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-RESEARCH ARTICLE-

FAMA AND FRENCH FIVE-FACTOR ASSET PRICING MODEL: EVIDENCE FROM MOROCCAN STOCK MARKET

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─Abstract─

This research paper comprehensively analyzes the correlation between cross-sectional variation in Moroccan stock returns and the underlying behavior of four fundamental variables: size, book-to-market ratio, investment, and profitability. This investigation

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employed on a comprehensive monthly dataset comprising 54 companies listed on the Casablanca Stock Exchange (CSE) between 2009 and 2017. The results of the study indicate that there exists a statistically meaningful impact on the book-to-market ratio, size, and profitability. Nevertheless, the variable of investment exhibits a negative effect. Upon analysis of this study, it has been demonstrated that the Fama-French five-factor model shows inadequacies in its ability to fully discern the cross-sectional nature of stock returns in the CSE. However, compared to the three-factor and four-factor models, the five-factor model presents a greater potential for exposition in assessing assets in the stock market.

Keywords: Asset pricing model, Fama and French five-factor model, three-factor model, Casablanca Stock Exchange (CSE)

1. INTRODUCTION

In finance and business, it is commonly observed that many professionals and academics encounter challenges in identifying alterations that have taken place in the cross-section of stock returns through asset pricing models. This pursuit involves exploring novel models and techniques that ensure the accuracy of professionals' forecasting of future returns. The Fama French Five-Factor Model (FF5FM) is widely regarded as one of the most commonly employed techniques in internal research for predicting financial asset pricing and stock returns, among a range of other methods. Despite its significant contribution to comprehending the correlation between risk and returns, this model has not received adequate attention in the Moroccan stock market. It would be interesting to investigate whether there are any discernible differences in the efficacy of asset pricing models between the Moroccan stock market and other established markets, such as the US market. This is particularly relevant as the Moroccan markets are comparatively nascent and less prominent than their major counterparts.

Consequently, it is imperative to assess the efficacy of the model's survey results compared to those of other models. This study aims to evaluate the effectiveness of the Fama and French (2015) five-factor model compared to other models, such as the Fama-French three-factor model and other four-factor models. Additionally, the study seeks to analyze the predictive capacity of the Fama-French five-factor model on Moroccan stock data.

Moreover, the requirement for additional information regarding the five-factor model and its modifications prompts us to empirically examine this model in the Moroccan equity market, specifically in the Casablanca Stock Exchange. Accordingly, the objective of this study is to explore the following research question: What is the impact of market premium, size, book-to-market ratio, profitability, and investment risk factors? Can the five-factor asset pricing model evaluate and discern mean returns within the CSE?

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This study endeavors to provide novel insights and suggestions on utilizing asset pricing models in elucidating average returns by examining the extent to which the alpha is statistically indistinguishable from zero. The term "alpha" is commonly employed in investment circles to denote a strategy's ability to surpass market performance. The terms "excess return" or "abnormal returns" are also widely utilized in academic literature. In this study, the intercept of the conducted regressions, denoted as alpha, will be used as a metric to evaluate the effectiveness of the different systems and function as a performance indicator for each design. Alpha can be conceptualized as the systematic, unattributed component of meaningful outcomes.

Furthermore, to the best of our understanding, this investigation is innovative, as it represents one of the initial endeavors to comprehensively examine the Fama-French five-factor model and its variations in the Casablanca Stock Exchange within the context of the Moroccan equity market. This dissertation contributes significantly to the existing knowledge regarding experimental analyses of the FF framework in the Moroccan stock market. The predominant employment of the FF three-factor model in empirical tests of the FF system within the Moroccan stock market can be attributed to the system's age. Moreover, the present study has operationalized and employed the GRS test to assess the models' ability to provide greater explanatory power. A significant proportion of previous research has focused on determining the mean adjusted R2 values of various models and quantifying the quantity of regression intercepts that are statistically significant rather than employing any methodical performance evaluation measures.

Moreover, this study contributes to the existing literature and holds practical implications for management. Furthermore, it will facilitate the determination of the most suitable resource between the three-factor and five-factor models for practical applications such as portfolio performance evaluation, assessment, and cost-of-equity assessment, particularly in the context of the Moroccan stock market. Undoubtedly, the CAPM is the most commonly employed model in these contexts due to its straightforwardness and economy, both of which have elicited various theoretical and empirical criticisms. Consequently, there is a notable surge in the demand for alternative models.

Consequently, the subsequent sections of this article are structured into three parts. The initial segment centers on thoroughly examining existing literature on the topic at hand, aiming to comprehensively comprehend prior research on the subject matter. This section pertains to the collection and management of data, with a focus on the methodology employed to establish a correlation between stock assets and fundamental variables. The third section comprehensively discusses the study's outcomes and discoveries.

2. REVIEW OF THE LITERATURE

The objective of each investor is to increase the profit margin while considering any impending risk. When the return is maximized, investors are highly motivated to engage in hazardous activities such as investments. To avoid investment risks, numerous theoretical models have emerged and evolved to clarify the direct relationship between risk and return. In this regard, Harry Markowitz (1952) laid the groundwork for the mean-variance model as the foundation of modern portfolio theory (MPT). Similarly, James Tobin introduced a "Separation Theorem" model in 1958 (Tobin). Tobin's model incorporates a risk-free return as a central component. Using Markowitz's and Tobin's models as inspiration, Sharpe (1964) and Lintner (1965) created the capital asset pricing model (CAPM). It employs the excess market returns as the only variable for explaining the market movement of equities.

Even though the CAMP is a popular model, it is not immune to emergent empirical issues. Moreover, according to Robert C. Merton (1973), the CAPM's single-dimension approach is insufficient to explain asset returns precisely. In addition, the price-to-earnings (P/E) ratio was formerly known as the value effect, which was Basu (1977)'s initial perception. Stattman (1980), instead of using the P/E ratio as a benchmark, uses the Book-to-Market ratio of a company. The company's scale plays a significant role in shedding light on the peculiarities of CAPM (W. Banz, 1981). Based on previous analyses, Fama and French (1992, 1993) devised the FF3FM to capture the interrelationship between the expected excess returns and the market premium. In addition, they have added two factors, represented by book-to-market equity and the market capitalization-determined scale of the company. Fama and French (2006) empirically evaluated Miller Modigliani's (1961) valuation formula, which explains the relationship between expected stock returns and the B/M, anticipated profitability, and expected investment. The inadequacy of the three-factor model prevented a comprehensive explanation of the variations in stock return about investment and profitability. Eugene F. Fama and Kenneth R. French concluded in 2015 that the three-factor model required the addition of investment and profitability factors. The French-Fama five-factor model is therefore formulated as follows:

$$\mathrm{R_{it} - R_{Rt} = a_i + b_i(R_{Mt} - R_{Ft}) + s_iSMB_t + h_iHML_t + r_iRMW_t + c_iCMA_t + ei_t}$$

Where R_{it} is the return of asset i at time t, R_{Ft} the risk-free return, $R_{Mt} - R_{Ft}$ the excess market return, SMB_t the size factor, HML_t the value factor, $RMW_t$the profitability factor, and CMA_t the investment factor. The coefficients b_i ,s_i,h_i,r_i, and c_i are the asset's sensitivity to each of the factors, a_i is the intercept, and eit is the error term at time t.

In their study, Fama and French (2015) incorporated all equities in the United States. The present study pertains to a survey carried out over 606 months, commencing in July 1963 and concluding in December 2013. Fama and French have demonstrated the comparative efficacy of three-, four-, and five-factor model compositions concerning the sets of portfolios on the Left-Hand Side (LHS). The inadequacy of the five-factor model is manifested in its inability to account for the low average returns observed in small stocks. Despite the lower profitability, the returns of small stocks exhibit similar behavior to those of larger investments. Upon the inclusion of RMW and CMA factors, the efficacy of the HML factor began to diminish as it could not accurately capture the returns of stocks with low average values.

The initial evaluation of the five-factor model proposed by Fama and French yielded a varied set of outcomes. Experiments were carried out across diverse markets and timeframes. Chancharat et al. (2007) posit that the returns of the Singapore stock market positively influence the Thai market. However, no evidence supports the correlation between the Thai and Australian stock market returns. Hence, it is deemed valuable to examine the Thai stock market utilizing the five-factor model, the efficacy of which may be substantiated. Maxim (2015) conducted a comparative study to evaluate the predictive effectiveness of various models, including the CAPMN, DCAPM, APT, and two-, three-, and five-factor models, in the context of the Bucharest Stock Exchange for the period spanning from 2006 to 2013. The findings of this research illustrate the considerable explanatory capacity of the stock asset within the FF5FM, surpassing all prior corresponding models.

A study examined the FFFFM phenomenon in the Australian stock market from 1982 to 2013. According to Chiah et al. (2016) findings, the FFFFM model exhibits greater explanatory capacity than the three-factor model. A study was conducted by Chiah (2016), and Li (2016) on the FFF5FM in the Australian stock market from 1982 to 2013. The results of their study indicate that the Fama-French Five-Factor Model (FFF5FM) exhibits a notably superior explanatory capacity when compared to both the three-factor model and the Carhart four-factor model. The effectiveness of the FF5FM compared to other competing models is demonstrated by explaining asset pricing anomalies. The authors Li (2016) conducted an empirical investigation of the FFF5FM about China's stock market. The study was conducted over a period spanning from July 1995 to June 2014. The findings indicate that the FFF5FM outperformed the three-factor model regarding profitability.

Nonetheless, Foye and Valentinčič (2020) conducted an out-of-sample evaluation of the abovementioned models, utilizing them to analyze the UK stock market from 1989 to 2016. The results indicated that neither the three or five-factor models could account for cross-sectional returns. In contrast, Kubota and Takehara (2018) found that the five-factor model exhibits superior performance compared to the three-factor model in elucidating the mean returns of the Japanese stock market. In a recent study conducted by Irwan Adi Ekaputra et al. (2020), it was asserted that the FF5 and FF3 models exhibited a deficiency in elucidating the surplus portfolio returns in the markets of Indonesia and Singapore. Tripathi and Singh (2020) conducted an empirical analysis of the Indian market, demonstrating that the five-factor model provides a more effective description of the variations in equity returns compared to the single-factor capital asset pricing model. The study was carried out between July 2000 and June 2015. The suitability of the two models has been considered concerning various factors, including but not limited to dimensions, market dynamics, investment patterns, value propositions, and profitability incentives. Acaravci and Karaomer (2017) conducted an empirical investigation to assess the efficacy of the Fama-French five-factor model (FF5F) in the context of Borsa Istanbul (BIST). The study findings indicate no evidence of pricing error based on the Gibbons et al. (1989) GRS-F test of FF5F. Therefore, it appears that FF5F is a valid input in the Built-In Self-Test (BIST).

Furthermore, FF5F purportedly elucidates fluctuations in surplus portfolio gains. Dirkx and Peter (2020) conducted a study to examine the applicability of the six-factor model in the German market. The findings suggest that the performance of the six-factor model is comparatively inferior to that of the three-factor model. In 2021, M.N. López-García introduced a novel five-factor model for evaluating returns in the Chinese stock market. This model incorporates the Momentum factor and a new memory factor, denoted as H. The study's findings suggest that the H factor exhibits superior explanatory power compared to the Momentum factor. Foye and Valentinčič (2020) analyzed the applicability of the five-factor model in the Indonesian market. Their findings suggest that the probability and investment factors may not be sufficient in fully elucidating the average return of portfolios.

3. DATA AND METHODOLOGY

As mentioned at the beginning of this paper, the data collected for the analysis of this study incorporate monthly returns of common stocks listed on the Casablanca Stock Exchange (CSE) from 54 companies from January 2009 to December 2017. Besides, this data is taken from the Decypha database, which encompasses Total Liabilities, Shares Outstanding, Total Assets, and Operating Income, which can be calculated as revenues - the cost of goods being sold – selling expenses of general administration – the expense of interest.

3.1 Model Component Construction

A dual-step method is set up to construct the Fama French five-factor model. The method's first step involves the evolvement of independent variables, while the second step is based on creating dependent variables.

3.1.1 Construction of Portfolios: Dependent variables

Blume (1970) posits that the assessment of betas is contingent upon the extent to which we can eliminate errors by pooling stocks in portfolios. Fama and French (2015) employ three distinct sets of portfolios for this purpose. Initially, the 2X3 sorting algorithms existed, subsequently succeeded by the 5X5 sorting algorithms, ultimately culminating in the 2X4X4 sorting algorithms.

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Table 1: the portfolio construction process using the three sets mentioned above. Each stock in the table is associated with a particular category or classification. Regarding this study, the convergence of different types leads to a variety of portfolios in the stocks. The present analysis involves the computation of monthly returns, considering the corresponding weight of excess allocated to each portfolio. The Median breakpoint pertains to partitioning stocks into two distinct groups, alongside quartile - four and quantile - five.

Set	Sort	Breakpoints
2*3 sorts	6 portfolios on Size and BE/ME 6 portfolios on Size and OP 6 portfolios on Size and INV	Size: median BE/ME:30^{th} and 70^{th} percentile OP: 30^{th} and 70^{th} percentile INV: 30^{th} and 70^{th} percentile
5*5 sorts	25 portfolios on Size and BE/ME 25 portfolios on Size and OP 25 portfolios on Size and INV	Size: quantiles BE/ME : quantiles OP : quantiles INV: quantiles
2*4*4	32 portfolios on Size, BE/ME, and OP 32 portfolios on Size, BE/ME, and INV 32 portfolios on Size, OP, and INV	Size: median BE/ME: quartiles OP : quartiles INV : quartiles

Our study's cross-sectional analysis of equity returns involved implementing the 5X5 sorting method based on size and other factors such as value, investment, and profitability. Due to this rationale, we have three partitioned sets, each comprising 25 subsets of LHS portfolios. The cumulative return of 75 portfolios' time series has been computed. A range of portfolios is offered, thereby rendering the diversity in the cross-section of the portfolio suitable for explication. Upon identification of the compositions within the portfolio, the ensuing calculation is performed: The formula R_it-R_Ft entails deducting the risk-free rate from the assessed value derived from the monthly surplus returns of each portfolio. To arrive at this line of reasoning, the risk-free rate was

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computed using the 13-week Moroccan Treasury Bill rate, as opposed to the utilization of Fama and French's 1-month Treasury Bill rate.

3.1.2 Construction of Factors: Explanatory variables

To evaluate the effectiveness of the factors mentioned above in elucidating stock returns on the Stock Exchange of Morocco, it is necessary to employ an empirical model that incorporates these factors as explanatory variables. Using the variable that emulates the portfolio can be beneficial when undertaking this task. To this, the small minus big (SMB) portfolio goes so far as to imitate the risk factor per the company's size. Concerning the high minus low (HML) portfolio, it is supposed to mimic the risk factor following the company's book-to-market equity. In addition, the robust minus week (RMW) portfolio is presumed to act similarly as the risk factor depending on the company's profitability. At last, the conservative minus big (CMA) portfolio will imitate the risk factor per the company's investment.

In this study, we consider Fama and French (2015) to calculate the asset pricing factors. To streamline this computation, we implement the 2X3 categorization method.

Table 2: factors' construction, we have 18 portfolios with 2 X 3 sorts. To elaborate, six portfolios have been allocated for three intersections. The initial intersection is positioned between two groups that exhibit varying sizes, ranging from small to large. The remaining three groups represent high, neutral, and low book-to-market regarding the second point of intersection. It is situated amidst a minor and a major cluster, each operating based on sturdy, impartial, and feeble operational profitability. The subsequent section pertains to the intermediate group, situated amidst a larger cohort, alongside three additional clusters categorized as conservative, neutral, and aggressive investments.

Breakpoints	**Factor components**
Size: median BE/ME:30^{th} and 70^{th} percentile OP: 30^{th} and 70^{th} percentile INV: 30^{th} and 70^{th} percentile	$SMB_{BE/ME}$=(SH+SN+SL)/3-(BH+BN+BL)/3 SMB_{OP}=(SR+SN+SW)/3-(BR+BN+BW)/3 SMB_{INV}=(SC+SN+SA) /3-(BC+BN+BA) /3 SMB= ($SMB_{BE/ME}$+SMB_{OP}+SMB_{INV})/3 HML=(SH+BH)/2-(SL+BL)/2 RMW=(SR+BR)/2-(SW+BW)/2 CMA=(SC+BC) /2-(SA+BA) /2

Following this, the market portfolio's factor is calculated based on the difference resulting from the evaluated monthly return of every single stock and the 13-week Moroccan Treasury Bill. Therefore, we use the Moroccan All Shares Index (MASI) as a proxy for the market portfolio. Concerning the representative for the risk-free rate, we use the 13-week Moroccan Treasury Bill. The Moroccan Treasury Bill rate data is taken from the Bank Al-Maghrib website.

3.2 Asset Pricing Tests

After assessing all relevant variables, we evaluate the explanatory power of the Fama and French three-factor and five-factor models in the Moroccan stock market context. The utilization of time-series regressions of OLS, denoting ordinary least squares, is also employed. Fama and French (2015) used both 5x5 and 2x4x4 sorting techniques to assess the efficacy of the five-factor model. This phase of the study aims to investigate the implementation of each model specification in representing the mean returns in the Moroccan stock market. Moreover, by employing the four-factor model framework, we aim to evaluate the degree of overlap between the HML factor and the RMW and CMA factors. The table below presents additional information regarding the specifications of the asset pricing tests.

Table 3: In this table, we illustrate the specifications of Asset Pricing Tests R_Mt-R_Ft, which refers to the value-weighted return on the market portfolio of each sample stock minus the 13-week Moroccan Treasury Bill; the size factor is represented by SMB (small-minus-big) while the value factor is represented by HML (high-minus-low); RMW(robust-minus-weak) is the factor of profitability; and CMA, which refers to conservative-minus- The construction of all aspects, except for Rm-Rf, is based on independent stock types, which are then divided into five groups of varying sizes: five B/M groups, five OP groups, or five Inv groups.

3.3 Factor Spanning Tests

This subsection elaborates on utilizing factor-spanning tests to ascertain the extent to which any element associated with the Fama and French five-factor model can be accounted for by other factors relevant to the Moroccan stock market. Specifically, the factor-spanning tests can perform regression analysis on each of the five factors against the remaining four using OLS.

Table 3:comprehensive information regarding the specifications of the factor-spanning tests.

Model	Regression Equation
Fama – French Three-Factor Model	$R_{it} - R_{Rt} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + ei_t$
Fama – French Five-Factor Model	$R_{it} - R_{Rt} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + ei_t$

Fama – French Four-Factor (combine RM-RF, SMB, and pairs of HML, RMW, and CMA)	$R_{it} - R_{Rt} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + ei_t$ $R_{it} - R_{Rt} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + c_i CMA_t + ei_t$ $R_{it} - R_{Rt} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + r_i RMW_t + c_i CMA_t + ei_t$

Table 4: The specifications of the Factor Spanning Tests. The value-weighted return on the market portfolio of each sample stock is adjusted by subtracting the 13-week Moroccan Treasury Bill every month to represent R_{Mt}-R_{Ft}. SMB (small-minus-big) represents the size factor, while HML (high-minus-low) represents the value factor. RMW (robust-minus-weak) is the factor of profitability, and CMA, which refers to conservative-minus-aggressive, symbolizes the factor of investment. The construction of all factors, except for Rm-Rf, is based on the independent sorting of stocks into five groups of varying sizes: five B/M groups, five OP groups, or three Inv groups.

Dependent variable	Regression Equation
$\boldsymbol{R_{Mt} - R_{Ft}}$	$R_t - R_{Ft} = a_i + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + ei_t$
$\boldsymbol{SMB_t}$	$SMB_t = a_i + b_i(R_{Mt} - R_{Ft}) + h_i HML_t + r_i RMW_t + c_i CMA_t + ei_t$
$\boldsymbol{HML_t}$	$HML_t = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + r_i RMW_t + c_i CMA_t + ei_t$
$\boldsymbol{RMW_t}$	$RMW_t = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + c_i CMA_t + ei_t$
$\boldsymbol{CMA_t}$	$CMA_t = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + ei_t$

Based on the abovementioned regressions, the models are evaluated for their significant interference, and the associated risk factors are examined. The null hypothesis in this context demonstrates that the examined models offer a satisfactory account of the surplus returns of Moroccan stocks, as the model does not yield significant abnormal returns. Furthermore, it has been demonstrated that the identified risk factors are adequate in providing a satisfactory explanation for the observed excess returns. The conventional statistical framework involves the utilization of p-values to evaluate the efficacy of diverse asset pricing models by analyzing the coefficients featured in the regression outputs. The GRS test statistic proposed by Gibbons M.R, Stephen Ross, and Jay Shanken in 1989 has been utilized in the current investigation. The following equation delineates the methodology employed to compute the GRS test statistic.

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$$GRS = (\frac{T}{N})(\frac{T-N-L}{T-L-1})[\frac{\widehat{\alpha}'\widehat{\Sigma}^{-1}\hat{\alpha}}{1+\bar{\mu}'\widehat{\Omega}^{-1}\bar{\mu}}]$$

T represents the sample's size, while N represents the number of LHS portfolios. L represents the number of RHS portfolios, $\widehat{}$ and α represents an NX1 vector of the intercepts of the regression. While $\widehat{\Sigma}$ represents the covariance matrix of residuals of the sample, $\bar{\mu}$ is an LX1 vector of the means of the explanatory factors. At last, $\widehat{\Omega}$ represents the covariance matrix of the explanatory factors in the sample.

In the null hypothesis, all the stated regression intercepts describing mispricing are jointly equal to zero. The represented GRS test statistic goes along with an F distribution, characterized by different degrees of freedom of N and T-N-L. The rejection of the null hypotheses suggests the deficiency of the asset pricing model in describing asset returns.

4. EMPIRICAL RESULTS

4.1 Patterns of Average Returns

According to Fama and French's research in 2015, companies that exhibit high BE/ME ratios tend to generate comparatively higher returns than those with low ratios. Meanwhile, the size remains consistently coarse. Their sample observed that as the size decreases, there is a corresponding return increase while maintaining a relatively constant BE/ME ratio. In addition, it is noteworthy that larger corporations exhibit lower projected returns relative to their smaller counterparts and demonstrate a trend of diminishing returns over time, particularly during periods of reduced profitability. Nevertheless, firms of all magnitudes that engage in assertive investments typically exhibit diminished returns. Regardless of whether companies' portfolios are constructed based on intersectional groups OP or INV groups or even constructed with BE/ME groups, size remains a significant factor. The Moroccan Stocks sample exhibits no discernible differences despite notable deviations. The tabular format presented below serves as a visual representation of the outcomes of our investigation.

Table 5: monthly excess returns derived from Size and BE/ME, Size and OP, and Size and INV. The table categorizes the companies into five groups based on their size, varying from small to large. The quantiles of market capitalization for each stock in Morocco during year t are utilized, specifically after each December, to accomplish this task. Similarly, firms are assigned to five distinct categories based on their BE/ME, OP, and INV, which span from the lower to upper quartiles of their respective distributions. Each intersection of size corresponds to either BE/ME, OP, or INV based on the weight of the portfolio's value. The table displays monthly excess returns relative to the 13-week Moroccan Treasury Bill rate. The table illustrates the relationship between portfolio size and average returns as depicted in panel A, where two out of five BE/ME columns indicate a decline in average returns with an increase in portfolio size. As

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delineated by their respective magnitudes, the initial and tertiary cohorts demonstrate that equities generate average excess returns of 0.69% and -0.28% every month.

	Low	**2**	**3**	**4**	**High**
Panel A: Size - BE/ME portfolios					
Small	0,86%	-0,43%	-0,18%	-0,30%	-0,71%
2	0,39%	1,05%	-0,36%	0,05%	-0,64%
3	1,42%	0,13%	1,06%	0,00%	3,90%
4	0,45%	0,35%	-0,15%	-0,06%	-3,99%
Big	0,69%	0,37%	-0,28%	0,45%	-0,69%
Panel B: Size – OP portfolios					
Small	-0,85%	0,10%	-1,35%	1,27%	0,99%
2	-2,04%	0,43%	0,78%	0,37%	0,54%
3	-0,43%	-0,11%	1,02%	0,51%	0,75%
4	-1,55%	-0,01%	0,25%	0,36%	0,43%
Big	-1,17%	1,17%	-0,05%	0,83%	0,20%
Panel C: Size – INV portfolios					
Small	-0,59%	-0,45%	-0,72%	0,63%	-0,27%
2	-1,97%	0,16%	0,00%	0,35%	1,35%
3	-0,09%	-0,11%	1,17%	0,61%	1,25%
4	-0,99%	-0,28%	0,10%	0,53%	0,74%
Big	-0,19%	0,20%	0,65%	0,37%	1,33%

The percentage increase in a numerical value is observed for small-scale enterprises, ranging from 0.86% to -0.18% for the company's most diminutive size category. However, targeting the correlation between return and B/M proves to be a complex task due to the demonstrated incongruity of the effect. This phenomenon can be attributed to the entirely arbitrary nature of the average return's behavior. Thus, the above statistics fail to substantiate that small companies require a greater excess to compensate investors for potential failures and risks. By isolating the impact of value while keeping the size constant, it is anticipated that four out of five rows with reduced book-to-market ratios will yield excess returns. The decrease mentioned above aligns with the concurrent rise in the book-to-market ratio of corporations. In the third row, an exception is noted wherein the average returns increase from 1.42% in the lowest value quantile to 3.90% in the highest value quantile. Nonetheless, this pattern does not align with the prevailing patterns observed in the United States market. It can be observed that as the book value of equity increases across rows, a corresponding increase in profits is relatively higher than the market value of equity.

Panel B of the table depicts the outcomes of the patterns pertaining to the portfolios formed based on size and OP. The findings indicate that the size effect continues to have a contrasting influence, as evidenced by its persistence in three out of five profitability classifications. When maintaining a consistent level of operating profitability, an increase in size is associated with a decrease in average returns. Notably, a shortage of fluctuation distinguishes the decline in the mean return in three operating points.

The manifestation of mean returns across varying scales is apparent in generating comparatively escalating returns by lucrative enterprises. The relationship between the degree of profitability and the fluctuation of average returns is established. As the average returns increase, so does the overall profitability. The impact of profitability is significant across various group magnitudes and for all quantiles of size. The strength of the correlation between high operating profitability and higher average returns is greater than that between low operating profitability and increased average returns. Specifically, when operating profitability increases, average returns increase within a range of -0.85% to 0.99% for high OP and within a range of -1.17% to 0.20% for low OP.

Panel C in the table exhibits the patterning outcome for portfolios formed based on size, which remains inconsistent and maintains four out of five investment categories. The panel further indicates a positive correlation between the size of INV groups and their respective increases.

Ultimately, the impact of investment contradicts the other impacts. Stated differently, it is necessary for returns to exhibit a monotonic decrease as one moves from the leftmost conservative to the rightmost aggressive. Investment firms exhibit disparate behavior as conservative growers possess a lower rate of returns than their counterparts who demonstrate relatively higher growth. The inconsistency in the investment pattern showing opposition in this sample leads to a reversal.

4.2 Risk Factors

This subsection represents the analysis of risk factors, for which Table 6 illustrates average return statistics. The following table also includes standard deviations and t statistics for the factor returns.

Table 6: data about factor returns from month to month. The market portfolio factor is computed as $R_{Mt} - R_{Ft}$, which is considered a weighted value of all the sample's monthly returns minus the Moroccan Treasury Bill rate with 13-week maturity. At the end of December, five different size groups, ranging from Small to Big, are allocated to companies with a market capitalization of every single stock of Morocco within the year t. In the same way, firms are set to the groups of 3 BE/ME, OP beside INV, and for the crisis, we use the 30th and 70th percentiles as breakpoints. SMB, as a size factor, is considered as the average of small stock portfolio returns minus the average of big stock portfolios. The value factor, *HML,* is the average of the high *BE/ME* portfolio returns minus the average of the low *BE/ME* returns. In addition, RMW, as the profitability factor, is considered the average of the robust OP portfolio return minus the weak *OP*

portfolio returns. Finally, CMA, As the factor of investment, is the average of the conservative portfolio returns minus the average of the aggressive portfolio returns.

	RM – RF	**SMB**	**HML**	**RMW**	**CMA**
Panel A: Descriptive statistics					
Mean	-0,03016	-0,00017	-0,00448	0,009558	0,002869
Std. Dev.	0,03225	0,021988	0,040535	0,029708	0,035012
T-Statistic	-9,71932	-0,07973	-1,14885	3,343391	0,851647
P-Value	1,1E-16	0,468299	0,12659	0,000571	0,198156
Panel B: Correlations					
RM – RF	1	-0,3767	0,122345	-0,30036	-0,72372
SMB	-0,3767	1	0,167754	0,044805	0,154216
HML	0,122345	0,167754	1	-0,27283	-0,37657
RMW	-0,30036	0,044805	-0,27283	1	0,592172
CMA	-0,72372	0,154216	-0,37657	0,592172	1

The mean excess return of equity (RM – Rf) is -0.03016 with a corresponding standard deviation of 0.03225 (t = 9.71932). The statement implies a negative comparison to the estimated value in the United States, as illustrated by Fama and French's (2015) study, which encompassed a testing period spanning from July 1963 to December 2013. According to Fama and French's (2015) findings, the estimated return of the excess market is 0.50%.

Table 6, Panel A presents a negative outcome regarding the average return of SMB and HML. The sample means are -0.00017 and -0.00448, respectively, with corresponding standard deviations of 0.021988 (t = -0.07973) and 0.040535 (t = -1.14885). Hence, the adverse outcomes elucidate that corporations' stocks, possessing comparatively substantial worth with a feeble profitability margin, exhibit superior efficacy in contrast to those enterprises distinguished by diminutive values and sturdy levels of profitability. This observation indicates that the matter is in alignment with the initial analysis. The results of our study indicate a contrast with the outcomes obtained in the United States stock market, as Fama and French (2015) reported. Multiple economists, in addition to Fama and French, have concluded that the impact of size has diminished in recent years.

The average return of RMW, as depicted in panel A of Table 6, exhibits a positive trend compared to the sample. The sample's mean is 0.009558, with a standard deviation of 0.029708, resulting in a t-value of 3.343391. The RMW exhibits a high average return with a corresponding standard deviation compared to the four factors. The findings indicate a significant correlation between profitability and moderate impact, consistent with the previously analyzed data. Thus far, it has been observed that elements with positive signs show that stocks exhibiting strong operating profitability yield greater returns than those with weaker operating profitability.

The average returns of the CMA, as shown in panel A of the table above, exhibit positivity compared to the sample. The mean value of the sample is 0.002869, with a standard deviation of roughly 0.035012 (t=0.851647). The current investigation suggests that the premiums associated with CMA are relatively low. Consequently, companies that make aggressive investments tend to exhibit superior performance compared to those that adopt a more conservative investment approach. This matter also demonstrates coherence with the previously provided analysis.

Thus, it can be inferred that each component of the Fama and French model, namely SMB, HML, and CMA, exhibits a notably low level of returns during the tested period. The HML factor shows a monthly average return approximating zero, specifically -0.00448. This implies that the observed disparity in yield is minimal and is delineated by the high and low book-to-market ratio equities on an average basis.

4.3 Correlations between Factors

Panel B of Table 6 was utilized to demonstrate the correlation between a matrix of factors.

The initial indication is a negative correlation in the market premium. A negative correlation is present in all of the factors in the panel except for HML, which has been estimated to have a coefficient of 0.122. The coefficient of correlation between the market premium and CMA exhibits a strong negative association, with a value of -0.724. The association between the market premium and the SMB and RMW factors shows a weak negative correlation, as evidenced by the respective coefficients of -0.377 and -0.300. Fama and French (2015) have reported a negative correlation between the factors of profitability, value, investment in the market, and the size factor.

Upon further examination of the data presented in the table mentioned above, it can be observed that there exists a marginal positive correlation between the size variable of small and medium-sized businesses and the value factor of high book-to-market ratio securities, as indicated by a coefficient of 0.168. Additionally, a modest positive correlation with a coefficient of 0.154 has been observed between the size factor of SMB and the investment factor of CMA.

Regarding the association between the value factor of HML and the profitability factor of RMW, it can be stated that there exists a negative correlation between the two variables, with a coefficient of -0.273. Therefore, it can be inferred that an escalation in profitability results in a reduction of the book-to-market ratio. Following basic accounting principles, a rise in profits requires a corresponding increase in the book value of equity. The findings presented appear to contradict the data analyzed by Fama and French (2015), wherein a slight positive correlation was observed in both the 2X 2 and 2X 3 sorts, with coefficients of 0.04 and 0.08, respectively.

A negative correlation has been observed between the value factor returns of HML and the investment factor of CMA, with a coefficient of -0.376. It is noteworthy that investments made by companies with a high book-to-market (B/M) ratio is commonly referred to as low, despite being unexpected and unusual. As per the research conducted by Fama and French, the estimated coefficient for the correlation between the factors is 0.70.

The analysis reveals a significant correlation between the returns of RMW and the factors of profitability and investment, represented by a coefficient of 0.592. Specifically, the investment factor, denoted as CMA, positively correlates with RMW's returns. According to Fama and French's research in 2015, the outcome was anticipated as it aligns with the favorable association identified between profitability and investment.

4.4 Performance of Asset Pricing Models

In this empirical study, where we study how the Fama and French five-factor model performs in the stock market of Morocco, we allocate three statistics besides running twenty-five and thirty-two regressions. For this, we use various portfolio sets along with the use of five sets of factors. All the details are provided in Table seven.

- According to Gibbons et al. (1989), the GRS statistic tests the null hypotheses in which the intercepts from the asset pricing regressions are jointly equal to zero. Thus, the GRS test's p-value of 0.05 or smaller means that the hypothesis of intercepts for all the regressions equal to zero cannot be rejected.
- The regression intercepts' average absolute value is – **A|ai|**. Simply put, we use the average absolute value of the intercepts to examine if the regression intercepts are close to zero.
- We use average adjusted R2 to illustrate how every model explains variation in average returns.

Our findings demonstrate that all factor models have p-values for GRS tests that are 0.05 percentage points below the threshold. Therefore, the adoption of the null hypothesis shows that the alphas cannot be distinguished from zero when combined. However, direct comparisons between p-values and factor models do not necessarily indicate that this method is superior to others. The adjusted R-squared and average absolute alpha values were used to evaluate the performance of asset pricing models. We analyze sorts to determine which method of modeling returns performs best on the Casablanca Stock Exchange.

We will begin by introducing universally applicable generalizations. Among all other models that increase investment with the market factor and other variables, the performance of a two-factor, four-factor model is the worst overall. This is owing to the constant high intercept of the two 4FM.

In the end, the performance of the concerned models on the GRS test is also deemed subpar. The performance of the five-factor model is subsequently ranked as the second-worst across the first two measures, as it possesses a very low adjusted R-squared across all types.

However, when using the 5FM, we observe a noteworthy increase in the adjusted R-squared for each type. However, the 5FM can provide between 25% and 33% of the explanation for returns of various kinds. Similarly, the adjusted R-squared measure describes the performance of 3FM and the three 4FM. The models are only 1% or 2% less effective than the 5FM. In Table Seven, additional statistics regarding the metrics are presented.

Table 7: the tests' statistics concerning the models of asset pricing. In panel A of the table below, we assess the extent to which factors can explain excess returns recorded from month to month on twenty-five Size– *BE/ME* portfolios and on twenty-five *Size – OP* portfolios in Panel B. In panel C, we do the same thing with twenty-five *Size – INV* portfolios, 32 *Size – BE/ME – OP* portfolios (Panel D), 32 *Size – BE/ME – INV* portfolios (Panel E). Finally, we assess 32 Size – OP – INV portfolios in panel E. Twenty-five portfolios are constructed on 5 x 5 sorts, while 32 are constructed on 2 x 4 x 4 sorts. Tests are conducted using three or four factors for each portfolio's sort.

	GRS	P-Value	$A\|ai\|$	A(R2)
Panel A: 25 Size – BE/ME portfolios				
RM – RF SMB HML	7.2612097	0,00	0,0094	0,244592
RM – RF SMB HML RMW	7.1723023	0,00	0,00922	0,269136
RM – RF SMB HML CMA	9.247385	0,00	0,01742	0,277228
RM – RF SMB RMW CMA	7.7903652	0,00	0,0167	0,283184
RM – RF SMB HML RMW CMA	7.6805789	0,00	0,01692	0,288264
Panel B: 25 Size – OP portfolios				
RM – RF SMB HML	4.1506622	0,00	0,0072	0,280912
RM – RF SMB HML RMW	4.5075747	0,00	0,007	0,315236
RM – RF SMB HML CMA	6.426148	0,00	0,01458	0,305812
RM – RF SMB RMW CMA	5.2595124	0,00	0,01332	0,313812
RM – RF SMB HML RMW CMA	5.1390029	0,00	0,01351	0,330548
Panel C: 25 Size – INV portfolios				
RM – RF SMB HML	3.436153	0,00	0,0083	0,255412
RM – RF SMB HML RMW	3.6387071	0,00	0,00813	0,27334
RM – RF SMB HML CMA	14.853936	0,00	0,01591	0,295804

RM – RF SMB RMW CMA	12.968413	0,00	0,01581	0,28878
RM – RF SMB HML RMW CMA	12.553138	0,00	0,01544	0,296936
Panel D: 32 Size – BE/ME – OP portfolios				
RM – RF SMB HML	53.7391	0,00	0,00839	0,243281
RM – RF SMB HML RMW	52.980488	0,00	0,00823	0,274572
RM – RF SMB HML CMA	36.068315	0,00	0,01574	0,273213
RM – RF SMB RMW CMA	31.303999	0,00	0,01537	0,277409
RM – RF SMB HML RMW CMA	30.749935	0,00	0,01536	0,290888
Panel E: 32 Size – BE/ME – INV portfolios				
RM – RF SMB HML	5.4920538	0,00	0,01009	0,215869
RM – RF SMB HML RMW	5.4723244	0,00	0,00995	0,237844
RM – RF SMB HML CMA	16.07279	0,00	0,01773	0,249866
RM – RF SMB RMW CMA	14.135025	0,00	0,01802	0,248478
RM – RF SMB HML RMW CMA	13.548107	0,00	0,01796	0,259769
Panel F: 32 Size – OP – INV portfolios				
RM – RF SMB HML	5.0040036	0,00	0,00953	0,224269
RM – RF SMB HML RMW	5.7601752	0,00	0,00938	0,245063
RM – RF SMB HML CMA	14.165449	0,00	0,01681	0,253809
RM – RF SMB RMW CMA	11.552076	0,00	0,01648	0,258816
RM – RF SMB HML RMW CMA	12.240961	0,00	0,01657	0,267119

First, we test the Fama and French three-factor model. The other tests incorporate the 4FM combinations followed by the five-factor model. The role of GRS statistics is to assess if the values predicted estimation of all the twenty-five or thirty-two intercepts is close to or equals zero. P-values demonstrate to which extent the GRS test is significant. $A|ai|$ represents the average absolute intercept values from 25 or 32 regressions. A (R2) represents their average adjusted R-squared.

4.4.1 5x5 Portfolio Sorts

The sort 5x5 of the size and value of the portfolios demonstrates a solid performance of the operating profitability, size, and value contained in the 4FM. For example, it produces an alpha value of 0.00922. Consequently, the 3FM's size and value performance is superior to that of the 2FM and even the 5FM. The size and profitability classification indicates a very low incidence of intercept for the 4FM's size, operating profitability, and worth. The estimated intercept is 0.007, which is modest in comparison to the intercept of the 4FM from the previously mentioned type. It also has the smallest pricing error compared to all other models of various kinds. The three-factor model of size and value has the second-lowest intercept, followed by the five-factor model. Scale and investment indicate that the 4FM has the lowest intercept with its scale, profitability, and value. Nonetheless, we perceive an increase in size and worth in 5FM's performance.

Now we will summarize the GRS statistics for the 5x5 format. Now that the alphas are equal to zero, there is no test rejection, so the models are not rejected either. However, the significance of the model's performance rather than the statistical rejection of the model is the focus of the study. While 3FM and 4FM have the highest GRS ratings of all types, their efficacy is the worst. According to Fama and French (2015), the 5FM exhibits an advanced GRS in two types. In general, the 3FM yields superior results, indicating that the model's scale and value successfully explained the returns for various types. The 3FM's intercept is frequently smaller than that of other models. However, the 4FM's performance remains the finest among all models. Additionally, it is possible to demonstrate that both value and profitability contribute to explaining returns. The adjusted R-squared is the only indicator of the 5FM's development, which remains insufficient in terms of its ability to explain returns.

4.4.2 2x4x4 Portfolio Sorts

Since the construction of the portfolios is identical, the generated results are nearly similar to those of the 5x5 type. As can be seen, the extant intercepts are considerably larger than the 5x5 sorts. In addition, as we examine all 2x3x4 types, we observe that the adjusted R-squared decreases, while the five-factor model produces the highest adjusted R-squared for all 2x3x4 types. In the size-value and profitability portfolios, the intercept at 0.00823 generated by the four-factor model is the lowest. We have previously stated that the performance of the value-size-profitability model adequately explains the returns for the specified type. However, as the adjusted R-squared value indicates, the five-factor model outperforms all other models of the same kind. The size-value and investment portfolios exhibit the smallest intercept at 0.00995, which the 4FM generates along with size, value, and profitability. Therefore, the 3FM is superior to the 5FM, with the highest amended R-squared value. The size-operating and investment portfolios reveal that the 4FM, in addition to size, value, and operating profitability, produces the lowest pricing error at 0.000938. As evidenced by the 5x5 sorts, when we examine the intercept, the 3FM performs significantly better than the 5FM. The best efficacy of the 5FM is achieved when the adjusted R squared is ultimately high. As with the evaluated models, the GRS outcome is similar to the 5x5 types. Consequently, there is no model rejection, and the alphas are all equal to zero. In addition, the 3FM and the three 4FM have the worst performance with the highest GRS statistics. This indicates that the efficacy of the five-factor model is the best of all types. Presented in 5x5 formats, the 4FM performs comparatively well in size, value, and operating profitability, while the 5FM performs marginally worse. This result suggests that the reason for this is a greater spectrum of dissimilarity in larger types. Consequently, their productivity results are generally consistent when value and profitability increase in tandem with scale. Thus, it is demonstrated that value and profitability function well as models. It may be plausible to hypothesize that value may explain some of the returns investment presents.

4.5 Observations

The model comparison generates numerous significant findings that are shared. The five-factor model best depicts returns from a statistical standpoint, as its adjusted R-squared is the highest of all possible types. Therefore, from a statistical perspective, it performed admirably. In general, the size-value and size profitability models yielded fairly comparable results across the tested types, which was not unexpected because it was anticipated that a model employing particular variables would perform best in describing the returns of portfolios comprised of securities with the same characteristics. Specifically, these variables best-explained returns. This gave birth to the hypothesis that the value and profitability associated with an investment can capture the returns on investment. According to Novy-Marx, a profitability effect's influence on the cross-section of returns is comparable to value. This study examines the likelihood of profitability and value coexisting. Using profitability to hedge a value strategy enables the investor to capture both premiums without incurring additional risk. The potential for investment redundancy contradicts the findings of Fama and French (2015). Which discovered that the other factors absorbed the assimilated value, but Chiah et al. (2016) observed that value continued to explain the Australian stock market. The following session will be used to verify this implication. In addition, we will conduct a regression of the return of each of the five factors on the other four.

4.6 Factor Spanning Test Results

The following table ensures that the CMA factor is not redundant. It is similar to the table used by Fama and French in 2015 to demonstrate the redundancy of their HML factor.

Table 8 :the regression results for each factor regressed on four other elements. (RM – RF) is the market portfolio factor that we compute, regarding it as a monthly weighted value of the return of every stock in the sample minus the 13-week Moroccan Treasury Bill rate. At the end of December, companies are divided into five categories based on their size, using the market capitalization of all Moroccan stocks over the past year t. Similarly, firms are set to BE/ME, OP, and INV, and for the crisis, the 30th and 70th percentiles are used—each Size group's intersections with BE/ME, OP, or INV form value-weighted portfolios. As a size factor, SMB is calculated as the average return of small stock portfolios minus that of large ones. HML is the average of the high BE/ME portfolio returns minus the low estimated BE/ME portfolio returns. In addition, RMW, as the profitability factor, is calculated as the average robust OP portfolio returns minus the average low OP portfolio return. Ultimately, CMA, As the investment factor, is the average of the returns on conservative portfolios minus the average on aggressive portfolios.

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	Int	**RM – RF**	**SMB**	**HML**	**RMW**	**CMA**	**R2**
RM – RF							
Coef.	-0.030187		-0.351664	-0.081070	0.187201	-0.761971	0.624739
t-Statistic	-14.67517		-3.799830	-1.513318	2.294913	-10.34299	
P-Value	0.0000		0.0002	0.1333	0.0238	0.0000	
SMB							
Coef.	-0.010273	-0.349614		0.095421	0.031905	-0.110641	0.197438
t-Statistic	-2.968478	-3.799830		1.794281	0.382878	-1.060680	
P-Value	0.0037	0.0002		0.0757	0.7026	0.2913	
HML							
Coef.	-0.010421	-0.268295	0.317639		-0.030365	-0.630329	0.213885
t-Statistic	-1.603629	-1.513318	1.794281		-0.199623	-3.482606	
P-Value	0.1119	0.1333	0.0757		0.8422	0.0007	
RMW							
Coef.	0.015435	0.259854	0.044546	-0.012736		0.665828	0.386166
t-Statistic	3.878142	2.294913	0.382878	-0.199623		6.332876	
P-Value	0.0002	0.0238	0.7026	0.8422		0.0000	
CMA							
Coef.	-0.022086	-0.668623	-0.097656	-0.167132	0.420905		0.720618
t-Statistic	-8.506778	-10.34299	-1.060680	3.482606	6.332876		
p-Value	0.0000	0.0000	0.2913	0.0007	0.0000		

The monthly intercept values for RM – RF, SMB, HML, and CMA are markedly negative at -0.030187, -0.010273, -0.010421, and -0.022086, respectively. While the regression to explain the RMW factor is positive and greater than three standard deviations from zero (0.015435 per month), it is less than zero.

A statistically insignificant intercept indicates that a substantial portion of the factor return variance on the left-hand side of the regression is explained by the factors on the right-hand side. In 1987, Huberman and Kandel proposed that removing irrelevant components would not damage a mean-variance-efficient tangency portfolio created by combining other factors. The CMA factor aids the five-factor models' explanation of average returns over time. When CMA is the dependent variable, the RMF can clarify all other factors, and other factors can explain 72 percent of CMA. The analysis does not support the hypothesis that value and profitability can attract investment.

5. CONCLUSION

This study aims to determine if the five-factor model of Fama and French is valid for interpreting time-series variation in excess portfolio returns for the Moroccan equity market during 2009-2017. According to the results, the FF5FM maximizes the adjusted R2 values and minimizes the significance of the alpha terms. In addition, a model can explain 30.52 percent of the variance in stock returns, which is less than the average adjusted Rs degree for other markets. Based on these results, it would appear that FF5M is unable to accurately predict the return cross-sections at the Casablanca Stock Exchange (CSE). However, neither the FF3FM, FF4FM, nor FF5FM can fully explain the cross-section of stock benefits on the market. However, the four-factor model is most effective when size, value, and operating profitability are present. This model's high explanatory power is largely attributable to the RMW's prominence. CMA is not an excessive factor in the observed analysis regarding factor redundancy. Moreover, the potential candidates cannot be observed in any investigated factor.

Can the five-factor model be applied practically to the Moroccan stock market? The response is positive despite the deficiencies. Eugene F. Fama et al. (2017) assert that it is difficult to develop an ideal model. Less-than-perfect models can adequately explain typical outcomes. According to this study's findings, a relatively decent model is not fundamentally about adding more variables. Factor models are widely used as a device for portfolio production evaluation and design. Upon evaluation by alphas, anomalous returns generate the only profits in the initial application. This analysis suggests that the French five-factor model would perform no better than the four-factor model. However, profitability, value, and investment costs must also be considered if the portfolio tilts toward size. The 5FM must be chosen because its factor slopes may produce valuable statistics. The FFFFM refers to the empirical asset pricing model initially developed to identify well-known anomalies in the US stock market. Therefore, substantial enhancements or even replacements may be required for the factor construction to be more applicable on the Moroccan stock market.

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