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How Well has Fama-French Five-Factor Model Explained Asset Returns? - A Systematic Literature Review

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Abstract

Despite producing mixed findings, the Fama and French's (2015) model has been widely used to explain stock returns. This paper conducts a systematic literature review of the Fama and French's (2015) five factor model to evaluate its empirical validity in estimating the average returns of stocks. The review revolves around four major themes: performance of the five-factor model in explaining stock returns and whether it outperforms the three-factor model in stock returns estimation; predictive power of the two new factors in the five-factor model namely profitability and investment factors; value factor's redundancy for describing average stock returns after accounting for profitability and investment factors; and the exploration of other factors that could enhance the model's explanatory power. The paper used the PRISMA (The Preferred Reporting Items for Systematic Reviews and Meta-Analysis) method as a search strategy to conduct the systematic reviews. Highly cited articles published the Web of Science database from 2015 to 2022 were explored and a final sample of 61 were used in the review. The reviews find that in most studies, the Fama-French five-factor model is superior to the three-factor model in predicting the average stock market return at the national and regional levels. On the predictive power of profitability and investment factors, the findings were mixed. Similar conclusion was reached for the redundancy of value factor in explaining stock returns. Several other factors have also been found to increase the explanatory power of the five-factor model. The systematic literature of this paper evaluates several specific research questions related to Fama-French models, thereby providing researchers an understanding of the research topic and its evolution over time. Future review could be further expanded further to include articles from the Scopus-indexed journals. Insights from this paper are also useful for investors engaging in factor investing and in formulating asset allocation strategy.

Keywords: Five-factor Model, Three-factor Model, Profitability, Investment, Asset Pricing Model

Introduction

Asset pricing model is important to assist investors in estimating the value of equity. The capital asset pricing model (CAPM) is a well-known asset pricing model developed by (Sharpe, 1964; Lintner, 1965). The CAPM is a single-factor model that describes asset return as a function of the market risk factor, measured by beta. While the CAPM was the first asset pricing model to establish an equilibrium relationship between risk and return, the model was subjected to much criticisms due to its inability to explain an asset's return that was unrelated to market risk. In response, Fama and French (1993) augmented the CAPM by introducing three factor model to include size and value factors, alongside the market risk factor to uncover risk dimensions beyond the market factor. This is because empirical evidence has shown that on average, small firms have higher risk-adjusted returns than larger firms (Banz, 1981). Another irregularity is regarding the value factor of firms (Rosenberg et al., 1985). Value stocks were found to have high tendency to outperform growth stocks (Fama & French, 1998). The three-factor model of Fama and French (1993) has since become influential and widely used to explain stock return. Fama and French (1996b) show that many anomalies of CAPM observed from portfolio formed based on earning to price, cash flow to price, sales growth and past long-run returns, are all captured by the Fama and French's (1993) three-factor model. That is, these stock return patterns are explained by returns from portfolio formed on size and value risk factors.

Nevertheless, subsequent empirical studies conducted to assess the model's empirical validity have resulted in mixed findings. Vo (2015) finds that in the Australia context, while value is a priced factor but the size factor is not. According to Foye et al (2013), one of the weaknesses of Fama and French's (2013) model is the poor performance of the market risk factor. On the other hand, the explanatory power of the three-factor model was found to be valid for financial firms (Baek & Bilson, 2015). One recent study finds that the Fama and French three-factor model greatly improves the original CAPM in capturing variations in stock return in India (Sahai & Kumar, 2021). Nonetheless, the search for the determinants of asset pricing model continues. While extant literature has employed the Fama-French three-factor model as the standard asset pricing model to explain cross-sectional variation in stock returns, the model lacks theoretical explanation for the inclusion of the size and value factors (Kubota and Takehara, 2018).

In a study by Titman et al (2004), it was found that substantial increase in capital investments by firms could imply a negative equity returns. Another study found that a company's profitability is positively correlated with average equity returns (Novy-Marx, 2013). Considering these results, Fama and French proposed a five-factor model to include profitability and investment factors to improve on the three-factor model (Fama & French, 2015). Hence, the five-factor model was developed to provide a better description of the average returns in 23 developed markets (Fama & French, 2017). Since 2015, there have been many empirical studies conducted on the application of the Fama and French five-factor model. However, to our best knowledge, there has not been a systematic literature review published with regards to this particular topic. A systematic literature review could provide a comprehensive understanding on a topic of interest in advancing the field of knowledge. In addition, a systematic review enhances the review process by documenting a transparent and replicable method (Foglie & Panetta, 2020). Furthermore, a systematic review could also offer a thorough evidence to build upon a research and a myriad of future research directions (Xu et al., 2019).

The research questions central to the current study are: "To what extent Fama and French five-factor model describes the average equity returns?", and "What modification has been added to Fama and French five factor model to overcome its limitation?". In the literature, the study of the Fama and French five-factor model includes the assessment of the newly added factors namely the profitability and investments factors, the overall dynamic of the five-factor model, and how well the model describes the average returns of equity. For example, the addition of investment and profitability factors has resulted in the value factor to be redundant (Fama & French, 2015). However, it was found that the value factor retains its explanatory power in the Australian equity market (Chiah et al., 2016). The current study is conducted based on a total of 61 articles retrieved from the Web of Science Core Collection database. The selection process is explained in details in the research design section and a brief summary of each article in this study is compiled in Appendix A.

The remaining sections of this paper is organised as follows. Section 2 explains the Fama and French five-factor model. In Section 3, the research design is discussed, detailing the sample articles and selection process. Section 4 compiles the findings, themes and discussions of individual themes. Section 5 concludes the paper with contribution and suggestions for future research in this area.

The Five-Factor Model of Fama and French (2015)

Fama and French (1993) extends the traditional capital asset pricing model CAPM (Sharpe 1964) by including size and value factors:

$$R_{it} = R_{ft} + \beta_i(Rm_t - R_{ft}) + s_iSMB_t + h_iHML_t + \epsilon_{it} \quad (1)$$

Where R_i is the return on test portfolio *i*; R_f is the risk-free rate; β_i is portfolio *i*'s capital asset pricing model beta, Rm is the market return, SMB (small minus big) is company's size based on market capitalisation; and HML (high minus low) is the value factor based on the market-book ratio. In essence, by including the size and value factor into the CAPM model, Fama-French three-factor model is aimed at improving the predictive capability of the asset-pricing model by capturing the size and value premium alongside the market risk premium. The performance of the model seems to improve with the addition of other factors which have been shown to impact the market returns (Sahai & Kumar, 2021).

As such, the Fama and French five-factor model (Fama & French, 2015) then extends the earlier three-factor model by incorporating the profitability and investment factors as follows.

$$R_{it} = R_{ft} + \beta_i(Rm_t - R_{ft}) + s_iSMB_t + h_iHML_t + r_iRMW_t + c_iCMA_t + \epsilon_{it} \quad (2)$$

Where RMW (robust minus weak) is the profitability factor which is based on the operating profit; and CMA (conservative minus aggressive) is the investment factor which refers to the company's internal investment and returns.

Research Design

This paper conducts a systematic literature review on the applicability and the explanatory power of the Fama and French five factor model (Fama & French, 2015). Apart from that, this paper also examines the limitations of the model and how subsequent researchers have adjusted the model to improve its applicability. Thus, this paper contributes

to the literature by compiling empirical studies that examined the validity of Fama & French's five factor model as well as how scholars have subsequently enhanced the existing model to improve its performance. The methodology employed is systematic literature review, which is defined as a type of scientific investigations that involves rigorous compilation of past studies and synthesis of their results using a pre-determined method to reduce random error and biasness (Cook, 1997). Hence, a systematic literature review article provides a comprehensive understanding of the selected topic, reveals research gaps in that area, and assists in identifying potential future research directions (Paul & Criado, 2020). Furthermore, this study adopts a qualitative systematic literature review, in which the findings of the primary studies are summarised without being statistically combined (Cook, 1997).

The systematic literature review methodology in this paper is modelled after previous reviews conducted in the field of finance which comprises three stages: planning, execution and reporting (Foglie & Panetta, 2020). The articles selection method is based on the flow diagram from the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement Moher et al (2009) which initially requires searching the literature, which will result in a final number of records or articles. Then the records are screened to exclude some of the articles. Full-text articles are subsequently examined to exclude those that did not meet the eligibility criteria. Finally, the remaining articles otherwise known as the included studies are categorised into different taxonomy and summarised (Foglie & Panetta, 2020). The three stages of the systematic literature review are performed as below:

Planning

The topic selected is with regards to the Fama and French five factor model. This paper seeks to answer the following research questions: "To what extent the Fama and French five factor model is applicable in the empirical studies?", and "What modification has been added to Fama and French five factor model to overcome its limitation?". The Web of Science, or specifically, Web of Science Core Collection, a highly trusted citation index is chosen as the selected database for this study Xu et al (2019) as it is one of the most comprehensive databases of peer-reviewed journals which encompasses the Social Sciences Citation Index (SSCI) and Emerging Sources Citation Index (ESCI) (Foglie & Panetta, 2020). There are several reasons why we employed the Web of Science (WOS) as the research engine to retrieve articles. Unlike Scopus database which is owned by Elsevier, WOS is publisher-independent, hence removing any potential conflict of interest and bias in screening for a journal's quality and impact criteria. The WOS Core Collection is at the heart of WOS and it provides the world's highest quality and most impactful publications covering 6 citation indexes such as Science Citation Index Expanded (SCIE), Social Science Citation Index (SSCI), Arts & Humanities Citation Index (AHCI), Emerging Sources Citation Index (ESCI), Conference Proceeding Citation Index and Book Citation Index. Additionally, only WOS Core Collection indexes every article and journal's cited references, hence providing the most comprehensive citation network for researchers (Source: https://clarivate.com/webofsciencegroup/solutions).

Among other inclusion criteria, this paper includes articles published from the year 2015 to 2022. The start year 2015 corresponds to the year in which the Fama and French five-factor model was developed. In addition, the articles should be published in top journals (SSCI or ESCI edition), written in English, and can be found by using the keywords: fama and french five factor model. The use of only "and" Boolean operator in between the keywords is to allow for a large number of related articles to be displayed on the Web of Science search engine, in order to avoid selection bias. Next, the articles are limited to Business Finance and Business

subject area only. Also, the type of document is limited to Article and Early Access, excluding Proceedings Papers and Book Chapters.

Execution

Firstly, from the total of 138 articles (after excluding one duplicate), those that are considered off-topics were excluded. Specifically, articles which do not contain any discussion on Fama and French five factor model were excluded. This is done by reading the titles and also the abstracts of the articles. As a result, 16 articles are excluded at this stage, with 122 articles left.

Next, the sample assessment is conducted to ensure that all the articles are relevant to answer the research questions and also to avoid biasness in article selection. This is achieved by reading the abstracts of all sample articles to check the discussion regarding the applicability of the Fama and French five factor model, the comparative performance of the model, any modification and also the limitation of the five factor model. Articles that are not relevant in answering the paper's proposed research questions were excluded. For examples, articles that employ five factor model without evaluation (37), seek to develop new asset pricing models (7) and other miscellaneous articles considered irrelevant to the current systematic literature review (16). The original paper published by Fama and French (2015) is also excluded (1) at this stage as it is not relevant to the current review, which seeks to study the subsequent application of the said model. After excluding a total of 61 articles at this stage, the number of articles included in the qualitative synthesis is 61.

Double sample checking is the continuation from the previous sampling checking process. After reading the titles and abstracts, the full-text of the selected articles are examined including the objectives and the findings to ensure that they are relevant to the current scope of study. This particular step is crucial to ensure close alignment between the chosen articles and the research questions and also to avoid selection bias. The sample check is the substantial analysis entailing the analysis of the articles to categorise the main objectives.

Reporting

Finally, the findings are consolidated whereby the included articles (a total of 61 articles) are grouped into four main categories namely; the application of the Fama and French five factor model (26), the application and comparison of the Fama and French five factor model with other models (17), the enhancement of the five factor model (14) as well as the limitation of the five factor model (4). The main findings and themes of the articles are discussed according to the main groups in the following section.

Results

Sample and Data Population

Based on the systematic literature review methodology Foglie & Panetta (2020), a systematic review of the application of the Fama and French five factor model is conducted. The aim of this paper is to answer the aforementioned research questions. Hence, the initial population of 139 articles was obtained from the Web of Science Database by applying the keywords (fama, french, five, factor and model) as the selection criteria. During the screening process, articles were excluded if they do fulfil the screening criteria mentioned in section 3.2. The full-text articles are then assessed to ensure they are relevant to the scope of the current systematic review, hence resulting in a total of 61 articles. At this stage, articles will also be

excluded if they are merely utilising the Fama and French five factor model without critically evaluating its application are excluded. This is because the aim of this paper is evaluate the validity of Fama and French five factor model. Similarly, articles proposing newer asset pricing models are also excluded due to the lack of analysis of the five-factor model.

As a result, the final dataset consists of 61 articles selected from the Web of Science Database over the sample years from 2015 to 2022. The data was extracted on 4th of June, 2022 at 2.14 pm. Table 1 below indicates the number of articles published in each year from 2015 to 2022.

Table 1
Number of publications and year

Year	No of Articles
2015	0
2016	4
2017	6
2018	11
2019	13
2020	12
2021	12
2022	3
Total	61

Source: authors' own tabulation based on Web of Science search, 2022 edition.

Then, the list of leading business and business finance journals included in this study is listed in Table 2 below. The selected articles were sourced from journals indexed in the Social Science Citation Index (SSCI) and the Emerging Sources Citation Index (ESCI) of the Web of Science Core Collection Database.

Table 2
Number of publications, the Journal Citation Reports (JCR) Abbreviations, and Journal Edition.

No	Journal Name	Journal Citation Reports (JCR) ABBREVIATION	Journal Edition SSCI/ESCI	No
1	ASIA-PACIFIC JOURNAL OF ACCOUNTING & ECONOMICS	ASIA-PAC J ACCOUNT E	Q3 SSCI	2
2	ASIA-PACIFIC JOURNAL OF FINANCIAL STUDIES	ASIA-PAC J FINANC ST	Q4 SSCI	1
3	BORSA ISTANBUL REVIEW	BORSA ISTANB REV	Q1 SSCI	3
4	CUADERNOS DE GESTION	CUAD GEST	ESCI	1
5	EMERGING MARKETS FINANCE AND TRADE	EMERG MARK FINANC TR	Q2 SSCI	4
6	EMERGING MARKETS REVIEW	EMERG MARK REV	Q1 SSCI	5
7	GLOBAL BUSINESS REVIEW	GLOB BUS REV	ESCI	1
8	INTERNATIONAL JOURNAL OF FINANCE & ECONOMICS	INT J FINANC ECON	Q2 SSCI	2

9	INTERNATIONAL JOURNAL OF ISLAMIC AND MIDDLE EASTERN FINANCE AND MANAGEMENT	INT J ISLAMIC MIDDLE	Q3 SSCI	1
10	INTERNATIONAL JOURNAL OF MANAGERIAL FINANCE	INT J MANAG FINANC	ESCI	1
11	INTERNATIONAL REVIEW OF ECONOMICS & FINANCE	INT REV ECON FINANC	Q2 SSCI	1
12	INTERNATIONAL REVIEW OF FINANCE	INT REV FINANC	Q3 SSCI	3
13	ISTANBUL BUSINESS RESEARCH	ISTANB BUS RES	ESCI	1
14	JOURNAL OF AFRICAN BUSINESS	J AFR BUS	ESCI	1
15	JOURNAL OF ASIAN FINANCE ECONOMICS AND BUSINESS	J ASIAN FINANC ECON	ESCI	4
16	JOURNAL OF ASSET MANAGEMENT	J ASSET MANAG	ESCI	3
17	JOURNAL OF BANKING & FINANCE	J BANK FINANC	Q1 SSCI	1
18	JOURNAL OF EMPIRICAL FINANCE	J EMPIR FINANC	Q2 SSCI	1
19	JOURNAL OF FINANCIAL ECONOMICS	J FINANC ECON	Q1 SSCI	1
20	JOURNAL OF FINANCIAL RESEARCH	J FINANC RES	Q3 SSCI	1
21	JOURNAL OF INTERNATIONAL FINANCIAL MARKETS INSTITUTIONS & MONEY	J INT FINANC MARK I	Q1 SSCI	1
22	JOURNAL OF INVESTING	J INVEST	ESCI	1
23	JOURNAL OF RISK AND FINANCIAL MANAGEMENT	J RISK FINANC MANAG	ESCI	2
24	JOURNAL OF RISK FINANCE	J RISK FINANC	ESCI	1
25	JOURNAL OF SUSTAINABLE FINANCE & INVESTMENT	J SUSTAIN FINANC INV	ESCI	1
26	MANAGERIAL FINANCE	MANAG FINANC	ESCI	2
27	NORTH AMERICAN JOURNAL OF ECONOMICS AND FINANCE	N AM J ECON FINANC	Q2 SSCI	1
28	PACIFIC BUSINESS REVIEW INTERNATIONAL	PAC BUS REV INT	ESCI	2
29	PACIFIC-BASIN FINANCE JOURNAL	PAC-BASIN FINANC J	Q2 SSCI	6
30	QUANTITATIVE FINANCE	QUANT FINANC	Q2 SSCI	1
31	REVIEW OF FINANCIAL STUDIES	REV FINANC STUD	Q1 SSCI	1
32	REVIEW OF PACIFIC BASIN FINANCIAL MARKETS AND POLICIES	REV PAC BASIN FINANC	ESCI	1
33	SCHMALENBACH BUSINESS REVIEW	SCHMALENBACH BUS REV	ESCI	1
34	SPANISH JOURNAL OF FINANCE AND ACCOUNTING-REVISTA ESPANOLA DE FINANCIACION Y CONTABILIDA	SPAN J FINANC ACCOUN	Q4 SSCI	1
35	VISION-THE JOURNAL OF BUSINESS PERSPECTIVE	VISION-INDIA	ESCI	1
	Grand Total			**61**

Source: authors' own tabulation based on information from Journal Citation Reports, 2022 edition.

Research themes and Discussions

After analysing a total of 61 selected articles in the current systematic literature review, the paper has identified several themes. The first theme relates to the performance of the Fama-French five-factor model in explaining stock returns. This paper found 38 articles which concluded that the Fama-French five-factor model has empirical validity and is relevant in explaining average equity returns. Such evidence provides answers to this paper's research question regarding "To what extent the Fama and French five-factor model describes the average equity returns?". Specifically, the findings that the Fama and French five-factor model outperforms the earlier Fama and French three-factor model Fama & French (1993) as well as other models such as the Carhart four-factor model Carhart (1997) provide supporting evidence for the research question. Therefore, the first theme relates to the explanatory power of the Fama and French five-factor model in stock market returns estimation. Examples of studies indicating that the Fama and French five-factor model is superior to the three-factor model are as follows: (Chiah et al., 2016; Fama and French, 2016; Lin, 2016; Fama and French, 2017; Aras et al., 2018; Leite et al., 2018; Balakrishnan et al., 2018; Foye, 2018; Sarwar et al., 2018; Chai et al., 2019; Ishtiaq et al., 2019; Chiah et al., 2019; Dutta, 2019; Sadhwani et al., 2019; Shi et al., 2020; Foye and Valentincic, 2020; Kaya, 2021; Ryan et al., 2021). The validity of the Fama and French five-factor model can also be observed in national and regional studies. Countries wise, the five-factor model outperforms the three-factor model in describing the returns of equity market in the United States of America Sarwar et al (2018); Chai et al (2019); Roszkowska & Langer (2019); Alonso-Conde & Rojo-Suarez (2020); Hachicha (2020), Australia Chiah et al (2016); Zhong (2018); Chai et al (2019), South Africa (Charteris et al (2018) China Lin (2017); Guo et al (2017); Singh et al (2022), South Korea (Kang et al., 2019) Vietnam Ryan et al (2021), Poland Roszkowska & Langer (2019), India (Balakrishnan et al., (2018), Singh et al (2022), Pakistan Ishtiaq et al (2019); Sadhwani et al (2019); Ali et al (2021), Jordan Gharaibeh & A-Qudah (2020), and Turki (Aras et al., 2018; Kaya, 2021). Regionally, similar findings on the empirical validity of Fama and French five-factor model are also discovered in the context of international market Fama & French (2017); Cakici & Zaremba (2021), emerging market Foye (2018); Leite at al (2018); Lalwani & Chakraborty (2020), emerging European market Zaremba & Czapkiewicz (2017), and European market (Alonso-Conde & Rojo-Suarez, 2020). Hence, the above studies provide evidence on the effectiveness of Fama and French five-factor model in predicting equity returns globally. It is also important to note that while regional studies of the Fama and French five-factor model are robust, the predictive power of the model at the national level might differ and need to be investigated individually (Lin, 2017).

In addition to the outperformance of the Fama and French five-factor model against the earlier three-factor model, the research question regarding the validity of the model could be answered by examining the significance of additional factors included in the model. Fama and French (2015) proposed a five-factor asset pricing model which enhances the three-factor model by including profitability and investment factors to increase the explanatory power of the model. Therefore, the second theme is on the predictive power of profitability and investment factors in the Fama-French five-factor model. The related literature can be divided into three main categories namely; the profitability and/or investment factors greatly improve the explanatory power of the model; these factors are significant but only have weak effects; and these factors do not enhance the predictive power of the model.

Sarwar et al (2018) found that both profitability and investment factors significantly improve the explanatory power of the model in describing the average returns of the US

stocks, which is confirmed by more recent studies (Hachicha et al., 2020; Leite et al., 2020). Similarly, Skocir and Loncarski (2018) find that profitability and investment factors enhance the explanatory power of the three-factor model. The profitability factor is found to be the main driver of stock returns alongside the value factor in the Eastern Europe and Latin America markets, but not in the Asia market (Foye, 2018). Both investment and profitability factors, which are part of a firm fundamentals are significant in pricing assets in the Indian equity market Balakrishnan et al (2018) and South African market (Charteris et al., 2018). Roszkowska and Langer (2019) finds that profitability and size factors are particularly important in describing US and Polish stock returns. Chai et al (2019) also finds support for the significance of profitability and investment factors in pricing large Australian stock market. Gharaibeh and Al-Qudah (2020) discovered that both investment and profitability have significant explanatory power in Jordanian stock market, with profitability and value factors being the main drivers for cumulative returns. In addition to the findings indicating that all factors are significant, Chen and Gao (2020) finds that market factor is negatively correlated with profitability and investment factors. Ali et al (2021) discovered that profitability and investment factors significantly improve the predictive power of Fama and French five-factor model in pricing stock returns in Pakistan.

In the Chinese stock market, although investment factor is found to be significant, its contribution is trivial when compared to other factors in the model (Guo et al., 2017). While Fama and French five-factor model seems to outperform the three-factor model, the effects of profitability and investment factors are weak (Leite el al., 2018). Additionally, Foye and Valentincic (2020) found that the inclusion of profitability and investment only marginally improves the performance of the model in explaining Indonesian equity market returns. Similarly, in Turkish stock market, while the investment and profitability factors are significant, the effects are marginal (Kaya, 2021). The weak predictive power of profitability and investment factors are also documented for stocks returns in Australian, Canada, China, and the US (Lalwani & Chakraborty, 2020).

Furthermore, Lin (2017) finds that while value and profitability factors are significant stock return predictors, the investment factor is deemed redundant in explaining the average returns of Chinese equity market. Singh et al (2022) finds that investment factor has no explanatory power in the presence of profitability factor in the sample of Chinese and Indian stock market, despite the significant predictive power of profitability and investment factors in the Fama and French five-factor model. The mixed finding on the performance of the model is also documented in (Escribano et al., 2022).

On the other hand, there are articles indicating that the Fama and French five-factor model is not able to explain the average returns of equity markets. Contrary to Sarwar et al (2018); Ben Ammar et al (2018) finds that Fama and French five-factor model cannot explain the average returns of US stocks, particularly property and liability insurance stocks. Kubota and Takehara (2018) finds that the inclusion of the profitability and investment factors are not significant in pricing Japanese equity market. Similarly, these factors are not significant in pricing the assets on the Turkish stock market Azimli (2020) and German equity market (Dirkx & Peter, 2020). Huang and Liu (2019) documents the limitation of the five-factor model in describing average equity returns across different industries in China. In addition, it has also been found that the inclusion of the profitability and investment factors does not enhance the three-factor model's explanatory power (Zaremba et al., 2021). In the context of global market, Cakici and Zaremba (2021) finds that the additional two factors are not reliable and are highly dependent on the time period and geographical area of the sample. Particularly,

the investment and value factors are almost non-existent among large firms. Salim et al. (2021) finds that despite the significance of all factors in the model, the Fama and French five-factor model cannot describe the equity returns of Pakistani commercial banks. In the context of frontier market, the inclusion of profitability and investment factors did not improve the performance of the asset pricing model (Zaremba et al., 2021). Finally, Wang (2021) discovers that the Fama and French five-factor model's explanatory power diminishes during explosive or bubble period, due to excessive speculation.

The third theme is about the redundancy of the value factor in the Fama and French five-factor model. While Fama and French (2015) proposes a five-factor model in asset pricing, they also find that the value factor has become redundant when the profitability and investment factors are added to the model. The systematic literature review has discovered mixed findings with regards to this. Numerous studies that found the value factor to be redundant are (Gregoriou et al., 2016; Leite et al., 2018; Dutta, 2019; Kaya, 2021; Ali et al., 2021). Gregoriou et al (2016) find that the value factor become redundant with the inclusion of profitability and investment factors because they serve as good substitutes for the value factor. Leite et al (2018) also finds the value factor to be redundant when profitability and investment factors are included. Dutta (2019) finds that the value factor becomes redundant with the inclusion of the additional factors despite outperforming the earlier three-factor model. This is also observed in the Turkish stock market Kaya (2021) and Pakistan stock market (Ali et al., 2021).

However, a significant number of studies finds that the inclusion of the profitability and investment factors does not cause the value factor to become redundant, contrary to Fama and French's (2015) findings. For the pricing of Australian equity market, Chiah et al (2016) finds that the value factor remains significant even with the inclusion of additional factors. Similarly, Racicot and Theoret (2016) finds that the value risk factor is not redundant when evaluating hedge fund strategies. Further, the value factor remains significant despite the inclusion of profitability and investment factors in explaining stock returns in Pakistan Shaikh et al (2019), South Korea Kang et al (2019), Jordan Gharaibeh & Al-Qudah (2020), Vietnam Ryan et al (2021), China and India (Singh et al., 2022). Such evidence is also observed in a more recent study by (Chen & Gao, 2020).

The second research question in this systematic review is "What modification has been added to Fama and French five factor model to overcome its limitation?". In order to answer this question, articles are examined to find any modification or the limitation of the five-factor model. Hence, the fourth theme that emerges from this systematic review is the exploration of other factors that could potentially enhance the performance of the Fama-French five-factor model. For this theme, the momentum and liquidity factors are the most common factors being considered to be included in the asset pricing model. According to Skocir & Loncarski (2018), momentum factor can increase the explanatory power of the Fama and French five-factor model. This is in line with Fama and French (2016) which indicates that the five-factor model could not explain the accruals and momentum factors. Interestingly, Charteris et al (2018) attempt to establish whether the additional profitability and investment factors could explain the momentum anomaly in the South African market. The result indicates that the pricing errors are still significant, suggesting that the five-factor model is not able to capture the momentum anomaly. Chai et al (2019) suggests that the inclusion of momentum factor could enhance the Fama-French five-factor model's performance in pricing assets in the US and Australian stock markets. In addition, Zaremba et al (2019) documents that the Carhart four-factor model outperforms the Fama and French five-factor model in

describing the average returns of the Polish stock market, signifying the importance of the momentum factor in asset pricing, which is further confirmed by (Zaremba et al., 2021). However, the inclusion of momentum factor does not provide significant improvement to the model in the case of German stock market (Dirkx & Peter, 2020). In contrast, Gregory et al (2021) indicates that the explanatory power of the Fama and French five-factor model could be improved by including momentum and sustainability factors. Escribano et al (2022) also suggested the inclusion of the momentum factor.

Apart from momentum, the liquidity factor can also enhance the performance of the Fama and French five-factor model (Skocir & Loncarski, 2018). Racicot et al (2019) finds that illiquidity factor is important in the asset pricing model in the dynamic context. This is supported by Gong et al (2021), which finds that the liquidity factor could improve the performance of the Fama and French three-factor and five-factor models. Conversely, Safiuallah and Shamsudin (2021) finds that the inclusion of liquidity and interest rate factors does not improve the pricing ability of the model. More recently, Escribano et al (2022) proposes the inclusion of traded liquidity factor into the model.

Other factors that have been studied that could potentially enhance the performance of the Fama and French five-factor model are investor sentiment index Dhaoui & Bensalah, (2017); Hachicha et al (2020), low-risk anomaly Blitz & Vidojevic (2017), human capital component (Roy & Shijin, 2018), default risk factor Skocir and Loncarski (2018); Khan & Iqbal (2021), credit risk factor Li & Lin (2021), volatility risk factor Chen & Gao (2020), nominal interest rate factor Safiuallah & Shamsudin (2021); Escribano et al (2022), consumer price index Leite et al (2020) and sustainability factor (Gregory et al., 2021).

Conclusion and Future Studies

The Fama and French five-factor model proposed the inclusion of profitability and investment factors into the existing three-factor model. Thus, the five-factor model consists of the market, size, value, profitability and investment factors in estimating the average returns of the equity market. Many studies have been conducted to empirically test the validity of the five-factor model in predicting stock returns. The current paper conducts a systematic literature review of the empirical validity of the Fama and French five-factor model and contributes to the existing literature by identifying the research themes, potential gaps in the literature and direction for future studies. The initial sample consists of 139 article selected from the Web of Science Core Collection. After the removing duplicates, screening and full-text examination, the final sample of articles comprise of 61 articles relevant in answering the following research questions “To what extent Fama and French five-factor model describes the average equity returns?”, and “What modification has been added to Fama and French five factor model to overcome its limitation?”. After systematically reviewing 61 articles, the current study finds that there are four main themes in the literature related to Fama and French five-factor model: (1) the performance of the Fama-French five-factor model in explaining stock returns; (2) the predictive power of profitability and investment factors; (3) the redundancy of the value factor and (4) the exploration of other factors that could enhance the model’s explanatory power. Most notably, 38 articles reviewed in this paper provide evidence supporting the empirical validity of Fama and French five-factor model and suggesting that the five-factor model performs better than the earlier three-factor model in describing the average stock returns albeit to a varying degree. The applicability of the five-factor model varies across region and time period.

The finding from this systematic review is beneficial to practitioners and scholars alike. This paper expands understanding on the empirical validity of the Fama and French five-factor model. Collectively, the findings suggest that the regional and national risk factors could yield varying results, hence warranting separate investigations, which is well aligned with Lin (2017). The finding also indicates that the performance of the five-factor model is not uniform across different samples. There are cases whereby the five-factor model outperforms the three-factor model only marginally. Further, contrary to Fama and French (2015), the finding suggests that the value factor does not necessarily become redundant when the profitability and investment factors are included in the model. Last but not least, scholars could gain insights into several other factors that can be considered in future studies in developing a more robust asset pricing model with higher explanatory power to describe equity returns. Linnenluecke et al. (2019) contended that replicable review is the fundamental idea behind a systematic literature review so that other researchers are able to replicate the review process to determine if similar conclusions can be reached. That said, future systematic review studies could be expanded by using articles from Scopus database.

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Compliance with Ethical Standards

The authors declare that they do not have any conflict of interest.

Appendix A: Sample Population

Journal	Author (Year)	Timespan	Main objective	Main Findings
EMERG MARK REV	Foye, J. (2018)	1996 - 2016	To test whether the new five-factor model provides a better description of emerging markets returns than the three-factor model.	The five-factor outperforms the three-factor model in describing market returns in Eastern Europe and Latin America, but not in the Asian region. Value and profitability factors are the main drivers for stock return in Latin America and Eastern Europe. Value is the only key driver of stock returns in Asia.
J ASSET MANAG	Sarwar, G; Mateus, C; Todorovic, N (2018)	1967 - 2014	To investigate the risk-adjusted performance of US sector portfolios and sector rotation strategy using the alphas from the Fama-	The findings suggest that the Fama and French five-factor model explains the variability of the sector portfolio returns better than the three-factor model. The inclusion of profitability and investment factors increases the statistical

			French five-factor model as compared to the previous three factor model.	significance and decreases the alpha estimate for most sectors.
EMERG MARK REV	Foye, J; Valentincic, A (2020)	1995 - 2015	To evaluate to what extent the new Fama and French five-factor model offers a meaningful improvement over the three-factor model in the Indonesian stock market.	Fama and French five-factor model's (inclusion of profitability and investment factors) improvement from the three-factor model was only trivial at best in explaining returns. The three-factor model was found to have poor performance in describing equity returns in Indonesia.
INT REV FINANC	Kubota, K; Takehara, H (2018)	1978 - 2014	To investigate whether the five-factor model by Fama and French explains the pricing structure of stocks with long-run data in Japan.	Fama and French five-factor model is not the best benchmark pricing model for Japanese equity market as the profitability and investment factors were found to be statistically insignificant.
INT REV FINANC	Chiah, M; Chai, D; Zhong, A; Li, S (2016)	1982-2013	To investigate the performance of the five-factor model in pricing the Australian equities.	Fama and French five-factor model is able to explain more asset pricing anomalies and indicates superior performance. Also, the results show that the value factor does not become redundant in the presence of investment and profitability factors, hence contradicting Fama and French (2015).
EMERG MARK REV	Lin, Q (2017)	1997 - 2015	To provides an empirical evaluation of the Fama-French five-factor model in the Chinese equity market.	The study finds that the five-factor model consistently outperforms the three-factor model in the Chinese equity market. In contrast to the findings of Fama and French (2015), both value and profitability factors are important, while the investment factor is found to

				be redundant for describing average returns in our sample.
PAC-BASIN FINANC J	Chai, D; Chiah, M; Zhong, A (2019)	1963 – 2016 (US) and 1983 - 2016 (Australia)	To investigate the extent to which the Fama–French five-factor model with the inclusion of momentum factor, explains the Australian equity returns.	The results confirm that Fama and French five-factor model outperforms the three-factor model and the CAPM. Also, the momentum factor is a good addition to the five-factor model in both the US and Australian stock market.
MANAG FINANC	Gregoriou, G; Racicot, FE; Theoret, R (2016)	1997 - 2015	To test the new Fama and French (2015) five-factor model based on sample of hedge fund strategies drawn from the Barclay's Global hedge fund database.	It was found that the five-factor model did not significantly outperform the three-factor model. While the size and value factor were found to be justified, the investment and profitability factors were found to be good substitutes for the value factors, hence implying redundancy. This is consistent as per Fama and French (2015).
J FINANC ECON	Fama, EF; French, KR (2017)	1990 - 2015	To conduct an international test of the Fama and French five factor model.	The five-factor model was found to provide a better description of the average returns in 23 developed markets as compared to the three-factor model.
PAC-BASIN FINANC J	Wang, SP; Yu, L; Zhao, Q (2021)	2014 - 2015	To test the Fama-French five-factor model when stock prices exhibit explosive (or bubble) behavior in Chinese equity market	The explanatory power of the five-factor model declines from the random walk period to the bubble period possibly attributed to speculation.
PAC-BASIN FINANC J	Guo, B; Zhang, W; Zhang, YJ; Zhang, H (2017)	1995 – 2015 and 1997-2013	To provide an out-of-sample tests of the five-factor model introduced by Fama and French (2015) for the Chinese stock market.	The Fama and French five-factor model was significant in describing the Chinese stock market returns. However, the investment factor makes marginal contribution compared to the other factors which were found to be significant.

J ASSET MANAG	Racicot, FE; Theoret, R (2016)	1995 - 2012	To test the new Fama and French five-factor model on a sample of hedge fund strategies. This model embeds the q-factor asset pricing model which relies on the CMA and RMW factors.	The Fama and French five-factor model was found to be robust in the application of the hedge fund strategies. Furthermore, the value factor does not become redundant with the inclusion of the profitability and investment factors, contradicitng with Fama and French (2015).
REV FINANC STUD	Fama, EF; French, KR (2016)	1963 - 2014	To test the Fama and French five factor model in the presence of anomalies.	The Fama and French five-factor model improves the description of the average returns of equity compared to the three-factor model. With two exceptions, the accruals and momentum factors.
BORSA ISTANB REV	Azimli, A (2020)	2006 - 2015	To use a cash-based profitability factor that is completely free from accounting accruals to test the five-factor and three other models against eight different market anomalies in Borsa Istanbul (BIST)	The Fama and French five-factor model did not perform well in describing the average returns in BIST with only market and value factors being significant. The profitability and investment factors did not improve the performance of the three-factor model in the emerging market.
INT J ISLAMIC MIDDLE	Shaikh, SA; Ismail, MA; Ismail, AG; Shahimi, S; Shafiai, MHM (2019)	2001 - 2015	To study the cross section of expected returns on Shari'ah-compliant stocks in Pakistan by using single- and multi-factor asset pricing models.	The Fama and French five-factor model did not significantly outperform the three-factor model in describing the cross section of stock returns. However, the profitability and investment factor also did not render the value factor to be redundant, contradicting Fama and French (2015).
J INVEST	Cakici, N; Zaremba, A (2021)	1987 - 2019	To re-evaluate the performance of the Fama-French (2015) factors in	The Fama and French five-factor model did not perform well in describing the average returns of international

			the global markets.	market as the value, profitability and investment factors were found to be less reliable, depending on the geographical area and time period. The investment and value factors were almost non-existent among big firms.
PAC BUS REV INT	Ishtiaq, M; Tufail, MS; Muneer, S; Sarwar, MB (2019)	2007 - 2015	To examine both Fama-French three factor and five factor models in the Pakistan stock market to identify the best pricing model for Pakistani stocks.	The Fama-French five-factor model performs better than three-factor model in capturing the portfolio return of Pakistani stock market. The model is useful for selecting securities in a portfolio, asset pricing, assessing performance of fund managers and estimating the required rate of return on investment.
SCHMALENBACH BUS REV	Dirkx, P; Peter, FJ (2020)	2002 - 2019	To implement the Fama-French five-factor model and enhance it with a momentum factor for the German market.	The Fama and French five-factor model did not provide significant improvement from the three-factor model as the profitability and investment factors did not add significant explanatory power in the German equity market. Also includes the momentum factor.
J ASIAN FINANC ECON	Liammukda, A; Khamkong, M; Saenchan, L; Hongsakulvasu, N (2020)	1990 - 2020	To apply the Fama - French five factor model from using concept of time varying coefficient.	The Fama and French five-factor model is not able to capture the different effect at different times of 5 factors for Japanese portfolio.
GLOB BUS REV	Dutta, A (2019)	1990 - 2007	To assess whether the newly developed five-factor model of Fama and French (2015) has sufficient power to identify the long-term abnormal	The Fama and French five-factor model does outperform the three-factor model, but the explanatory capability is still lacking. The study also finds that the value factor to be redundant, as per Fama and French (2015), with the inclusion of the profitability

			performance of firms experiencing major corporate events.	and investment factors. The explanatory power of the Fama and French five-factor model also diminishes as time progresses.
VISION-INDIA	Balakrishnan, A; Maiti, M; Panda, P (2018)	1999 - 2015	To evaluate whether the existing asset pricing models of Fama–French three-factor model and five-factor model can capture the average returns on portfolios constructed based on firms' characteristics and fundamentals.	The Fama and French five-factor model is found to improve the three-factor model in explaining the average returns of Indian stock market. Average returns can be explained by firms' characteristics (size and value) and firm fundamentals (investment and profitability). The three-factor model itself was found to be robust in explaining equity returns.
PAC BUS REV INT	Sadhwani, R; Bhayo, MUR; Bhutto, NA (2019)	2000 - 2015	To examine the average returns patterns captured by the three-factor and five-factor asset pricing models of Fama and French in the Pakistan stock market.	The Fama and French five factor model is demonstrated through the GRS test to outperform the three-factor model in describing average stock returns in Pakistan's stock market.
J ASIAN FINANC ECON	Khan, UE; Iqbal, J (2021)	2006 - 2015	To test whether the Fama-French five-factor model augmented with a default risk factor improves the predictability of returns of portfolios sorted on the characteristics of firms and industry.	The Fama and French five-factor model does not explain the anomaly, default risk factor, in pricing asset. It was found that by including this factor to the five-factor model, the model performs better in describing portfolio average returns. Default risk prevails in the Pakistani equity market.
J AFR BUS	Charteris, A; Rwishema, M;	2000 - 2013	To test whether the Fama-French five-factor model can explain the momentum effect	The Fama and French five-factor model performs better as profitability factor and investment factor are significant in describing stock

	Chidede, TH (2018)		in the South African market.	returns in South African market.
J ASIAN FINANC ECON	Gharaibeh, OK; AL-QUDAH, AM (2020)	2006 - 2018	To analyse the determinants of risk factor model for the Jordanian banking stocks. This study adopts the Fama and French five-factor model.	The Fama and French five-factor model performs well in describing the Jordanian stock market. Both profitability and value factors provide the highest cumulative returns among the factors. The value factor is also not redundant, contradicting the finding of Fama and French (2015).
EMERG MARK FINANC TR	Roszkowska, P; Langer, LK (2019)	2000 - 2013	To study the comparative attractiveness of public equity investments in the Polish (emerging) and in the U.S. (advanced) stock markets using the Fama and French five factor model.	The Fama and French five-factor model performs well in the describing the returns of international stock market particularly the size and profitability factors.
ISTANB BUS RES	Aras, G; Cam, I; Zavalsiz, B; Keskin, S (2018)	2005 - 2017	To examine the validity of Fama-French five-factor model in the Turkish stock market and to compare the performance with other models.	The Fama and French five-factor model outperforms other models in describing the average equity returns in the Turkish stock market.
SPAN J FINANC ACCOUN	Kaya, E (2021)	2005 - 2017	To evaluate the performance of asset pricing models including Fama and French five factor model for Borsa Istanbul.	The Fama and French five-factor model mostly outperforms the CAPM and the three-factor model. Investment factor is found to be significant. So is the profitability factor which is not redundant despite having a weak effect. The value premium is found to be redundant, mirroring the findings in Fama and French (2015).
EMERG MARK REV	Leite, AL; Klotzle,	2007 - 2017	To investigate how the Fama and	The Fama and French five-factor model outperforms the

	MC; Pinto, ACF; da Silva, AF (2018)		French three-, four-, and five-factor models perform in emerging markets.	three-factor model in emerging markets. However, the effects of profitability and investment seem to be weak. The value factor is found to be redundant, parallel with the findings of Fama and French (2015).
J RISK FINANC MANAG	Ryan, N; Ruan, XF; Zhang, JE; Zhang, JA (2021)	2007 - 2015	To test the applicability of the different Fama–French (FF) factor models in Vietnam, by investigating the value factor redundancy and examining the choice of the profitability factor.	The Fama and French five-factor model outperforms the three-factor model in theVietnam stock market. Also, the value factor remains significant despite the inclusion of profitability and investment factors, with is inconsistent with Fama and French (2015).
PAC-BASIN FINANC J	Chai, D; Chiah, M; Gharghori, P (2019)	1982 - 2016	To compare the performance of a range of competing factor models in pricing large Australian stocks using the Fama and French five-factor model.	The Fama and French five-factor model remains the superior model in pricing large Australian stocks. The additional factors of profitability and investment can explain the cross-section of stock returns in the Australian stock market.
ASIA-PAC J ACCOUNT E	Shi, Q; Cheung, A; Li, B (2020)	1963 - 2014	To investigate the linear multi-factor asset pricing model.	The Fama and French five-factor model, along with other models, outperform the Fama and French three-factor model in describing equity returns of a large proportion of portfolios.
EMERG MARK REV	Zaremba, A; Czapkiewicz, A (2017)	2007 - 2015	To compare four asset pricing models including Fama and French five factor model and to test their explanatory power over a broad range of cross-sectional return patterns in emerging	The result shows that the Fama and French five-factor model best explains the anomaly returns of portfolios and verify its superiority over the other models in emerging European markets.

			European markets.	
ASIA-PAC J FINANC ST	Kang, H; Kang, J; Kim, W (2019)	2002 - 2015	To compare the empirical performance of the Fama and French five-factor model, the q-factor model, and their variations in the Korean stock market.	The Fama and French five-factor model outperforms other models in describing various anomalies in the Korean stock market. It's also found that the value factor is not redundant despite the inclusion of the q-factors (investment and profitability) which is inconsistent with Fama and French (2015).
MANAG FINANC	Lalwani, V; Chakraborty, M (2020)	1992 - 2017	To compare the performance of various multifactor asset pricing models across ten emerging and developed markets.	The Fama-French five-factor model improves the pricing performance compared to the three-factor model for stocks in Australia, Canada, China and the USA. However, despite the statistical significance, authors view this outperformance as modest and economically insignificant. The five-factor model does not outperform the three-factor model in the other 6 markets in the study.
INT J MANAG FINANC	Singh, K; Singh, A; Prakash, P (2022)	1999 – 2020	To investigate the explanatory power of the Fama-French five-factor model and compares it to the other asset pricing models.	The Fama-French five-factor model outperforms the three-factor model in describing the average equity returns. With the addition of the profitability and investment factors, the value factor remains significant in the Chinese and Indian stock market, diverging from Fama and French (2015). However, the investment factor has no explanatory power in the presence of profitability factor in the sample.
ASIA-PAC J ACCOUNT E	Shi, Q; Li, B (2020)	1967 - 2016	To supplement recent studies with daily data comparing the performance of three asset pricing	The Fama-French five-factor model outperforms the three-factor model in estimating average returns of portfolios formed with different anomalies.

			models including the Fama-French five factor model.	
CUAD GEST	Alonso-Conde, AB; Rojo-Suarez, J (2020)	1990 - 2021	To compare the performance over time of some of the most prominent asset pricing models including Fama and French five-factor model in the European and US equity markets.	The Fama-French five-factor model has better performance than the three-factor model in describing average equity returns in European and US markets.
PAC-BASIN FINANC J	Zaremba, A; Karathanasopoulos, A; Maydybura, A; Czapkiewicz, A; Bagheri, N (2020)	1997 - 2017	To determine whether Islamic or market-wide factors can better explain the cross-section of returns using asset pricing models including the Fama and French five factor model.	The Fama and French five-factor model outperforms other models in explaining cross-section of stock returns. The Islamic factors can explain better the cross-section of returns than the market wide factors, pointing to at least a partial market segmentation.
J ASIAN FINANC ECON	Salim, M; Hashmi, MA; Abdullah, A (2021)	2011 – 2020	To compares the performance of Fama-French three-factor and five-factor models using a dataset of 20 Pakistani commercial banks.	The Fama and French five-factor model does not improve the performance of the three-factor model in describing the average returns of commercial banks in Pakistan. However, all factors in the five-factor model are all significant, which is inconsistent with Fama and French (2015).
EMERG MARK FINANC TR	Ali, F; Khurram, MU; Jiang, YX (2021)	2003 - 2016	To test the Fama and French five-factor model in Pakistan.	The Fama and French five-factor model outperforms the three-factor model in describing average returns on Pakistan stock market as the profitability and investment factors significantly improve the explanatory power of the model. However, the value factor and momentum factor are found to be redundant,

				supporting the findings of Fama and French (2015).
EMERG MARK FINANC TR	Zaremba, A; Czapkiewicz, A; Szczygielski, JJ; Kaganov, V (2019)	2000 - 2018	To evaluate and compare the performance of four popular factor pricing models including the Fama and French five factor model in the Polish stock market.	The Fama and French five-factor model is not able to explain the cross-sectional variation in equity returns of the Polish stock market. Carhart four-factor model outperforms the Fama and French five-factor model.
EMERG MARK FINANC TR	Zaremba, A; Maydybura, A; Czapkiewicz, A; Arnaut, M (2021)	1996 - 2017	To compare the explanatory power of major empirical asset pricing models in explaining equity anomalies in the frontier markets.	The Fama and French five-factor model fails to explain momentum related anomalies and the inclusion of profitability and investment factors did not improve the explanatory ability of the model.
J ASSET MANAG	Dhaoui, A; Bensalah, N (2017)	1965 - 2015	To investigate asset valuation predictive power of investor sentiment using the Fama and French five-factor model.	The Fama and French five-factor model is valid in describing the expected equity returns. The inclusion of investor sentiment index further enhances the performance of the model.
J RISK FINANC	Chen, XY; Gao, NRW (2020)	2006 - 2018	To examine how the magnitude of contango or backwardation (MCB volatility risk factor) derived from VIX and VIX3M may affect the pricing of assets (Fama and French five factor model)	The Fama and French five-factor model is able to replicate largely similar findings in Fama and French (2015) with all factors are statistically significant. Market factor is significantly negatively correlated with profitability and investment, and positively correlated with size factor. However, the value factor is not redundant from this sample, which is inconsistent with Fama and French (2015).
INT J FINANC ECON	Zhao, Y; Stasinakis, C;	1965 - 2017	To investigate the predictability of the five Fama-	The Fama and French five-factor model is still significant in describing average equity

	Sermpinis, G; Fernandes, FD (2019)		French factors and explores their optimal portfolio allocation for factor investing.	returns. The market factor was found to be the weakest and performs the worst during the global financial crisis, along with the value factor.
BORSA ISTANB REV	Racicot, FE; Rentz, WF; Kahl, A; Mesly, O (2019)	1973 - 2015	To use the Fama and French five-factor model in a dynamic setting to capture the impact of illiquidity over the phases of business cycle.	The Fama and French five-factor model fails to capture the illiquidity factor in the market. However, adding the illiquidity factor causes all but the market risk to be insignificant in the model. This is despite the findings of Kalman filter approach which is supportive of the importance of illiquidity risk in the dynamic context.
J INT FINANC MARK I	Skocir, M; Loncarski, I (2018)	1985 - 2016	To introduce the eight-factor asset pricing model as an extension of the Fama and French (2016) five-factor model by including liquidity, momentum and default risk factors.	The Fama and French five-factor model's performance is enhanced when including profitability and investment factors. Furthermore, adding liquidity, momentum and default risk significantly increases the overall explanatory power of the model.
INT J FINANC ECON	Escribano, A; Jareno, F; Cano, JA (2022)	2000 - 2019	To study the potential effects of changes in international risk factors using Fama and French (2015) factor model employing factors such as nominal interest rates, momentum and momentum reversal factors and traded liquidity factor.	The enhanced Fama and French five-factor model has the highest explanatory power in the extreme quantiles, during the bullish and bearing market states. This means the factors' significance are mixed across the sample of construction companies in Europe.
BORSA ISTANB REV	Roy, R; Shijin, S (2018)	1986 - 2017	To introduce a human capital component to the Fama and French	The Fama and French five-factor model did not account for the human capital component. With the addition

			five-factor model proposing an equilibrium six-factor asset pricing model.	of this factor, the finding indicates the robustness of the six-factor model in explaining asset returns.
INT REV ECON FINANC	Li, TR; Lin, H (2021)	1997 - 2019	To apply the modified Fama-French five-factor which replaces the investment factor replaced by UMT (Untrustworthy minus trustworthy)	The modified Fama and French five-factor model improves when substituting investment factor with credit risk factor in the sample of Chinese equity market. This is because the credit risk premiums are an essential part of equity returns in China.
QUANT FINANC	Qiu, Y; Ren, Y; Xie, T (2019)	1958 - 2013	To propose a technique that evaluates the factors included in popular linear asset pricing models.	The Fama and French five-factor model outperforms the other three models in terms of the averaged Hansen and Jagannathan (AHJ) model weights.
INT REV FINANC	Safiullah, M; Shamsuddin, A (2021)	1996 - 2017	To compare Islamic equity portfolios with their non-Islamic counterparts using the Fama and French five factor model, and the model augmented with interest rate and liquidity factors.	The Fama and French five-factor model and the augmented version with interest rate and liquidity factors are not adequate for pricing non-Islamic and Islamic equity portfolios.
J RISK FINANC MANAG	Huang, J; Liu, HZ (2019)	2007 - 2018	To evaluate existing factors in the Chinese stock market and the extended Fama and French five factor model.	The extended Fama and French five-factor model has limitations in describing the average equity returns across different sectors as different factor has different relationship with different industries.
REV PAC BASIN FINANC	Hachicha, F; Charfi, S; Hachicha, A (2020)	2000 - 2017	To assess the asset pricing model by extending the Fama and French	The Fama and French five-factor model (including the q-factors; investment and profitability) outperforms

			model and applying the Bayesian Network (BN) modeling to discover the relationships across different risk factors.	other asset pricing model in describing individual stock returns in the US. Investor's sentiment also has the potential to be included to enhance the model.
J FINANC RES	Gong, CTM; Luo, D; Zhao, HN (2021)	1963 - 2017	To perform further analysis on the explanatory power of liquidity risk in asset pricing due to limited success of Fama and French three and five factor models.	The Fama and French five-factor model could be improved by incorporating the liquidity factors to increase its explanatory capabilities.
J SUSTAIN FINANC INV	Gregory, RP; Stead, JG; Stead, E (2021)	1999 - 2017	To incorporate a sustainability factor into the Fama-French five-factor model plus the momentum factor.	The Fama and French five-factor model could be improved by including the sustainability and momentum factors.
N AM J ECON FINANC	Leite, AL; Klotzle, MC; Pinto, ACF; Barbedo, CHD (2020)	1963 - 2017	To incorporate the CPI in the Fama and French five-factor model.	The Fama and French five-factor model is found to have significantly high explanatory ability and significant pricing errors. However, the addition of CPI causes the profitability factor to lose its explanatory power.
J BANK FINANC	Ben Ammar, S; Eling, M; Milidonis, A (2018)	1988 - 2015	To conduct a comprehensive asset pricing analysis for the U.S. property/liability insurance industry using monthly data.	The Fama and French five-factor model cannot explain the equity returns of property/liability insurance stocks in the US.
PAC-BASIN FINANC J	Zhong, A (2018)	1990 - 2013	To investigate the role of the asset-pricing model in explaining the idiosyncratic	The Fama and French five-factor model is utilized to estimate the robustness of idiosyncratic volatility model in Australia. The profitability

			volatility (IV) puzzle in the Australian equity market.	and investment factors are also included in the model.
J EMPIR FINANC	Blitz, D; Vidojevic, M (2017)	1963 - 2015	To investigate the whether Fama and French five factor model is able to explain stock returns anomaly.	The Fama and French five-factor model cannot explain the low-risk anomaly in the average equity returns.