

Research on the impact of the COVID-19 in service industry in U.S. stock market based on the Fama French Five Factor Model

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Abstract. Since the outbreak, the U.S. economy has experienced a great recession, in which the service sector has been hit hard, while it accounts for a large share of U.S. GDP, and twists and turns have hit the stock market. Based on the Fama-French five factor model, this paper conducted a regression analysis and coefficients comparison on the data of 26 months before and after the epidemic, with March 2020 as the node. The results show that the market rebounds quickly under the federal government's intervention and shows a state of continuous growth. However, the investors tended to make the overall investment style of the market more speculative. Investors no longer favor the value stocks with stable earnings but relatively slow growth. The book-to-market ratio, an important indicator, has less influence on overall investors, and companies with poor profitability have become the targets for speculators to bet on. It is worth noting that when the trend of the stock market is not consistent with the real economic conditions, investors must remain vigilant and cannot ignore the impact of the epidemic on the economy and enterprises because of the prosperity of the stock market.

Keywords: Keywords: Fama-French model, U.S stock market, COVID-19, Service industry.

1. Introduction

The outbreak brings a huge influence on the U.S. economy, and we can see this from the past data. For instance, during the Great Depression of 1930, the lowest annual GDP growth rate of the United States was -23.1%. However, the data shows that the United States' actual GDP declined by 32.9% in the second quarter of 2020, while the expected decline was 34%. This means the short-term impact of this outbreak in the U.S. is greater than that of the Great Depression of 1930. As a result of the Covid-19 pandemic, real U.S. gross domestic product (GDP) will shrink by 3.5% in 2020, which means the biggest annual decline since 1946, according to the first estimate released by the U.S. Commerce Department. At the same time, it was the first full-year contraction in the U.S. economy since the 2008 crisis, reflecting the huge impact of the coronal virus on the nation's economy. The service sector, especially restaurants and hotels, has been hardest hit by the outbreak-induced recession. The initial lockdown hit the face-to-face service sector hardest. Consumer spending is falling under curbs, social distance rules, and state mandates that force restaurants and other service businesses to operate fewer hours, which has led to a slump in the restaurant business. Travel and leisure have also been hit hard.

For the U.S. stock market, the outbreak leads to a time of ups and downs. The COVID-19 "black swan" attack caused a deep global recession, with the US, the epicenter of the pandemic, particularly hard hit. Affected by the epidemic, the U.S. stock market experienced several "circuit breakers" in a short period rare in history in March last year and quickly turned into a technical bear market. However, in the second half of the year, the US stock market quickly rebounded sharply from the low point in March, and not only recovered the "lost ground" before the end of the year but even hit record highs repeatedly under the backdrop of a sharp economic contraction.

The following analysis can explain this phenomenon. While the early days of the lockdown had a profound impact on society and a broad range of service sectors, it also led to a shift in consumer demand from services to goods, increasing the resilience of U.S. manufacturing and allowing manufacturing jobs to recover faster than the economy as a whole. That, coupled with stimulus from the Federal Reserve and the government, has pushed stocks off their lows, partly because of the beginnings of vaccination and optimism that the economy is about to restart. As optimism has grown,

investors have also become more bullish on stocks that traditionally do well when the economy comes out of recession, driving the market's reversal.

Horvath and Wang using R^2 to evaluate the ability of the Fama-French (FF) model's ability to explain the monthly excess returns of selected stocks during the crises, including COVID-19. They considered R^2 as statistically significant because the FF5 model retained the R^2 value on a high level. And find that only one R^2 of the FF5 model increased through the outbreak of COVID-19 and experiences the highest level of R^2 during the observable period, which means there is a substantial influence on R^2 during the epidemic outbreak COVID-19. It also mentioned that all the beta model parameters in the research are insignificant in the GMM model [1].

Based on the US market, Sun examined the performance of the FF5 model before and after the COVID-19 pandemic to evaluate the efficiency of the model during the period, ensure if there are any unexplained factors, and verify the incident impact on the five factors. The research finds out that the efficiency of this model in explaining the return of all industry portfolios increasing during the pandemic, but the unexplained factor behaviors are more obvious and appear in more industries in the after-outbreak period. And Sun also pointed out that due to the industry's characteristics, each industry's exposure to the factors will change differently. As a result, portfolios constructed based on exposure to size, value, profit, and investment effect probably need reconstruction by immediate factors beta [2].

Hou and Chen analyzed the American steel industry market before and after the COVID-19 epidemic based on the Fama-French 5 factor model. By evaluating the five factors by using multiple linear regression analysis and the result that Beta coefficient decreased, RMW became insignificant, SMB and HML still work but has little change, CMA remains insignificant. In conclusion, the epidemic had a severe impact on the steel industry, leading to the severe decline of the whole industry. And they also indicated that this huge decline causes stock insensitivity towards the market and brings RMW ineffective [3].

Chen et al. analyzed the impact of restrictions from US governments during the COVID-19 pandemic on stock returns in travel and leisure companies. It demonstrated that even the pandemic has been under control. Additional measures from the government like the stringency of restrictions will lead to negative effects such as decreased stock returns. Besides, as the results suggest, the company should pay more attention to liquidity management because companies with a smaller size, less tangibility, and higher cash reserves in this period are less affected by the restrictions. Moreover, restrictions have the highest impact on airlines, followed by tourism and gambling [4].

Gunay and Kurtulmus investigate the impact of the COVID-19 pandemic on four areas (airlines, restaurants, hotels, entertainment) in the US service sector in the study. Results indicated that companies with lower market capitalization have higher volatility in returns in restaurants and airlines, while the opposite is discovered in hotels and entertainment. And with the pandemic, all index returns show higher inter-connectivity than any other period. Besides, Markov regime-switching regression analysis suggests that entertainment and airlines are the two industries that would be most affected by the coronavirus. The gradual deterioration is going to happen reasonably among stocks of relatives small companies in the hotel industry. However, probably according to Maslow's hierarchy of needs, researchers observed no negative influence in stock returns of the restaurant [5].

Polyzos et al. are aimed to forecast the demand for international tourism based on the Covid-19 crisis in the study. Through two distinct methodologies (Long Short Term Memory neural network, Generalized Additive Model) and five different training sets, the team produced a 12-month forecast for international tourist arrivals. According to the research, the drop in tourists will continue at least until June 2021. An average drop of the prediction will be at 48.5%, with different scenarios ranging from 30.8% to 76.3%. And this, together with the epidemic crisis, will bring around 50% losses to the industry. Finally, tourism recovery should be expected after the summer of 2021 [6].

Akhtaruzzaman et al. make comprehensive research in oil price exposure across financial and non-financial sectors during the COVID-19 pandemic. Researchers augment the Fama-French five-factor model with oil price return in the baseline model according to prior literature. The result finds out

that the coronal virus pandemic relaxed the relationship between changes in oil prices and stock returns worldwide. Compared to the non-COVID-19 period, both positive exposures to the oil price risk of oil supply and infrastructure provider industries and negative exposure to the oil price risk of Oil demand and financial industries are proved weakened during the pandemic [7].

Ramelli and Wagner illustrate the process of amplifying anticipated real effects from the COVID-19 crisis through financial ways in their research. Initially, China was shut down effectively, and investors avoid U.S. stocks with China's exposure and internationally oriented companies. As China has been relatively improved later, investors rebuilt their favorability and confidence towards those stocks. As the virus became serious around Europe and America, economies locked down, and markets fluctuated drastically. The survival of firms with high corporate debt and little cash became an urgent problem which highlights the importance of preventive cash holdings to the corporation. As the result shows, the real economic impact of COVID-19 will be amplified by financial channels, and the outcome of ongoing policy interventions and individual behavior changes is unpredictable [8].

The COVID-19 has brought a huge impact on the world economy. The highly contagious virus has forced people to stay most of the time indoors while reducing unnecessary travel and close contact. While these new living habits become normal, they also bring a huge impact to the service industry. This research aims to study the influence of the coronavirus pandemic on the service industry in the U.S. stock market based on the Fama-French model, which has been widely used in investing, and to further interpret the influence to the investors in this industry.

2. Fama French Model

Markowitz, an American economist, put forward the mean-variance model in 1952 [9]. He proposed that to maximize investors' utility, the following conditions must be met: when the risk (variance) is the same, the highest rate of return is obtained, or the risk is minimal if the payoff is constant. Therefore, the covariance between each asset should be minimized when constructing the portfolio. This establishes the framework for capital asset pricing theory.

On this basis, Sharpe first proposed the capital asset pricing model in 1964 [10]. Lintner et al. further upgraded the model and make it into a complete theory system. This model is a mainstay of modern financial market pricing theory. It has been widely applied in fields like decision making, investing, and financing. The model believes that risk of investments comes from two directions: the first is system risk (which cannot be reduced through diversification of investment); the second is a non-systemic risk, a risk from individual stock (which can be reduced by diversification). Although CAPM is very useful for predicting portfolio returns, many empirical results show that CAPM cannot explain certain anomalies. After researchers' continuous exploration, the search for effective pricing factors has gradually become the main research direction in the field of asset pricing.

Fama and French proposed a three-factor model (1993) [11] based on predecessors' research. They believed that CAPM couldn't explain the difference in the return rate of different stocks. In addition to Beta risk, company size and book-to-market ratio were also important factors in capital asset pricing. Subsequent studies have proved that the three-factor model has good pricing power for stock returns. However, some scholars find that the three-factor model still cannot explain some anomalies in stock return pricing.

If the three factors can fully explain the excess returns brought by various risks, then the true value of α_i of any stock and any portfolio should be zero. With the continuing increase of related research, more and more abnormal stock returns have been found. Based on these findings, the researchers continuously revised the three-factor model. Profit factors and investment factors have been proved to have a certain relationship with the market performance of listed companies. Fama and French then added them to the three-factor model and obtained the five-factor model (2015) [12]. In later research, it shows a better ability to explain the American stock market's cross-sectional average return characteristics.

Following are the introduced formulas mentioned above.

In 1993, Fama and French put forward the famous three-factor model based on CAPM. It decomposed the excess return rate of individual stocks into market value factor, book-to-market ratio factor, and other unexplained factors (which can be regarded as the new α).

The formula is as follows

$$R_{it} = \alpha_i + \beta_i RM_t + s_i SMB_t + h_i HML_t + e_{it} \quad (1)$$

Where, $R_i = R_i - R_F$ is the expected excess return of security or portfolio i over risk-free investments, $R_M = R_M - R_F$ is the expected excess return of the market over risk-free investments, SMB is the expected excess return of small companies compared to large companies, HML is the expected excess return of stocks of a company with higher B/M overstocks with lower B/M, e_i is a zero-mean residual, β_i , s_i , and h_i are the coefficients of the three factors, α_i is the intercept for all securities and portfolios i .

In 2005, Fama and French added two new factors (profit and investment) to better explain the expected return of a cross-sectional stock portfolio.

The formula is as follows

$$R_{it} = \alpha_i + \beta_i RM_t + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{it} \quad (2)$$

RMW is the difference between the returns on diversified portfolios of stocks with robust and weak profitability. CMA is the difference between the returns on diversified portfolios of the stocks of low and high investment firms.

3. Results

Data used in this paper were adapted from the Kenneth R. French database. To study the influence of COVID-19 on the service industry, daily data from February 1, 2019, to March 31, 2021, have been selected in a total of 26 months. The multiple regression method is used to obtain comparative results, as shown in Table 1 and Table 2. (The confidence interval is 95%)

Table 1. Regression results before Covid-19 (02/2019 - 02/2020)

Item	Coefficients	Standard error	t Stat	P-value
Intercept	-0.018	0.016	-1.135	0.257
MKT	0.910	0.021	44.182	0
SMB	0.509	0.036	14.042	0
HML	-0.233	0.036	-6.450	0
RMW	-0.062	0.055	-1.129	0.260
CMA	-0.209	0.073	-2.854	0.005

Table 2. Regression results after the outbreak (03/2020 - 03/2021)

Item	Coefficients	Standard error	t Stat	P-value
Intercept	0.124	0.036	3.422	0.001
MKT	0.985	0.018	53.599	0
SMB	0.719	0.042	17.170	0
HML	0.007	0.035	0.216	0.829
RMW	-0.176	0.072	-2.460	0.015
CMA	-0.484	0.081	-5.959	0

As shown in Table 1 and Table 2, it is obvious that the pre-epidemic intercept (α) is not significant. Still, the post-epidemic intercept (α) is significant, indicating that there is an anomaly. The MKT

coefficient is both significant before and after the outbreak. This change shows that the sensitivity of the market has been increasing slightly. SMB coefficient is significant and greater than 0 both before and after the epidemic, indicating that the market is always inclined to invest in companies with small market capitalization. HML coefficient is significant before the epidemic, but it is not significant after the epidemic. RMW coefficient becomes significant after the epidemic, reflecting the market's preference for companies with weak profitability. The coefficient of CMA is significant both before and after the outbreak, indicating that the market has been biased toward aggressive companies.

4. Discussion

Based on Fama-French five factor model, this article analyzes the impact of COVID-19 on the U.S. service industry, and the following discussions will explain the change of each factor before and after the pandemic in detail. In the period covered by the study, the intercept was not significant before the epidemic outbreak. However, this data was significant in the period after the outbreak of the epidemic, reaching 0.124, which indicated that some previously unknown variable factors were recognized as an anomaly that impacted the service industry. The most significant unknown factor is the COVID-19. It's clearly a black swan event. No one can make accurate projections for the outbreak and targeted it to prepare. Also, it's impossible to predict the next move after the outbreak. The COVID-19 has caught the market off guard.

Looking at figures 1-2, we can see several leading economic indicators of the U.S. market plummeted at the beginning of the outbreak. The Composite Index of Leading Economic Indicators recorded a decline of 7% in March compared to the last year. The Index of Coincident Economic Indicators declined from nearly 107 touchings down to 92.

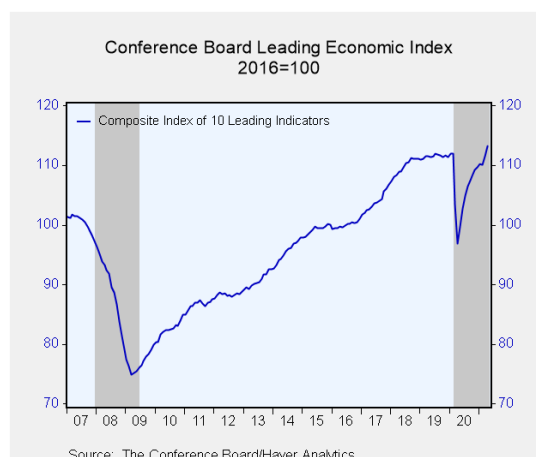


Figure1. Leading Economic Index [13]

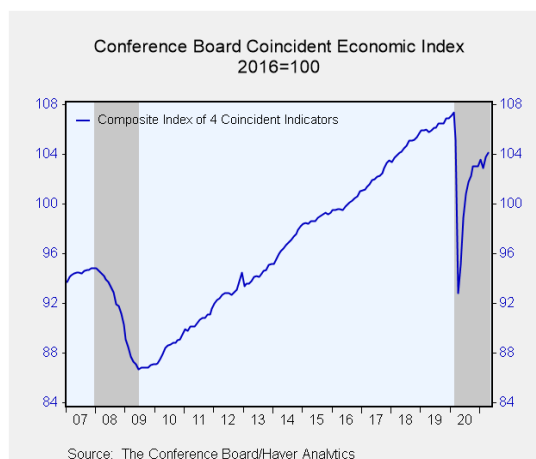


Figure 2. Coincident Economic Index [13]

The ratio of Coincident / Lagging Economic Index is considered another leading indicator of economic activity. It plunged to almost 80, its lowest level since May 1961, which preceded several years of positive economic growth.

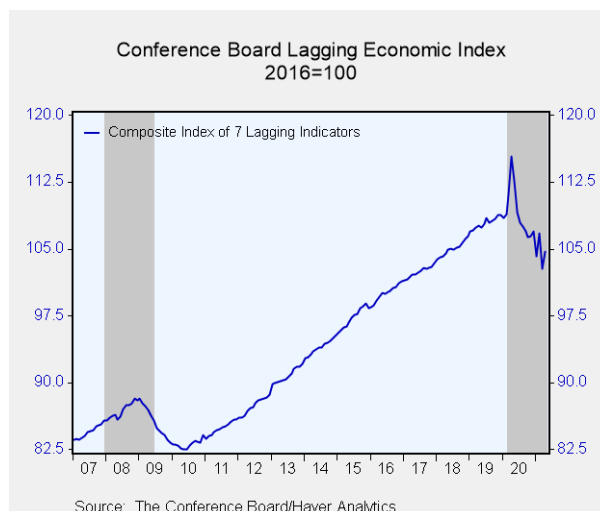


Figure 3. Lagging Economic Index [13]

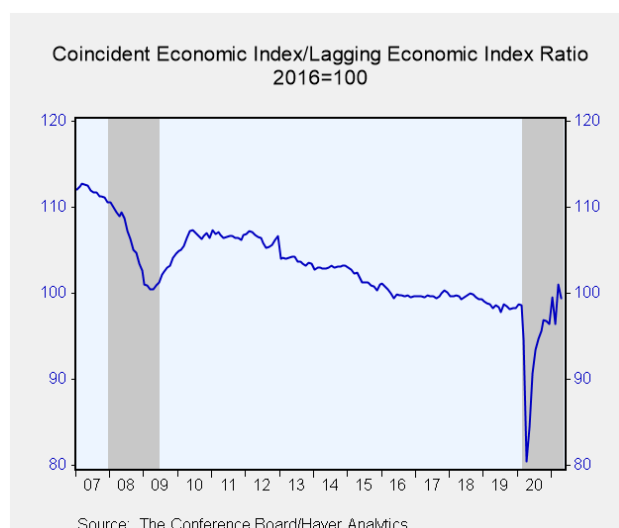


Figure 4. Coincident / Lagging Economic Index Ratio [13]

The heavy decline of these indicators at the point of the outbreak shows the significant impact of the anomaly (COVID-19 and other unknown factors) on the economy.

The fluctuation of the MKT coefficient is tiny. They are both significant, and there is only a slight increase from 0.91 before the outbreak to 0.99 after the outbreak because it represents R_i relative to R_M , so it can be seen that the market's sensitivity has increased. Since almost 80% of the US GDP comes from the tertiary industry represented by the service industry, and financial accounts for more than half of it, this means that the US economy has decoupled from the manufacturing industry. The tertiary industry, especially the financial industry, is highly dependent on market confidence, so once problems occur, there will be a chain reaction. And the market volatility can make investors cautious, which in turn makes the market sensitive.

At the beginning of the outbreak, the Conference Board's Consumer Confidence Index fell 26.9% to 86.9 in April after falling 10.4% in March. The Present Situation Index fell 54.2% to its lowest level since 2013.

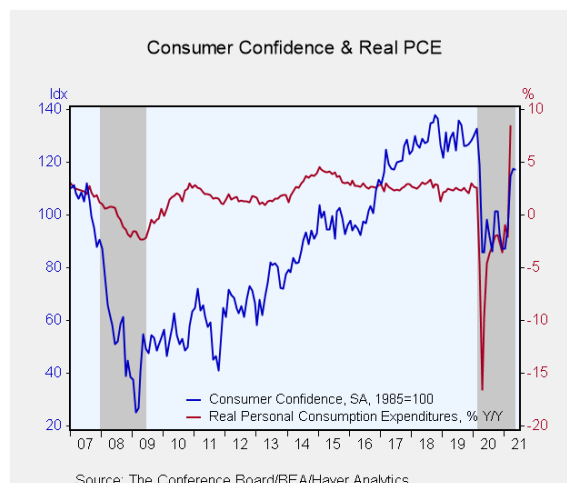


Figure 5. Consumer Confidence Index [14]

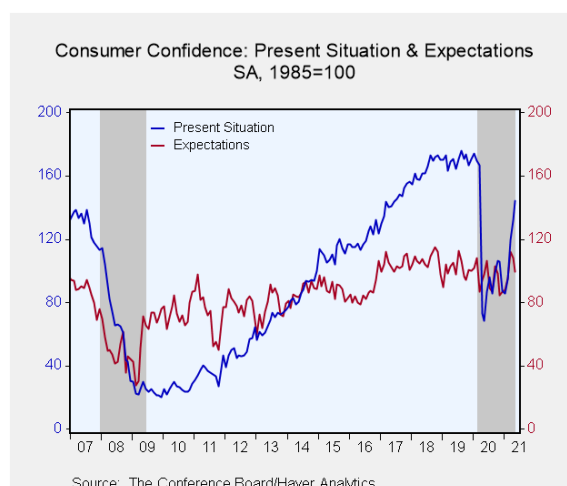


Figure 6. Present Situation Index [14]

Through the data from figure 5-6, we can find that the confidence of the whole market has dropped sharply under the attack of the epidemic, and at the same time, the market has undergone drastic fluctuations.

The SMB coefficients are all significant and greater than 0, and the data before and after the epidemic are 0.5 and 0.7, respectively, with an increase, indicating that investors always prefer companies with small market capitalization, and this preference is more obvious after the epidemic. Considering the reasons for information deviation, it can be concluded that investors have confidence in the future of some small companies. The more important reason is that under the extensive coverage of the service industry, many small and medium-sized companies occupy the main body of the industry. Under the epidemic's impact, the whole service industry suffered heavy losses under the sharp decline in consumption and the federal government's ban. Both large and small companies are experiencing a round of reshuffles. Perhaps the survival ability of large companies will be stronger, but the development prospect of many small and medium-sized companies is expected after experiencing the outbreak's impact.

According to the significant t-stats and negative value of the HML coefficient before the outbreak, the market preferred value stocks with stable performance and long-term development potential. However, the HML coefficient after the epidemic is not significant, indicating that the influence of the book-to-market ratio in the market and investors after the epidemic is significantly reduced, and its utility is no longer obvious.

RMW coefficient was not significant before the outbreak, but it was significant after the outbreak (-0.176). This change indicates that investors are more inclined to stocks with weak profitability after

the outbreak, which is relatively consistent with investors' preference for small companies shown by SMB, which fully reflects the speculative market.

The CMA coefficient before and after the epidemic was significant and less than 0, which were -0.2 and -0.5, respectively, showing an obvious increase in absolute value. It can be seen that the market has always maintained a preference for aggressive companies, reflecting investors' optimistic outlook for the development of the market. At the same time, it reveals that the epidemic's economic impact has not made investors pessimistic and thus conservative. Instead, investor confidence appears to have been more aggressive in the wake of the outbreak, seeing it as an opportunity to invest.

By observing the ISM service PMI (almost reaching 41, the worst situation since 2008) and the business activity & employment index (almost reaching 25, even worse than the situation in 2008) during the whole epidemic period from figure 7-8, it can be seen that in the early stage of the epidemic, the whole service industry experienced a very severe recession and basically showed negative growth for a period, which was close to or even lower than the state in the Sub-prime Mortgage Credit Crisis in 2008.

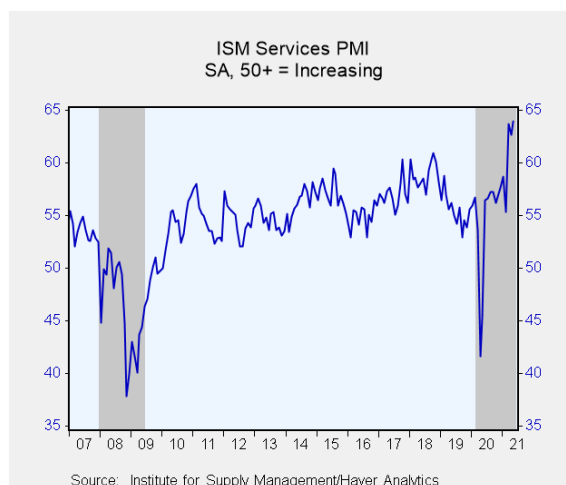


Figure 7. ISM Services PMI [15]

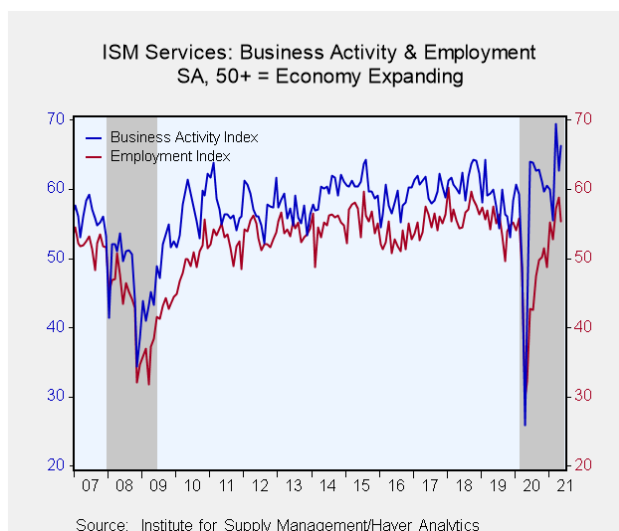


Figure 8. ISM Services Business Activity [15]

Interestingly, as shown in Figures 1-8, all the indicators mentioned above claimed a powerful rebound quickly after the short touchdown after the outbreak. And, it can be concluded that the reason behind this phenomenon must be closely related to the change of factors.

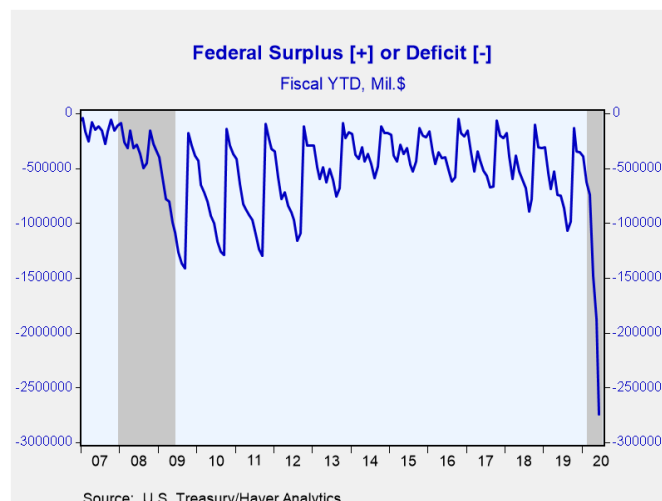


Figure 9. Federal Surplus or Deficit [16]

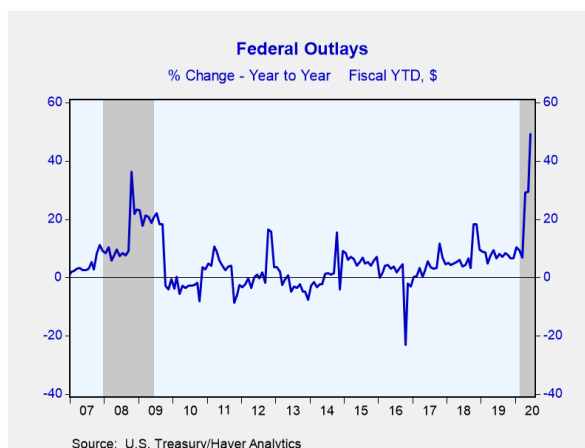


Figure 10. Federal Outlays [16]

According to the data from figure 9-10, the federal budget deficit was \$864.1 billion in May, up from \$8.5 billion 12 months earlier. Since the fiscal year that began in October, the cumulative deficit has grown to \$2.74 trillion, compared with \$747.11 billion a year earlier. By the fiscal year 2020, the deficit has surpassed the full fiscal year record of \$1.41 trillion set in 2009. The deficit so far this fiscal year is about 13% of gross domestic product. In the fiscal year 2020, federal spending is up 49.1%. Income protection payments surged 131% in the financial year, reflecting higher unemployment and payments to government wage protection schemes, which boosted spending [16].

It shows that it was the federal government's intervention, by pouring money into the market, that enabled the economy and the stock market, which had been hit hard by the epidemic, to recover quickly.

According to data compiled by Envestnet Yodlee, many of those who received federal aid for the outbreak chose to open accounts at brokerages or increase their exposure to the stock market.

The data from table 3 showed that individuals who received checks spent 81% more than the previous week, with some spending going to stock purchases. When people earning \$35,000 to \$75,000 received a stimulus check, stock trading volume increased 90 percent from the previous week. Americans earning between \$100,000 and \$150,000 a year saw an 82 percent increase in transactions, while the frequency of transactions over \$150,000 increased by about 50 percent. The increase in these transactions was surpassed only by increases in savings and cash withdrawals from ATMs.

Table 3. Consumers received stimulus checks made stock trades

Rank	<\$35K	\$35K-\$50K	\$50K-\$75K	\$75K-\$100K	\$100K-\$150K	\$150K+
1	Savings +250%	Savings +197%	Savings +188%	Savings +234%	Savings +223%	Loans +84%
2	ATM/Cash Withdrawals +199%	ATM/Cash Withdrawals +137%	ATM/Cash Withdrawals +102%	ATM/Cash Withdrawals +111%	Securities Trades +82%	Insurance +69%
3	Home Improvement +129%	Securities Trades +93%	Securities Trades +90%	Home Improvement +90%	ATM/Cash Withdrawals +76%	Savings +57%
4	Transfers +126%	Home Improvement +93%	Home Improvement +80%	Education +86%	Loans +70%	Travel +52%
5	Utilities +111%	Transfers +85%	Utilities +68%	Loans +70%	Home Improvement +69%	Home Improvement +52%
6	Electronics/ Gen. Merch. +100%	Utilities +75%	Travel +63%	Utilities +66%	Insurance +66%	Entertainment/ Recreation +48%
7	Education +99%	Electronics/ Gen. Merch. +67%	Electronics/ Gen. Merch. +61%	Rent +64%	Education +61%	Securities Trades +46%

Source: Envestnet Yodlee [17]

This has brought a lot of money into the market. The number of new investment accounts opened by several large discount brokerages, such as Charles Schwab, Interactive Brokers, Robinhood, and TD Ameritrade, rose by around 170% in the first quarter of 2020.

With the help of a large amount of money, many stocks that were not expected or suffered heavy losses in the epidemic have miraculously appeared to rise. Such as retailer JC Penney and car rental group Hertz. Hertz, for example, was hit hard by the COVID-19, which forced the company to file for bankruptcy in May 2020 with a total debt of \$19 billion. Its share price plummeted from \$2.84 on the 21st to an all-time low of \$0.56 on the 25th. Instead, the stock rose nearly 100% on the back of speculative investors [18].

According to the federal government's efforts to boost the economy in response to the outbreak, people have regained confidence in the stock market and invested more enthusiastically. Although some services companies suffered huge losses in the outbreak, profitability and even before the outbreak remained quite a gap, but it can get a blood transfusion to survive from the stock market and have the opportunity to obtain a bigger development. The flood of money entering the stock market caused the stock market to show strong growth momentum, making the market speculative, which led to the growth of SMB and the significance of RMW. Besides, the book-to-market ratio is not one of the primary factors that retail investors consider. This may help explain the reason that the HML coefficient is no longer significant. The service market is full of opportunities after the erosion of the epidemic. Aggressive companies are more favored. At the same time, under the reinvigoration of the U.S. stock market, the growth of the CMA coefficient was promoted.

Confidence in the market is returning at a rapid pace, and the ban is being further relaxed. It is worth looking forward to the recovery of profitability and growth of service sector companies in the future. This makes the market speculative, and the market is very different from what it was before the outbreak. It should be noted that although the market recovered strongly in the late stage of the epidemic due to the intervention of the federal government, the impact of the drastic fluctuations on the market and its impact still cannot be ignored.

5. Conclusion

Based on the Fama-French five-factor model, this paper studies the impact of COVID-19 on the US service industry. The results showed that the COVID-19 epidemic had a significant impact on the whole service industry. The epidemic caused many service enterprises to decline in revenue, brought a serious crisis to many enterprises with worth liquidity, and caused the whole industry to experience a round of reshuffles.

After experiencing a short downturn in the early stage of the epidemic outbreak, the stock market recovered rapidly under the strong measures taken by the federal government to revitalize the economy, and the overall direction of development shift towards better. Many enterprises are expected to ride out the crisis with the help of the rapidly growing stock market.

Although the epidemic outbreak hit the economy and the market hard, many service enterprises experienced the most difficult period in history, and even a large number of enterprises went bankrupt, suffering an unprecedented financial crisis. But the outbreak is also an opportunity for growth since it has inflicted the service industry and left many firms with fewer or weaker competitors. On this basis, radical enterprises are favored by investors because of their broader development prospects.

Under government subsidies, people brandishing government subsidies have jumped into the stock market, which has been rising strongly, hoping to make up for the financial losses caused by the outbreak. After the epidemic hit hard, the stock market gradually returned to prosperity. As investors' money increased, the ever-changing landscape of the stock market has become radically different from what it was before the outbreak.

Small companies and companies with weak profitability performance are generally favored. At the same time, the effectiveness of the book-to-market ratio, an important investment measure, is significantly reduced, and the market no longer favors value stocks with great potential for stable growth. These phenomena indicate that the speculative market behavior exploded in the overall market rise and continues to strengthen based on the conservative investment is no longer the mainstream.

Although the overall stock market performance is good and the growth trend is strong, the real phenomenon in the real society is the soaring unemployment rate, the widening gap between the rich and the poor, and a large number of enterprises that were hit hard in this epidemic. Yet the stock market has been unusually strong, even reaching record highs, thanks to government intervention, and the boom is one reason investors should be wary.

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