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U.S. Medical-related Industry Under Covid-19: Impacts and Reflections Based on Fama-French Model

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ABSTRACT
As a once-in-a-century black swan event, the global spread of the COVID-19 caused severe economic and social impacts. It made the market recognize the significant value of medical-related companies. During this epidemic, the medical-related industries demonstrated their ability to cope with such large-scale health crises, boosting global capital markets. Therefore, a study of the U.S. medical-related industries has implications for the capital markets. Based on the Fama-French multi-factor model, this study conducts a comparative analysis of the differences before and after the COVID-19 outbreak. It uses multiple linear regressions to conduct descriptive statistics on the returns of each factor for the health, medical equipment and drugs sub-sectors to study the impact of the COVID-19 on the returns of medical-related industries. The results indicate that the COVID-19 gave some opportunities to the health and medical equipment sectors. Still, the overall market was less volatile and did not significantly impact due to government controls, and investors preferred to choose smaller companies with higher returns. It is clear that for the capital market, medical-related industries are important to stabilize society and promote economic development and deserve long-term support and effective regulation.

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

1. INTRODUCTION

Coronavirus disease 2019 (COVID-19) was the first found outbreak in Wuhan, China. And then quickly becomes a global health crisis as WTO (World Health Organization) characterized it as pandemic on March 11, 2020. Besides its huge threat to people's health, COVID-19 significantly impacts the economy and the whole global market. Closure of public places, elongation of social distances, loss of trade etc., have all intensified the plummet in the economy. However, while most stock and bond markets are suffering from this enduring pandemic, the medical industry is growing at an unprecedented rate that strikes the market. Spending on medical care such as masks and sanitizers have grown to a global market of 100 billion. The spending on the vaccine in the pharmaceutical market also has a quick growth rate of over 10% and is expected to grow much more in the future to drop another medical spending. The United States still have the largest market for healthcare spending in the world. Therefore, it is worth using the Fama-French Model to analyze the capital market and its association with the health market to see what changes the whole market and how the model performs in better explaining and predicting changes of excess returns in the health market.

The quick encroachment of Covid-19 worldwide attracts many scientists analyzing its impact on different markets and the global economy. Goodell stated that when the economic condition is bad, the banks are vulnerable because of the possibility of nonperforming loans. Besides, individuals need to withdraw deposits to pay for their treatments, so there may be runs on banks in some extreme conditions. According to a model from Lagoarde-Segot and Leoni, there are more possibilities for developing countries to face banking industry collapse during the large-scale pandemics. What's more, microfinance institutions and banks will face many pressures lending to the poor because of the aggregate shock to all members [1]. While Didier et al. argued that during the economic crisis caused by the COVID,

supply shock and demand shock reinforced each other and affected firms and industries worldwide. Many companies and industries, such as restaurants, do not have enough cash to afford the spending if they almost have no revenue and could only last for a few weeks. Therefore, the COVID led to corporates' serious collapse and made them struggle to survive during the pandemic [2].

Some other researchers focus on the health care and drugs industries that experience the pandemic shock directly. Williams comprehensively analyzed the serious crises of the private health care sector market. He stated that hospitals and private providers shut down many services due to the acute financial crisis epidemic and experienced the high cost of COVID patient treatment and medicines. Additionally, insurance companies deferred or refused to make payments because they were facing extreme cancellations and claims, making the liquidity crisis severe. COVID also reduced almost all the medical tourism, which is one of the major revenues for private health care sectors, thus made critical economic problems for them [3]. Forman et al. predicted that COVID could make primary care practices lose great revenue and cause a financial crisis, which could even threaten their viability. Additionally, small and independent clinics suffered greater strokes. Although after the legislations, hospital systems and clinics that belong to the hospital experienced great relief, federal subsidies are almost impossible to cover primary care practices' financial viability [4]. Margaritti et al. reviewed the change in the dynamics of the demand for pharmaceutical products and summarized the evolution of the pharmaceutical market during the health crisis. This research makes a quantitative analysis of the sales dynamics and the main economic and financial indicators resulting from infections with the new coronavirus SA RS-CoV-2. It concludes that the health crisis caused by the 2020 pandemic runs the risk of deepening economic disparities between the Member States and the risk of a significant deterioration in budget deficits and public debt [5].

The dynamic impact of Covid-19 also brings tremendous changes to healthcare workers. Driggin et al. researched the cardiovascular considerations for patients, health care workers, and health systems during the COVID-19 Pandemic. By reviewing the peer-reviewed and pre-print reports pertaining to cardiovascular considerations related to COVID-19, this research gets the conclusion that the provision of cardiovascular care may place health care workers in a position of vulnerability as they become hosts or vectors of virus transmission [6]. Patricio et al. researched how COVID-19 has affected access to healthcare among migrants in Latin American cities. By using ethnographic research methods, this research conducted 130 interviews of both Venezuelan migrants and state and non-governmental actors within the healthcare ecosystems of these cities. Thus, this research gets the conclusion that people always have a prevalent reliance on alternative forms of care, such as telemedicine, easy-to-access pharmacies, and extralegal care networks and also COVID-19 has exacerbated preexisting conditions of informality and health inequities affecting Venezuelan migrants [7]. Zambrano-Barragán et al. researched early COVID-19 effects on the dynamics of decline and recovery in healthcare labor markets in the United States. Through descriptive analyses with monthly cross-sectional data on unemployment rates, employment, labor market entry/exit, and weekly work hours among healthcare workers in each healthcare industry and occupation, this research concludes that unemployment rates increased dramatically for all healthcare industries. The COVID-19 induced reductions are testing the resilience of the healthcare industry in physical mobility and restrictions on elective and nonemergent medical procedures [8].

Recently, researchers using regression methods to better analyze the changes in markets. Yan's analysis of manufacturer and medical industry in 2020 concludes that the manufactory industry is more volatile to the market economy than the health industry. Also, the coefficient differences suggest that the medical industry is large-scale corporations favored while manufactory ones are in the opposite. And the manufactory industry also has a relatively low book-to-market ratio which implies that it is more stable and develops slower than the medical industry in the future [9]. According to Horváth's examination of the Fama-French model during Covid-19, the R-square of growth portfolios decreases significantly during the financial crisis in 2008. And the influence of the Dotcom Bubble is significant to R-square. By using the Fama-French five-factor model and GMM model in analyzing the crisis during Covid-19, the result can be found is that Covid-19 also leads to a substantial decrease in R-square [10]. Hatfield et al. investigate how Covid-19 guidelines such as social distancing have shaped people's behavior. And perhaps more significantly, influence people's brains and do trauma in the long term. The results from 50 self-reported participants show that people are becoming more stressed about life qualities, and the pandemic also influence their communication abilities and other brain trauma. The period of such influence would continue as the pandemic prolongs [11]. Vernon et al. review COC (cost of capital) in the drug market using the Fama-French three-factor and CAPM models. The pharmaceutical industry has more size-related risks. This skewed payoffs in the pharmaceutical industry illustrate how the Fama-French model gives a higher prediction for COC than the CAPM model [12].

The purpose of this paper is to empirically evaluate the changes in the U.S. medical-related industries before and after the Covid-19 outbreak based on the Fama-

French multi-factor model, separately for the total healthcare sector and its three included sub-sectors of health, medical equipment, and drugs. At the same time, the collected industry background and actual situation were also combined to analyze the impact of Covid-19 on the U.S. medical-related industries and explore the possible reasons for it.

2. METHOD

Markowitz proposed the asset portfolio theory, which laid a solid foundation for the asset pricing theory. However, the assumption premise is too rational, and some scholars questioned the authenticity of his theory in terms of practical research. And the theoretical model at that time had high requirements for computer computing power, and the theoretical model was considered complex due to the limited technology for the computing process. Later, Sharpe, Lintner and NMossin proposed the CAPM model (Capital Asset Market Model), also known as the SLB model, based on asset portfolio theory, which is the backbone of modern financial market price theory and has a very important role in many research areas. The CAPM model equation is as follows.

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

The model reflects the relationship between the risk of a particular asset and its expected rate of return.

Fama and French proposed a three-factor model in 1992, arguing that in addition to β in the capital asset pricing model (CAPM model), market capitalization ME (risk premium due to differences in firm size) and book-to-market ratio BE/ME (risk premium due to differences in book-to-market) also have more significant explanatory power for excess returns, which are also known as small market capitalization stock anomaly and high book-to-market ratio stock anomaly. The basic form of the Fama-French three-factor model is as follows.

$$E(R_i) - R_f = \beta_{Mkt}[E(R_m) - R_f] + \beta_{SMB}SMB + \beta_{HML}HML + e_i \tag{2}$$

In Equation 2, SMB is the size factor return, and HML is the book-to-market ratio factor return. The Fama/French factor is constructed using a value-weighted combination of six factors formed based on size and book-to-market. Each specific factor composition is described as follows.

SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios,

$$SMB = \frac{1}{3}(Small\ Value + Small\ Neutral + Small\ Growth) - \frac{1}{3}(Big\ Value + Big\ Neutral + Big\ Growth) \tag{3}$$

HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios,

$$HML = \frac{1}{2}(Small\ Value + Big\ Value) - \frac{1}{2}(Small\ Growth + Big\ Growth) \tag{4}$$

Based on this, in 2015, Fama and French further proposed a five-factor model, adding profitability and investment style factors to the three-factor model to better describe the portfolio's excess return. The Fama-French five-factor model is as follows.

$$E(R_i) - R_f = \beta_{Mkt}[E(R_m) - R_f] + \beta_{SMB}SMB + \beta_{HML}HML + \beta_{RMW}RMW + \beta_{CMA}CMA + e_i \tag{5}$$

In Equation 5, RMW represents the profitability factor, and CMA represents the investment style factor, and they are composed as follows.

RMW (Robust Minus Weak) is the average return on the two robust operating profitability portfolios minus the average return on the two weak operating profitability portfolios,

$$RMW = \frac{1}{2}(Small\ Robust + Big\ Robust) - \frac{1}{2}(Small\ Weak + Big\ Weak) \tag{6}$$

CMA (Conservative Minus Aggressive) is the average return on the two conservative investment portfolios minus the average return on the two aggressive investment portfolios,

$$CMA = \frac{1}{2}(Small\ Conservative + Big\ Conservative) - \frac{1}{2}(Small\ Aggressive + Big\ Aggressive) \tag{7}$$

3. RESULTS

To better understand how the COVID impacted the medical market, one good choice is to use the Fama-French 5 factor model. Using the multiple regression method, the coefficients, t stat, and P-value of five independent variables could be produced. To get the results, some data needs to be collected in advance—the daily Ri of Medical Equipment, Health, and Drugs, the daily Mkt-RF, SMB, HML, RMW, CMA, Rf of market. Because the COVID started to spread rapidly in the United States in March 2020 and the vaccine was developed in December 2020, the data was divided into two periods to be considered as before and during the COVID, which are 2019.5 to 2020.2, 2020.3 to 2020.12, respectively. The result of the experiment is shown below.

Table 1. Regression results of three industries

		Before			During		
		Coefficients	t Stat	P-value	Coefficients	t Stat	P-value
Medical Equipment	Intercept	-0.03	-0.58	0.56	0.06	1.04	0.30
	Mkt-RF	0.66	10.27	0.00	0.83	29.30	0.00
	SMB	0.91	7.48	0.00	0.62	8.47	0.00
	HML	-0.26	-2.06	0.04	0.02	0.37	0.71
	RMW	-0.35	-1.72	0.09	-0.74	-6.13	0.00
	CMA	-0.02	-0.09	0.93	-0.07	-0.47	0.64
Health	Intercept	0.08	1.59	0.11	-0.04	-0.43	0.67
	Mkt-RF	0.88	15.35	0.00	0.99	25.88	0.00
	SMB	0.53	4.93	0.00	0.75	7.56	0.00
	HML	-0.07	-0.63	0.53	-0.14	-1.77	0.08
	RMW	-0.18	-0.97	0.33	-0.15	-0.94	0.35
	CMA	0.68	3.19	0.00	-0.27	-1.27	0.21
Drugs	Intercept	0.05	0.23	-0.03	0.10	0.05	0.00
	Mkt-RF	0.96	0.00	0.86	0.91	0.00	0.86
	SMB	1.39	0.00	1.19	0.93	0.00	0.80
	HML	-0.43	0.00	-0.64	-0.34	0.00	-0.44
	RMW	-0.75	0.00	-1.08	-1.29	0.00	-1.49
	CMA	0.17	0.41	-0.23	0.18	0.14	-0.06

The highlighted data is the data that has t stat higher than the threshold and to be considered as statistically significant, and only these data need to be discussed. The Health and Medical Equipment industries both have significant data of Mkt-Rf and SMB. Their Mkt-Rf is less than 1, and their SMB is more than 0, which means that for both two industries, their volatilities were lower than the market and small company stocks had a higher return rate than big company stocks. The Health and Medical Equipment industries have different results on HML, RMW, and CMA, and the results of before COVID period differ from during COVID period. For Medical Equipment, the coefficient of HML before COVID is less than zero, which means that the stocks of companies with the lower book to market ratio had a higher return rate. Additionally, its coefficient of RMW during the COVID is also less than zero, which means that the stocks of companies with weak profitability had a higher return rate than the robust ones. For the Health industry, the coefficient of CMA before the COVID is more than zero, which means that the stocks of conservational companies had higher return rates than aggressive ones.

4. DISCUSSION

4.1. Mkt-Rf

Because the health care industry is directly related to the safety of citizens, the medical market is less volatile due to government intervention. Additionally, because the assumptions for these industries are mainly about people's health and would not be greatly influenced by the economic situations, the development of these two industries has a lower correlation with the development of the whole economic system. And the whole market consists of various industries, and many industries are highly volatile due to many different factors such as cyclicality. Consumption in other industries has been hit hard during the outbreak. Still, the main business of the medical industry has been little affected during the outbreak and even was facing some opportunities. Although market volatility has increased due to the disruptions and difficulties in the operation of many hospitals and medical enterprises caused by COVID-19, the volatility of the medical industry is still less volatile than the market. Therefore, the results indicate that the Mkt-Rf of the health and medical equipment industries are always less than one. Although there is a slight rise during the COVID, they are still less sensitive to the market.

4.2. SMB

In the medical equipment industry, different medical equipment companies will face different earnings during the epidemic period. For example, companies that include respiratory machinery manufacturing may see greater earnings, but those who do not involve COVID-19 treatment devices may face a greater blow. With higher volatility across the market, investors tend to prefer larger more resilient companies and take less risk. As a result, it reveals that SMB in the medical device industry declined during the COVID. However, as for the health industry, despite the test of COVID-19, with the government's support, most clinics and hospitals with the capacity to treat COVID-19 patients are facing opportunities. For the Health industry, opportunities and challenges are much more similar across large and small companies and different types of companies than in the medical equipment industry. Therefore, the whole industry volatility increase is small, the risk is small,

and the risk premium is small. Investors still consider investing their limited funds in stocks of small companies to achieve the higher rise of the price to get a higher yield than investing in large companies.

4.3. HML

The coefficient result for HML changes significantly in medical equipment during the COVID period. HML coefficient is not strong enough for explaining the model significantly with its low t-stats in all industries both before and after COVID. However, the HML factor for medical equipment increases significantly from negative to positive, while the HML factor for health and drugs doesn't change much. Drugs and health care industries are run by many more small companies than the equipment industry. Though their book-to-market ratios are higher than the equipment industry, they diversify the risk and continuing making profit facing increasing demand. The numbers of companies building medical equipment are significantly lower than those in drugs and health care. These large companies usually have a high book-to-market ratio, allowing them to maintain cash liquidity during the pandemic. Even though companies with low book-to-market can also survive well in health and drugs industries as the demand increases significantly, those in medical equipment would just be worse if they have a low book-to-market ratio because equipment usually requires a large number of cash flows. As more and more companies with low book-to-market ratios have bad fundamental financial performance, those companies with high book-to-market ratios survive and bring more stock returns to the market.

4.4. RMW

RMW factor significantly explained the stock price before and during Covid-19. RMW factor was weakly negatively correlated with the stock price. And the correlation was not significant. This shows that investors don't care much about the profitability of the medical and drug industries. Under the impact of this global pandemic, demand for drugs and medical care should increase accordingly. But in the US, situations are a bit different. Due to the pandemic, people get unemployed, and their fear of the pandemic make them buy insurance first. This prevents them from receiving health care immediately. RMW in medical equipment becomes much more negatively significant, indicating how investors now focus much more on the profitability of weak ones than robust ones since small companies rebound quickly to the market. Drugs behave similarly, and the factor during COVID is the strongest of all. The profitability is now no longer investors' focus. Since, predictably, all medical and drugs industries would grow in the short term. Investors also put their expectations in the future. Under such circumstances, profitability is not the solution. They want those companies to have the ability to invest in new products such as medicine or vaccines facing the future successive pandemic.

4.5. CMA

CMA is designed to capture the difference between the returns of a diversified portfolio of low and high investment company stocks and is a factor that can represent investment patterns. The coefficient of CMA during the Covid-19 was more variable in the health sector of the medical market, with a coefficient greater than 0 before the outbreak, indicating that the returns of conservative investment companies' stocks were higher than the returns of aggressive stock companies. In contrast, no significant changes in CMA occurred in the other two sectors, namely the drug market and the medical equipment market. Therefore, the calculation results generally present that the Covid-19 outbreak had less impact on the CMA factor, highlighting the capital market's confidence in the medical industry, which is due to the many pharmaceutical giants in the U.S. Sound drugs and medical device R&D and production has an important role in stabilizing the social and financial markets, and can also bring more robust returns to attract the investors in the market. With the aging of the population and the improvement of people's living standards in recent years, the long-term investment value of the medical industry will be further solid.

5. CONCLUSION

This article examines the applicability of the Fama-French 5 factor model before and during Covid-19, mainly in the health market. Most of the results are statistically significant enough to conclude that the Covid-19 brings both opportunities and risks to health industries. The demand for drugs and equipment rises. However, investors may incline to invest in smaller companies. This is because perhaps those larger companies invest much at first, and the return and profitability are not very certain in the short term. After all, the whole industry is still closely related to the market, and investors need to be careful when considering investing in the health industry.

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