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Does Five-Factor Model Perform Better Than Three Factor Model? Evidence from Developed Countries of The Asia Pacific Region

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ABSTRACT

This study evaluates whether the "Fama-French five-factor model" can explain the variations in expected returns better than the "three-factor model." Using the stock returns and accounting variable data from DataStream for 1,300 plus listed firms across six developed countries of the Asia Pacific region, including; Australia, Hong Kong, Japan, Israel, New Zealand, and Singapore for the period of Jun-2006 to February-2020. The paper is the first to examine the "five-factor model" performance across the developed countries of the Asia Pacific region. The empirical findings reveal that the Asia Pacific region for the sample period earns an equity premium. In addition, results report the redundancy of size factor (SMB) and value factor (HML), while the profitability (RMW) and investment premium (CMA) are positive and significant. Moreover, the study used Gibbons, Ross, and Shanken (GRS) test to the asset pricing model. The GRS test results on the "five-factor model" compared with the "three-factor model" demonstrate that profitability and investment factors add significant explanatory power to the analysis in the Asia Pacific region.

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1. Introduction

Almost all "asset pricing" methods are developed based on "CAPM" (Pisanie, 2018). Over a decade, several scholars, including Treynor (1961), Sharpet (1964), Lintner (1965), and Black, Jensen, and Scholes (1972), constructed and conceptualized the model collectively but independently. The "CAPM" model suggests a relation between "expected return on a stock" and market systemic risk. The only component in this model capable of explaining cross-sectional differences in expected stock returns is β, which is assessed by (the slope acquired by regressing a "stock's return" on the market return).

The contributions of Ross (1978) via developing the "arbitrage pricing theory" and "Fama and French" (1993) with the development of the "three-factor" (FF3) model triggered a paradigm change in "asset pricing" as a whole. Furthermore, Carhart (1997) added a "fourth factor" of stock price momentum to the model. Finally, "Fama and French" (2015) added two more variables linked to "profitability" and "investment" to their earlier FF3 model, resulting in a five-factor (FF5) model.

Over 60 years have passed to find the answer to a fundamental question in finance: how does the risk associated with an "investment" influence its "expected return?" Further, the exploration of the factors that impact equity returns is continued. The "Asset pricing" modeling has developed from a one-factor "CAPM" to FF5 model due to significant growth in asset-pricing literature to better explain the differences in the cross-sectional pattern of average stock returns. As per "Fama and French" (1993), research on nonfinancial sector stocks in the three leading US stock exchanges from 1963 to 1990 "CAPM" cannot sufficiently explain differences in "cross-sectional expected returns." Hence, to expand the original CAPM model, "Fama and French" (1993) include firm size and the book-to-market equity ratio to solve this problem.

Over the past half-century, "the asset pricing model" has evolved. Nonetheless, the hitches in the twenty-first century are much more than estimating basic asset returns by pricing "firm-specific" and "market-related" risks. Given its negative environmental impacts, a corporation's risk portfolio is incomplete without addressing "climate change" since climate change significantly impacts output and investment opportunities. (Akbar et al., 2021; Bolton and Kacperczyk, 2019; Dietz, Bowen, Dixon, and Gradwell, 2016; Dietz et al., 2018; Görgen et al., 2020; Kim, An, and Kim, 2015; Krueger, Sautner, and Starks, 2020).

The evolution has continued, and the new risk variables have been introduced to the "asset pricing" equation throughout time. In their quest for a better model, Chiah, Chai, Zhong, and Li (2016) discovered that the FF5 model outperformed the FF3 model for Australian stock markets. On the other hand, Japanese stock market experienced a reverse scenario, where the FF3 model outperformed the FF5 model (Kubota and Takehara, 2018). This article analyses the Asia Pacific area with six developed countries: "Australia, New Zealand, Hong Kong, Israel, Japan, and Singapore," in line with the study of "Fama and French" (2017). "Asset pricing" literature lacks the studies that compare the FF3 model and the FF5 model on the sample of developed countries of the Asia Pacific region, including "Hong Kong, New Zealand, Israel, and Singapore." Furthermore, "Fama and French" (2017) only included four countries in their Asia Pacific zone ("Australia, New Zealand, Hong Kong, and Singapore"). This research aims to expand asset pricing research using better data sets for the six developed economies in the Asia Pacific area, thereby filling a gap in the "asset pricing literature."

This research has three contributions and empirical results. The article first looks at the premiums of the right-hand side factors, such as "equity premium (Mkt), size premium (SMB), value premium (HML), profitability premium (RMW), and investment premium (CMA)." Second, the "factor spanning test" is used to determine the degree to which regression intercepts can explain average returns and identify which factors may be redundant. The study's last and fourth major topic is comparing model performance using the "GRS test."

The remainder of this article is in the following sequence. The literature review is in part 2, the data model and technique are in section 3, the empirical findings are in section 4, and the conclusion is in section 5.

2. Literature Review

The "asset pricing" modeling consists of two main categories: absolute and relative. Under relative asset pricing, the value of assets is derived from the market price of other assets without questioning where the values of these other assets originate. The "Black-Scholes option pricing formula" is one such example. On the other hand, absolute "asset pricing" is the critical problem in finance, i.e., understanding asset values concerning their exposure to "fundamental sources" of macroeconomic risk (Pitsillis, 2005). This section briefly summarizes the critical literature on "asset pricing models" among these models are the "mean-variance model," "Tobin's capital market line," "CAPM," "arbitrage pricing theory (APT)," FF3 model, and FF5 model. Until "Markowitz's mean-variance" model in 1952, portfolios were only assessed using average returns. The best average returns were utilized to build a portfolio, with little concern for the risk. By incorporating the mean-variance trade-off in portfolio selection research, Markowitz (1952) challenged this notion. Hence, the current theory of portfolio management was developed based on this method.

"Sharpe" (1964) and "Lintner" (1965) utilized the "CAPM" model, which is similar to Markowitz (1952) to evaluate the risk-return relationship. On the other hand, "CAPM" refers to the portion of the risk affected by the market as "systematic risk." Researchers were attempting to discover how capital markets determine the value of a company and the price of its shares. These frameworks served as the foundation for the idea of the "efficient markets hypothesis" (EMH), which was presented by (Fama, 1970). When stock prices accurately represent all of the information available, a market is said to be efficient.

Fama and MacBeth (1973) evaluated the "CAPM" model by utilizing the data from the "New York Stock Exchange." They found that average return and beta had a significant and favorable relationship. They also found that the link was not perfect, leading them to believe that other variables might be affecting the results. Ross (1976) developed the "arbitrage pricing theory" (APT) in response to the "CAPM," which argues that an "asset pricing model" is based only on arbitrage concerns. The model indicates that the anticipated return on an asset is affected by various risk variables, not only market risk, as the "CAPM" does. According to the APT model, the return on a security is proportionate to several systemic risk variables. The systemic risk variables, on the other hand, are not included in the APT model.

Numerous markets all around the world tried the "CAPM" in many ways with varying outcomes. Empirical tests in favor of the "CAPM" model were initially conducted by Friend and Blume (1970), Jensen et al. (1972), and Fama and MacBeth (1973). They used monthly data from the "New York Stock Exchange" from 1926 to 1966 to assess the "CAPM." To minimize beta estimate error, they split all of the stocks into ten portfolios. They used time-series and cross-sectional methods for evaluating the "CAPM" and discovered that the security market line has a positive and substantial slope (SML). Based on which they predicted an increase in the risk-free rate.

The "CAPM" model is the single-factor model that relates merely market returns to the average returns of securities or portfolios. Fama and French (1992) examined additional variables, and "Fama and French" (1993) extended the "CAPM" model with three more return components. The market factor is the first of the three components in the FF3 model, and it explains how the returns mimic those of a market portfolio. The second consideration is the firm size, termed SMB ("small market capitalization minus big market capitalization of companies"). It computes the extra return on capital that small capital companies get over big capital firms. The third component of the model is the HML ("high book-to-market ratio minus low book-to-market ratio"). The excess return on value equities over growth stocks is calculated using this factor. Thus, the FF3 model comprises three components: the market factor, the SMB, and the HML, which combined better explain stock return variance than the "CAPM" model (Fama and French 1993). The term "asset pricing theory" refers to studying the prices, valuations, and returns on uncertain payment entitlements such as stocks, bonds, and options.

Many empirical methods, unlike others, favor the FF3 model because of its ability to capture stock return fluctuations. The FF3 model was tested and shown to beat the CAPM, particularly defining stock returns more accurately in different markets (Bahl, 2006). The FF5 model was developed by "Fama and French" (2014) by adding two additional components to the FF3 model, namely profitability and investment considerations (Fama and French 1993). RMW (returns of businesses with high operational profitability minus returns of companies with low operational profitability) is the "profitability factor." In contrast, CMA is the "investment factor" (returns of conservatively investing firms against aggressively investing firms). "Fama and French" (2015) also examined the performance of the FF3 and FF5 devices. They found that the FF5 model beats the FF3 model in terms of overall performance using Nasdaq data. The FF5 model, however, does not explain why tiny businesses' stock returns are so poor, they pointed out.

According to the literature assessment, "asset pricing models" do not consistently explain enough variance in stock returns. As a result, academics have evaluated the validity of "asset pricing models" and compared their performance. Following Fama and French's (2015) research, investigations have been undertaken to assess the performance of these models utilizing data from various stock markets. We use a large sample of 1300 plus businesses from 2006 to 2020 to construct portfolios, evaluate the validity, and compare the performance of FF5 with FF3 across six developed countries of the Asia Pacific region.

3. Data and Methodology

The sample includes the monthly stock returns and accounting data covering 1,300 plus publicly-listed companies from six developed countries of the Asia Pacific region, including "Australia, Hong Kong, Israel, Japan, New Zealand, and Singapore." The dataset covers all publicly listed and delisted companies (to prevent survivorship bias) derived from the "ASSET4 ESG, a Thomson Reuters DataStream software (TDS)", with a sample period ranging from April 2006 to June 2020.

To be included in the sample, a stock must have "at least 24 months" of returns and accounting data, as shown in Table 1. The number of shares outstanding, adjusted price (P), unadjusted price (UP), total assets for t-2 and t-1, "total revenues, cost of goods sold, selling, general, and administrative expenses, interest expense" for t-1, minority interest, market capitalization, market equity data for December of t-1 and June of t, and (positive) book equity data for t-1 are among the data. All variables are denominated in US dollars to minimize exchange rate risk, compare "asset pricing models" across markets, and have a meaningful integration of international equities.

SMBt is the ("small minus big") common risk factor established by "Fama and French" (1993). It shows the return differential between a portfolio of small-cap equities and a portfolio of large-cap companies in the market. In June of year t, portfolios are constructed based on market capitalization (a proxy for size) calculated using accounting data for the fiscal year ending t-1).

HMLt "Fama and French" (1993) developed HMLt, which stands for the ("high minus low") common risk factor. It is the return differential between a portfolio of companies with the higher book-to-market ratio and a portfolio of stocks with the lowest book-to-market ratio in the market. Each year, portfolios are created in June based on the book-to-market ratio calculated using accounting data for the fiscal year ending t_{-1}).

RMWt is the ("robust minus weak") common risk factor established by "Fama and French" (2015). It is the return differential between a portfolio of high-profitability companies and a portfolio of low-profitability equities in the market. The fiscal year's profitability ending t-1 is evaluated using accounting data, and portfolios are created in June of that year. "Annual revenues minus cost of goods sold, interest expenditure, and selling, general, and administrative" costs are divided by book equity at the end of fiscal year t-1 to determine profitability.

Table 1
Factor Construction

Factor	Formula
SMB_{BM}	$(SH + SN_{bm} + SL)/3 - (BH + BN_{bm} + BL)/3$
SMB_{OP}	$(SR + SN_{op} + SW)/3 - (BR + BN_{op} + BW)/3$
SMB_{Inv}	$(SC + SN_{inv} + SA)/3 - (BC + BN_{inv} + BA)/3$
SMB	$(SMB_{BM} + SMB_{OP} + SMB_{Inv})/3$
HML	$(SH + SL)/2 - (BH + BL)/2$
RMW	$(SR + SW)/2 - (BR + BW)/2$
CMA	$(SC + SA)/2 - (BC + BA)/2$

Construction of Size, Book to Market B/M, profitability, and investment factors. Based on the independent sorts (2x3); particularly two Size groups, and two or three B/M, operating profitability (OP), investment (Inv) groups.

3.1. Right Hand Side (RHS) factors

"The RHS factors are portfolios constructed at the end of June in each year t, through 2x3 sorting on size, B/M, OP, investment. For the Asia Pacific region, stocks are sorted on market cap. In line with Fama and French (2015), the top 90 percent of market cap stocks are classified as big stocks while the bottom 10 percent are the small stocks. The breakpoints for B/M, OP, investment are the 30th and 70th percentile of their respective variables for the big stocks. The dollar-denominated returns are computed from the US investor's perspective using the one-month US Treasury bill rate as the risk-free rate. The very first RHS factor, Mkt, is the region's value-weighted market portfolio minus the risk-free rate. Market portfolio for the region is the value-weighted market returns—value-weighted returns of each stock are divided by the region's total market cap at the end of June in year t. The RHS explanatory factors are developed through 2x3 sorting that produces the six portfolios for the region. Based on NYSE breakpoints, 2x3 sorting for size and B/M generates six portfolios—SG, SN, SV, BG, BN, and BV, where S and B indicate small or big and G, N, and V indicate growth, neutral, and value (bottom 30%, middle 40%, and top 30% of B/M), respectively. After independent sorting, we compute the value-weighted returns for each of the six portfolios from July of year t to June of t+1" (Akbar et al.,2021).

3.2. Summary Statistics for Factor Returns

The mean, standard deviation, and t values of factors for the Asia Pacific region are shown in Table 2. The equity premium is (0.64 percent per month, t =1.9) throughout the study period of June 2007 to February 2020. The size premium presents the statistical trend for smaller market capitalization companies' stocks to outperform larger market capitalization companies' stocks. Due to the importance of the size effect (Fama & French, 1993) minted it into a fundamental risk factor in the asset pricing equation. As per results reported in table 3, the size premium (small firm stocks earn more returns than big firm stocks) is 0.35% per month (t= 0.70) demonstrates that the regions show a positive but insignificant size premium. The absence of size premium in the region indicates the riskier condition for small-cap stocks than mega-cap stocks.

The value premium HML is the average return gap between the high value –high book equity to market equity BE/ME ratio portfolio (H) and the low value –low BE/ME ratio portfolio.

Table 2
Summary statistics for factor returns: June 2007 – February 2020, 153 months

	Asia Pacific				
	Mkt	**SMB**	**HML**	**RMW**	**CMA**
Mean	0.57	0.35	-0.13	-0.03	0.77
Std Dev	4.14	6.25	4.47	3.97	4.32
t –Mean	1.72	0.70	-0.37	-0.10	2.20

The table 2 presents summary statistics of the RHS factors for Asia Pacific region denominated in US dollars. Portfolios are constructed at the end of June each year t through 2x3 sorting with the breakpoints of 30th and 70th percentiles lagged (fiscal year t-1). Mkt is return on a region's value-weight market portfolio minus the US one month T-bill rate is followed by Mean and standard deviation for SMB, HML, RMW, CMA factors.

The value premium (average HML returns), according to results reported in table 3, is negative and insignificant (−0.14% per month, t = −0.37). The statistics mentioned above confirm that value premium is not observed in the region; hence, high BE/ME ratio firms do not earn higher returns than low book equity to market equity firms. The "profitability premium (RMW)" is negative and insignificant (−0.03 per month, t = 0.10). It leads to the observation that profitable (robust) firms seem to have performed primarily poorly (lower stock returns) compared to weak firms.

The "investment factor (CMA)" quantifies the difference between the return on low and high-investment portfolios. The findings in Table 3 indicate that the "investment premium" (average CMA returns) is positive and statistically significant (0.77 percent per month, t = 2.2). These findings imply that low-investment companies' equities receive a higher rate of return than high-investment firms' stocks.

4. Empirical Results and Discussion

4.1. Factor Spanning Tests

The "factor spanning test" is used to evaluate how well average returns can be described by "regression intercepts" and detect potentially redundant factors. The regression results for the region are shown in Table 3, demonstrating that four variables account for the average returns on the fifth factor. The regression intercept is the average premium that is unexplained and unaccounted for by other factors (Barillas, Kan, Robotti, & Shanken, 2020). Suppose a factor has an insignificant intercept near zero. In that case, it will be considered redundant and may be removed from the RHS factor equation since the other factors will have captured its premium in the model (Fama and French, 2015). Mkt, the market factor, is not redundant (t = 1.73, 0.58 percent each month).

Table 3
Factor spanning tests

	Coefficients						t-Statistics						
	Int	**Mkt**	**SMB**	**HML**	**RMW**	**CMA**	**Int**	**Mkt**	**SMB**	**HML**	**RMW**	**CMA**	**R2**
Mkt	0.589		0.164	-0.147	-0.108	-0.01	1.73		3.06	-1.78	-1.15	-0.09	0.091
SMB	0.400	0.366		0.032	-0.189	-0.02	0.78	3.06		0.25	-1.35	-0.13	0.232
HML	0.379	-0.14	0.014		-0.207	0.018	1.12	-1.78	0.25		-2.26	0.23	0.232
RMW	0.507	-0.08	-0.065	-0.162		-0.18	1.70	-1.15	-1.35	-2.26		-2.57	0.236
CMA	0.658	-0.01	-0.007	0.020	-0.246		1.86	-0.09	-0.13	0.23	-2.57		0.091

In the region, the four factors are used in every regression equation to explain the average returns on the fifth factor: June 2007– February 2020, 153 months. Mkt presents the value-weight return on the market portfolio of the stocks of a region, minus the one-month Treasury bill rate; SMB (small minus big) is the size factor; HML (high minus low B/M) is the value factor; RMW (robust minus weak OP) is the profitability factor; and CMA (conservative minus aggressive Inv)" is the investment factor. The following Right-Hand Side (RHS) factors are constructed by sorting the size factor into two groups and rest of the factors into three groups.

Furthermore, the findings indicate that the size factor SMB is redundant (0.40 percent each month, t = 0.78). The value factor HML is the most crucial element to look for while looking for redundancy. Following the findings of (0.37 percent each month, t =1.12), this is likewise redundant (Fama and French, 2015). The "profitability factor RMW" is not redundant; the area has positive and meaningful values, although low (0.50 percent per month, t = 1.70). CMA is a favorable and substantial investment factor (0.65 percent per month, t =1.86). Due to their redundancy, the size factor SMB and the value factor HML are redundant for characterizing Asia Pacific average returns throughout the sample period. The average returns of Mkt, RMW, and CMA variables are spanned (thoroughly explained) by the average returns of the region.

The nine Size-B/M portfolios for the region are constructed at the end of June of each year. The break points for Size and B/M are the 3rd, 7th percentiles of aggregate market cap for a region. The B/M (book-to-market equity) quintile breakpoints use the big stocks (top 90% of market cap) of the region. The intersection of the 3x3 independent Size and B/M sorts construct the nine value-weight Size-B/M portfolios. The table demonstrates the three-factor and five-factor intercepts with t-statistics. The five-factor model is

4.2. Asset Pricing Regressions

Table 4 presents the intercepts of asset pricing regressions for three and five-factor models. Based on the 3x3 sorting that generates nine portfolios for each of the double sorted portfolios, including size–B/M, size–OP, and size–Inv. Henceforth, size, B/M, OP, and Inv are divide into three parts, called "tercile," each containing a third of the population. The intercepts show how the description of average returns changes with the change in the model, for instance, from the three-factor to the five-factor model.

Table 4
Three-factor and five-factor intercepts for nine Size-B/M portfolios of Asia Pacific: June 2007 – February 2020, 153 months

$$R_{it} - R_{ft} = \alpha_i + b_i Mkt_t + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t$$

	Intercepts(α)			t-Statistics (α)		
	Low B/M	**BM2**	**High BM**	**Low B/M**	**BM2**	**High BM**
Three Factor Intercepts						
Small	-0.15	0.00	-0.11	-0.32	0.02	-0.32
2	-0.13	-0.71	-0.07	-0.37	-2.35	-0.20
Big	-0.03	-0.25	-0.07	-0.26	-2.82	-0.49
Five Factor Intercepts						
Small	-0.15	0.15	-0.27	-0.31	0.39	-0.74
2	-0.11	-0.61	0.11	-1.30	-2.04	0.29
Big	0.05	-0.32	-0.09	0.37	-3.67	-0.67
	Low OP	**OP2**	**High OP**	**Low OP**	**OP2**	**High OP**
Three Factor Intercepts						
Small	0.62	-0.52	-0.19	1.13	-1.42	-0.50
2	-0.58	-0.44	0.39	-1.49	-1.45	0.88
Big	-0.20	-0.04	-0.14	-1.80	-0.53	-1.25
Five Factor Intercepts						
Small	0.61	-0.50	-0.25	1.51	-1.37	-0.75
2	-0.46	-0.24	0.40	-1.17	-0.83	0.90
Big	-0.20	-0.07	-0.11	-1.69	-0.86	-1.01
	Low Inv	**Inv2**	**High Inv**	**Low Inv**	**Inv2**	**High Inv**
Three Factor Intercepts						
Small	0.62	-0.14	-0.84	1.03	-0.34	-1.64
2	0.66	-0.39	-0.33	1.71	-1.00	-0.84
Big	0.13	-0.04	-0.15	0.69	-0.39	-0.81
Five Factor Intercepts						
Small	-0.15	-0.17	-0.35	-0.35	-0.41	-0.75
2	0.13	-0.29	0.04	1.48	-0.74	0.11
Big	0.01	-0.10	-0.00	0.09	-0.95	-0.02

4.2.1.Size–B/M portfolios

Table 4 reports the intercepts of nine size–B/M portfolios for the FF3 and FF5 regressions based on 3x3 sorting. These regressions are the basic building blocks of the asset pricing model test. When a model better explains the cross-sectional returns, its intercept must be near zero and insignificant; therefore, a lesser value of insignificant intercept is required. As per results reported in Table 4, the FF3 model "regression intercepts" for the Asia Pacific report negative and insignificant intercepts of regressions for small size – low B/M tercile, following statistics −0.32 percent (t = −0.53), −0.15 percent (t = −.32) present the three, FF5 model respectively. The values mentioned above fulfill the requirement, e.g., near-zero and insignificant, so where do the problematic values exist in the region? These are found in B/M level two tercile of big firms. The regressions intercept for FF3 model −0.25 percent (t = −2.82) and FF5 model −0.32 percent (t = −3.67), the intercepts are mainly close to zero and insignificant.

4.2.2. Size–OP portfolios

Table 4 presents the intercepts of nine size–OP portfolios for the FF3 and FF5 models. The lowest values of intercepts are observed in the Asia Pacific, further FF3 and FF5 models only report a single intercept which is significant and exists only in the big firms; big firm – low B/M tercile for FF3 and FF5 model −0.20 percent (t = −1.80), −0.20 percent (t = −1.69) respectively.

4.2.3. Size–Inv portfolios

The Asia pacific market reports the only two significant "regression intercepts" found through the FF3 model in firm size two –low investment tercile 0.66 percent (t = 1.71) and small firm –high investment tercile −0.84 percent (t = −1.64). Whereas rest of the two-factor model does not provide any evidence of significant intercepts."

4.3. Asset Pricing Tests

"The study's main objective is to evaluate the effectiveness of asset pricing models. As a consequence, it is essential to compare model performance. For a model to be considered optimum, the regression intercepts for a collection of double- or triple-sorted portfolios must be indistinguishable from zero. The intercepts are computed using the GRS F-statistic to test the null hypothesis that the slopes of all regressions are equal to zero (Gibbons, Ross, and Shanken, 1989). Furthermore, the GRS test may be used to compare the performance of asset pricing models. The dispersion of the unexplained part of LHS average returns relative to the dispersion of LHS average returns is calculated by comparing the performance of competing models using zero or near-zero sum of intercepts as a reference point. Which guarantees that the model adequately captures the bulk of the variation in portfolio average returns. To pass the GRS test, F-statistics must be close to 1.0, resulting in a judgment in which the null hypothesis is not rejected. The following equation represents the GRS model's null hypothesis.

$H_0: \alpha_i = 0 \; i = 1, \ldots,$ N,

Here, α_i is the sum of LHS portfolios intercepts, the LHS portfolios are the value-weighted average returns on portfolio i minus risk-free rate defined as $\bar{r}_i$. The dispersion is computed by the ratio of unexplained dispersion Aa_i^2 on LHS portfolios to total dispersion on LHS portfolios, that is, $\frac{Aa_i^2}{A\bar{r}_i^2}$. Further, GRS computations include the unexplained dispersion attributed to sampling error, $\frac{As^2(a_i)}{Aa_i^2}$, where, $As^2(a_i)$ denotes the average of the squared sample standard errors of a_i and Aa_i^2 is the average of squared intercept. A good model shows a low value of $\frac{Aa_i^2}{A\bar{r}_i^2}$, the ratio of unexplained dispersion to total dispersion, and high value of $\frac{As^2(a_i)}{Aa_i^2}$, the ratio of sampling error to unexplained dispersion" (Akbar et al., 2021).

GRS statistics are shown for the three and five-factor model across the Asia Pacific region: June 2007 to February 2020. Sampling error to unexplained dispersion $\frac{As^2(a_i)}{Aa_i^2}$, the ratio of unexplained dispersion to total dispersion $\frac{Aa_i^2}{A\bar{r}_i^2}$ and average adjusted R2 of the nine regressions.

Table 5

The statistical summary explains the monthly excess returns on the (3x3) sorts for Size-B/M, Size-OP, and Size-Inv portfolios

Model factors	GRS	p(GRS)	$\frac{As^2(a_i)}{Aa_i^2}$	$\frac{Aa_i^2}{A\bar{r}_i^2}$	AR^2
Panel A: 9 Size-BM portfolios					
Mkt SMB HML	1.371	0.206	0.301	0.175	0.811
Mkt SMB HML RMW CMA	1.946	0.050	0.300	0.203	0.821
Panel B: 9 Size-OP portfolios					
Mkt SMB HML	1.221	0.286	0.308	0.350	0.800
Mkt SMB HML RMW CMA	1.197	0.301	0.290	0.319	0.827
Panel C: 9 Size-Inv portfolios					
Mkt SMB HML	1.088	0.375	0.360	0.370	0.740
Mkt SMB HML RMW CMA	0.550	0.835	0.330	0.189	0.777

Table 5 presents the empirical findings of the "GRS test" specified under the 3x3 portfolio sorting and include the F-statistics, P-value, the "ratio of sampling error to unexplained dispersion," $\frac{As^2(a_i)}{Aa_i^2}$, the ratio of unexplained dispersion to total dispersion, $\frac{Aa_i^2}{A\bar{r}_i^2}$, and average adjusted R^2 of the nine regressions. Results show the FF3 model works well with the insignificant and lesser value of unexplained dispersion. The intercepts of size–B/M portfolio display that most of the significant intercepts belong to small-cap stocks that number increase as moving from FF 3to FF5 model. While the FF5 models reject the null hypothesis at the "5% level of significance," the results are similar (Fama and French, 2017).

4.3.1. GRS –Results for Size–OP Portfolio

After assessing the performance of factor models for size–B/M portfolios, we evaluated the performance of the FF3 model against the FF5 models on the test assets sorted based on size and OP. The "GRS test" results show that the FF5 model produces a lower value of unexplained dispersion and higher adjusted R-squared values. It rejects the FF3 model over the FF5 model, which better explains the average returns.

4.3.2. GRS –Results of Size–Inv portfolios

The next in the row of assessment is executing the asset pricing model and related tests on the size–investment test assets portfolios. The FF5 model outperforms the FF3 as per the "GRS test" results with insignificant values.

4.3.3. Results of Size–B/M–OP portfolios

Following "Fama and French" (2017) methodology, the slope intercepts are computed for the regions under each of the 2x4x4 sorts. The results illustrate that most intercepts are negative and insignificant. The low OP quartile of mega-cap stocks in FF5 models show declining intercepts with the increasing level of B/M.

Table 6
Three-factor and five-factor intercepts for 32 Size-B/M-OP portfolios; Jun 2007 to Feb 2020

	Small								Big							
	Intercepts(α)				t-Statistics (α)				Intercepts(α)				t-Statistics (α)			
	LBM	BM2	BM3	HBM	LBM	BM2	BM3	HBM	LBM	BM2	BM3	HBM	LBM	BM2	BM3	HBM
Three Factor Intercepts																
LOP	-1.06	-0.75	-0.89	-0.12	-2.07	-1.95	-3.17	-0.51	-0.54	0.15	0.22	-0.02	-1.30	0.64	1.08	-0.11
OP2	-1.08	-0.60	-0.41	-0.75	-2.73	-2.32	-1.77	-2.29	-0.14	-0.10	0.11	-0.50	-0.55	-0.69	0.70	-2.46
OP3	-0.59	-0.59	-0.59	-0.76	-2.64	-3.27	-2.17	-1.86	-0.19	-0.32	-0.11	-0.14	-0.91	-1.85	-0.52	-0.50
HOP	-0.19	-0.22	0.22	-0.05	-0.91	-0.95	0.71	-0.15	-0.01	-0.13	0.26	-0.43	-0.06	-0.59	0.79	-1.25
Five Factor Intercepts																
LOP	-0.84	-0.73	-0.70	-0.05	-1.63	-1.88	-2.55	-0.23	-0.46	0.24	0.28	0.08	-1.08	1.05	1.34	0.45
OP2	-1.00	-0.54	-0.33	-0.78	-2.51	-2.05	-1.42	-2.38	-0.14	-0.15	0.04	-0.53	-0.56	-1.04	0.25	-2.59
OP3	-0.54	-0.60	-0.50	-0.78	-2.37	-3.27	-1.84	-1.87	-0.26	-0.31	-0.18	-0.19	-1.22	-1.78	-0.88	-0.66
HOP	-0.16	-0.28	0.19	-0.10	-0.72	-1.19	0.60	-0.26	0.02	-0.18	0.24	-0.69	0.13	-0.82	0.72	-2.05

Note: t-value statistics the value greater than 1.645 and less than1.96 presents 10% significance level, the t value greater than 1.96 and less than 2.57 presents 5 % level of significance and t values greater than 2.57 shows the 1% level of significance.

The region presents fairly strong and significant intercepts, with the slopes increasing with an increasing level of B/M. The low OP of the FF5 model displays booming intercepts from −0.84 (t = −1.63) to −0.05 (t = −0.23). However, most of the significant "regression intercepts" were found in the micro-cap stocks. The FF5 model, on the other hand, beats the FF3 models in the Asia Pacific by better explaining "average returns." However, the level of significance does not support the GRS findings in its favor. The "GRS test" results reject both the FF3 and FF5 models.

4.3.4. Results of Size–B/M–Inv portfolios

The empirical findings enclosed in Table 7 demonstrate several significant "regression intercepts" across micro-cap and mega-cap stocks. The FF3 model displays the five significant intercepts in micro-cap stocks while the mega-cap carries only one. The FF5 model follows the same pattern and holds the same number of significant slopes in micro and mega-cap stocks. Nonetheless, most of the slopes are negative with insignificant t-statistics, which is considered suitable for passing the "GRS test."

Table 7. Three-factor and five-factor intercepts for 32 Size-B/M-Inv portfolios; Jun 2007 to Feb 2020

	Small								Big							
	Intercepts(α)				t-Statistics (α)				Intercepts(α)				t-Statistics (α)			
	LOP	OP2	OP3	HOP	LOP	OP2	OP3	HOP	LOP	OP2	OP3	HOP	LOP	OP2	OP3	HOP
Three Factor Intercepts																
LInv	-0.06	-0.40	0.00	-0.75	-0.26	-1.42	0.00	-2.48	-0.06	-0.03	-0.02	0.04	-0.18	-0.15	-0.08	0.14
Inv2	-0.09	-0.77	-0.91	-0.55	-0.43	-3.00	-3.03	-1.64	-0.10	-0.14	-0.20	-0.03	-0.53	-0.67	-1.21	-0.11
Inv3	-0.43	0.11	-0.29	-0.68	-1.78	0.43	-1.01	-2.10	0.12	0.50	0.03	-0.06	0.52	2.03	0.20	-0.32
HInv	0.11	-0.03	0.02	-0.33	0.41	-0.11	0.06	-0.93	0.12	-0.27	-0.32	-0.14	0.43	-1.32	-1.40	-0.54
Five Factor Intercepts																
LInv	-0.15	-0.41	0.08	-0.56	-0.66	-1.40	0.31	-1.89	-0.13	-0.11	-0.02	0.15	-0.36	-0.47	-0.11	0.51
Inv2	-0.15	-0.83	-0.86	-0.58	-0.64	-3.19	-2.82	-1.68	-0.19	-0.17	-0.22	0.14	-1.01	-0.82	-1.35	0.56
Inv3	-0.51	0.18	-0.14	-0.42	-2.10	0.71	-0.50	-1.35	0.01	0.38	-0.00	0.06	0.05	1.54	-0.02	0.29
HInv	-0.01	-0.11	-0.00	-0.23	-0.03	-0.34	-0.01	-0.66	-0.04	-0.43	-0.34	0.03	-0.15	-2.17	-1.44	0.13

Note: t-value statistics the value greater than 1.645 and less than1.96 presents 10% significance level, the t value greater than 1.96 and less than 2.57 presents 5 % level of significance and t values greater than 2.57 shows the 1% level of significance.

4.3.5. Results of Size–OP–Inv portfolios

The results reported in table 8 show that the Asia Pacific market exhibits many significant intercepts in both factor models. In the mega-cap stocks, the low investment quartile across all factor models shows the increasing intercepts with progressing level of profitability. Table 9

Table 8
Three-factor and five-factor intercepts for 32 Size-B/M-Inv portfolios; Jun 2007 to Feb 2020

	Small								Big							
	Intercepts(α)				t-Statistics (α)				Intercepts(α)				t-Statistics (α)			
	LBM	BM2	BM3	HBM	LBM	BM2	BM3	HBM	LBM	BM2	BM3	HBM	LBM	BM2	BM3	HBM
Three Factor Intercepts																
LInv	0.01	-0.35	-0.36	-0.27	0.04	-1.01	-1.29	-0.81	0.42	0.22	-0.07	0.17	0.97	0.88	-0.36	0.60
Inv2	-0.20	-0.48	-0.92	-0.45	-0.78	-1.64	-2.87	-1.21	0.32	-0.07	-0.26	-0.26	1.11	-0.37	-1.52	-0.84
Inv3	-0.61	-0.46	-0.69	-0.89	-2.64	-1.73	-2.34	-2.68	-0.17	0.01	-0.27	-0.57	-0.77	0.09	-1.26	-2.18
HInv	0.20	-0.12	-0.01	-0.41	0.85	-0.48	-0.05	-1.17	-0.08	0.14	0.16	0.03	-0.33	0.49	0.72	0.13
Five Factor Intercepts																
LInv	-0.04	-0.31	-0.28	-0.12	-0.13	-0.89	-0.98	-0.37	0.45	0.12	-0.04	0.41	1.04	0.49	-0.20	1.53
Inv2	-0.30	-0.52	-0.79	-0.30	-1.12	-1.72	-2.45	-0.81	0.08	-0.19	-0.29	-0.22	0.29	-0.93	-1.64	-0.71
Inv3	-0.73	-0.44	-0.67	-0.75	-3.15	-1.64	-2.22	-2.25	-0.25	-0.09	-0.34	-0.48	-1.16	-0.48	-1.57	-1.82
HInv	0.14	-0.18	0.01	-0.31	0.60	-0.72	0.04	-0.89	-0.17	0.03	0.13	0.17	-0.67	0.11	0.58	0.66

Note: t-value statistics the value greater than 1.645 and less than1.96 presents 10% significance level, the t value greater than 1.96 and less than 2.57 presents 5 % level of significance and t values greater than 2.57 shows the 1% level of significance.

Reports the "GRS test" results for the Asia Pacific, which are pretty interesting, where the FF3 model is rejected but presents a slight difference between both these values. The condition becomes baffling as the value of sampling error is substantial in the FF5 model, and the mean adjusted R square is more significant in the FF5 model that better predicts average returns higher for the FF5 model that better explains the average returns.

Table 9
Statistical summary to explain the monthly excess returns on the (2x4x4) sorts for Size-B/M-OP portfolios, Size-BM-Inv portfolios and Size-OP-Inv portfolios

Model factors	GRS	p(GRS)	$\frac{As^2(a_i)}{Aa_i^2}$	$\frac{Aa_i^2}{A\bar{r}_i^2}$	AR^2
Panel A: 32 Size-BM-OP portfolios					
Mkt SMB HML	1.695	0.022	0.270	0.390	0.691
Mkt SMB HML RMW CMA	1.676	0.024	0.280	0.380	0.695
Panel B: 32 Size-BM-Inv portfolios					
Mkt SMB HML	1.519	0.057	0.280	0.371	0.697
Mkt SMB HML RMW CMA	1.370	0.114	0.282	0.306	0.665
Panel C: 32 Size-OP-Inv portfolios					
Mkt SMB HML	1.126	0.315	0.273	0.245	0.677
Mkt SMB HML RMW CMA	1.131	0.310	0.272	0.242	0.685

GRS statistics are shown for three and five factor model across Asia Pacific region: June 2007 to February 2020. Sampling error to unexplained dispersion $\frac{As^2(a_i)}{Aa_i^2}$, ratio of unexplained dispersion to total dispersion $\frac{Aa_i^2}{A\bar{r}_i^2}$ and average adjusted R2 of the 32 regressions.

5. Conclusion

This study evaluates the performance of "asset pricing models," that whether two new factors, the "profitability (RMW)" and "investment factor (CMA)" introduced by "Fama and French" (2015), explain the variation in expected returns more than the previous FF3 model. A sample of six developed countries of the Asia Pacific region, including Australia, New Zealand, Hong Kong, Japan, Israel, and Singapore. The sample covers 1300 plus publically listed firms over 15 years ranging from June 2006 to February 2020. Using the accounting variables and stock returns data, we formed 3x3 and 2x4x4 independent test assets. The 3x3 sort contains nine portfolios; Size-BM, Size-OP, and Size-Inv. At the same time, the 2x4x4 sorts comprise 32 independent portfolios; Size-BM-OP, Size-BM-Inv, Size-OP-Inv.

Moreover, the study explores the factors premiums; results show the absence of size premium that confirm the returns of small stocks do not outperform the big stocks that indicate the risker conditions for small firms in the region. As per the findings, no value premium (HML) is observed that states returns of high BE/ME firms are less than the low BE/BM ratio firms. Besides, the value premium results further reveal the lack of "profitability premium" in the region, demonstrating the poor returns of profitable firms compared to weak firms. On the other hand, the "investment factor premium (CMA)" is positive and significant, presenting the higher returns of low investment firms than high investment firms.

An "asset pricing model" will be considered good with a better explanation of cross-sectional returns when its regressions intercepts are near zero and insignificant. As per the findings of 3x3 sorts size–B/M portfolios, most of the intercepts are negative and insignificant, but the mid-cap stock under both models reports two significant values. The intercepts of nine size–OP portfolios for the FF3 and FF5 models are negative and insignificant, but there is only one significant value under both factor models. However, there is no significant intercept in the size-OP sorts for the FF5 model, while the FF3 model again reports two significant intercepts. These intercepts collectively lead towards "GRS test" results for size-B/M sorting FF3 model works well than the FF5 model with the insignificant and lesser value of unexplained dispersion. In comparison, the FF5 model performs better than the FF3 model in the Asia Pacific region for 3x3 sorting size-OP and size-Inv portfolios.

The portfolio diversification further clarifies the "GRS test" results; most of the "regression intercepts" are negative and insignificant under the second portfolio 2x4x4 sorting. The FF5 model outperforms the FF3 model by better explaining the average returns under all three categories; Size–B/M–OP, Size-BM-Inv, and Size-OP-Inv. However, the significance level does not support the "GRS test" results in its favor the "GRS test" results reject FF3 models for Size–B/M–OP, Size-BM-Inv.

Chiah et al., (2016) found similar results in Australian stock markets, reporting the better performance of the five-factor model than the three-factor model. Nartea et al., (2009) compared the performance of three-factor model with CAPM and demonstrated substantial BM and momentum effects but a very modest size impact. The study shows that although the FF model has some advantage over the CAPM in terms of explanatory power, it still leaves a significant portion of the variance in stock returns unexplained. Additionally, the FF model is unable to account for New Zealand's significant momentum impact. Using Hong Kong stock returns Lam et al., (2010) examine the performance of a four-factor asset pricing model in comprison of three-factor model and reveal that the four-factor model can adequately explain return variation. The findings indicate that all four variables are significant in the model, although the intercepts are not. Additionally, the model is supported by the reasonably high adjusted R2 values and the insignificance of an additional explanatory variable, residual standard deviation.

Moreover, the model's robustness is tested for two effects: up and down-market situations and seasonal behavior. A recent study by Ekaputra & Sutrisno, (2020) evaluates the performance of the Fama-French three-factor (FF3) and five-factor (FF5) models. Whether the book-to-market factor (HML) is redundant in both markets in the presence of profitability and investment factors. In contrast to prior research, empirical results of the study demonstrate that FF5 does not outperform FF3 in explaining excess portfolio gains in both markets.

Further, in contrast to the US market, they discover that the HML component is not redundant in either market. The findings hold valid for equally weighted and value-weighted portfolios, as well as for a variety of factor-building techniques. Kubota and Takehara, (2018) evaluate if Fama and French's (2015) five-factor model adequately describes the price structure of stocks using long-run data for Japan. Utilizing the generalized method of moments (GMM) tests, they perform conventional cross-section asset pricing tests and assess the explanatory power of the two new Fama and French variables and found RMW and CMA are not statistically significant. Thus, the original Fama and French five-factor model is not the optimal benchmark pricing model for Japanese data from 1978 to 2014. These studies brought different results but non of the studies has conducted the comprison between the two well-known models of Fama and French (1993) and (2015). This study concludes that "profitability" and "investment factors" add more to the asset pricing model and better explains the variations in the six developed countries of the Asia Pacific region. The findings may shed insight on which variables contribute to the development of more accurate asset pricing models in Asia Pacific markets. As both financial practitioners and academics will benefit from improved asset pricing models.

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