Impact of COVID-19 on Service-related Industries of U.S. Market Based on Fama-French Five-Factor Model

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ABSTRACT

Asset pricing theory is essential in finance, and many scholars have contributed to establishing the best model to measure the price of assets. COVID-19, which is a worldwide health crisis, continuously destroys the global economy. This paper aims to apply the Fama-French Five-Factor Model to evaluate the stock performances in a portfolio of service industries (utilities, communication, personal service, business service) before and after COVID-19, using data derived from U.S. stock markets. The results indicate that market risk (MKT) is always the most significant factor contributing to the stock return before and after the pandemic. In all industries except business service, High minus Low (HML) has changed from insignificant to significant with coefficient increasing, which means that the stock return is positively associated with HML. Besides, Small minus Big (SMB) in the utility industry has turned from significant into insignificant with a negative coefficient, revealing that investors start to prefer small companies. Furthermore, in both personal and business service industries, Robust minus Weak (RMW) and Conservative minus Aggressive (CMA) have changed from insignificant to significant, indicating that the profitability and aggressive strategies have become to play an essential role in the stock return. The conclusion draws that in most cases, companies with a high Book-to-Market ratio perform better after the epidemic, and the negative CMA coefficient means that most companies make aggressive investments. In the personal services industry, investors should focus on companies with high profitability and vice versa in the business services industry.

Keywords: Fama-French Five-Factor Model, COVID-19, Service-related industry, Regression.

1. INTRODUCTION

1.1. Background

Capital Asset Pricing Model (CAPM), which was created by William Sharpe et al. [1], is very significant in that it evaluates the relationships between the systematic risk and expected return for the stock and successfully illuminates the importance of stock's performance to the market (beta) in measuring the required return. An investor can use CAPM for investment appraisal since it provides a better discount rate than other rates. Moreover, CAPM is easy to use as its calculation is a linear equation that can be used to estimate a range of possible outcomes.

However, CAPM is limited because of the unrealistic limitations that the only factor that constitutes the stock's required return is the systematic risk. In reality, the return of stock attributes to a variety of factors.

In 1992, Fama and French developed the Fama-French Three-Factor Model to remedy the shortcomings of CAPM [2]. They added the CAPM's size risk factor (SMB) and value risk factor (HML). This model is considered to be a better tool in measuring the performance of stocks. Recently, in 2014 Fama and French extended their model [3]. Apart from the original three factors, two new factors are added: profitability (RMW) and investment (CMA). Since this model captures the profitability and investment patterns in measuring the required return, it still needs to be proven

to be an improved model compared with the three-factor model.

Since the beginning of 2020, the unprecedented pandemic has spread worldwide, destructing the industries and economy. Various strategies aiming to prevent infections, such as social distancing, community lockdowns, and travel restrictions, make many companies go bankrupt, with millions of workers losing their jobs, which harshly influenced the stock market. According to Graff and Carley [4], in March 2020, nearly 10 million individuals claimed that they were unemployed, most of whom were initially in the industries of service, retail, and production. The service industry, which works for customers and occasionally provides goods, cannot avoid the shock from COVID-19. Unlike the manufacturing industry that wholly stopped operations or high-tech industry that can easily swiftly the workplaces to the online platform, the service industry has a mixed response to COVID-19. This paper evaluates the utilities, communication, personal services, and business services sectors' stock performances before and after the pandemic.

1.2. Related research

The epidemic has a great impact on the economy. It has also attracted the attention of many scholars. First, Yang covers some related knowledge of the model involved. Yang et al. studied a new model with the data of the U.S. services sector, which is an extension of the 5-factor model in Fama-French, using the non-normal error term of SSAEPD and EGARCH-type volatility. On the one hand, the GARCH volatility model is slightly better than the EGARCH volatility model, and its equation is better than SSAEPD in capturing thick tail. On the other hand, stronger left fat-tailedness can be captured using the SSAEPD model [5]. In addition, COVID-19 is a severe blow to the United States. It causes heavy losses in most industries. Mieszko et al. investigated the crash in the U.S. stock market in March 2020 caused by the COVID-19 pandemic. The study examined the changes in stock price reactions to the development of COVID-19 and some government interventions. This result indicated that although many industries, including real estate, entertainment and hospitality, plunged significantly, some specific stocks' prices in healthcare, food, natural gas, software sectors soared abnormally. The research also showed the poorest performers' responses when facing revenue shock, including remunerations for top management and increasing salaries. The latter actions provided evidence about corporate governance scandals similar to that in the 2000s [6].

In addition, the outbreak of the epidemic has also had an impact on the data derived from the Fama-French Five-Factor Model. However, some industries have a negligible impact. Liu used the Fama-French

Five-Factor Model and multiple linear regression to evaluate the stock markets of the hardware industry before and after the COVID-19 pandemic. The relative information is selected from the U.S. stock market from 2019.07.01 to 2020.10.30. The results have shown that the COVID-19 has had adverse effects on the hardware industry and led to several simulative influences. The hardware industry, which is included in the electric service, is now becoming less and less sensitive to fluctuations in the market. Other factors in the Fama-French Five-Factor Model are insensitive. Hence, the COVID-19 has influenced the hardware industry overwhelmingly [7]. Due to the excessive impact on people, Liu has some suggestions to investors based on this model. Liu applied the Fama-French five-factor model to examine the performance of the service industry before and after the COVID-19 pandemic outbreak (about 7 months). Related data were collected from Kenneth R. French Data Library, including market, size, value, profitability, and investment. The result indicated that these five factors were all related to the return of the service industry, and HML, CMA, SMB factors were all negative. Given that COVID-19 is still prevalent and harms the prospect of service business, Liu gave an investment suggestion that investors should be cautious when choosing a more diminutive - cap, less-investment activities and weaker-profitable business [8].

The epidemic has also had a great impact on the service industry. Albanesi and Kim found that the service industry declined due to the economic decline during the COVID-19. However, due to different industries, different genders have different effects. They believe that occupational distribution is the biggest reason for the difference between married workers. Moreover, it is found that the problem of susceptibility to occupational automation has appeared, and the occupations with the most significant changes in employment are usually occupations with higher susceptibility to automation. Therefore, a lot of real-time data is used for research. Albanesi and Kim used the Current Population Survey (CPS) between 1976 and 2019. The age range is 25-54. He also believes that the epidemic will have a potential long-term impact. It has caused a severe blow to employment in the service industry. Among them, mothers and women are the more serious ones. The loss of work and childcare puts mothers under pressure. When these people return to employment again, they will also experience lower wages. The work recovery period will also be significantly lengthened [9]. Albanesi and Kim's focus is more on gender issues at work and market recovery. However, Gunay and Kurtulmus are concentrated in specific service industries. Gunay and Kurtulmus studied the impact of COVID-19 on the four significant aspects of American hotels, entertainment, catering, and aviation. Iterated Cumulative Sums of Squares (ICSS)

tests in dynamic conditional correlations and Markov regime-switching regression analysis. The impact of the epidemic is mainly concentrated in hotels, entertainment, and aviation. The impact on catering is small. Gunay and Kurtulmus also considered Maslow's hierarchy. It is hoped that these companies can make solutions as soon as possible, with the least impact on company operations. The black swan also includes in the risk consideration plan. Reflect the stock prices of the service industry through investors' expectations. Assess the extent of damage caused by COVID-19 to the service industry. Finally, Gunay and Kurtulmus conducted an MRSR analysis and determined the dependent variable, the independent variable. The data obtained prove that there is no negative impact on the stock income of the catering industry. For other industries, it recommends that liquidity and management require action and update risk management [10].

It is not only the service industry that has been hit hard. It is also severe in the retail industry. However, some environmental resources have no impact. It may have something to do with people not going out. Gössling assessed tourism and global changes during the COVID-19 outbreak. The most relevant liquidity issues with the economy are catering and tourism. After tourism, service and retail industries are under the most significant pressure. They have temporarily laid off half of their labor force. Compared with other sectors of the Norwegian economy, tourism has been particularly hard hit, and oil, gas, shipping and other industries have reportedly not been significantly affected. The epidemic may exacerbate the already considerable income gap. The assessment discussed that it is an opportunity to reconsider the transformation of the global tourism system and make it more consistent with sustainable development [11]. Hou's research complements Gössling's thinking on retail. Moreover, Hou made a comparative analysis and gave suggestions. Hou analyzed the differences in retail sales during the COVID-19 outbreak. Using the Fama-French five-factor model, the research revealed that small companies typically have a smaller range of inventories and goods in the retail sector than larger companies, and therefore have fewer economic losses and greater flexibility to respond to an outbreak. In addition, some e-commerce companies that work with small resellers released mobile applications to strengthen the relationship between resellers and customers. Hou suggested that investors should focus on small retail companies with high book-to-market ratios and companies with cutting-edge technology and e-commerce platforms [12].

Finally, the literature shifts to the perspective of the market. Foye assessed that the Fama-French five-factor model is better than the three-factor model for stock valuation in emerging markets. They used data from 18 regions. It tests that in Eastern Europe, the five-factor

model in Latin America is better than the three-factor model. In Asia, it is impossible to assess which is better and also mentions three points. First, based on Lo and MacKinlay's study, sample testing is required. In addition, the importance of emerging markets to investors. Finally, it is using stock returns to understand the differences in results due to regions. Through these three points, it shows the practicality of the five-factor model. Research shows that HML is the only non-repetitive factor, and the five-factor model is more suitable in Eastern Europe and Latin America. GRS statistics are less [13]. The Fama-French five-factor model is also suitable for the United States. Sarwar et al. investigated the performance of U.S. sector portfolios and sector rotation strategy. The research compared returns of U.S. sector portfolio using the Fama French five-factor model and the three-factor model. This study indicated that the five-factor model fit better in the U.S. sector, but the alphas only present significantly in a specific period. To test if the alphas represent real out/underperformance of sectors for investors, the research applied long-only and long-short sector rotation strategies based on FF5 rolling alphas. Long-only sector rotation strategies generated a higher Sharpe ratio than the S&P500 buy-and-hold, while the long-short strategy performed poorly [14].

1.3. Objective

In the particular stage of COVID-19, the impact on various industries is different. Therefore, this study will evaluate the impact of the COVID-19 on the US market based on the Fama-French five-factor model. The research will analyze data by using some industries included in the Fama-French five-factor model. Moreover, the regression method is adopted to compare and discover the significance of the data. The widespread unemployment and life changes brought about by the epidemic have changed people's lives. Consequently, the research will analyze the four major parts of the utilities, communication, personal services, and business services. Through data analysis, the epidemic has different impacts on these four industries. Investors are also affected by the epidemic and take different measures.

2. METHOD

2.1. Capital Asset Pricing Model

The capital asset pricing model (CAPM) is based on Markowitz portfolio theory [15], illustrating that the expected return for a stock portfolio and the expected risk premium are linear:

$$E(R_i) = R_f + \beta * [E(R_m) - R_f] \qquad (1)$$

Where $E(R_i)$ is the rate of return for a stock portfolio, R_f is the rate of return for the risk-free asset, $E(R_m)$ is the rate of return for the market, and $[E(R_m) - R_f]$ is the equity market premium. β stands for the factor coefficient.

2.2. Fama-French Three-factor Model Theory

Fama and French investigated that the return rate of the portfolio of stocks cannot be estimated accurately by β from CAPM because it also is influenced by the public company's size and book-to-market. So Fama and French decided to incorporate these two factors into CAPM and developed the Fama-French three-factor model (FF3F). The size of a public firm is represented as market capitalization. The book-to-market ratio is equal to the book value of equity to the market value of equity.

In Fama-French three-factor model, "Small minus Big" (SMB) and "High minus Low" (HML) represent the size and book-to-market, respectively. The expected return of the stock portfolio is estimated at:

$$E(R_i) - R_f = \alpha + \beta_1 * [E(R_m) - R_f] + \beta_2 * SMB + \beta_3 * HML + \varepsilon_i \qquad (2)$$

Where SMB is the difference between the portfolio return of small-size stocks and big-size stocks, HML is the difference between the portfolio return of the high book-to-market ratio stocks and low book-to-market ratio stocks.

2.3. Fama-French Five-factor Model Theory

Fama-French five-factor model with two additional factors, profitability and investment patterns, is developing the three-factor model. The mathematical formula for the five-factor model is the following:

$$E(R_i) - R_f = \alpha + \beta_1 * [E(R_m) - R_f] + \beta_2 * SMB + \beta_3 * HML + \beta_4 * RMW + \beta_5 * CMA + \varepsilon_i \qquad (3)$$

Where RMW is the difference between the portfolio return of stocks that have robust profit rates and stocks that have weak profit rates, CMA is the difference between the portfolio return of stocks that have conservative investment and stocks that have aggressive investment.

In Fama-French five-factor model, factors reflect that an industry with a small size, high book-to-market ratio, robust profitability and conservative investment pattern is generally accompanied by high risks.

3. RESULTS

The data used in this study are daily Fama-French 5 factor (2x3) and 49 daily industry portfolio data sets from Kenneth R. French data library. Firstly, in the daily 49 industry portfolio data set, four industries in the service industry, namely, utilities, communication, personal services and business services, are selected for preprocessing. The dataset is then divided into two time periods: before COVID-19 and after the COVID-19 outbreak. COVID-19 was declared a global pandemic by the World Health Organization on March 11, 2020, so March 2020 was chosen as the cut-off point. At the end of December 2020, the New Coronavirus vaccine began to appear on the market. Therefore this research selected March 2, 2020, to December 31, 2020 (about ten months) as the period after the COVID-19 outbreak. In contrast, the before COVID-19 period was selected from May 1, 2019, to February 28, 2020 (about ten months).

The data before COVID-19 and after the COVID-19 outbreak were applied to fitting the five factors for multiple regression analysis. Afterwards, the coefficients and statistics are obtained.

Table 1. 5-Factors multiple regression of utility industry before and after COVID-19

Factor	Before COVID-19		After COVID-19	
	Coefficient	T-Stat	Coefficient	T-Stat
Mkt-RF	0.556	10.901	0.969	24.298
SMB	-0.377	-3.920	-0.154	-1.497
HML	-0.098	-0.995	0.183	2.164
RMW	-0.644	-4.011	-0.457	-2.668
CMA	1.000	5.265	0.987	4.501

Table 2. 5-Factors multiple regression of communication industry before and after COVID-19

Factor	Before COVID-19		After COVID-19	
	Coefficient	T-Stat	Coefficient	T-Stat
Mkt-RF	0.818	15.643	0.887	28.602
SMB	0.738	7.502	0.672	8.404
HML	0.129	1.276	0.367	5.579
RMW	-0.135	-0.820	-0.109	-0.815
CMA	0.184	0.945	-0.292	-1.713

As shown in Table 1 and Table 2, by comparing the data before and after the epidemic, the HML of utilities and communication industries has changed from insignificant to significant, and the coefficient is greater than 0, indicating that investors will choose more returns on portfolios of high book to market ratio stocks. In addition, the significance of SMB in the utility industry has changed from significant before COVID-19 to insignificant after COVID-19, indicating that the influence of small and big stock portfolio returns in the industry on investors has decreased.

Table 3. 5-Factors multiple regression of personal services industry before and after COVID-19

Factor	Before COVID-19		After COVID-19	
	Coefficient	T-Stat	Coefficient	T-Stat
Mkt-RF	0.723	15.184	0.889	28.582
SMB	0.374	4.173	0.589	7.350
HML	-0.041	-0.447	0.265	4.022
RMW	0.290	1.935	0.561	4.197
CMA	0.002	0.013	-0.506	-2.955

Table 4. 5-Factors multiple regression of business services industry before and after COVID-19

Factor	Before COVID-19		After COVID-19	
	Coefficient	T-Stat	Coefficient	T-Stat
Mkt-RF	1.020	31.734	1.124	51.582
SMB	0.011	0.178	0.031	0.560
HML	-0.364	-5.864	0.074	1.593
RMW	-0.024	-0.236	-0.185	-1.977
CMA	-0.221	-1.849	-0.531	-4.428

As Table 3 and Table 4 illustrate, the RMW and CMA of the personal services and business services industry have changed from insignificant to significant, reflecting that investors pay more attention to considering the strength of stock profitability and investment attitude. The coefficient of the personal services industry is greater than 0, indicating that investors tend to choose stocks with robust profitability and adopt conservative investment policies. On the contrary, the coefficient of the business services industry is less than 0, and investors tend to choose stocks with weak profitability and adopt positive investment policies.

In addition, the HML factor in the personal service industry is the same as the two industries mentioned above. After the epidemic outbreak, it becomes significant from insignificant, accompanied by an increase in the coefficient. The opposite is true for business services, where HML changes from significant to insignificant.

4. DISCUSSION

U.S. capital markets are experiencing economic turmoil due to the COVID-19 outbreak. In this paper, the Fama-French five-factor model was used to analyze the performance of four industries before and after the COVID-19 outbreak. The differences of t-statistics and coefficients in the two periods were compared, and the reasons for the changes were proposed to provide a reference for investors.

4.1. MKT

The overall observation of the four tables shows that the T value of MKT for the four industries (the whole service industry) is above the threshold at a 5% significant level, which is significant in the two periods before and after COVID-19. When investors analyze the service industry, they should fully consider the market factors. In addition, the market coefficient of the services industry is greater than 1, and that of other industries is less than 1. This industry is more sensitive to market changes.

The MKT has been an essential factor in the U.S. market, both before and after the outbreak. With COVID-19, home-centred living and remote software have become a part of life. Face-to-face services industries have been severely affected, confusing the

market. Therefore, after the epidemic outbreak, the factors of the four major industries have been strengthened to some extent, and investors should fully consider market factors when making investments.

4.2. SMB

Before the outbreak of the epidemic, the SMB of the Utility industry was significant, and the factor was negative, which reflected that investors preferred significant stock portfolio returns before the outbreak. However, it changed significantly to not significantly after the outbreak, indicating that the attitude of investors changed and the status of small stocks increased. Investors often see small companies as vulnerable to economic downturns. Small businesses do not have the scale of large businesses, and they lack the resources and capacity to respond to emergencies. For example, many small businesses are financially fragile, so their cash flow will be disrupted in an emergency, and they will quickly run into financial difficulties. At the same time, large companies have more capital, so they will last longer and cope better. Through COVID-19, investors found that small enterprises are more likely to transform and develop into new fields in the face of emergencies. Therefore, the significant tendency of investors to invest in large and small stocks turned insignificant after the outbreak.

4.3. HML

The tables illustrated above indicate that the influence of HML in all four industries changed dramatically throughout the pandemic. The 2019 data shows that in the utilities, communications, and personal services industries, the HML factor was insignificant in explaining the stock price fluctuations. While in 2020, it became significant, accompanied by increasing coefficients, which implies that the companies with higher book-to-market ratio were equipped with better profitability. However, the situation was the opposite in the business service industry, with HML changing from significant to insignificant. Nevertheless, the coefficient still increased.

Several reasons account for that phenomenon. Firstly, the increase of the HML coefficient reveals that the high Book-to-Market ratio started to contribute to the companies' excess return. Before the pandemic, since emerging industries can grow fast and make a profit, people tend to invest in them. However, after the outbreak of COVID-19, emerging industries cannot sustain the shock from the pandemic, with the stagnation of economic growth and lack of various resources. Therefore, investors are more likely to have an optimistic attitude towards well-established industries. Secondly, a high Book-to-Market ratio means that the company's equity is undervalued in the

market compared to its book value. Unlike before the epidemic, investors held a more pessimistic view of these industries, thus increasing the HML coefficient and HML significance. Furthermore, although the coefficient increased in the business service industry, the HML became insignificant. The service industry was not inclined to companies with a high or low Book-to-Market ratio.

4.4. RMW

The RMW factor indicates that the relative changes of the stock resulting from the profitability premium. This factor was not statistically significant in both the personal services industry and business services industry before the COVID-19 outbreak, while after that, it was significant. The RMW factor was significant during the pandemic, indicating that a stock's profitability is vital in return. The coefficient of RMW was still positive in the personal services industry, which reveals that businesses with high-profit rates perform better in this industry. In contrast, businesses with low-profit rates perform better in the business services industry, presented by the negative coefficient.

Under the influences of COVID-19, the US stock market crashed, and Dow Jones Industrial Average (DJIA) plunged 6,400 points, about 26%, in March 2020. In the personal services industry, profitable firms are financially capable and strong, while medium-sized enterprises struggle for their profit. Investors tend to invest in the former ones because their financial situation is better. However, investors are willing to invest in firms with lower profitability in the business services industry, including computer-related services, R&D labs, medical equipment rental and leasing etc. Most investors predict that the stock price of big firms has already reached the bottom and will rebound soon, resulting in speculation behaviours. So, although these companies have low-profit rates during COVID-19, their stock prices are less affected. Investors begin to pay attention to its profitability in the services industry and change their own investment decisions depending on it.

4.5. CMA

CMA is the difference between returns on the portfolio of stocks with conservative investment and a portfolio of stocks with aggressive investment. It is possible to find the difference in returns between the two in diversified investments. The results show that CMA has become significant in both personal and business services. After the outbreak, the P-value exceeded the significant criterion. Table 3 and 4 involve many service industries, including daily life and medical machinery or other parts. The flexibility before the epidemic was also relatively large. After the COVID-19

outbreak, various service industries have been hit hard. Most of the service staff resigned. People are forced to reduce infections at home, leading to the suspension or rest of various small personal services. It makes personal service a heavy loss. However, the negative CMA value invests slightly easing, and it is more deliberate during the epidemic. Because the coefficients are all negative, it shows that the reward of some high-profit companies, the aggressive company are higher than small companies with conservative investments. During this period, some companies found investment opportunities, and there were investment mergers and acquisitions. Getting better quality assets at lower cost prices is a reasonable way to occupy the market. In the data of business service, there are business services such as medical care and business services. Some companies acquired some companies to expand their business during the epidemic. It causes companies to get more extensive assets. For example, Zoom bought the company Five9 in 2021. Zoom expanded its scale, and also reduced risks and expanded revenue. Some service-type private hospitals are also choosing to merge and reorganize with other hospitals to maintain their profits. In general, CMA can find some market reactions.

5. CONCLUSION

This research analyzes the impacts of COVID-19 on four industries, including utility, communication, personal services, and business, using the Fama-French five-factor model. After the outbreak of COVID-19, the SMB factor indicates that the size of a public firm in the utility industry is no longer critical for investors. The positive and significant HML factor denotes that companies with a high Book-to-Market ratio perform better in this period, thus needing investors to focus more on these businesses in the utility industry, communication industry and personal services industry. According to the positive RMW factor, investors should pay attention to the public company with high profitability when investing in the personal services industry. However, those firms with low profitability perform better in the business industry, represented by the negative RMW factor. The negative CMA factor in the services industry indicates that most companies make aggressive investments to expand the scale and spread risk. Lastly, in these four industries, the stock in the business services industry is more sensitive to market changes.

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