

# Research on the Impacts of Covid-19 on U.S. Medical Industry Based on Fama-French Five Factor Model

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## ABSTRACT

Under the dramatic impact of Covid-19, the global economy has decreased sharply, and many countries have experienced negative economic growth during the pandemic. This study uses Fama and French Five-Factor model to investigate the reasons causing these changes and provide referential suggestions on how to invest in stocks of the medical industry during black swan events. Based on the Fama-French five-factor model and data selected from the Center for Research of Security Prices (CRSP), this article explains stocks return in the medical field from May 2019 to February 2020. Specifically, the detailed influence of Covid-19 in health, medical equipment, and drug industries is analysed according to market risk premium, size, book-to-market value, profitability, and investment. The result shows that  $\beta_{MKT}$  becomes larger and  $\beta_{SMB}$  becomes smaller in Health Industry. Meanwhile,  $\beta_{HML}$  in Medical Equipment becomes insignificant and  $\beta_{RMW}$  becomes significant after COVID-19. And the result of drugs shows the  $\beta_{SMB}$  is larger than 1, which indicates investment in a small value company is better. For the whole Medical field, low-profit stock portfolios are profitable.

**Keywords:** Fama-French Five Factor Model, Covid-19, Medical industry, U.S. stock market

## 1. INTRODUCTION

### 1.1. Background

On January 21st, the first case of Covid-19 was confirmed in the United States. The outbreak and spread of novel coronavirus (Covid-19) disease have become a public health crisis and affected the global economy. It is said that America has about 4.25% of the world's population, but over 20% of total Covid-19 death. The pandemic has seriously weakened America's economy. During the second quarter of 2020, the real GDP growth of America fell 31.4%, which is not seen since the Great Depression. The unemployment rate hit 14.7% earlier in 2020.

Only when the spread of the disease is contained can there be any hope of economic recovery. The delivery of effective medical care to all patients has become a great challenge. Also, inadequate personal protective equipment and testing kits are key challenges the

medical industry must deal with. Under this situation, the health care systems are quickly adapting to meet the challenges. The medical device regulatory environment is trying to supply sufficient PPE and life-saving equipment. Medical device manufacturers must also rise up to embrace the opportunities to bring their devices faster to the market. In 2020, North America was expected to account for the largest share of the Covid-19 drugs market and is expected to grow at high rates. To sum up, this pandemic is significantly affecting the medical industry in the United States.

Changes in the medical industry can be seen in the stock market. Increased uncertainty is affecting the required rate of return by investors and, therefore, the current market value of stocks. To analyze the rate of return and the price of medical stocks, the Capital Asset Pricing Model (CAPM) is needed. To go further, the use of the Fama and French five-factor model can make the analysis more clearly and thoroughly by the segmentation of different kinds of factors. With the help of the Capital Asset Pricing Model, investors can have a

deeper understanding of the impacts of Covid-19 on the medical industry in the United States, which is beneficial to their future investment decisions.

### **1.2. Related Research**

Since Covid-19 has caused dramatic impacts on the global economy, many researchers devoted themselves to analyzing the related data for better understanding.

Teresa and Fikriaaimsto have examined the impact of Covid-19 on the volatility of stock returns in 15 countries. The evidence shows that the emergence of Covid-19 will affect the volatility of stock returns in their observed countries except in Britain, and exchange rate changes have a negative impact on stock returns in most countries [1]. Christensen used multivariate analysis to investigate how Covid-19 causes frictions in the market and prices to deviate from their equilibrium values. The results show that some industries, relative to the market, such as Games, Meals and Mines, have increased the volatility significantly after the outbreak of Covid-19 [2]. Moreover, Dave et al. devote themselves to finding the relationship between price and Covid-19. They find that large price increases for meat products occurred across the board, and price declines for corn were largely energy driven and did not affect the food purchases of U.S. consumers [3]. Also, researching how pandemic influences investors' sentiment can provide lots of information for scholars. Sun et al. explored the relationship between the outbreak of the Covid-19 and investors' sentiment towards the medical industry using data and information from five countries. After dealing with CRNs (Covid-19 news), ERAs (economic news) and mass data, it's concluded that both CRNs and ERAs have positive and significant impacts through the investors' optimistic sentiment on the five countries' medical stock portfolios [4].

As different countries' situations are varied, it's of great value for academics to find out the relationship between a certain country and its industries before and after the outbreak of Covid-19. Kanno investigates the daily stock market prices of 2169 firms to compare the impact of Covid-19 on major industries in Japan. It's noticeable that the precision instrument industry shows a positive correlation due to the rising demand for medical equipment by Covid-19. Moreover, the correlation coefficient in the pharmaceutical industry is positive in Osaka [5]. As China is the first country to be affected by Covid-19, so many experts devote themselves to investigating the influences on the Chinese market. To empirically study Chinese industries' market performance and response trends to Covid-19, Sun et al. use the event study approach, finding that the pandemic has adversely influenced transportation, mining, electricity & heating, and environment industries. On the contrary, the healthcare

industry and some other industries are resilient to the pandemic [6]. Similarly, He et al. use data of listed companies in China and adopt big data portrait analysis then find that Covid-19 dramatically affected technology, cultural and commercial industries. However, both Chinese patent medicine and medical equipment achieved rapid development during the period [7]. To find more about America, Hou and Chen analyze the data to compare the steel industry in America before and after Covid-19 and then conclude that the steel industry in the USA has decreased dramatically by the outbreak of the Covid-19 from a macro perspective [8]. Li and Duan use the Fama and French Three-Factor and Five-Factor models to conduct ordinary least square estimations of thirty U.S. based industry portfolios, and contrary to many previous studies, the Fama and French Five-Factor model may be more suitable for estimation under specific market environments [9].

Among all the industries, medical and health care are related tightly to Covid-19, so comparing the differences of medical and health care industries will help the world deal with the pandemic, recovering economy, and improve these industries' developments.

Dickinson and Mehta use data from the Medical Group Management Association and mainly adopt graph method to compare the differences between 2009 and 2019 recessions in health care and economy. The research concludes that Covid-19 causes serious economic challenges to the American health care system [10]. Tang et al. highlight the importance of materials science in providing tools and technologies for antiviral research and treatment development in their review [11]. After the outbreak of Covid-19, scholars tend to find a new method to produce medical equipments which can shorten the processing time and be convenient to transport. Belhouideg describes and compares the ingredients, designs and usage of certain medical equipments such as protective masks, face shields etc., to emphasize the unexpected impact of 3D printing against Covid-19 and its giant importance in the medical industry in his article [12].

### **1.3. Objective**

As Covid-19 has caused great damage to lots of industries and economic recession worldwide, analyzing the impacts that Covid-19 has had on the medical industry is of great value for people to recess the economy. This study, based on Fama and French Five-Factor model, explores to find out the reasons behind these changes and provide some relevant suggestions on how to invest the stocks of the medical industry during similar black swan events.

**2. METHOD**

The Capital Asset Pricing Model (CAPM), based on the Markowitz model, was developed by American scholars Sharpe et al. in 1964 [13], which depicts the relationship between systematic risk and expected return for assets, and explains how equilibrium price forms. CAPM is widely used throughout finance for pricing risky securities and in investment decisions and corporate finance areas. In 1993, the Fama-French three-factor model (FF3F) was already published by Fama and French, which proposes that stock returns could be explained jointly by market risk, market capitalization and book-to-market equity ratio. In 2013, profitability and investment were added to the description of average returns by Fama and French.

In CAPM, the equation for calculating the expected return of an asset given its risk is:

$$E(R_i) = R_f + \beta_i [E(R_m) - R_f] \tag{1}$$

where  $E(R_i)$  is the expected return of investment,  $R_f$  stands for the risk-free rate,  $\beta_i$  is the investment's beta, and  $E(R_m) - R_f$  stands for a market risk premium.  $\beta_i$  is a measure of how much risk the investment will add to a portfolio. For instance,  $\beta_i$  will be greater than one if a stock is riskier than the market.  $\beta_i$  multiplied by the market risk premium is the return expected from the market above the risk-free rate, with risk-free rate added to the product, the result gives the required return or discount rate of an asset.

In the FF3F:

$$E(R_{it}) - R_{ft} = \alpha_i + b_i [E(R_{Mkt}) - R_{ft}] + s_i \text{SMB}_t + h_i \text{HML}_t + e_{it} \tag{2}$$

$R_{it}$  is the return on security or portfolio for period  $i$ ,  $R_{ft}$  is the risk-free return,  $R_{Mt}$  is the return on the value-weight market portfolio,  $\text{SMB}_t$  is the return on a diversified portfolio of small stocks minus returns on a diversified portfolio of big stocks,  $\text{HML}_t$  is the difference between the returns on diversified portfolios of high and low B/M stocks and  $e_{it}$  is a zero-mean residual [14]. In the Fama-French five-factor model (FF5F):

$$E(R_{it}) - R_{ft} = \alpha_i + \beta_{\text{MKT}} [E(R_{\text{Mkt}}) - R_{ft}] + \beta_{\text{SMB}} \text{SMB}_t + \beta_{\text{HML}} \text{HML}_t + \beta_{\text{RMW}} \text{RMW}_t + \beta_{\text{CMA}} \text{CMA}_t + e_{it} \tag{3}$$

Where  $\text{RMW}_t$  is the difference between the returns on diversified portfolios of stocks with robust and weak profitability and is the difference between the returns on diversified portfolios of stocks of low and high investment firms. If  $\beta_{\text{MKT}}$ ,  $\beta_{\text{SMB}}$ ,  $\beta_{\text{HML}}$ ,  $\beta_{\text{RMW}}$ ,  $\beta_{\text{CMA}}$  cover all variation in expected returns, the intercept  $\alpha_i$  should be 0 for all securities or portfolios  $i$  [14].

**3. RESULTS**

The data are selected from 49 Industry Portfolios in the Center for Research of Security Prices (CRSP), and the study mainly focuses on the two periods of time. To compare the different performance in the stock market of the medical field, from May 2019 to February 2020 is considered to be “before” period and from March 2020 to December 2020 is named in “after” period, which means it is the time that vaccine developed and the epidemic is basically under control.  $\text{Mkt-R}_f$ ,  $\text{SMB}$ ,  $\text{HML}$ ,  $\text{RMW}$  and  $\text{CMA}$  are adopted as independent variables to conduct the regression and obtain the coefficients.

**Table 1.** Results of Multi Regression

Industry	Item	Period	Mkt-Rf	SMB	HML	RMW	CMA
Health	Coefficients	Fore	0.8545	0.9007	-0.0812	-0.4826	0.2985
		Aft	1.1284	0.8313	0.0601	-0.336	-0.2613
	P-value	Fore	0.0000	0.0000	0.4768	0.0100	0.1760
		Aft	0.0000	0.0000	0.6383	0.1926	0.4310
Medical	Coefficients	Fore	0.6639	0.9100	-0.2570	-0.3492	-0.0223
		Aft	0.8259	0.6151	0.0221	-0.7426	-0.0721
Equipment	P-value	Fore	0.0000	0.0000	0.0406	0.0874	0.9263
		Aft	0.0000	0.0000	0.7115	0.0000	0.6423
Drugs	Coefficients	Fore	0.9623	1.3883	-0.4349	-0.7484	0.1655
		Aft	0.9333	0.9557	-0.3726	-1.2451	0.1062
	P-value	Fore	0.0000	0.0000	0.0000	0.0000	0.4113
		Aft	0.0000	0.0000	0.0000	0.0000	0.4990

As shown in Table 1, the P-value of RMW in the Health Industry is changed from 0.01 to 0.19, indicating that RMW becomes insignificant after Covid-19 spread

worldwide. Also,  $\beta_{\text{MKT}}$  becomes larger than 1 after the epidemic occurred, which indicates the Health Industry

is sensitive to the overall market. However,  $\beta_{SMB}$  becomes significantly smaller after the Covid-19.

According to the results of Medical Equipment, its P-value of HML is increased from 0.0406 to 0.7115, which means HML become insignificant. Meanwhile, the P-value of RMW is declined from 0.0874 to 0.000, which indicates RMW turns into significant.

The result of Drugs shows that  $\beta_{SMB}$  is larger than 1 before the Covid-19 spread and indicates investment in small value companies is better at that time.

The RMW of the business service industry is significant during the epidemic, but it is insignificant before the epidemic. Besides, the coefficient of the RMW is negative during the epidemic.

## 4. DISCUSSION

### 4.1. Health

According to the coefficient results of the five-factor model, it can be clearly found that coefficient  $\beta_{MKT}$ , which represents the market factor, has significantly increased from 0.85 to 1.18. Before the outbreak of Covid-19, the health industry is less sensitive than the whole market, whereas, after Covid-19, the health industry is more sensitive than the whole market. The main reason is that the massive outbreak of Covid-19 has made people pay more attention to healthcare. Being aware of the importance of immunity and health, people are willing to spend more on healthcare services and courses. More specifically, more people will take a regular physical examination, go to fitness programs and so on. What's more, to fight the pandemic, the online health industry has grown rapidly after the outbreak of Covid-19. As traditional healthcare services and courses move online, smart and Internet medical care is opening up a bigger market, effectively solving the uneven distribution of healthcare resources. Health demand will lead the health industry into a new era of rapid development. However, more opportunities also mean more challenges. In the face of the rapidly changing pandemic, the healthcare industry is at greater risk. They could go out of business at any time because of the shortage of capital chain or the incremental cost to fight for the pandemic. Therefore, the sensitivity of the healthcare industry will exceed that of the whole market.

Additionally, it appears that  $\beta_{SMB}$ , which represents SMB, becomes significantly smaller after the pandemic. It means that in the health industry, the difference in the return between small-cap stocks and big-cap stocks is smaller after the outbreak of Covid-19. There are two reasons. On the one hand, small healthcare companies are less able to take risks, such as the outbreak of Covid-19, which means they are unable to wait for future opportunities and may go out of business at the

beginning of the pandemic. On the other hand, big companies have more power to grab more space in the new market.

### 4.2. Medical Equipment

Both  $\beta_{MKT}$  and  $\beta_{SMB}$  were significant before and after the outbreak of Covid-19. Since America needed a great quantity of medical equipment to defeat the pandemic,  $\beta_{MKT}$  has increased after the outbreak, indicating the booming medical equipment development.  $\beta_{SMB}$  was greater than 0 before and after the pandemic, which meant low market value companies in the medical equipment industry tended to have a higher return. Being influenced by Covid-19,  $\beta_{SMB}$  has decreased from about 0.91 to 0.62, showing that investors valued high market value companies better to provide medical equipment, increasing returns.

$\beta_{HML}$  was significant in the medical equipment industry before the pandemic, but it was no longer significant after the outbreak.  $\beta_{HML}$  was negative before and changed to positive, indicating that companies with high book-to-market value ratios have higher profitability after the outbreak. Since the medical equipment industry needs diverse advanced technology and materials, before the pandemic, companies with low book-to-market value ratios had better prospects with more investors paid attention to them, which led to  $\beta_{HML}$  was negative and significant analyze the stocks. After the pandemic, the medical equipment shortage results in investors paying more attention to medical equipment than other industries, so  $\beta_{HML}$  became insignificant.

RMW compares the difference in returns between low and high profit stock portfolios. According to the result, it has changed from insignificant to significant during the two periods.  $\beta_{RMW}$  was less than 0, and it dropped to -0.74 from -0.35, indicating that investors tend to be speculative when faced with an investment opportunity, leading to low profit stock portfolios having better profitability than high profit portfolios. Being deeply influenced by Covid-19, many people were being infected every day, also causing medical equipment shortage. The US government has announced that it will purchase 500 million more masks in the next year, so profitability in medical equipment companies has dramatically increased. While CMA remained insignificant before and after the pandemic.

### 4.3. Drugs

All the five factors MKt-Rf, SMB, HML, RMW and CMA, are significant in regard to explaining drug stock return both before and after the outbreak of Covid-19. Additionally, the coefficient values of MKt-Rf, HML and RMW increase after the global pandemic. At the same time, both SMB and CMA have witnessed a decrease in coefficient values after Covid-19, which

indicate the explanatory power and influence of the five different factors in terms of the drug industry.

Specifically, the stock movement of the drug industry is consistent with the whole market as  $\beta_{MKT}$  is positive, and the drug industry is sensitive than the whole market both before and after the global pandemic since  $\beta_{MKT}$  is much larger than 1. The main reason for this phenomenon is that, with government predominance of drug research and development, testing and deployment, related suppliers as well as developers of both hardware and service have experienced a significant increase in their business in terms of vaccines, therapeutics and diagnostic reagents during Covid-19 [15]. Moreover,  $\beta_{SMB}$  is larger than 0 both before and after the global pandemic, which means small-cap stocks can receive higher returns in the drug industry during the period of Covid-19. The Russell 2000 index, which is on behalf of small caps, has been underperforming the SPX 500 from 2012 to 2019. However, the Russell 2000 index has soared by more than 19% since last November, while the S&P 500 index only rose by 6.5% [16]. The coefficient values of HML and RMW are negative. Also, both HML and RMW factors have become more significant, indicating that low book-to-market value ratios and weak profitability have a higher probability of profit after Covid-19 due to the speculative drug industry [3]. Although the CMA factor is significant both before and after Covid-19, the influence is less noticeable compared with other factors since the development of the American drug industry is relatively mature and pharmaceutical giants have experienced rapid expansion after several mergers and acquisitions [17].

#### **4.4. Overview**

Before and after the outbreak of the Covid-19, market, scale, and profitability are significant to the entire medical industry, indicating that scale and profit are prevalent in the entire medical industry. But it's different for RMW in the health industry, possibly because the severity of the pandemic has taken the focus away from profitability.

Before the outbreak, the entire healthcare industry was less sensitive than the market. After the epidemic outbreak, both the health industry and medical equipment showed an obvious trend of improving their sensitivity. The sensitivity of drugs remained basically unchanged, and the sensitivity of the medical industry to the market was greatly improved. This is mainly because the outbreak has brought more attention to the health care industry, which has increased its sensitivity due to the emphasis on physical health checks and the aggressive purchase of medical equipment needed by Covid-19 patients.

At the same time, the sensitivity of SMB in the medical industry is generally very high. Still, it decreases significantly after the pandemic, which indicates that the return difference between small-cap and large-cap stocks in the whole medical industry is small. While the high return advantage of small and medium-sized enterprises remains significant, investors believe that companies with high market capitalization are better suited to achieve high returns in the face of the pandemic. The reason is that smaller companies in the health care industry are less able to take risks and are less able to compete with larger companies in a tough environment.

In addition, the coefficient of HML in the medical industry has been generally improved, indicating that companies with higher book value have higher profitability after the outbreak.

This paper uses the Fama-French five-factor model and CAPM model to study the response of the business service industry to the epidemic and the impact of the epidemic on the U.S. stock market.

## **5. CONCLUSION**

Based on Fama and French Five-Factor model, this study analyzed the impacts Covid-19 has had on the medical industry, divided into health, medical equipment and drugs industries. After the Covid-19, several changes of the coefficient and significance of the five factors has been concluded, the reasons behind which are also seriously discussed.

Firstly, from the result that  $\beta_{MKT}$  is bigger and  $\beta_{SMB}$  becomes smaller, it can be found that the health industry is facing both more opportunities and challenges, and big companies may have more advantages compared to small companies. Secondly, the results indicate the booming development of the medical equipment industry. And when faced with an investment opportunity, investment tends to be speculative, leading to low-profit stock portfolios had better profitability than high profit portfolios in this industry. Lastly, the stock movement of the drug industry is consistent with the whole market because, with government predominance of drug research and development, testing and deployment, related suppliers and developers of both hardware and service have experienced a significant increase in their business during Covid-19.

From this study, the impacts of Covid-19 on the medical industry in the United States has been thoroughly explored and discussed. Investors can have a deeper understanding of the phenomena and reasons for the changes, which could help their future investment decisions.

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