



# Exploring A New Factor Based on The Fama-French Model During COVID-19

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**ABSTRACT.** COVID-19 has had a huge impact on all industries in the world. Change brings risks but also opportunities. During the pandemic, the Fama-French five-factor model may not be suitable for some industries. This paper tries to explore the explanatory power of the five-factor model and introduce the influencing factors of COVID-19 to improve the model. The article begins with a multiple linear regression for 49 industries using the five-factor model. Then the growth rate of COVID-19 confirmed cases is added as the new factor in six industries where the five-factor model is weak to explain the excess return. The financial trading industry performs best after adding the new factor and there are some interesting results. The results indicate there is a positive correlation between the pandemic and the excess return of the trading industry. Then this article discusses insignificant factors in regression results and the positive coefficient of the proposed factor for the trading industry. Particularly, similar results may occur in the future when encountering significant events similar to COVID-19, which are useful for the trading industry and other decision-makers.

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

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# 1 Introduction

## 1.1 Background

More than three years have passed since the first case of novel coronavirus was detected in Wuhan, China in 2019, and many countries in the world are still living under the shadow of this pandemic. The U.S. economy has started to recover, but there are still many problems due to COVID-19. In applied economics, the Fama-French five-factor model is widely used, but some studies have shown that the five-factor model cannot explain well in some industries. However, the current relevant research period is relatively short without covering the present recovery period. This paper selects the data from March 2020 to November 2022. The U.S. stock market has entered a recovery period. The S&P 500 index also rose from 2585 at the beginning of March 2020 when the epidemic broke out to 4080 at the end of November 2022. With a relatively complete research period, it is more meaningful to study the five-factor model and propose new factors.

## 1.2 Related Research

When something happens that has a huge impact on the entire world, which model can better explain the current situation is always a topic that scholars care about. Bartholdy and Peare compare the explanatory power of CAPM and the Fama-French three-factor model in the New York Stock Exchange and the research shows the Fama-French three-factor model has a better performance to estimate stock returns [1]. Li and Duan analyze if the explanatory power of the Fama-French three-factor and five-factor models has a large increase in 30 American industries during the COVID-19 and the results prove both models can explain better during the pandemic and the five-factor model performs better than the three-factor model [2].

For many markets, COVID-19 has had a negative impact. Szczygielski et al. study the effect on the market returns from the COVID-19 pandemic with empirical regression methods. The research finds a negative correlation between COVID-19-related uncertainty and market returns where the uncertainty is expressed by an aggressive index and market returns include 68 global industries [3]. Al-Awadhi uses panel data regression to investigate how COVID-19 influences the Chinese stock market and research shows Hang Seng Index and Shanghai Stock Exchange Composite Index are negatively affected by COVID-19, more significantly

by daily data [4]. But COVID-19 may also have a positive effect or positively affect the market. Liu compares the American hardware sector before and after the pandemic within Fama-French five-factor model. The results show there is some stimulation for high-value companies caused by the pandemic although it hurts the overall stock market [5]. Sansa explores the financial market under the influence of the epidemic from 1st March 2020 to 25th March 2020 in China and the USA. The research uses the simple regression method and receives a positive correlation between confirmed covid-19 cases and stock market returns [6].

Some research also finds the Fama-French five-factor model may not be suitable for every market. Horváth and Wang analyze the strength of the Fama-French five-factor model during COVID-19 and the financial crisis in the USA, measured with  $R^2$ . During these selected events  $R^2$  experiences a significant decline compared to what happened before and almost all the coefficients have a decrease of more or less [7]. Dirkx et al. find the Fama-French five-factor model does not play a significant role in explaining the German stock market and then the research introduces a momentum factor referring to winners and losers according to performance. Results show the new model only slightly enhances the explanation in the German stock market [8]. With the momentum factor, Doğan et al. test the suitability of the Fama-French model in Borsa Istanbul, and the research shows that this model is very suitable for Borsa Istanbul [9].

### 1.3 Objective

Most articles that study the impact of COVID-19 directly use the Fama-French five-factor model and focus on a single industry in a certain period, while this paper analyzes the suitability of the five-factor model for 49 industries in the same period. For the industries which are not suitable for the five-factor model, a new factor will be added to explore whether the regression results have an improvement. After introducing the new factor, there is also something interesting the pandemic has a positive impact on the trading industry. This article will analyze and summarize the industries that have significantly improved after the introduction of new factors, and the conclusions are also helpful for the rapid response to similar events in the future.

## 2 Data and Methodology

### 2.1 Data

The 49 industries' monthly data and Fama-French five-factor data come from the Kenneth R. French Data Library and the growth rate of COVID-19 confirmed cases data is from WHO. WHO only provides daily data and then this paper aggregates the data into monthly data. To match the industry data, which is measured by the growth rate, this article also calculates the percentage change of confirmed cases as the case growth. Before March, the number of confirmed cases in the U.S. was very low, and it increased rapidly since the beginning of March so the data this article uses is from March until the latest data, November 2022.

### 2.2 Methodology

Fama-French six-factor model

$$R_{i,t} - R_{f,t} = \alpha_{i,t} + \beta_m(R_{m,t} - R_{f,t}) + \beta_{SMB} * R_{SMB,t} + \beta_{HML} * R_{HML,t} + \beta_{RMW} * R_{RMW,t} + \beta_{CMA} * R_{CMA,t} + \beta_{COV} * R_{COV,t} + \varepsilon_t \quad (1)$$

Where  $R_{i,t}$  represents the return of a stock or portfolio in time  $t$ .  $R_{f,t}$  is the return of the risk-free asset in time  $t$ .  $R_{m,t}$  is the value-weighted market portfolio return.  $R_{SMB,t}$  describes the return that small companies earn more than larger ones.  $\beta_{HML}$  Indicates the risk premium brought about by the book-to-market ratio (High minus low).  $\beta_{RMW}$  states the return that strong profitable firms earn more than weak ones.  $R_{CMA,t}$  states the risk premium resulting from differences in investment levels (Conservative minus aggressive).  $R_{COV,t}$  represents the growth rate of monthly confirmed cases of COVID-19.  $\beta$  is the coefficient of the factor reflecting the information on the expected rate of change of the factor.  $\alpha_{i,t}$  can be simply used to test the fit of the model. If the  $\beta$  can reflect all the future changes for each factor  $\alpha_{i,t}$  should be zero meaning the model works great.  $\varepsilon_t$  is the residual term.

### 2.3 Assumption

COVID-19 is a huge shock to the entire market no matter which industry it is. In this case, the Fama-French five-factor model may be not enough for explaining all industries. This paper uses linear regression to explore the explanatory power for all

industries. For the regression results, if the intercept cannot be rejected at the 0.1 probability level, this article thinks the five-factor model is not so suitable for this industry meaning a new factor should be introduced to eliminate the intercept.

### 3 Results

#### 3.1 Regression Results with The Five-Factor Model

Table 1 shows there are six industries whose p-value of intercept is less than 0.1. They are business supplies, textiles, agriculture, communication, trading, and coal. For these industries, the Fama-French five-factor model cannot explain all and new factors need to be considered.

**Table 1.** Regression results with the five-factor model

	$\alpha$	P-value of Intercept	R <sup>2</sup>
Business Supplies	-0.016	0.005	0.807
Textiles	-0.023	0.052	0.772
Agriculture	0.018	0.052	0.527
Communication	-0.014	0.056	0.696
Trading	0.008	0.064	0.918
Coal	0.048	0.090	0.239
Fabricated Products	0.028	0.130	0.467
Automobiles and Trucks	0.031	0.159	0.571
Consumer Goods	-0.008	0.164	0.703
Petroleum and Natural Gas	0.017	0.209	0.753
Aircraft	-0.015	0.237	0.674
Insurance	0.006	0.316	0.694
Recreation	-0.013	0.319	0.636
Non-Metallic and Industrial Metal Mining	0.012	0.343	0.562
Rubber and Plastic Products	0.006	0.345	0.817
Measuring and Control Equipment	0.006	0.365	0.782
Electronic Equipment	0.006	0.403	0.843

Apparel	-0.008	0.413	0.737
Electrical Equipment	0.005	0.433	0.884
Steel Works Etc	0.012	0.451	0.561
Business Services	-0.004	0.452	0.886
Precious Metals	-0.014	0.475	0.155
Banking	-0.003	0.495	0.909
Printing and Publishing	-0.006	0.529	0.773
Construction Materials	-0.004	0.554	0.885
Healthcare	-0.006	0.561	0.688
Tobacco Products	-0.005	0.575	0.551
Wholesale	0.002	0.585	0.892
Personal Services	-0.004	0.614	0.788
Shipbuilding, Equipment	Railroad -0.003	0.618	0.839
Retail	0.003	0.620	0.826
Defense	-0.004	0.664	0.423
Restaurants, Hotels, Motels	-0.003	0.674	0.827
Construction	-0.004	0.677	0.791
Chemicals	-0.002	0.686	0.842
Candy & Soda	-0.003	0.710	0.545
Shipping Containers	-0.003	0.717	0.573
Medical Equipment	-0.002	0.755	0.782
Real Estate	-0.002	0.779	0.849
Computer Software	0.001	0.787	0.906
Entertainment	-0.002	0.812	0.747
Machinery	0.001	0.819	0.846
Utilities	-0.002	0.824	0.484
Beer & Liquor	-0.001	0.833	0.611
Food Products	-0.001	0.864	0.589
Transportation	-0.001	0.865	0.755
Pharmaceutical Products	0.001	0.869	0.611
Computers	-0.001	0.872	0.689

### 3.2 Regression Results with The New Factor

Then this paper adds the growth rate of confirmed cases as a new factor to explore the effect of the pandemic on six industries. The results show that the intercept of trading and agriculture disappears but the p-value of intercept for the other four industries even decreases. However, the trading industry benefits a lot after introducing the six-factor model. For the trading industry, the COVID-19 factor is significant at the 0.1 probability level, and the intercept is insignificant even at the 0.2 probability level. Although the intercept of the agriculture industry disappears the proposed factor is insignificant.

**Table 2.** Regression results with the six-factor model

	Five-factor model		Six-factor model		
	P-value of Intercept	R <sup>2</sup>	P-value of Intercept	R <sup>2</sup>	P-value of $\beta_{cov}$
Trading	0.064	0.918	0.220	0.926	0.054
Agriculture	0.052	0.527	0.117	0.522	0.396
Coal	0.090	0.239	0.013	0.368	0.017
Textiles	0.052	0.772	0.046	0.766	0.543
Communication	0.056	0.696	0.035	0.696	0.323
Business Supplies	0.005	0.807	0.000	0.843	0.013

### 3.3 Comparison of Regression Results for the Trading Industry

Because only the trading industry has a large promotion this article then focuses on the analysis of the changes in the trading industry regression. Table 3 shows the regression results before and after adding the proposed factor. Size and profitability factors are insignificant regardless of whether the new factor is introduced but the p-value of the intercept increases to 0.220 meaning the null hypothesis cannot be rejected even at the 0.2 probability level. The  $R^2$  also has an improvement from 0.918 to 0.926. The significant new factor means the pandemic influences the trading industry. However, the positive coefficient means that COVID-19 positively influences the trading industry, which is contrary to. experience.

**Table 3.** Regression results for trading industry

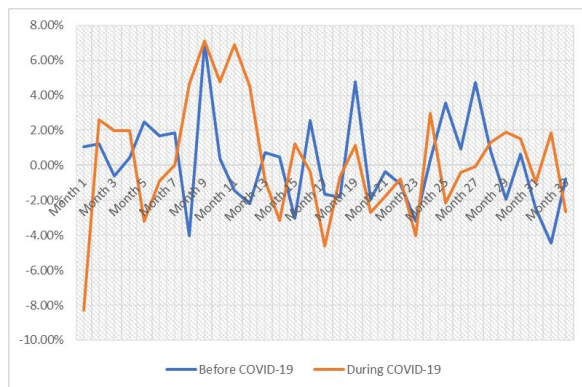
	Without COVID-19 factor		With COVID-19 factor	
	Coefficient	P-value	Coefficient	P-value
Intercept	0.008	0.064	0.005	0.220
$R_m - R_f$	1.134	0.000	1.173	0.000
RSMB	-0.168	0.316	-0.094	0.565
RHML	0.480	0.000	0.609	0.000
RRMW	-0.259	0.125	-0.220	0.170
RCMA	-0.466	0.010	-0.588	0.002
RCOV	/	/	0.0000221	0.054
$R^2$	0.918		0.926	



## 4 Discussion of the Trading Industry

### 4.1 Insignificant Size Factor

For the trading industry, the size factor is insignificant meaning the size premium cannot effectively explain the excess return. To explore the reason, this article compares the size premium in the same cycle before and during COVID-19. Because the pandemic period analyzed in this paper is from March 2020 to November 2022, the period before the pandemic that is considered first should be from March 2017 to November 2019. But the size factor is also insignificant during this period for the unfavorable p-value and March 2016 to November 2018 is the best choice before the pandemic period. Figure 1 shows the difference in size premiums before and during the pandemic. Surprisingly, size premium shows a high degree of similarity between the two cycles. At the beginning of the pandemic outbreak, the size premium is incredibly small because small firms are less able to respond to risks. The two periods exhibit highly consistent volatility after a period of adjustment.



**Fig. 1.** size premium before and during COVID-19

However, the figure 2 exhibits return of the trading industry in these two periods has very different fluctuations. The size premium is significant before COVID-19 meaning it can explain excess return of trading industry. Then it still has similar volatility during pandemic, but the return of trading industry changes a lot, which means the size premium is relatively weak in explaining the trading industry during COVID-19.

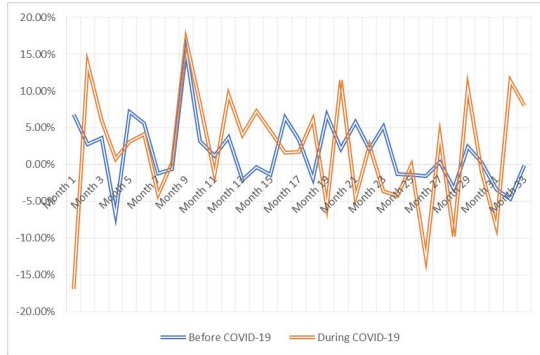


Fig. 2. Return of trading industry before and during COVID-19

### 4.2 Insignificant Probability Factor

The probability factor is also insignificant during COVID-19. Regardless of whether the pandemic occurs or not, the profitability factor is a redundant factor. Table 4 shows the coefficient and p-value of RMW before and during COVID-19. For the comparability of the results, this article selects the period from January 2017 to December 2019 as the period before the outbreak. Of course, March 2020 to November 2022 is the period during the pandemic. The full period is from January 2017 to November 2022. The regression model is the Fama-French five-factor model before COVID-19 and full-time. When regressed the period during the pandemic the covid factor is added. The unfavorable p-values show the RMW coefficient is insignificant meaning that companies in the financial trading industry have relatively uniform operating margins.

Table 4. Regression results for probability factor before and during the COVID-19

Time period	Coefficient	P-value
Before COVID-19	-0.3051	0.334
During COVID-19	-0.220	0.170
Full time	-0.2128	0.134

### **4.3 Positive Coefficient of Proposed Factor**

Then this paper discusses the reason for the positive coefficient of the COVID-19 factor. Empirically, the pandemic negatively affects the returns of the trading industry because of the sluggishness of the overall economy and the decline in consumption. During COVID-19, many industries had to shut down, but the financial trading industry has not been affected too much and has been running. With the outbreak of the epidemic, people must stay at home, which means that people have a lot of leisure time. So, people spend more time researching financial markets and trading. Moreover, due to the lack of consumer catering, brick-and-mortar industries such as catering, and hotels do not look like a good investment choice. At last, more money will flow into financial trading markets such as stocks and derivatives.

Quantitative easing also contributes to the positive coefficient. Due to the sluggish economic development, the Federal Reserve cut interest rates twice in March 2020 when the pandemic just started. On March 3 and March 15, the Federal Reserve cut 50 and 100 basis points respectively. When interest rates are lower, investors save less and invest more, which means further stimulus for the trading industry. The stock market responded quickly to the news. Although Dow Jones Industrial Average had a decrease on March 3 the index adjusted on March 4 and surpassed the amount on March 2. S&P 500 ETF Trust also shows the same pattern. The reason why there is a decrease on March 3 is that the first reaction of investors after seeing the emergency rate cut is to hold a negative attitude towards the entire market. After careful consideration, they think it is a better choice to invest funds in the stock market instead of saving. Moreover, the S&P 500 increased 6% on March 17 which is the second session after news of second interest rates cut was released. The NASDAQ 100 stock index also had a growth with 4.16% at that day. In addition, Federal Reserve launched a \$700 billion monetary policy program. This program is related to asset purchases including treasuries and mortgage-backed securities. These registered funds would inject liquidity into the market and stimulate economic growth.

## **5 Conclusion**

This paper is undertaken to study the suitability of the Fama-French five-factor model during COVID-19 and explore which new factor can help to improve the explanatory power of the model. After the proposed factor was added, the trading industry can be

explained by the model. Compared with the current literature, this article finds there is a positive relationship between the growth rate of COVID-19 confirmed cases and the excess return of the trading industry with a sufficiently long data period from March 2020 to November 2022. If there are similar events in the future, the same characteristics are likely to appear in the trading industry, and market participants can respond quickly making the whole industry through the high volatility period more quickly.

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