

Analysis of COVID-19 on Service Industry Based on Fama and French Five-Factor Model

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Abstract— The Fama and French five-factor model was developed as an expansion of the previous Fama and French three-factor model, where the five-factor model included two additional factors profitability and investment to the existing three factors market, size, and value to better estimate the expected return of the security. As COVID-19 had negatively impacted the economy in the U.S., this study applied the Fama and French five-factor model to examine the performance of the service industry before and after the outbreak of COVID-19 using the dataset from Kenneth R. French Data Library and draw insight about the prospect of the service industry. The estimated coefficients as well as the t-statistics of the five factors for before and after the outburst of COVID-19 periods were computed and analyzed. The result showed that all five factors market, size, value, profitability, and investment were statistically significant during the COVID-19 period, with changes in some of the factors after the hit of the pandemic, revealing the return of service industry is associated with the five factors. Specifically, investors during this crisis and in the future should be more cautious toward service businesses that have smaller-cap, weak profitability and less investment activities.

Keywords: COVID-19, Service Industry, Fama and French five-factor model

I. INTRODUCTION

Capital Asset Pricing Model, also known as CAPM, is an economic model developed by Sharpe [1] and Lintner [2] that explains stock's return as a function of market return. According to CAPM, the only relevant factor contributing to the return of the stock is the beta (B_i), which is the stock's performance relative to that of the market. Even though CAPM offers insights about the relationship between risk and expected return of the stock, the model performs poorly when fitting the empirical data. The main drawback of the CAPM model is it only assumes one risk factor which is the excess market return to explain the excess return of a stock. In reality, the return of the stock depends on various factors.

Indeed, Fama and French found that beta alone is not sufficient to explain average return [3]. Thus, they developed an alternative model in response to the poor performance of CAPM. They formulated the model based on three factors: 1. Excess market return, 2. Small minus Big (SMB): the difference between excess return of small-size stocks and big-size stocks, 3. High minus Low (HML): the difference between excess return of high-book-to market ratio stocks and low-book-to market ratio stocks. The two additional factors SMB and HML added to CAPM resolved some of the previous anomalies (outperforming tendency). The Fama and French three-factor achieved a success

in capturing the cross-section of average return of U.S. stocks [4].

Recently, Fama and French [5] added another two factors, profitability (RMW) and investment (CMA) to the three-factor model and this five-factor model was found to be a better tool for evaluating performances than the three-factor model. Even though Fama and French showed that the Fama and French five-factor model has more explanatory power than the precedent three-factor model in explaining stocks' returns, they highlight the need to empirically test the model to different markets and time periods to analyze their robustness [6]. In this regard, many previous researchers have tested the validity of the Fama and French five-factor model in different markets.

A. Literature Review

Lohano and Kashif [7] tested the efficacy of the five-factor model on the Pakistan Stock Exchange. They applied the model on monthly data of 896 companies from November 2000 to December 2016. The results showed that five-factor model using the cross-sectional approach achieved a remarkable performance in explaining returns on securities in the Pakistan Stock Exchange. In addition, Chiah et.al [8] applied Fama and French five-factor model on the Australian market. They found that the five-factor model outperformed the three-factor and other asset pricing models in explaining Australian equities, indicating the high effectiveness of the Fama and French five-factor model. Moreover, Li et.al [9] demonstrated the validity of the five-factor model on the U.S. stock market through their testing of a new pricing model. Furthermore, Ragab et.al [6] compared the Fama and French three-factor model and five-factor on the Egyptian stock market using time-series regression and the Gibbons Ross Shanken (GRS) test, and they revealed that the five-factor model provides a better explanation of stock returns in Egyptian Stock market based on the adjusted R2 and the values from the GRS test.

B. Objectives

COVID-19 is an unprecedented pandemic that has severely affected many industries across the globe. Numerous companies went bankrupted and millions of workers lost their jobs as a result of lock down and closed operations. One of the most negatively impacted industries is the service industry. Unlike technology companies that are able to make a smoother transition to online platform in response to the pandemic, due to the nature of service-sector which depends on customer-provider interaction and gathering of people, the sudden lockdown and the remote working mode was a big hit. For instance, according to a recent study [10], personal and laundry services in the U.S.

lost 79% of business owner activity in April and 48% in May. In addition, Bartik et al. [11] reported that in-person industries like personal services or retails suffered more disruptions for dealing with the pandemic than other professional sectors with minimal need for face-to-face contacts. For these businesses, the plans to transform to digital formats seemed very implausible. Because COVID-19 has created a fear of “contact”, it is highly likely that the disruptive impacts will last long in the service industries during post-pandemic, and there will still be a lot of uncertainties and challenges in term of business format and their services in relations to customers [12].

Since Fama and French five-factor has shown to be a valid model in many studies, and few have yet to use the Fama and French five-factor model to analyze the impacts of COVID-19 on industries, the goal of this research paper is to apply the Fama and French five-factor model on the U.S. service industries to compare the performances of the service industries before and after COVID-19 had happened, and provide insights and investment strategies for the service industries to move forward.

II. FAMA AND FRENCH FIVE-FACTIR MODEL

After the empirical success of the Fama and French three-factor model, many researchers found additional patterns such as investment and profitability that are related to the average return stocks [6]. So Fama and French decided to incorporate the two factors profitability and investment into their previous three-factor model and developed a five-factor model. The mathematical formula for the Fama and French five-factor is the following:

$$R_{it} - R_{ft} = b_i(R_{mt} - R_{ft}) + s_iSMB_t + h_iHML_t + r_iRMW_t + c_iCMA_t \quad (1)$$

where R_{ft} is risk-free rate, $R_{it} - R_{ft}$ is the excess return of stock, $R_{mt} - R_{ft}$ is the excess return of the market, SMB_t is the difference between returns on portfolio of small-size stocks and portfolio of big-size stocks, HML_t is the difference between returns on portfolio of high-book-to-market ratio stocks and low-book-to-market ratio stocks, RMW_t is the difference between returns on portfolio of stocks that have robust profitability and portfolio of stocks that have weak profitability, and CMA_t is difference between returns on portfolio of stocks that have conservative investment and portfolio of stocks that have aggressive investment. b_i , s_i , h_i , r_i and c_i are the factors coefficients.

III. RESULT

The data used in this research are the daily Fama/French 5 Factors (2x3) and daily 30 Industry Portfolios datasets from Kenneth R. French Data Library. The Fama/Fench 5 Factors include the calculated five factors of the model and the 30 Industry Portfolios included the calculated returns of the 30 industries. The daily 30 Industry Portfolios dataset was first preprocessed to only have the equal-weighted returns as the daily returns. Both datasets were then divided into two time periods: before COVID-19 happened and after the outbreak of COVID-19. The before COVID-19 period was selected from 08/16/2019 to 03/10/2020 (approximately 7-month period). March 10, 2020 was chosen to be the dividing date because COVID-19 was declared as a global pandemic by World Health

Organization on March 11, 2020. The after COVID-19 period was selected from 03/11/2020 to 09/30/2020 (approximately 7-month period).

A multivariate regression with covariates being the five factors are applied on the service industry dataset both before COVID-19 and after COVID-19; the corresponding statistics are then reported. The estimated coefficients of the five factors as well as their t-statistics for before COVID-19 and after COVID-19 are presented in the table below.

TABLE I. THE ESTIMATED COEFFICIENTS OF THE FIVE FACTORS AND THEIR CORRESPONDING T-STATISTICS FOR THE PERIOD BEFORE COVID-19 AND AFTER COVID-19

Factors	Estimates Before COVID-19	t-statistics Before COVID-19	Estimates After COVID-19	t-statistics After COVID-19
MKT	1.074	48.575	1.082	64.477
SMB	-0.120	-2.337	-0.105	-2.306
HML	-0.298	-6.502	-0.239	-6.362
RMW	0.123	1.395	0.159	2.121
CMA	-0.893	-8.325	-0.824	-8.067

IV. DISCUSSION

Before COVID-19, the four factors MKT ($R_{mt} - R_{ft}$), SMB, HML, CMA are statistically significant but the RMW factor is not. After the outbreak of COVID-19, all five factors became significant. More details of each factor are presented as follows.

The market factor, MKT, indicates the relative movement of the stock in response to the market. Since the market coefficient is greater than one, the service industry is relatively sensitive to the movement of the market. As service industry comprised a big proportion of the U.S. economy, the outlook of the economy is clearly an indicator for the performance of the service industry. After the outburst of COVID-19, the MKT coefficient is still statistically significant, and the magnitude of the coefficient increased. This is expected because the performance of the service industry is very sensitive to the change in the market. As COVID-19 had disrupted the market in general, it is highly likely that the service industry is hit severely as well. With overall volatility increased in the U.S. financial market, their systematic effects on the industries cannot be neglected [13]. The result suggests that the market factor should be taken into consideration into the analysis of the service industry.

The SMB factor indicates the relative movement of the stock in response to the size premium. Before COVID-19, the SMB coefficient is -0.120 for the service industry. Since the SMB coefficient is negative and closer to zero, it suggests that the service industry tends to big-size stocks. This means that larger size industries will outperform smaller size industries. After the outbreak of COVID-19, the SMB coefficient shows little change; it is still statistically significant and negative. This negative SMB during the COVID-19 crisis demonstrates that smaller-size businesses would have been significantly disrupted. Such finding confirms with a broader study by Alekseev et.al [14] who, through their surveys, highlighted the struggles and financial hardships small businesses in the U.S. experienced

during the time of COVID-19. Because small-size businesses do not have the scales that large-size businesses have, they lack the resources and capabilities to respond to this sudden pandemic [10]. For instance, many small-size businesses are financially fragile so as pandemic like this compelled them to stop operating; their cash flows will be disrupted and they will soon fall into financial hardships, whereas large-size companies have more capitals so they will sustain it longer and responded it better [11]. The result indicates that we need to be cautious when making investment toward small-size business during the pandemic.

The HML factor demonstrates the relative movement of the stock in response to the book-to-market ratio premium. Before COVID-19, the HML coefficient is -0.298. Because the HML coefficient is negative, low book-to-market ratio can explain excess return of service business. A low book-to-market ratio reveals that the businesses have values overestimated by the market. In other words, the market and the public have high expectations toward these businesses. In our service industry portfolios, fields like telephone interconnect systems, data management and education are popular fields that have received a lot of attentions in comparison to the traditional fields like laundry, auto repairs, watch repair, etc. This is why the HML factor is negative as people have relatively positive attitudes toward these new service fields. The HML factor after the hit of COVID-19 is still statistically significant and negative but it is increased to -0.239. This increase shows the reversal of the previous period: high book-to-market ratio started to favor the excess return of the service industry amid the COVID-19 pandemic, reflecting the disruptive impact COVID-19 on the service industry as a whole. The reversal to high-book-to market ratio firms is in conformity on the macro-levels as emerging markets had hard time in coping with the impacts of pandemic given their slow paces of economic growth and lack of capital inflows [15]. Furthermore, this increase of HML in the positive direction shows a lower market valuation and people's losses of optimism for the service fields with respect to the period before the pandemic.

The RMW factor indicates the relative movement of the stock in response to the profitability premium. Before COVID-19, the profitability coefficient is 0.123 for the service industry. However, the RMW coefficient is not statistically significant which suggests profitability premium is not an important factor. During the COVID-19 pandemic, the RMW factor becomes statistically significant and stays positive, indicating businesses that have big profit perform better. Furthermore, the RMW coefficient increases to 0.159. This is expected as COVID-19 had disrupted the global economy, causing economy depression. Businesses that are profitable during this difficult time are often those that are financially capable and strong, and they will stand out even more among the fragile businesses. This positive value of and increase in RMW also correspond with the positive size-premium, which reveals that small to medium-size firms were struggling for profitability during the crisis [16]. The change of RMW from insignificance to significance demonstrates how the COVID-19 pandemic has put a weight on the profitability of the business.

The CMA factor indicates the relative movement of the stock in response to the investment premium. Because the CMA coefficient is negative, aggressive investment activity can

explain service industry return. This also shows people's optimism and positive attitudes towards the service industries. The CMA factor after COVID-19 is still statistically significant and negative with decrease in magnitude. This decrease in magnitude reflects the disruptive impact COVID-19 brought to business, pivoting investments to be less aggressive. The decrease in investment activity corresponds with the study [17] that investors acted more cautiously during the pandemic. This also aligns with the decrease in magnitude of the book-to-market ratio, as the pandemic has weakened the economy in general, distressing investment activities. Nevertheless, the return of the service industry is still negatively correlated with investment, demonstrating businesses with strong investment activity are likely to perform well amid the pandemic. One possible explanation is that as strong investment indicates greater cashflow of the business, and with greater cashflow, businesses are more capable at coping with a pandemic like this.

V. CONCLUSION

COVID-19 certainly has negative impacts on the service industries as RMW factor increases in magnitude and becomes significant during the pandemic, demonstrating return gradually favors businesses with robust profitability. The negative HML factor and its increase during COVID-19 indicate the decrease of market valuation and the public's expectation for service industry. The negative CMA factor negative indicates that businesses with aggressive investments are associated with returns. The negative SMB factor denotes that big-size businesses performed better amid the pandemic. Lastly, the service industry is overall very sensitive to fluctuation of the market. For the prospect of service businesses, investors should be cautious when investing towards smaller-cap, less-investment activities and weaker-profitability businesses, as COVID-19 is still prevalent.

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