The Impact Analysis of COVID-19 on Transportation Industry in Terms of Fama-French Five-Factor Model

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Abstract—Whether the average return of stocks can be predicted has always been the focus of academic attention. Under the framework of market efficiency hypothesis, the pricing model is constantly improved and refined. Among various pricing approaches, Fama-French Five-Factor Model (FF5) exhibits well performance in predicting average stock returns and asset pricing. In 2020, COVID-19 is spreading rapidly around the world, with high rates of infection making it one of the most serious viruses of the 20th century. At the same time, it also affects related industries and stock markets in the United States. Based on FF5, this research empirically investigates the variation of transportation industry in the US under the impact of COVID-19 in terms of regression. According to the analysis, the model has strengthened the explanation of the sector after the epidemic, and the epidemic has not significantly affected the U.S. transportation sector. According to the analysis, the significance and style of the Fama-French model factors changed significantly, with the transportation sector being more insensitive to the market, while stocks in the sector remained somewhat speculative. Overall, this paper comprehensively evaluates fund performance and more effectively measures a fund's ability to generate excess returns through active investment management. The obtained results are helpful for stock price predicting, and can provide guidance and ideas for corporate investment.

Keywords-Fama-French Model; COVID-19; transportation industry.

1 INTRODUCTION

Asset pricing is now an important subject of financial research, where the Capital Asset Pricing Model is one of the well-known models proposed in 1990 based on Harry Markowitz's portfolio choice model, which was created by Markowitz previously [1]. CAPM is still frequently utilized in applications such as assessing a company's cost of capital and analyzing managed portfolio performance 40 years later. CAPM is appealing because it explains the path to quantify risk in terms of expected return [2]. Asset pricing has sought to comprehend how risk premia on financial products are determined. It has plenty of assumptions, including complete market participant agreement on predicted returns and returns differentials, unfettered risk-free borrowing, and unfettered short selling. CAPM also has a lot of assumptions [3,4]. Just by considering a portfolio with an arbitrarily large number of assets, the return on the remainder of

a particular asset's return can be made arbitrarily small. However, the CAPM model has plenty of defects and limitations as already discussed in previous literature [5-8]. The model has been criticized for mispredicted results compared to realized returns and the impact of other risk factors. Ideally, when included in any single-factor-based asset pricing model, the inclusion of firm-specific parameters must increase the explanatory power of that single-factor model. On this basis, Fama and French have taken into consideration the factors of size, earnings-to-price ratio, leverage, and book-to-market ratio to improve the performances of the models [9-14]. According to the analysis, the three-factor model leaves most of the diversity in average returns earnings and investing unexplained. This is why they decided to include the fourth and fifth variables, i.e., the RMWt factor and the CMAt factor [15].

Over time, the Fama-French model has become more widely used. Dolinar et al. tested the suitability of the emerging Croatian stock market with a five-factor model. It is shown in this study that the FF3 is slightly more successful than CAPM. Compared to other models, the FF5 was shown to capture the largest changes in stock returns [16]. Yan and Bao mainly analyzed the coefficients of the two models in the study to confirm the influencing factors of the health industry [17]. Mao studied the impact of the epidemic on the book industry and conducted an empirical study on the book industry based on the Fama-FF5 [18]. Zhang uses the FF5 To study the change in the explanatory power of US manufacturing. The non-significant intercept coefficient becomes significant. When investing in US manufacturing companies following the pandemic, investors should pay greater attention to the effects of the factors [19]. In addition, the findings of Yang's found that electric vehicles Automobiles have good development prospects [20].

Due to the outbreak of COVID-19 in recent years, which has affected a wide area, the economy in many parts of the United States has experienced great fluctuations. This study will adopt the FF5 to conduct a detailed analysis of various factors in the U.S. transportation industry before and after the epidemic and provide corresponding investment recommendations. The rest part is separated as follows. Sec. II will demonstrate the methods used in this research, and introduce each model in detail. Sec. III will give our final results and discussions based on the results. Finally, the conclusion and future outlook will be presented in the Sec. IV.

2 METHODOLOGY

2.1 Data

According to French's Data Library, the daily data of transportation industry in 30 industry categories and Fama-French 5 Factors data [Daily]are selected for analysis. Considering that the COVID-19 spread in the United States in March 2020, data from March 2020 to February 2022 were selected as the data after the outbreak, and data of the same time period (March 2018 to February 2020) were selected as the comparison reference before the outbreak. This paper performed multiple linear regression to estimate coefficients. Depending on the results, we can give some experience and enlightenment to relevant investors and decision-makers to change the orientation of the investment.

2.2 CAPM

CAPM is the first approach to give an asset pricing model in theory. CAPM model explains that the theoretical relationship between expected return and expected risk of assets is expressed by linear relationship. The mathematical expression of CAPM model as follows:

$$R_i - R_f = \beta(R_M - R_f) \tag{1}$$

Where R_i represents the expected rate of return of a single asset or portfolio, R_f represents the risk-free rate of return, R_M represents the expected return rate of the market portfolio, β represents the systematic risk factor of an asset, $R_M - R_f$ represents the market risk premium.

2.3 FF5

Fama and French's Research optimized CAPM model and established the FF5 model, which can further explain the inherit connection between risk and returns, which can be analytically described as follows:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + \varepsilon_{it} \tag{2}$$

Here, the SMB, HML, RMW and CMA are the four extra factors added by. In terms of market value and depending on operating margin and investment style, all stocks can be divided into various types. These types form the value of the different variables that used to fit the function. After the adjustment and calculations, four factors are constructed by different combinations. When all the variables are obtained, the regression can be fitted.

3 RESULTS & DISCUSSION

3.1 Correlation analysis

Based on the FF5, this paper investigates the changes in market returns, market capitalization size, book-to-market ratio, profitability, and investment style of the transportation industry. Based on the database, we selected the transportation data from the FF5 (daily) and 30 industry portfolios to conduct multiple linear regressions from March 2018 to February 2020 and March 2020 to February 2022 respectively, to calculate the coefficients in the FF5. For comparison, the factor coefficients were judged at 5% significance. The adjusted mean values of R^2 of the five-factor model, as shown in Tables. 1 and 2, after the new crown epidemic, have all increased substantially, indicating that the five-factor model fits better after the epidemic. Therefore, it can be inferred that the accuracy of the Fama-French five-factor model for industry pricing after COVID-19 is higher than that before the epidemic.

Table 1 Coefficient of 5-factor model of transportation industry before epidemic

Variable	Coefficient	Std. Error	t-Statistic	Prob.
α	-0.010	0.026	-0.385	0.700
MKT-Rf	1.115	0.030	37.521	0.000
SMB	0.308	0.052	5.968	0.000

HML	0.237	0.054	4.399	0.000
RMW	0.679	0.076	8.876	0.000
CMA	0.062	0.100	0.616	0.538
R-squared	0.784	Mean dependent var		-0.011
Adjusted R-squared	0.782	S.D. dependent var		1.232
S.E. of regression	0.575	Akaike info criterion		1.744
Sum squared residual	164.414	Schwarz criterion		1.794
Log likelihood	-432.499	Hannan-Quinn criter.		1.763
F-statistic	361.352	Durbin-Watson stat		2.213
Prob(F-statistic)	0.000	-		-

Table 2 Coefficient of five-factor model of transportation industry after epidemic

Variable	Coefficient	Std. Error	t-Statistic	Prob.
α	-0.003	0.032	-0.077	0.938
MKT-Rf	0.952	0.020	46.567	0.000
SMB	0.266	0.042	6.407	0.000
HML	0.306	0.035	8.782	0.000
RMW	0.201	0.058	3.437	0.001
CMA	-0.301	0.077	-3.892	0.000
R-squared	0.864	Mean dependent var		0.102
Adjusted R-squared	0.863	S.D. dependent var		1.950
S.E. of regression	0.721	Akaike info criterion		2.197
Sum squared residual	259.160	Schwarz criterion		2.247
Log likelihood	-547.532	Hannan-Quinn criter.		2.216
F-statistic	635.317	Durbin-Watson stat		1.972
Prob(F-statistic)	0.000	-		-

3.2 Regression analysis

An analysis of the intercept term α in the Fama – French five-factor model equation reveals that the transportation conference intercept term before and after COVID-19 is anomalous and always negative, but at the same time (as shown in Table. 1 and Table. 2), α is not significant. COVID-19 dealt a devastating blow to many industries, and the transportation industry was the hardest hit. In major U.S. cities, public transportation systems are essential for commuters, tourists, and

the general public. However, COVID-19 has completely changed all that, which leads to the amount of ridership on U.S. public transit has plummeted. General manager Robert Powers told Fortune magazine that before the outbreak of COVID-19, the system served 420,000 passengers per day. The San Francisco Bay Area Rapid Transit system lost 90 percent of its passenger traffic during the days of lockdown and quarantine in March 2020. With fares and parking fees accounting for two-thirds of its revenue, the total loss to the San Francisco Bay Area Rapid Transit system amounted to approximately $1 billion. San Francisco's transit system was not the only one affected. It is seen that their passenger volumes decline by 80 percent and 90 percent, respectively. The combined losses for the three transit systems amounted to billions of dollars. According to the American Public Transportation Association (APTA), as of the end of October, the nation's transit ridership was only about 62 percent of what it was before the epidemic. As vaccination rates in the U.S. have slowly increased and the number of pneumonia cases in many states has declined, transit system passenger traffic has rebounded slightly but is still not as high as it was before the epidemic. The New York Metropolitan Transportation Authority and McKinsey Company, a consulting firm, conducted a study that predicted a 10 to 15 percent drop in passenger traffic that would last for several years. He noted that this decline would cause a structural deficit of about $1 billion to $1.5 billion, but the situation is still uncertain.

The coefficient of the market factor in the model is greater than 0 and around 1 (seen in Table. 1 and Table 2), indicating that the trend of the run is consistent with the overall market run during the sample period; As can be seen, the market factor Mkt-Rf decreases from 1.115 to 0.952, with a downward trend due to the epidemic, which means the industry is less sensitive relative to the market. The market capitalization factor SMB shows significantly higher returns for small-cap stocks. In general, companies with smaller market capitalization are smaller and the companies are relatively less stable and therefore riskier and need to earn higher returns to compensate. The p-value corresponding to the profitability factor RMW was much less than 0.05 and was significant before and after the outbreak, indicating that transportation industry stocks are speculative. MKT, SMB, HML, and RMW are significant and do not change much, indicating that it only has some insignificant effects on the transportation industry. CMA changes from insignificant to significant. In conclusion, the impact of the new crown epidemic on the factors of the transportation industry is small and does not significantly affect the capital market's expectations of the transportation industry. It is worth noting that the model adjusted R^2 is higher after the epidemic, which proves that the matching of the model is enhanced under the epidemic condition.

3.3 Limitation

Although a long time seems to be passed since the outbreak of the new crown epidemic, a few years of data is not enough to predict the general direction of the industry in the future for cycle forecasting purposes from an economic perspective. Therefore, we still need to pay close attention to the situation of the new crown epidemic to explore the deeper impact of the general environment on the industry. In addition, from the analysis, we can see that the CMA factor was not significant before the COVID-19 outbreak, but became significant after the outbreak, of which the specific drivers could not be reflected through the model, while the CMA factor is one of the important factors in analyzing the development of the industry. Besides, it is such a significant change may be closely related to the industry forecast.

4 CONCLUSION

In summary, this research analyzes the difference between the U.S. transportation sector before and after COVID-19 based on the five-factor Fama-French model. Specifically, the model has strengthened the explanation of the sector after the epidemic, and the epidemic has not significantly affected the U.S. transportation sector. According to the analysis, the significance and style of the Fama-French model factors changed significantly, with the transportation sector being more insensitive to the market, although the epidemic only had some impact on the transportation industry and did not remarkably affect capital market expectations for the transportation sector, while stocks in the sector remained somewhat speculative. In the future, first, it is necessary to continue to strengthen the support for the transportation industry, a sound transportation system plays an important role in stabilizing society and financial markets. Secondly, one needs to strengthen the regulation of the transportation industry speculation as well as prevent and combat insider trading and artificial manipulation of stock prices. COVID-19 has not subsided, just a few years of data is not enough to predict the future direction of the industry. On this basis, we still need to pay more attention to the situation of COVID-19 and collect more data to better predict the direction of the industry for cycle forecasting purposes. Additionally, because the CMA factor is the key to analyzing enterprise development, we should pay more attention to the CMA factor. Overall, our research comprehensively evaluates fund performance and more effective measures of a fund's ability to generate excess returns through active investment management. The obtained results help predict the trend of the stock market in the future and can provide guidance and ideas for corporate investment. These results indicate that the government and the financial market must provide continuous support and effective supervision for the transportation industry. Therefore, it is recommended that the relevant authorities continue to pay attention to the above-mentioned issues to ensure the stability of the financial market and to better promote the development of the real economy.

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