# Using Three-factor and Five-factor Models to Explore the Impact of the Covid-19 on the US Stock Health Care Industry

Zian Xiang*

Economics and Management School, Wuhan University, Wuhan, China

*Corresponding author: 2020301051236@whu.edu.cn

**Abstract.** Based on the Fama-French three and five factor models, this paper empirically studies the changes in the healthcare industry in the U.S. stock market before and after the epidemic. The results show that the explanatory power of the two models after the epidemic has increased, the influence of market factors has been reduced, the "small-scale" effect of the US stock health care industry has increased, and the market has more preference for growth stocks, and the profitability factor has become significantly affected by the epidemic. The investment style factor is redundant. The medical industry after the epidemic still has investment value.

**Keywords:** Fama-French Model; COVID-19; Pharmaceutical Industry.

## 1. Introduction

### 1.1 Background

As a once-in-a-century black swan event, the new crown pneumonia epidemic, which had a great impact on the global economy. U.S. stocks were blown four times at one time, and countries had to one after another Lockdown measures to curb the spread of the epidemic, and with it the economy It has been severely impacted, and serious inflation has occurred since 2022. In addition, the new crown epidemic has also caused the market to recognize the significant value of pharmaceutical companies. New Corona Virus Infected Pneumonia It is an acute respiratory infection and there is no clinical drug or medical The ventilator will not be able to cure the new coronary pneumonia However, it plays an important role in the treatment, so it has caused looting in various countries. In this epidemic, the biopharmaceutical industry has also demonstrated how to deal with such a large The ability to scale health crises, November 9, 2020, Pfizer Pharmaceuticals Announcing a new joint development with German biotech company BioNTech Coronavirus mRNA vaccine can effectively prevent 90% of new coronavirus infections, giving The global capital market has injected a booster. Therefore, for US stocks medicine Empirical research conducted by the industry is of great significance to understanding the impact of the new crown epidemic.

### 1.2 Related research

Besimi and Bisheva consider the Macedonian Stock Exchange as a frontier market to be a good research object. They empirically tested the explanatory ability of the traditional CAPM model and the improved Fama-French three-factor model on the frontier Macedonian stock exchange, and found that the results were not ideal [1]. The Autoregressive Distributed Lag (ARDL) model was used by Su and Paz to empirically analyze the Spanish REIT market. The study finds that the FF3 model can better reflect return on investment in Spanish REIT market than the traditional CAPM model and another model which was called the Carhart four-factor model, and the market factor is less convincing than the size factor and the value factor in the long run [2]. Wu et al. gave up the classic market capitalization (SMB) and book-to-market ratio factors (HML) and replaced them with exchange-traded fund (ETF) factors to reconstruct the traditional FF model to investigate whether the addition of new factors would improve the Fama-French model. The study found that the explanatory power of the new model is not as good as the original FF3, but the basic idea of adding new factors to improve the explanatory ability of the model is worth adopting [3].

Han et al study whether the FF3 model is useful in A-share market. The study found that the FF3 model is useful in the Shenzhen main market and has a high degree of fit. The market capitalization

factor has the highest explanatory ability for returns, followed by SMB and HML. However, if the research object is replaced by GEM market, the HML is a redundant factor, and the new model after excluding the book-to-market ratio factor has a stronger explanation, which may be caused by excessive speculation on the GEM [4]. Bergeron proved that the assumption that the return generation in the FF3 model is linear is not necessary, because the complete model can be derived only by considering that the return of the asset comes from the three factors assumed by the model [5]. The research subjects of Abd-Alla and Sobh chose the Egyptian Stock Exchange to test the validity of the FF3 model. The results of the study overturn the null hypothesis, and both SMB and HML factors are redundant, proving that there is no small-cap effect and book-to-market effect in this market [6].

Li tested China Shanghai's A-share market to verify whether the FF3 model is really better than the CAPM, and the result of the study is that both the size factor and the book-to-market ratio factor improve the explanatory ability of the model for both individual stocks and industries, and that returns are not solely determined by market factors [7]. Hu et al. tested whether the scale factor and book-to-market ratio factor are significant in the A-share market. The test result is that the size effect is significant, but the other is not significant. The analysis believes that this is caused by the small number of stocks in the market, high speculation and strong stock price volatility [8].

Haqqani conducts empirical tests on Pakistan stock market using three-factor and five-factor models, respectively. The paper found that the FF5 model performed better than the FF3 model in this stock market [9]. Mallik's research object selected the cement manufacturing industry of the Dhaka Stock Exchange, and the research content is which of the traditional CAPM model and the FF3 factor model is more explanatory for this industry. Studies have shown that the explanatory ability of the FF3 factor model is stronger [10].

### 1.3 Objective

French obtained the Kenneth R. French database which collected data on the U.S. stock market over the last century, and this article directly uses the data in the database. Considering that the new crown epidemic broke out in February 2020, the data from February 2020 to January 2022 was selected as the data after the COVID-19, and the data of the same length of time (February 2018 to January 2020) was selected as the comparison before the epidemic refer to. The model first divides companies into small-cap and large-cap stocks based on the market capitalization of the listing formula, with each group accounting for 50 percent of each. The stocks was sorted according to the book-to-market ratio from high to low, and divided into three groups High, Middle and Large, and each accounting for 33%. Cross stocks to get the combination of six groups. As for the five-factor model, two factors, RMW and CMA, are introduced on the basis of the three-factor model. Conservative style (C), neutral investment style (N), aggressive investment style (A), and finally got 18 groups. The multiple linear regression method was used to calculate the data, and the coefficients of the two models before and after the epidemic were obtained, and significance tests were carried out to understand the influences of the new crown epidemic on the health care industry through the analysis of the coefficients and significance.

## 2. Method

The three-factor model used in this article is Fama & French's model in their 1993 paper. The model's expression is:

$$R(t)-Rf(t)=a+b1[Rm(t)-Rf(t)]+b2SMB(t)+b3HML(t)+e(t) \quad (1)$$

Among them, R(t) is the return rate of the stock or industry, Rf(t) is the hypothetical risk free rate, Rm(t) is the market return rate, author uses the market index instead. [Rm(t)-Rf(t)] is the market premium factor, which reflect the impact of the overall market on stocks or industries. SMB(t) is the scale factor, which means smaller companies have higher risk and therefore require higher returns.

HML(t) is the book-to-market ratio factor, which reflects higher returns on value stocks than growth stocks. The construction of the three factors follows the factor construction method in the Fama&French's paper. Factors were constructed based on the national market data, and the specific construction process is as follows.

Based on this, in 2015 Fama and French believeed that the model is not perfect, and they changed the Three-Factor Model to a Five-Factor Model, adding profitability and investment style factors to better characterize portfolio excess rate of return. The expression is as follows:

$$E(Ri)-Rf=a+b1Mkt+b2SMB+b3HML+b4RMW+b5CMA+ei \quad (2)$$

In Equation (2) RMW stands for profitability factor and CMA stands for investment style factor.

## 3. Results and discussion

Calculated using multiple linear regression methods on data from the healthcare industry. The coefficients of the two models were tested for significance test.

**Table 1.** Descriptive statistics of the returns of various factors in the health care sub-industry of U.S. stocks before and after the epidemic

| Time | Project | FF3 Model | | | FF5 Model | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mkt | SMB | HML | Mkt | SMB | HML | RMW | CMA |
| 2018.02-2020.01 | Coefficient | 1.31 | 0.86 | -0.73 | 1.41 | 0.55 | -0.57 | -1.41 | 0.21 |
| | T-value | 6.67 | 2.45 | -2.74 | 6.56 | 1.36 | -1.34 | -1.7 | 0.7 |
| 2020.02-2022.01 | Coefficient | 0.72 | 1.93 | -0.59 | 0.95 | 1.47 | -0.49 | -0.83 | 0.212 |
| | T-value | 4.57 | 6.98 | -3.53 | 5.39 | 4.33 | -2.31 | -2.24 | 0.57 |

The result shows that the FF3 model can only reflect 79% of the distribution of the average abnormal returns before the epidemic, while the five-factor model can explain 81% of the distribution. For the post-pandemic situation, the three-factor model can explain about 83% of expected returns, compared with about 86% for the other model, and in the FF5 model, the explanatory power of the last two factors have been partially replaced by the other three factors, because the SMB and HML in the five-factor model before and after the epidemic are higher than those in the three-factor model. Before and after the break, the significance of the market factor decreased, the market value factor and the book-to-market value ratio factor increased significantly, the profit factor changed from insignificant to significant, and the investment factor remained insignificant.

Market factors tend to decrease due to the impact of the epidemic, that is, the sensitivity of asset price changes relative to the market has decreased. Before the outbreak, the entire healthcare industry was highly cyclical, and the industry index fluctuated with the volatility of the broader market index. With the aggravation of the epidemic and even normalization, the market's demand for the healthcare industry has changed. During the process of stock price revaluation, the stocks of the healthcare industry are less affected by the market. For example, from February 2019 to January 2020, the Dow Jones Industrial Average rose 13.02%, UnitedHealth Group rose 9.05%, and from February 2020 to August 2022, UnitedHealth Group rose 100.57%, while the Dow Jones Industrial Average rose 100.57% Up only 10.54%, UNH's earnings after the epidemic have taken a different path than the market index. The stock price trends of the two are also very different. UNH is greatly affected by market surprises, so the stock price fluctuates greatly. The market value factor SMB has increased a lot before and after the epidemic, indicating that the market is more optimistic about small-cap stocks. Generally speaking, companies with smaller market capitalizations are riskier and need to receive higher returns to compensate, and the epidemic has increased the amount of this compensation. The book-to-market value ratio factor HML decreased before and after the epidemic, indicating that the market's evaluation of growth stocks has decreased. The profit factor RMW has decreased, indicating

that speculation has weakened. The U.S. healthcare industry is relatively mature. Pharmaceutical giants have expanded rapidly after several mergers and acquisitions. There is not much room for growth, and the investment impact is not obvious. The investment factor CMA before and after the epidemic is redundant and will not be discussed here.

From the data results, after the epidemic, the sensitivity of the healthcare industry to the market has decreased, the effect of small-cap stocks has increased, the effect of growth stocks has decreased, and the effect of investment and profitability is not obvious. This shows that the new crown epidemic has changed the pattern of the pharmaceutical industry to a certain extent, reflecting the resource allocation role of the capital market. In addition, the adjusted R square of the two models after the epidemic has improved to varying degrees, which shows that the matching degree of the models has increased under the epidemic conditions. Covid-19 has limited impact on the pharmaceutical industry of U.S. stock market, which "small-scale" effect and tends to growth stocks, adding a certain speculative attribute. United States, as the world's largest capital market, his pharmaceutical stocks still have investment value after being hit by the epidemic. The pharmaceutical industry will have more important investment value as human beings pay more attention to health.

## 4. Conclusion

The purpose of this article is to examine the impact of the COVID-19 pandemic on the U.S. healthcare industry. The study found that the new crown epidemic has reduced the impact of market factors on the industry and increased the returns of small-cap stocks. The profit and investment effects are still not obvious. At the moment of economic recession and rising inflation, coupled with the tightening policy of the Federal Reserve, the S&P 500 may fall further, and the healthcare sector, which has gone out of the independent market, has a relatively independent rise and fall logic, among which small-cap stocks have more value.

## References

[1] Besimi F, Bisheva A. A Comparative analysis of the explanatory power of the CAPM and the Fama-French three-factor model on cross-sectional variation of returns on stocks trading on the Official market of the Macedonian Stock exchange[J]. Economy, Business & Development: An International Journal, 2021, 2. Fangfang. Research on power load forecasting based on Improved BP neural network. Harbin Institute of Technology, 2011.

[2] Su Z, Paz P. Applying the Fama and French Three-Factor Model to Analyze Risk/Reward in the Spanish REITs: An ARDL approach[J]. Journal of European Real Estate Research, 2021.Ma Kunlong. Short term distributed load forecasting method based on big data. Changsha: Hunan University, 2014.

[3] Wu Y, Mo X, Wang Y, et al. Research on Mathematical Methods of Improving Fama and French Three-factor Model Based on ETF Factors[J]. Journal of Physics: Conference Series, 2021, 1865(4):042103-.

[4] Han S Z, Zhang L, Han G Y, et al. The Three-factor Model and China's Multiple Stock Markets[J]. Journal of International Commerce, Economics and Policy (JICEP), 2019, 10. [5] C Bergeron (2021). The three-factor model without a linear return generating process.In Economics Bulletin.

[5] Bergeron C. The three-factor model without a linear return generating process[J]. Economics Bulletin, 2021, 41.

[6] Abd-Alla M H, Sobh M. Empirical Test of Fama and French Three-Factor Model in the Egyptian Stock Exchange[J]. Financial Assets and Investing, 2020(2).

[7] Li uses CAPM and Fama-French three-factor models to empirically test the expected returns of the Shanghai A-share portfolio. The main conclusion is that in the Chinese stock market, market risk is not the only factor that determines the expected returns of the market portfolio or individual stocks, and the size factor (SMB) and book-to-market ratio factor (HML) can play a better role.Fangfang. Research on power load forecasting based on Improved BP neural network. Harbin Institute of Technology, 2011.

[8] Hu G X, Chen C, Shao Y, et al. Fama–French in China: Size and Value Factors in Chinese Stock Returns[J]. International Review of Finance, 2019, 19(1):3-44. Ma Kunlong. Short term distributed load forecasting method based on big data. Changsha: Hunan University, 2014.

[9] Haqqani K, Rahman W. The Empirical Test of Fama-French Five-Factor Model: Evidence from Pakistan Stock Exchange[J]. 2020.

[10] Mallik A, Bashar M, Uddin M S. Empirical Evidence of CAPM and Fama French 3 factor model at Cement Industry of DSE[J]. Global Journal of Management and Business Research, 2020:1-6.