Tests of the Fama-French five-factor model in the US stock market under the COVID-19 pandemic

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Abstract. At the end of 2019, the COVID-19 spread widely around the world, leading to a global economic recession. The data for this article is taken from a database created by Kenneth R. French. Given that the COVID-19 pandemic was widespread in the United States in March 2020 and remained stable through February 2023. In this paper, multiple linear regression method is adopted to conduct empirical analysis and test on the Fama-French five-factor model, and explore the explanatory strength of the five-factor model on the US stock market before and after the epidemic. The results showed that the volatility and average return of the market increased significantly after the epidemic. The epidemic enhanced the market value effect, and also enhanced the explanatory power of the profit factor and investment style factor.

Keywords: Multiple linear regression analysis; Fama-french five-factor model; American stock market; COVID-19

1 Introduction

At the end of 2019, the COVID-19 spread widely around the world, leading to a global economic recession. In this paper, multiple linear regression method is adopted to conduct empirical analysis and test on the Fama-French five-factor model, and explore the explanatory strength of the five-factor model on the US stock market before and after the epidemic.

2 Literature Review

Li and Zhang (2021) based on the Fama-French three-factor and five-factor model, this paper analyzed the changes of 49 U.S. stock industries before and after the COVID-19 pandemic, and the results showed that the five-factor model had less improvement in data matching and explanatory power than the three-factor model. The "small" nature of the US stock market was still dominant, and the pandemic had even reinforced this trend [1]. Weixuan et al. (2022) found that after the outbreak of the epidemic, the fitting degree of the American industry model to the industry was improved. HML factor of

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service industry and CMA factor of paper industry changed from significant to insignificant, while RMW factor of catering industry changed from insignificant to significant [2]. Zhang (2021) concluded that the Fama-French five-factor model fitted the US stock market better during the epidemic than before the epidemic [3]. Philippe and Leyla (2022) showed that the application of Fama-French three- and five-factor models was limited in the underlying environment, as they did not provide reliable results in firm-specific environments affected by major crises such as the COVID-19 pandemic [4].

3 Method

3.1 Fama-French five-factor model

If the three factors explain all the difference in stock portfolio returns, the above intercept term a_i will be equal to 0. With the continuous study and demonstration of capital asset pricing model, scholars had found that there were still some returns in the stock market that cannot be explained by the three factors, so Fama and French (2015) built a five-factor model with more explanatory power [5].

$$R_{it} - R_{ft} = a_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + e_{it}$$

4 Data selection and factor construction

The data in this paper are selected from the daily data in the database created by Kenneth R. French, which is from March 2020 to February 2023, considering that the COVID-19 pandemic was widespread in the United States in March 2020 and remained stable through February 2023. And pre-pandemic data are selected for an equal length of time from March 2019 to February 2020 for comparison. This paper uses the 2×3 factor construction method proposed by Fama and French(2015a).

5 Empirical test and result analysis

5.1 Five-factor descriptive statistical analysis

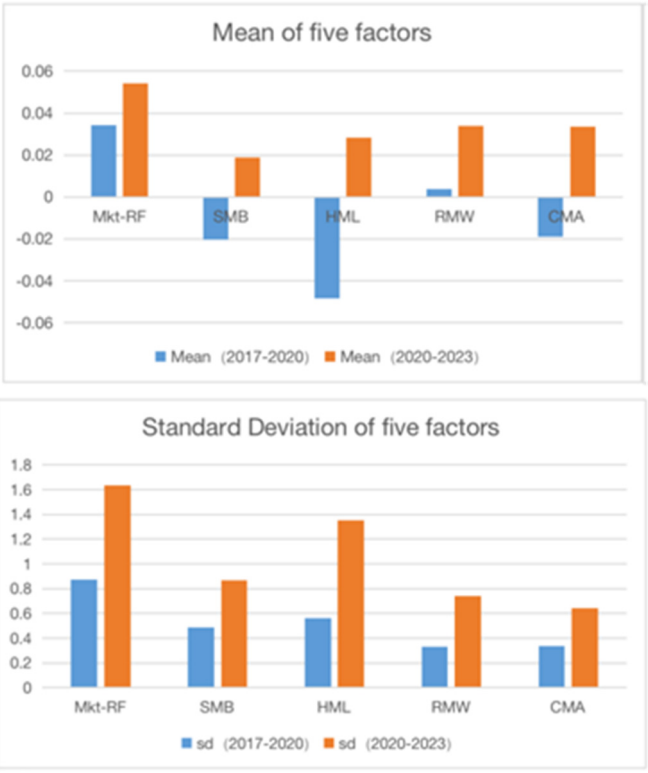

Fig. 1. Comparison of mean and standard deviation before and after the epidemic

In figure 1, it showed that the average return during the epidemic was significantly higher than that before the epidemic, especially the return rate of the portfolio constructed by SMB, HML and CMA, changing from negative to positive. At the same time, the standard deviation after the epidemic was much larger than that before, and the instability was significantly increased, indicating that the covid-19 had increased the volatility of the US stock market.

5.2 Factor correlation analysis

5.2.1 Analysis of correlation coefficient between factors.

During 2017~2020, Rm-Rf was negatively correlated with HML, RMW, and CMA, but positively correlated with SMB, indicating that stocks with large scale, low book value, weak profitability and aggressive investment style before the epidemic had higher market β coefficient. It is worth noticing that the correlation coefficient between

CMA and HML was high, which was 0.56866194, indicating that companies with stable investment style were often accompanied by a high book-to-market ratio.

In contrast, during 2020~2023, Rm-Rf was still negatively correlated with HML, RMW and CMA, and positively correlated with SMB, which was the same as before the epidemic. However, the correlation between CMA and Rm-Rf was stronger than that of HML and RMW, and the data showed that stocks with aggressive investment style were more consistent with the market during the epidemic. It also shows that HML and RMW can explain CMA to a large extent.

5.2.2 Redundancy factor test analysis.

In 2017~2020, at the level of 0.05, the p-value obtained by the test of five factors was all greater than 0.05, and the intercept term was significantly not zero, indicating that none of the five factors can be linearly represented by other factors. That means there was no redundancy.

In 2020~2023, at the level of 0.05, the result was the same as before. However, at the 0.1 level, when CMA regression was performed for the other four factors, p-value=0.0591<0.1, and CMA factor was significantly zero.

5.3 Descriptive statistical analysis of explained variables

5.3.1 Size-B/M Portfolios.

In Size-B/M (2017~2020), when the book-to-market ratio was fixed, companies with large market value obtained better excess returns, which violated the market value effect. In this case, companies with low book-to-market ratio showed more obvious performance. At the same time, the earnings of high BM ratio before the epidemic were lower than those of low BM ratio wholly.

In Size-B/M (2020~2023), when the book market value was fixed, there was no regular change as the market value increased, and the market value effect was not reflected. However, during the epidemic period, the earnings of a high BM ratio were generally higher than those of a low BM ratio. It is worth noticing that small cap companies made higher and more significant returns when their book value was high.

5.3.2 Size-OP Portfolios.

In Size-OP (2017~2020), the income of large market capitalization with fixed profitability was much higher than that of small market capitalization, which violated the market capitalization effect, and this phenomenon was more obvious in the portfolio with high profitability.

In Size-OP (2020~2023), companies with small market value had better performance than those with large market value, and the market value effect was relatively obvious. It showed that during the epidemic period, investors paid more attention to the profitability of small-market companies, and small-market companies with high profitability often brought higher returns to investors.

5.3.3 Size-Inv Portfolios.

In Size-Inv (2017 ~ 2020), companies with large market value tended to gain higher returns, which violated the market value effect. However, whether large or small, aggressive investing styles tend to yield higher returns.

In Size-Inv (2020 ~ 2023), companies with small market value tended to get higher returns, and the market value effect was relatively obvious. In addition, companies with conservative investment styles tended to gain higher return.

5.4 Cross grouping regression test

The regression will be conducted for the cross grouping of explanatory variables and explained variables to test the explanatory strength of each factor. The explained variables include Size-B/M, Size-OP, Size-Inv group, each group is cross-sorted into 25 groups.[6]

Table 1. The number of factors that are not significant at 0.05 level

	2017~2020	2020~2023
Intercept	75	75
Mkt-RF	0	0
SMB	0	1
HML	8	2
RMW	14	9
CMA	17	14

Table 1 shows the number of factors significantly equal to zero at 0.05 level in the three groups. The null hypothesis of multiple linear is that the constant term is zero and the coefficients are 0. Compared with the results before and during the epidemic, although the explanatory power of CMA was weak all the time, COVID-19 enhanced the explanatory power of HML, RMW and CMA.

6 Conclusion

In this paper, descriptive statistics, correlation coefficient analysis and redundancy factor analysis were carried out on the five factors, descriptive statistics were carried out on the explained variables (average excess return) of the Size-B/M, Size-OP, Size-Inv group, and cross-grouping regression was tested to test the explanatory strength of each factor before and during the epidemic.

The results showed that in the descriptive statistical analysis, the average return during the epidemic was significantly higher than that before the epidemic, especially the return rate of the portfolio constructed by SMB, HML and CMA factors changed from negative to positive. At the same time, it shows that the COVID-19 pandemic had increased volatility in the U.S. stock market.

In the correlation coefficient analysis, stocks with large scale, low book value, weak profitability and aggressive investment style before and after the epidemic all had higher market β coefficient. It is worth noting that prior to the pandemic, robust investment styles were often associated with high book-to-market ratios. Aggressive stocks were more in line with the market during the pandemic. At the same time, the portfolio with sound investment style was often accompanied by the characteristics of strong profitability and high book-to-market ratio, which also indicates that CMA can be explained by HML and RMW to a large extent.

Before the epidemic, the market value effect was violated in the Size-B/M, Size-OP, Size-Inv group, while after the epidemic, the market value effect was very obvious in the Size-OP, Size-Inv group. Before the epidemic, the addition of CMA and RMW to the five factors was not obvious, but during the epidemic, the interpretation of these two factors was greatly enhanced.

Reference

1. Li Shuai & Zhang Qiang. (2021). Empirical research and regulatory thinking on the impact of COVID-19 on American stock industry -- based on the Fama-French three-factor and five-factor model. Wuling Academic Journal (05),48-57.
2. Weixuan Huang, Jiaqi Wang & Kaidi Zhu. (2022). Analysis of U.S. industries based on Fama-French five-factor model under COVID-19..(eds.) Proceedings of 2022 International Conference on Company Management, Accounting and Marketing (CMAM 2022) (pp.33-40).
3. 3.Shu Zhang. (2021). Research on the Application of Fama-French Five-Factor Model in American Stock Market Before and During the COVID-19 Pandemic.
4. Kostin Konstantin B., Runge Philippe & Mamedova Leyla E..(2022).Validity of the Fama-French Three- and Five-Factor Models in Crisis Settings at the Example of Select Energy-Sector Companies during the COVID-19 Pandemic. Mathematics (1).
5. Fama E F, French K R. A five-factor asset pricing model [J]. Journal of Financial Economics, 2015, 116(1):1-22
6. Fama E F, French K R. The Cross-Section of Expected Stock Returns[J]. Journal of Finance, 1992, 47(2):427-465.