further enhance factors identification and pricing efficiency. These measures would help to mature the Zambian capital market and help it on the road to emerging market standards.

5.4 Recommendations for Further Research

Future research should expand the sample both ahead as more listings enter the alternative market (LuSE Alt-M) and backward in time to include the pre-2020 LuSE timeframe. It would be possible to determine whether the Carhart advantage on momentum and the FF5 advantage on fundamentals apply to all Southern African frontier markets by conducting comparable studies throughout the Committee of SADC Stock Exchanges.

Lastly, future studies should investigate whether cross-sectional fit is further improved by liquidity-adjusted versions of these factor models or models that include commodity-price or exchange-rate factors unique to Zambia's copper-dependent economy. Future research should extend the sample period both forward and backward as new data becomes available. A longer time horizon would improve statistical power, make it possible to analyze many market cycles, and provide a more trustworthy assessment of factor premium stability under different macroeconomic conditions.

Declaration of Competing Interests

The authors declare that they not aware of any competing financial interests or personal relationships that may have influenced the work described in this document.

Funding

This research did not receive specific grants from any public, commercial, non- profit sector funding bodies.

Acknowledgements

The authors would like to offer my heartfelt gratitude to everyone who made a contribution to this research

Ethical considerations

The article followed all ethical standards appropriate for this kind of research.

References

(PDF) A Comparative Study of the Fama-French Three Factor and the Carhart Four Factor Models: Empirical Evidence from Morocco. Available from: [accessed Jun 01 2026].

A. T. Hossain (2022). Asset pricing, investment, and profitability in developing economies. Finance and Trade in Emerging Markets, 58(11), 3221–3241.

Abrache, J., and Tazi, K. (2022). the Casablanca Stock Exchange's momentum factor. Cogent Finance & Economics, 10(1), 2127483.

Adegoke, S., Adelaja, A., & Onifade, A. (2024). Reconciling momentum and profitability anomalies in emerging stock markets. Journal of Asset Management, 25(3), 211–234.

Aguenaou, S., Abrache, J., Kadiri, B.E. (2011), Testing the Fama-Frenchthree factor model in the Moroccan stock market. InternationalJournal of Business, Accounting, and Finance, 5(2), 1-10

An empirical study of the Fama-French-Carhart multifactor model: UK Evidence, Nwani, C. (2015). Sharpe, W. F. (1964) IOSR Journal of Economics and Finance, 6, 95-10. Capital asset prices: A theory of market equilibrium in risky situations. Journal of Finance, 19(3), 425-442.

Asness, C., Frazzini, A., Israel, R., & Moskowitz, T. (2019). Fact and fiction in factor investing. Journal of Portfolio Management, 45(7), 5–28.

Atodaria, A. (2025). Momentum effects in emerging Asia: Evidence from India and Malaysia. Pacific-Basin Finance Journal, 89, 102105.

Britten, J., and Cox, S. (2019). The Johannesburg Stock Exchange provides evidence for the Fama-French five-factor model. Journal of Investment Analysts, 48(4), 240-261.

Carhart, M. M. (1997). On persistence in mutual fund performance. Journal of Finance, 52(1), 57–82.

French, K. R., and Fama, E. F. (1993). common risk factors for bond and stock returns. Financial Economics Journal, 33(1), 3–56.

French, K. R., and Fama, E. F. (2004). Theory and evidence for the capital asset price model. Economic Perspectives Journal, 18(3), 25–46.

French, K. R., and Fama, E. F. (2015). An asset price model using five factors. Journal of Financial Economics, 116(1), 1–22. Foye, J. (2018). The Fama-French five-factor model is thoroughly tested in emerging markets. Review of Emerging Markets, 37, 199–222.

J. Lintner (1965). the selection of risky investments for capital budgets and stock portfolios, as well as the valuation of risk assets. Economics and Statistics Review, 47(1), 13–37.

J. Mossin (1966). equilibrium in the market for capital assets. 34(4), Econometrica, 768-783.

M. Claesson (2021). Local or universal? Multi-factor asset pricing comparisons across 30 stock markets. 75, 101737, International Review of Financial Analysis.

Peter, F. J., and Dirkx, P. (2020). The German market is supported by the Fama-French five-factor model. 53(2), 187–222, Credit and Capital Markets.

S. Mosoeu (2022). Evidence from emerging markets regarding profitability and the cross-section of stock returns. Review of Emerging Markets, 51, 100898.

Shanken, J., Ross, S. A., and Gibbons, M. R. (1989). an evaluation of a portfolio's effectiveness. Econometrica, 57(5), 1121-1152.

Shikaputo, C., Kapena, S., and Musawa, N. (2018). The Fama-French five-factor model is being tested on the Lusaka Securities Exchange. 6(7), 1–14, International Journal of Economics, Commerce, and Management.

Smith, B., Shi, R., and Kamstra, M. (2024). evaluating factor models using intercept tests and pricing errors. Asset Pricing Studies Review, 14(1), 89–131.

Titman, S., and Jegadeesh, N. (1993). The efficiency of the stock market is affected by returns from purchasing winners and selling losers. Journal of

Finance, 48(1), 65–91.

Valentinčič, A., and J. Foye (2020). Indonesian factor models are being tested. Review of Emerging Markets, 42, 100665.

Zhang, L., Xue, C., and Hou, K. (2020). reproducing abnormalities. Financial Studies Review, 33(5), 2019–2133.