Asset Pricing Models Performance in the North America Stock Market

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Abstract. This study investigates how effectively the five-factor asset pricing model (FF5) elucidates the behavior of stock returns during COVID-19 pandemic and the period of 2000-2023. Using portfolio-level data and regression analysis, this study assesses the model's ability to capture fluctuations in stock returns. Results in this paper demonstrate that the five-factor model remains robust during the COVID-19 pandemic, with significant relationships between expected returns and factors such as the market risk premium, size, value, profitability, and investment. The model exhibits a high explanatory power, effectively explaining a significant portion of the variability observed in stock returns over longer timeframe. However, it is important to acknowledge the study's limitations, including its focus on North American portfolios and the relatively short duration of the COVID-19 period analyzed. Future research should explore the model's performance in other regions and during different market crises. This study adds to the relevant literature by empirically validating the effectiveness of FF5 under both normal and pandemic market conditions, which contributes valuable insights into the model's applicability and robustness across different market environments. The findings underscore the importance of considering multiple factors in asset pricing models and their adaptability to diverse market environments.

Keywords: Asset Pricing, Five-Factor Model, Stock Returns, COVID-19 Pandemic.

1 Introduction

The five-factor model (FF5) has garnered significant attention in the study of asset pricing [1]. This model has been widely explored and applied in various studies and industry practices. While previous research has predominantly examined its performance under normal market conditions, empirical evidence has consistently supported its effectiveness in the North American market [2]. To explain how global market returns behave, a variety of asset pricing models have been proposed. Notable among these models are the capital asset pricing model (CAPM) developed by Sharpe and Lintner, the Fama and French three-factor model, and the Carhart four-factor model. These models

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have gained recognition for their ability to provide frameworks that capture stock performance and market anomalies [3-6]. Expanding on these models, Fama and French presented the five-factor model, incorporating additional factors of profitability and investment alongside market, size, and value-growth factors. This improved model has exhibited greater capability in explaining asset returns. Nevertheless, the model's effectiveness shows variability across various regions, as indicated by the research conducted by Racicot and Rentz, who observed significant differences in the significance of factors [7].

During the process of paper review, there is limited research exploring the performance of the FF-5F model during stock market crises. Unlike past pandemics, which had minimal traces on the NA stock market, the COVID-19 crisis has a substantial and notable impact on stock market performance [8]. This study intends to investigate how the COVID-19 pandemic will affect the functionality of the FF5 model between January 2020 and June 2022, exploring whether there have been any changes in its effectiveness under unique market conditions in comparison to the overall stock market. With portfolio returns serving as the dependent variables, this research concentrates on the performance assessment of conversational valuation models. The study utilizes portfolio-level data span from 2000 to 2023. The objective is to compare the effectiveness of several widely recognized asset pricing models. The study's goal is to assess these asset pricing models' explanatory and predictive power in connection to actual portfolio returns by conducting a thorough comparison analysis. The findings of this study will contribute to the existing body of literature on asset pricing models by shedding light on FF5's performance during stock market crises, specifically the COVID-19 pandemic. The results will be particularly relevant for investors, financial analysts, and portfolio managers who rely on these models for making investment decisions and managing risk. Understanding how FF5 performs during periods of market stress will help enhance its applicability and provide insights into its limitations and potential areas for improvement.

By conducting such tests, it can further evaluate the effectiveness of the CAPM, FF3, and FF5 in explaining stock returns and determine their adaptability in different market environments. This analysis contributes to our understanding of the robustness check of these models, as well as their effectiveness under various market conditions. Analyzing the robustness and stability of the CAPM, FF3, and FF5 in relation to how well they can predict stock returns and adjust to various market conditions provides important insights. Additionally, it enhances our understanding of their effectiveness across different market conditions.

2 Methodology

2.1 Data Description

This research uses all data from the highly regarded database on Ken French's website, a comprehensive resource known for its wide array of financial information related to asset pricing. For this analysis, we specifically employ data from six portfolios in the North American region, which are categorized and sorted based on their size and book-to-market (B/M) ratios within developed markets. The data covers daily returns from July 1, 1990, until April 30, 2023. However, our analysis is predominantly concentrated on assessing the performance of the model’s post-2000. As such, the chosen timeline for our primary dataset is from January 3, 2000, to April 30, 2023, which will allow us to scrutinize the model's effectiveness and estimate the significance of each variable. To further delve into the robustness of the model, we aim to assess its performance amidst the COVID-19 pandemic, which spans from January 1, 2020, to June 30, 2022. This assessment will enable us to juxtapose the model's effectiveness during an extraordinary global event against its typical performance over the longer timeline.

Dividends and capital gains are included in the returns supplied in the dataset, which is stated in U.S. dollars, but they are not shown in continuously compounded form. Each year in June, stocks within each respective region are bifurcated into three B/M groups and two market capitalization categories (big and small). Small stocks make up the remaining 10% of stocks in each area, while major stocks make up the top 90% according to market capitalization as of June. By determining the 30th and 70th percentiles of the B/M distribution among the big stocks within each respective region, the B/M breakpoints for classifying stocks into big and small groups are determined. For the portfolio construction, developed size breakpoints are employed for the developed portfolios. However, within each region, we assign stocks to the developed portfolios using B/M breakpoints that are region-specific. Using independent 2x3 sorts based on size and B/M, we create six portfolios that are weighted based on value: SG, SN, SV, BG, BN, and BV. These portfolios are categorized as either small (S) or big (B), and further classified as growth (G), neutral (N), or value (V) based on their corresponding B/M ratios.

2.2 Model Specification

This section offers an overview of the methodology employed in our analysis to evaluate the FF5 model. We discuss the variables incorporated in the model and the regression framework utilized to estimate the coefficients of the model.

Model Variables. This research structures the asset pricing factors by following the methodologies proposed by FAJASY [9]. It adopts the procedures detailed on Ken French's website and found inspiration in prominent studies like those conducted by Fama and French in 1993 and 2015, along with Sharpe's work in 1964. The factors examined in our analysis encompass market risk, company size, value, profitability, and investment. By utilizing these well-established factors and calculation procedures, this research aims to provide a robust analysis of the asset pricing models under investigation. The chosen factors have been widely recognized and extensively studied in the literature, contributing to the credibility and reliability of the findings. The adherence to established methodologies ensures consistency and comparability with previous research, allowing for a comprehensive evaluation of the models' explanatory and predictive power. Table 1 explains the meaning of these factors.

Table 1. Factor definitions.

Factors	Description
MKT (Market Risk)	This factor quantifies the excess return on the market portfolio.
SMB (Small Minus Big)	Represents the size factor in the model, differentiating between small and large companies.
HML (High Minus Low)	Denotes the value factor, separating companies based on their book-to-market ratios.
RMW (Robust Minus Weak)	The profitability factor in the model, meaning the difference between robustly profitable and weakly profitable companies.
CMA (Conservative Minus Aggressive)	This is the investment factor in the model, contrasting conservative and aggressive firms.
MKT (Market Risk)	This factor quantifies the excess return on the market portfolio.

Regression Framework. To estimate the coefficients of FF5, this paper employs a regression framework. In the regression analysis, the chosen portfolio's excess return is the dependent variable, and the aforementioned variables make up the independent variables. The regression equation can be represented as follows:

$$y_t = \alpha + \beta_1 * MKT_t + \beta_2 * SMB_t + \beta_3 * HML_t + \beta_4 * RMW_t + \beta_5 * CMA_t + \varepsilon \quad (1)$$

Where α represents the intercept of the regression model, which is the expected return of the portfolio when all factor returns are zero; β_1, β_2, β_3, β_4, and β_5 are coefficients that measure the portfolio's sensitivity to the respective factors. Keeping all other factors fixed, they show how much the excess return on the portfolio would vary if the corresponding factor changed by one unit. The error term (or residual) indicates the excess return on the portfolio that cannot be explained by any other element in the model. The importance and influence of each component in explaining the excess returns of the chosen portfolios can be assessed by estimating the coefficients. Next section presents the empirical outcomes obtained from estimating the FF5 using the selected datasets.

3 Empirical Results

3.1 Descriptive Statistics

Table 2 presents key asset pricing factors, including MKT, SMB, HML, RMW, and CMA. MKT, representing the market risk premium, shows the highest volatility with a standard deviation of 1.227. Its mean return of 0.027 is statistically significant (t-statistic = 1.71), indicating a deviation from zero. SMB and HML display lower mean returns and less volatility, while RMW and CMA present higher mean returns, all significant as per their t-statistics. These results illustrate the variability in returns and risk characteristics across different asset pricing factors. The statistical significance of the mean returns suggests that these factors have predictive power for asset pricing.

Table 2. Statistics summary.

Var.	Mean	SD	P25	P50	P75	Min	Max	T-stat.
MKT	0.027	1.227	-0.46	0.04	0.57	-11.93	10.62	1.71
SMB	0.007	0.553	-0.30	0.01	0.31	-4.60	5.14	0.94
HML	0.012	0.766	-0.30	0.00	0.29	-6.51	6.64	1.18
RMW	0.021	0.494	-0.21	0.01	0.25	-3.26	3.43	3.35
CMA	0.019	0.550	-0.21	0.00	0.22	-6.47	3.69	2.66

In Table 3, the correlation matrix reveals the interrelationships among these factors. MKT shows a weak positive correlation with SMB (0.119) and slight negative correlations with HML, RMW, and CMA. SMB and HML show a small positive correlation. Notably, HML and CMA display a strong positive correlation (0.724), suggesting these factors often move in the same direction. The correlations, although present, are not excessively high to suggest problematic multicollinearity. The correlation matrix provides valuable information on the relationships between the factors considered in the analysis. By understanding these interrelationships, researchers and investors can better interpret the impact of these factors on portfolio returns and make informed decisions based on their combined effects.

Table 3. Correlation matrix.

	MKT	SMB	HML	RMW	CMA
MKT	1.000				
SMB	0.119	1.000			
HML	-0.116	0.110	1.000		
RMW	-0.334	-0.304	0.176	1.000	
CMA	-0.325	0.003	0.724	0.343	1.000

3.2 Regressive Results

Tables 4 to 9 display data from regression tests conducted on six portfolios during two periods (COVID-19 and 2000-2023), using three models. Every portfolio aligns with a group of companies sorted by size and B/M ratios. The coefficients show how much each portfolio's returns respond to the relevant factors in each model. In particular, they seem to relate to six portfolios that intersect two size categories (SMALL and BIG) and three B/M groups (Lo, 2, Hi). these regression tests and the analysis of the coefficients provide a comprehensive evaluation of the impact of various factors on the returns of the portfolios. By considering the results across different models and time periods, as well as the specific combinations of size and B/M ratios, it can gain valuable insights into the factors that drive portfolio performance and make more informed investment decisions.

Table 4. Regressive results of SMALLLoBM Portfolio.

	COVID-19			2000-2023		
	CAPM	FF3	FF5	CAPM	FF3	FF5
MktRF	1.163** (0.02)	1.008*** (0.007)	1.011*** (0.006)	1.171*** (0.008)	1.072*** (0.003)	1.025*** (0.002)

SMB		1.178** (0.016)	1.035** (0.015)		1.074*** (0.006)	0.986*** (0.005)
HML		-0.601*** (0.01)	-0.502** (0.015)		-0.575*** (0.004)	-0.491*** (0.005)
RMW			-0.354** (0.019)			-0.321*** (0.006)
CMA			-0.104** (0.025)			-0.0959*** (0.007)
Cons.	-0.0393** (0.04)	-0.0163*** (0.01)	-0.0056*** (0.01)	-0.0010*** (0.009)	-0.0078*** (0.003)	0.0016*** (0.002)
R^2	0.7759	0.9807	0.9809	0.7943	0.9768	0.9857
Obs.		652			6065	

Table 5. Regressive results of ME1BM2 Portfolio.

	COVID-19			2000-2023		
	CAPM	FF3	FF5	CAPM	FF3	FF5
MktRF	1.093** (0.017)	0.995*** (0.004)	0.994*** (0.004)	1.059*** (0.005)	1.007*** (0.001)	1.005*** (0.002)
SMB		0.902*** (0.009)	0.897*** (0.0099)		0.899*** (0.003)	0.895*** (0.003)
HML		-0.0831*** (0.005)	-0.0680** (0.01)		-0.0518*** (0.002)	-0.0513*** (0.003)
RMW			-0.00005** (0.013)			-0.0191*** (0.004)
CMA			-0.0283** (0.017)			0.0033*** (0.005)
Cons.	-0.0163** (0.03)	-0.0042*** (0.006)	-0.0034*** (0.006)	0.0110* (0.007)	0.0070*** (0.002)	0.0074*** (0.002)
R^2	0.8678	0.9931	0.9932	0.8671	0.9908	0.9909
Obs.		652			6065	

Table 6. Regressive results of SMALLHiBM Portfolio.

	COVID-19			2000-2023		
	CAPM	FF3	FF5	CAPM	FF3	FF5
MktRF	1.076** (0.02)	1.008*** (0.004)	1.012*** (0.004)	1.003*** (0.006)	0.986*** (0.001)	0.984*** (0.001)
SMB		0.869*** (0.009)	0.840*** (0.01)		0.862*** (0.003)	0.859*** (0.003)
HML		0.413*** (0.005)	0.410*** (0.01)		0.400*** (0.002)	0.402*** (0.003)
RMW			-0.0958** (0.012)			-0.0121*** (0.004)
CMA			0.0265** (0.017)			-0.00155*** (0.004)
Cons.	0.01** (0.04)	0.0142*** (0.006)	0.0154*** (0.006)	0.0188** (0.008)	-0.0132*** (0.009)	0.0091*** (0.002)

R^2	0.7413	0.9937	0.9942	0.8047	0.9925	0.9925
Obs.		652			6065	

Table 7. Regressive results of BIGLoBM Portfolio.

	COVID-19			2000-2023		
	CAPM	FF3	FF5	CAPM	FF3	FF5
MktRF	1.054** (0.014)	1.052*** (0.005)	1.050*** (0.004)	1.011*** (0.004)	0.992*** (0.002)	1.004*** (0.0018)
SMB		-0.175** (0.011)	-0.161** (0.012)		-0.177*** (0.004)	-0.149*** (0.004)
HML		-0.372*** (0.006)	-0.367** (0.013)		-0.399*** (0.003)	-0.412*** (0.004)
RMW			0.0484** (0.016)			0.106*** (0.005)
CMA			-0.0202** (0.021)			0.00242*** (0.006)
Cons.	0.0135** (0.02)	0.0170** (0.008)	0.0166** (0.008)	0.007** (0.005)	0.0131*** (0.002)	0.0105*** (0.002)
R^2	0.8932	0.9878	0.988	0.919	0.9842	0.9855
Obs.		652			6065	

Table 8. Regressive results of ME2BM2 Portfolio.

	COVID-19			2000-2023		
	CAPM	FF3	FF5	CAPM	FF3	FF5
MktRF	0.905*** (0.006)	0.925*** (0.006)	0.925*** (0.006)	0.946*** (0.002)	0.961*** (0.002)	0.975*** (0.002)
SMB		-0.156** (0.012)	-0.122** (0.014)		-0.111*** (0.004)	- 0.0856*** (0.005)
HML		0.0798*** (0.007)	0.0497** (0.014)		0.124*** (0.003)	0.0924*** (0.005)
RMW			0.0775** (0.018)			0.0896*** (0.006)
CMA			0.0387*** (0.024)			0.0436*** (0.007)
Cons.	- 0.00194*** (0.01)	-0.005*** (0.009)	- 0.0078*** (0.009)	0.0086*** (0.003)	0.0075*** (0.002)	0.0046*** (0.002)
R^2	0.9699	0.9773	0.9782	0.9662	0.9743	0.9758
Obs.		652			6065	

Table 9. Regressive results of BIGHiBM Portfolio.

	COVID-19			2000-2023		
	CAPM	FF3	FF5	CAPM	FF3	FF5
MktRF	1.033** (0.02)	1.052*** (0.006)	1.050*** (0.006)	1.034*** (0.005)	1.077*** (0.002)	1.045*** (0.002)
SMB		0.134** (0.014)	0.0335** (0.014)		0.0346*** (0.005)	-0.0222*** (0.005)
HML		0.615*** (0.008)	0.721** (0.014)		0.625*** (0.004)	0.695*** (0.005)

RMW			-0.209** (0.018)			-0.204*** (0.006)
CMA			-0.151** (0.024)			-0.0917*** (0.007)
Cons.	-0.0056** (0.04)	-0.0132*** (0.0099)	-0.0041*** (0.009)	0.0052*** (0.007)	-0.0035*** (0.003)	0.0030*** (0.002)
R^2	0.7784	0.9823	0.9866	0.8547	0.9765	0.982
Obs.		652			6065	

In regard to the results for the period during COVID-19, it can be seen that the CAPM, FF3, and FF5 models all exhibit significant coefficients for their respective factors. Specifically, in all models, MktRF is significantly positive, indicating that higher market risk is associated with higher expected returns. The factors related to SMB and HML in the FF3 and FF5 models also show significance, indicating these elements play a significant role in explaining the fluctuation in stock returns during this period.

Comparing the results for the 2000-2023 period, it can be seen that the CAPM, FF3, and FF5 also effectively capture the influences of their respective factors. The R-squared values for these models are impressively high, which implies that a significant part of the variations in stock returns is explained by the models. As anticipated, FF5 typically accounts for a larger fraction of the return variability (denoted by higher R-squared values) compared to the CAPM and FF3, considering it encompasses more factors. This data implies that these asset pricing models are effective in elucidating stock returns over an extended period. The RMW and CMA factors in the FF5 model reveal notable negative coefficients, implying that companies with increased profitability and reduced investment tend to have lower expected returns. This outcome aligns with the findings of Fama and French (2015), who discovered that more predicted returns are frequently found in companies with lower investment and more profitability.

However, there are significant differences in the explanatory power of these models. For instance, although the CAPM model captures the impact of market risk on stock returns, it is not as explanatory as the FF3 and FF5 models. The FF3 model, which introduces the SMB and HML factors, offers a more comprehensive explanation of stock return fluctuations. Yet, compared to the CAPM and FF3 models, the FF5 model typically accounts for a larger fraction of return variability (as indicated by higher R-squared values) given it encompasses more factors, including profitability (RMW) and investment (CMA).

In the results for the 2000-2023 period, it can be seen that these three models effectively capture their respective factors. The R-squared values for the CAPM, FF3, and FF5 models are impressively high, indicating these models explain a significant portion of the variation in stock returns. However, as we observed during the COVID-19 period, the FF5 model typically explains a larger fraction of return variability, once again highlighting its superior explanatory power over the CAPM and FF3 models. This data indicates that despite differences in certain aspects, these asset pricing models are effective in explaining long-term stock returns. In particular, the FF5 model not only accounts for a larger portion of return variability, but the RMW and CMA factors in the FF5 model show notable negative coefficients, suggesting that firms with higher profitability and lower investment tend to have lower expected returns. This result is consistent with the findings of Fama and French (2015), who found that firms with higher profitability and lower investment often have higher expected returns. Therefore, it can be concluded that although the CAPM, FF3, and FF5 models have their strengths in explaining stock returns, the FF5 model, given its broader array of factors, exhibits a more robust explanatory power, especially in explaining stock returns in complex market conditions.

4 Robustness Check

An exceptional opportunity to evaluate the robustness of asset pricing models is presented by the economic catastrophe brought on by the COVID-19 pandemic [10]. Throughout the pandemic, global markets faced heightened volatility and uncertainty, triggering significant alterations in stock returns. These modifications could influence the model performance, allowing a critical assessment on their stability. To validate the models' resilience, it's crucial to test them against diverse scenarios. This study also conducts a robustness check for the span of the COVID-19 pandemic from January 2020 to June 2022. The outcomes are illustrated in Tables 4 through 9. Columns (1) - (3) in each section depict the regression results for stock returns under the COVID-19 pandemic.

Despite the challenges posed by COVID-19, the high R-squared values retained by the models attest to their robustness. Even amid the crisis, the models effectively accounted for the variations in stock returns, underscoring their resilience. A comparison of the models across various portfolios reveals that the FF-3F and FF-5F models typically outperformed the Capital Asset Pricing Model (CAPM), achieving higher R-squared values and, thereby, a better fit to the data. This suggests that the additional factors of size and value in FF3, and profitability and investment in FF5, captured a greater proportion of stock return variations than the singular market risk factor in the CAPM model. Furthermore, the persistence of significant coefficients for all variables across all portfolios and models during the COVID-19 period reaffirms the robust relationship between these factors and returns. These factors remained to contribute significantly to the variation in stock returns notwithstanding the global crisis. This enduring relationship bolsters the reliability and resilience of these asset pricing models even in the face of global crises such as the COVID-19 pandemic. The fact that these models maintained their reliability and explanatory power during a global crisis like the COVID-19 pandemic underscores their resilience. Investors and financial analysts can rely on these asset pricing models to make informed decisions and manage risks even in tumultuous market conditions. Their robustness and ability to capture stock return variations provide a valuable tool for navigating the complexities of the financial landscape, offering stability and insights in times of uncertainty.

5 Conclusion

This study examines the performance of FF5 in explaining stock returns throughout the COVID-19 epidemic and the longer period from 2000 to 2023, with a focus on the North American market. The findings indicate the model's continued robustness and effectiveness in capturing the fluctuations in stock returns, even amidst unparalleled market scenarios. This study's results confirm the importance of the relevant factors in accounting for stock returns during the pandemic. The model's explanatory power is further affirmed by its capacity to significantly explain the variance in stock returns over a prolonged duration. Notably, the profitability and investment factors display pronounced correlations with expected returns. Nonetheless, the study has certain limitations that warrant consideration. First, the analysis largely concentrates on North American portfolios, potentially limiting the applicability of the results to other regions. Also, the study's timeframe only encompasses a relatively brief span of the COVID-19 pandemic, suggesting the need for more research to understand the pandemic's long-term effects on stock returns. Future studies could look into the FF5 model's performance across various geographical areas and during different market crises. It would also be beneficial to examine the model's relevance to other asset classes besides stocks, like bonds or commodities. Moreover, enriching the model with additional factors or fine-tuning the existing ones might enhance its explanatory power and provide a deeper comprehension of the dynamics of asset pricing.

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