A Test of Fama-French Five-Factor Model in Quantitative Easing

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Abstract. In the evolving context of financial markets, the global financial crisis and subsequent quantitative easing policies have reignited scrutiny of the effectiveness of asset pricing models. This study employs the Fama-French methodology to conduct a detailed analysis of data from July 1963 to January 2024, a period encompassing significant economic shifts, to evaluate the robustness of the Fama-French three-factor and five-factor models under different market conditions. By examining five key factors—market excess returns, size premium, value premium, profitability, and investment style—across various time frames, the research seeks to identify the efficacy of these models in explaining stock returns during quantitative easing policies. The findings reveal variations in the explanatory power of these models across different market cycles. This study underscores the importance of incorporating additional risk factors to accurately capture the complexities of financial markets, especially during pivotal economic policy periods. However, it also recognizes the limitations imposed by the exclusion of data, potentially overlooking specific market dynamics crucial for understanding the impacts of the financial crisis and quantitative easing. By expanding the understanding of classic asset pricing models within the contemporary financial markets and shedding light on market dynamics under quantitative easing, this research not only provides valuable insights but also sets a direction for future exploration in financial market analysis and asset pricing model development.

Keywords: Fama-French models, asset pricing, quantitative easing, financial markets.

1. Introduction

In recent years, the complexity and dynamic changes of the financial markets have continuously attracted widespread attention from both the academic and practical fields. Particularly, in the context of the global financial crisis and the subsequent implementation of quantitative easing policies, reassessing the effectiveness of asset pricing models has become a crucial topic. The Fama-French three-factor and five-factor models, as classic frameworks for explaining stock returns, whether their applicability and explanatory power remain stable in different market environments has always been a hot topic in the field of financial research [1-2].

In the past few years, numerous studies have been dedicated to exploring the performance of these classic models in modern financial markets. For instance, Markowski focuses on comparing the explanatory power of CAPM models during different periods and has a result that beta could be used depending on the condition of the market (up market period or down-market period) [3]. Wang and Chen focus on anomalies of the CAPM model through data processing [4]. Other studies attempt to explore the impact of additional market and macroeconomic factors on stock returns by expanding the model factors.

This study draws on the method of Fama-French to conduct a detailed analysis of the data from July 1963 to January 2024, including the period of the global financial crisis and the implementation of quantitative easing policies [2]. By comparing the performance of five factors-market excess returns, size premium, value premium, profitability, and investment style-across different periods, this study aims to assess the robustness of the Fama-French three-factor and five-factor models and explore the impact of quantitative easing policies on the effectiveness of asset pricing models.

2. DATA

2.1. Data Resources and Data Collection

The data of this research are from Kenneth R. French data library and CRSP database, both of the two databases are well acknowledged and widely used. Kenneth R. French data library provides data on factors return among different financial markets and several portfolios formed according to their size, book-to-market ratio, operating profitability, and investment. CRSP database provides specific data on U.S. stock markets. The data from July 1963 to January 2024 was collected, focusing specifically on the performance of five factors: excess market return (Mkt-RF), size premium (SMB), value premium (HML), profitability (RMW) and investment style (CMA).

2.2. Data Processing

In the process of data collection, data cleaning was first carried out to exclude missing values and outliers to ensure the accuracy of the analysis. Subsequently, the data were standardized to facilitate comparative analysis over different periods. During data processing, it is worth noting that the excess market return is significantly higher during quantitative easing, and also the risk-free rate of return (RF) first becomes zero during quantitative easing. As a result, the breakdown of the data takes into account changes in the market environment, particularly during the 2008 global financial crisis, and the time frame for the implementation of quantitative easing.

3. Methodology and Results

3.1. Methodology

Fama and French three-factor model and Fama and French five-factor model were used as the basic framework of the research, and the results were compared with the performance of the CAPM model of Sharpe and Lintner [1-2, 5-6]. Specifically, the effectiveness of these factors in explaining stock returns was examined by constructing regression models of factor load and factor return. In addition, the GRS statistic of Gibbons, Ross and Shanken was used to evaluate the model's ability to explain cross-sectional returns of multi-asset portfolios [7].

3.2. Result

Table 1 shows statistics for four different time period factor returns, and 1963-2024/2008-2022 means subtracted the period of 2008-2022 from 1963-2024. The data of each time period includes three statistical indicators: mean, standard deviation and t-Statistic, corresponding to five factors: excess market return (Mkr-RF), size premium (SMB), value premium (HML), profitability (RMW) and investment style (CMA).

Using data from July 1963 to December 2013, almost the same results were obtained as Fama and French (2014) to ensure that the methods used in the research for the other three periods are correct and consistent.

From July 1963 to January 2024, Market excess return has increased by 14%, SMB has decreased by 25%, HML has decreased by 23.68%, and CMA has decreased by 18.18% compared with the period of 1963-2013. Also, the t-Statistics show that the SMB factor is not significantly different from zero at a 5% level in this period.

After the observation of statistical anomalies from July 1963 to January 2024, it is noticed that the expanded data is significantly different from the previous value. As a result, the data for the period of quantitative easing from November 2008 to April 2022 was stripped. In this period, the mean of excess market return soared to 1.13, showing a stronger market performance than it was. More importantly, the t-Statistics show that all the other four factors (SMB, HML, RMW, CMA) are not significantly different from zero at a 5% level during quantitative easing, which may indicate that those factors probably have no contribution to asset pricing in this period.

When the data of the quantitative easing period is removed from the dataset, the excessed market return decreases, and all the statistics of SMB, HML, RMW and CMA are converged back to the previous values. Moreover, the t-Statistic shows that the significance of all factors has rebounded, and is significantly different from zero at a 5% level except for SMB, which is 1.94.

Table 1. Statistic data for factor returns during four different time period

Panel A: 1963-2013						Panel B: 1963-2024					
	Mkt-RF	SMB	HML	RMW	CMA		Mkt-RF	SMB	HML	RMW	CMA
Mean	0.50	0.28	0.38	0.27	0.33	Mean	0.57	0.21	0.29	0.28	0.27
Std dev.	4.49	3.06	2.82	2.24	2.01	Std dev.	4.49	3.04	2.99	2.22	2.08
t-Statistic	2.74	2.29	3.28	2.94	4.07	t-Statistic	3.41	1.83	2.59	3.44	3.52
Panel C: 2008-2022						Panel D: 1963-2024/2008-2022					
	Mkt-RF	SMB	HML	RMW	CMA		Mkt-RF	SMB	HML	RMW	CMA
Mean	1.13	0.04	-0.11	0.26	0.16	Mean	0.41	0.26	0.40	0.29	0.30
Std dev.	4.45	2.68	3.39	1.87	1.84	Std dev.	4.50	3.14	2.83	2.32	2.14
t-Statistic	3.23	0.17	-0.41	1.81	1.14	t-Statistic	2.15	1.94	3.34	2.96	3.35

Table 2 shows the correlation coefficients of the five factors during four different time periods. The data results of panels A, B and C are similar. The positive and negative signs of the correlation coefficients among each factor are the same, and the slightly differences among the three panels are slight differences in value.

In panel C, the correlation between HML and CMA decreased significantly, while the correlation between Mkt-RF and SMB increased significantly. Also, RMW and CMA factors have very small correlation coefficients with other factors. SMB factor has correlation coefficients with other factors except CMA higher than 0.3.

Table 2. Correlation coefficient matrix for factor returns during four different time periods

Panel A: 1963-2013						Panel B: 1963-2024					
	Mkt-RF	SMB	HML	RMW	CMA		Mkt-RF	SMB	HML	RMW	CMA
Mkt-RF	1.00	0.28	-0.27	-0.23	-0.40	Mkt-RF	1.00	0.28	-0.20	-0.19	-0.36
SMB	0.28	1.00	-0.09	-0.34	-0.12	SMB	0.28	1.00	-0.01	-0.35	-0.09
HML	-0.27	-0.09	1.00	0.07	0.69	HML	-0.20	-0.01	1.00	0.08	0.69
RMW	-0.23	-0.34	0.07	1.00	-0.05	RMW	-0.19	-0.35	0.08	1.00	-0.01
CMA	-0.40	-0.12	0.69	-0.05	1.00	CMA	-0.36	-0.09	0.68	-0.01	1.00
Panel C: 2008-2022						Panel D: 1963-2024/2008-2022					
	Mkt-RF	SMB	HML	RMW	CMA		Mkt-RF	SMB	HML	RMW	CMA
Mkt-RF	1.00	0.41	0.21	-0.16	-0.15	Mkt-RF	1.00	0.25	-0.37	-0.21	-0.44
SMB	0.41	1.00	0.31	-0.37	0.05	SMB	0.25	1.00	-0.13	-0.34	-0.13
HML	0.21	0.31	1.00	-0.01	0.57	HML	-0.37	-0.13	1.00	0.12	0.72
RMW	-0.16	-0.37	-0.01	1.00	0.09	RMW	-0.21	-0.34	0.12	1.00	-0.05
CMA	-0.15	0.05	0.57	0.09	1.00	CMA	-0.44	-0.13	0.72	-0.05	1.00

The GRS statistics in the QE period are significantly lower than the previous period, for /SMB (CAPM model) and HML (three-factor model) is 2.14, RMW and CMA (five-factor model) are 2.17, which may reflect that there is no significant difference among CAPM model, three-factor model and five-factor model in explaining the cross-sectional return of assets during the quantitative easing period. However, the five-factor model of fitting ability for asset regression is better. The P-value also shows a significant increase from the previous two periods, but is still below the significance level of 0.05, indicating that the model is also insufficient to fully explain asset returns during this

period. However, if the simplified GRS-test is adopted considering the relatively small data size in this period, the obtained value will be higher than the significant level of 0.05.

Moreover, after excluding data from November 2008 to April 2022 from the dataset spanning 1963 to 2022, the GRS test results for CAPM, the three-factor model, and the five-factor model all showed some degree of improvement. However, their explanatory power for asset returns was not as strong as that observed in the complete sample from 1963 to 2024 (See Table 3).

Table 3. GRS test for different factors in four different time periods

Panel A: 1963-2013				Panel B: 1963-2024			
	GRS	A|a_i|	P-value		GRS	A|a_i|	P-value
/SMB	4.47	0.27	1.25E-11	/SMB	4.34	0.20	2.32E-11
HML	3.67	0.10	9.30E-09	HML	3.88	0.10	1.13E-09
HML RMW CMA	3.12	0.09	7.58E-07	HML RMW CMA	3.14	0.08	5.54E-07
Panel C: 2008-2022				Panel D: 1963-2024/2008-2022			
	GRS	A|a_i|	P-value		GRS	A|a_i|	P-value
/SMB	2.14	0.23	3.04E-03	/SMB	4.10	0.27	3.22E-10
HML	2.14	0.13	3.05E-03	HML	3.25	0.10	3.01E-07
HML RMW CMA	2.17	0.11	2.62E-03	HML RMW CMA	2.95	0.10	3.29E-06

4. Conclusion

Through in-depth analysis of this study, several key findings have been identified. First, the Fama-French three-factor and five-factor models demonstrated varying explanatory powers across different market cycles, particularly during the implementation of quantitative easing policies. The five-factor model, compared to the three-factor model and the CAPM model, showed no significant differences in the GRS test for intercepts, but the sum of absolute values of intercepts was smaller, indicating stronger explanatory power for asset returns. This result underscores the importance of incorporating more risk factors under varying economic policies and market conditions.

Secondly, market excess returns (Mkt-RF) significantly increased during the quantitative easing period, whereas the impact of the size factor (SMB) was nearly negligible, suggesting that large stocks might not have performed significantly differently from small stocks during the period of quantitative easing. Moreover, the influences of the profitability (RMW) and investment style (CMA) factors were also diminished during this period, potentially due to market structure changes driven by macroeconomic policy impacts. During the quantitative easing period, aggressive investment styles were encouraged, and the significance of profitability was reduced, indicating profitability was not the only criterion.

Lastly, the research highlights the critical importance of deep insights into the changes in the influence of financial market factors. Understanding how these factors affect asset pricing, especially during key periods like the global financial crisis and the implementation of quantitative easing policies, is crucial for investors, market analysts, and policymakers. The findings affirm the effectiveness of the Fama-French five-factor model across multiple periods and reveal the complex dynamics of financial markets in response to macroeconomic policy changes. For example, exploring new factors might require consideration of their significance in different economic periods.

While this study provides valuable insights into the performance of asset pricing models across different market cycles and economic policies, it also acknowledges certain limitations. One notable limitation is the exclusion of data from November 2008 to April 2022, which, although improving the GRS test results for CAPM, FF3, and FF5 models, resulted in a decreased explanatory power for asset returns compared to the analysis with the complete datasets from 1963 to 2024. This exclusion could potentially overlook specific market dynamics and influences present during the excluded period, especially those related to the global financial crisis and the subsequent quantitative easing policies.

In conclusion, the study not only expands understanding of the application of classic asset pricing models in modern financial markets but also offers new insights into market dynamics under quantitative easing policies. These discoveries enhance recognition of the impact of market factors and provide new directions for future financial market research and asset pricing model development.

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