

Better or Not? Research on the Influence of Covid-19 on U.S. Financial Industry Based on Fama-French Five Factor Model

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ABSTRACT

Influenced by the “black swan incident” Covid-19, huge changes have occurred in the global financial market. Based on Kenneth French-Data Library, this paper uses multiple linear regression to analyze the statistical data of the U.S. stock financial industry before and during Covid-19, which is used to test the impact of Covid-19 on the financial industry and effectiveness of the Fama-French five-factor model (FF-5 model). The result shows that the epidemic had a certain stimulative effect on applying the Fama-French five-factor model in the real stock market. Among them, the coefficients and significance level of MKT, SMB, and HML have increased significantly, making the model more sensitive to capture changes in risky assets, although CMA and RMW are redundant. In addition, Covid-19 has had a huge influence on the financial industry with sharp fluctuation of related industry indexes. The market differentiation structure of the financial industry and investors' risk appetite also have changed significantly during this period.

Keywords: Fama-French Model, Covid-19, Business service, U.S. stock market

1. INTRODUCTION

Asset pricing is one of the most important topics in financial economics. It attempts to explain the asset price or value paid in the future under uncertain conditions. In 1953, Markowitz first mentioned the concept of portfolio risk in his academic paper asset selection: effective diversification and mathematically defined investor preference by using the mean and variance of portfolio return. In addition, Markowitz deduces the principle of investment diversification through mathematical methods to systematically explain the problem of portfolio selection [1, 2]. On this basis, the Capital Asset Pricing Model (CAPM model) proposed by William Sharpe, Jack Treynor, John Lintner, and Jan Mossin in the 1960s further describe the relationship between asset risk and expected rate of return. Under certain assumptions, the expected rate of portfolio return only depends on the sum of risk-free interest rate and market risk premium [3, 4]. Since then, economists began to pay extensive attention to the relationship between risk and investment return.

However, the CAPM model could not be well applied to the real market that the market risk sensitivity. Factor β is difficult to fully capture the

change of return on risky assets. In 1992, Fama and French proposed a three-factor model (FF-3 model), adding size factor SMB and value factor HML in addition to the original systemic risk factor [5, 6]. They believe that the excess return of stocks can be explained by market risk, market value risk, and book to market ratio risk. Companies with smaller market capitalization tend to achieve higher returns than companies with larger market capitalization, while the value companies with high B/M tend to obtain higher returns than growth companies. With the evolution of the financial market structure, the explanatory power of the three-factor model gradually decreases. Therefore, in 2015, Fama and French proposed a five-factor model (FF-5 model) based on the three-factor model and added the investment level factor CMA and profitability factor RMW to the model [7, 8]. Among them, RMW is the difference between the returns of high/low profitable stock portfolios. At the same time, CMA is the difference between the returns of stock portfolios of companies with low/high reinvestment ratios. Compared with the FF-3 model, the results show that the FF-5 model is more effective.

These asset pricing models are widely used in investment decision-making and corporate finance and

have a profound impact on the development of the financial market. Besides, due to the strong effect of the FF-5 model in the real market, many investors take the model as the key mechanism in their investment decision-making. Meanwhile, the application of the FF-5 model in the real market has been doubted by some scholars.

Diallo, B. et al. analyzed the fitting degree of the Fama-French three-factor model and the Fama-French five-factor model in American industries from 1926.7 to 2019.1 utilizing machine learning in August 2019. They mainly used Bayesian Optimization Support Vector Regression (BSVR) method to predict portfolio return. Among them, the correlation coefficients of the FF-3 model are more than 90%, while the correlation coefficients of the FF-5 model are distributed between 48% - 89%. Therefore, Diallo B. et al. concluded that the practical application performance of the FF-3 model in the American stock market is better than that of the FF-5 model [9]. Besides, based on the company level data from July 1992 to December 2014, Cakici, N. analyzed the explanatory power of the Fama-French five-factor model in 23 developed stock markets on October 14, 2015. Cakici, N. found that the results of the FF-5 model in North America, Europe, and global markets were similar to those in the United States. However, the test results of gross profit margin and investment level show that the explanatory power of these two factors is weak in Japan and the Asia Pacific region, which questions the explanatory power of the FF-5 model. In addition, Cakici, N. pointed out that the explanatory power of the regional model is better than that of the global model. It can be seen that the global market is not fully integrated, and there are still structural differences among markets [10]. In addition, Chiah, M. et al. evaluated and compared the performance of the FF-5 model and other models, including the three-factor model in 2016. The results have shown that the addition of profitability and investment level factors improves the model's explanatory power, and the FF-5 model can explain more asset pricing anomalies than other models. However, they consider that the FF-5 model could not fully explain the time-series changes in portfolio returns. Moreover, in the analysis of Chiah, M. et al., it is not found that the addition of two new factors mentioned by Fama and French (2015) leads to the redundancy of the HML factor [11].

Some relevant researches show that it has statistical significance merely in a specific period and region, such as the outbreak of Covid-19. First, Hou, D. et al. mainly used the FF-5 model to research the American steel industry in 2021 and compared the results of the two periods after regression analysis based on the FF-5 model. First, they thought that the market risk beta value increased significantly after the epidemic, indicating that the steel industry became more sensitive to

economic fluctuations. Secondly, Hou, D. et al. believe that the RMW factor became no longer significant before and after the epidemic, indicating that the epidemic's impact on the iron and steel industry is all-round, and the profitability of the whole industry is declining significantly. Third, they pointed out that the other factors have little change and are less affected by the epidemic situation [12]. Secondly, Li K. et al. analyze the fitting degree of the FF-3 model and FF-5 model to 30 industries in the United States before and after the epidemic in 2021. First, after the outbreak of the epidemic. They found that the explanatory power of the FF-3 model increased to a certain extent, in which the SMB factor increased by 3.7% and the HML factor increased by 14.29%. Secondly, Li, K. et al. found that the explanatory power of Fama French five factors has been greatly improved, in which the significance of HML and CMA factors has been increased by 64.29% and 100%, respectively. Therefore, they believe that the epidemic outbreak further simplifies the market structure, and covid-19 has a positive impact on the effectiveness of the FF-5 model, which is conducive to investors' investment decisions according to the model [13]. Besides, Liu, Y. made a regression analysis on the performance of the American hardware industry before and after the epidemic by the FF-5 model in 2021. Liu, Y. found that market risk beta, SMB, and CMA had a significant relationship with the industry before the epidemic. After the epidemic, only the market risk beta has a significant relationship with the industry, decreasing its correlation significantly. Therefore, Liu, Y. believed that the outbreak of the epidemic did great damage to the hardware industry and has a certain stimulating effect. In addition, due to the failure of other beta coefficients in the hardware industry, the hardware industry is more in line with the CAPM model, and its sensitivity to market systemic risk is further reduced [14].

In December 2019, COVID-19 began to appear and spread widely in the world in the following months. COVID-19's wreak havoc has caused a huge impact on the economy of all countries. The GDP growth rate of most countries in the world has fallen sharply or even become a negative growth rate. Taking the United States as an example, compared with 2019, the total GDP decreased by 3.5%, setting the largest negative growth record since the end of World War II. In the financial market, US stocks triggered the circuit breaker mechanism four times in March 2020, which happened only once in the previous history of the U.S. stock market. COVID-19's influence on the financial market is impossible to ignore, which indicated the financial industry has inevitably become one of the most affected industries in the period of COVID-19. As a widely concerned model, the effectiveness of the FF-5 model under the influence of COVID-19 has become a critical issue worthy of research. In terms of the financial

industry, this paper mainly studies the changes in the significance of five factors of the FF-5 model during COVID-19. It provides the underlying reason for this transformation according to the statistical summary.

2. METHOD

Here is the function of the CAPM model:

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

Where R_f is the risk-free interest rate; β_m is the beta coefficient (the systemic risk of asset I); R_m is the expected market return of market portfolio M ; $R_m - R_f$ is the market risk premium, that is, the difference between the expected market return and the risk-free return; R_i is the expected return on asset i . Capital asset pricing model mainly considers two sources of return on risky assets, one is the risk-free interest rate, and the other is the risk compensation obtained by its market risk.

Because the selection of influencing factors in the CAPM model is too simple, that could not well reflect the complicated changes of risk assets in the real market. Therefore, the appearance of the FF-3 model makes up for the defects of the CAPM model to a certain extent, which adds size factor SMB and value factor HML . The basic form of the FF-3 model is as follows:

$$R_i - R_f = \beta_m(R_m - R_f) + \beta_{SMB}SMB + \beta_{HML}HML \tag{2}$$

β_m is used to measure the sensitivity of assets to market risk. Then, β_{SMB} is the coefficient of company size while β_{HML} represents the coefficient of value level.

Among the equation, the SMB factor calculates the difference in returns between small-scale (low market value) company stocks and large-scale (high market value) company stocks, representing the risk premium caused by different companies' market values. Among them, company size risk refers to that the company's size has a certain impact on the risk of the company's shares: if the asset size is small, the risk will increase relatively. On the contrary, if the asset scale is large, the risk will be relatively reduced. Therefore, stocks with small market capitalization can often obtain higher expected returns.

Besides, the HML factor calculates the difference between high B / m value (value company) stocks and low B / m value (growth company) stocks, which represents the risk premium caused by the different book to market ratio (B / m value refers to book to market ratio, and book to market ratio = owner's equity/market value of the book). In the real market, value companies often obtain higher expected returns and higher risks than growth companies, according to the stock market database. Because Fama-French three-

factor selection is concise and effective and has good explanatory ability. It has become one of the standard methods for all kinds of financial market research and investment strategy design.

With the continuous evolution of the financial market, many subsequent studies found that the old anomalies may have been solved. However, the Fama-French three-factor model is insufficient to explain some new anomalies, including profitability anomalies and investment level anomalies. Hence, this paper introduced the Fama-French five-factor model (FF-5 model), which added the profitability factor and investment level factor based on the Fama-French three-factor model to strengthen the model's practical performance. The equation of the Fama-French five-factor model is as follows:

$$R_i - R_f = \beta_m(R_m - R_f) + \beta_{SMB}SMB + \beta_{HML}HML + \beta_{RMW}RMW + \beta_{CMA}CMA \tag{3}$$

β_{RMW} is the coefficient of profitability while β_{CMA} represents the coefficient of investment level.

While profitability is equal to the ratio of gross profit to book equity. RMW factor represents the difference between the yield of high-profit portfolio stocks and low-profit portfolio stocks. Due to the different profitability of each company, its profitability risk is also different. This means that industries with higher profitability will generally produce a higher expected rate of return with higher risk.

The CMA factor represents the difference between the return rate of a high-level stock portfolio and a low-level stock portfolio, representing the investment level risk caused by different reinvestment proportions. In addition, the investment level risk can be measured by the reinvestment rate. We believe that companies with low investment rates have a higher risk, and investors have higher requirements for these companies, and vice versa.

3. RESULTS

According to the Kenneth. French-Data Library, the data in this paper is selected from the U.S. financial industry of 49 Industry Portfolios [Daily]. This paper uses the method of multiple linear regression to measure the effectiveness of the Fama-French five-factor model for the industry before and during the COVID-19 (2019.5-2020.2 before Covid-19/ 2020.3-2020.12 during Covid-19). Among them, the financial industry is mainly classified as banking, insurance, real estate, and trading. The charts below show the coefficients of the five-factor regression analysis for each sub-industry by student's t-test.

Table 1. Descriptive statistics of FF-5 model of banking and insurance industry after and during the epidemic

Industry	Item	Period	RM-RF	SMB	HML	RMW	CMA
Banking	Coefficients	Fore	0.7808	0.4233	0.5686	-0.4932	0.0266
		Aft	0.8813	0.7133	0.8405	-0.1604	-0.1112
	t-Stat	Fore	32.137	9.3054	12.188	-6.4421	0.2956
		Aft	41.285	13.0135	18.834	-1.7557	-0.9544
	P-value	Fore	0	0	0	0	0.7678
		Aft	0	0	0	0.0806	0.3409
Insurance	Coefficients	Fore	0.8848	0.0411	0.2116	-0.5091	0.4355
		Aft	0.9469	0.3442	0.4691	-0.1137	0.0562
	t-Stat	Fore	27.972	0.6906	3.4662	-5.1158	3.6989
		Aft	49.688	7.012	11.618	-1.3901	0.5363
	P-value	Fore	0	0.4905	0.0006	0	0.0002
		Aft	0	0	0	0.1659	0.5922

In Table of banking, between May 1, 2019, and February 28, 2020, Rm-RF, SMB, HML, and RMW are effective factors, which have varying degrees of explanatory power for the expected return of the banking industry. After 2020.3.1, although RWM becomes non-significant statistically, the coefficients of the other three factors increase further. Among them, the coefficient of Rm-RF is 0.8813, while the coefficient of SMB increases from 0.4234 to 0.7134 (about 68%). Besides, the coefficient of HML increases from 0.5686 to 0.8406 (about 48%). On the other hand, the results show that the CMA factor is not effective for American banking.

In Table of insurance, before the COVID-19, RM-RF, HML, RMW, and CMA factors all showed significance under the t-statistical test, while SMB is the only redundant factor. Among them, coefficients and t-statistic value of RM-RF and HML increase with the outbreak of COVID-19, indicating that the insurance industry is more sensitive to market risk and size. On the contrary, RMW and CMA were not significant in the second period and became redundant factors. Besides, SMB is transformed from a redundant factor into an effective factor during COVID-19.

Table 2. Descriptive statistics of FF-5 model of real estate industry after and during the epidemic

Industry	Item	Period	RM-RF	SMB	HML	RMW	CMA
Real estate	Coefficients	Fore	0.8366	0.6586	0.0949	-0.0001	0.053
		Aft	0.9704	0.9252	0.3339	0.0224	-0.5283
	t-Stat	Fore	12.663	5.9789	0.8377	-0.001	0.2359
		Aft	28.784	10.653	4.6753	0.1552	-2.8488
	P-value	Fore	0	0	0.4032	0.9991	0.8137
		Aft	0	0	0	0.8767	0.0048

In the Table of real estate, Rm-RF and SMB factors showed strong significance at all times. With the emergence of the Covid-19, the coefficient of Rm-RF increased to 0.9704, and the coefficient of SMB increased significantly from 0.6586 to 0.9252 (increased by about 40%). On the other hand, HML and CMA

factors were significant in the second period while there are inefficient factors before the Covid-19. In addition, the market has never considered RMW as an influencing factor to measure the yield of the real estate industry.

Table 3. Descriptive statistics of FF-5 model of the trading industry after and during the epidemic

Industry	Item	Period	RM-RF	SMB	HML	RMW	CMA
Trading	Coefficients	Fore	0.9712	0.2794	0.2534	-0.0635	-0.0046
		Aft	0.9621	0.4667	0.3974	-0.1697	-0.2409
	t-Stat	Fore	21.948	3.7875	3.3378	-0.5074	-0.0305
		Aft	41.859	7.8829	8.1603	-1.7195	-1.9058
	P-value	Fore	0	0.0002	0.001	0.6124	0.9756
		Aft	0	0	0	0.087	0.058

In Table of trading, trading is the industry least affected by the COVID-19 that the significance of the five factors had no change before and during COVID-19. In terms of effective factors, SMB and HML factors have been greatly enhanced in terms of coefficients. Among them, SMB increased from 0.2794 to 0.4667 (about 67%) while HML factor increased from 0.2534 to 0.3974 (about 57%). In addition, multiple linear regression found that investment level (RMW) and

profitability (CMA) have always been redundant factors and have no explanatory power for the trading industry.

4. DISCUSSION

According to the multiple linear regression analysis results, this paper analyzes the impact of covid-19 on the U.S. financial industry through the two dimensions of the significance level and correlation coefficient

change of each factor in the FF-5 model. Then, it researches the underlying reason for the transformation and provides corresponding investment decision-making ideas. In addition, the four sub-industries of the financial industry include banking, insurance, real estate, and trading.

4.1. *R_m-RF* coefficient

As shown in Table 1, except that trading remained stable in the four sub-industries, the coefficients of other industries increased sharply, which means that the financial industry's sensitivity to market risk increased significantly. Take the U.S. stock market as an example. In March 2020, the U.S. stock market fused four times in eight consecutive trading days. In the above four trading days, the Dow Jones Industrial Average fell by 7.8%, 10.0%, 12.9%, and 6.3%, respectively. Historically, there was only one circuit breaker in the U.S. stock market before 2020, which occurred on October 27, 1997, and the Dow Jones industrial index fell 7.2% that day. The rapid spread of the epidemic in countries worldwide with increasing U.S. Infection Cases is one of the internal causes of the stock market crash. While covid-19 has all-around destruction on the financial market, and the financial industry has also experienced a sharp decline. Among them, J.P. Morgan Chase's share price fell from \$130.73 to \$79.58, which lost nearly 40% during the period of 2.20-3.20. Therefore, as one of the heavily weighted sectors in the U.S. financial market, the correlation between the financial industry and the market portfolio yield increased significantly when the black swan event occurred in the security market. In terms of investment decision-making, investors should bring macroeconomic indicators and relevant government policies into the investment decision-making mechanism and reasonably adjust the portfolio structure accordingly.

4.2. *SMB* coefficient

The impact of the outbreak of the epidemic on this factor is considerable. The coefficients of all sub-industries have increased significantly. Among them, banking, insurance, and trading remained significant before and after the COVID-19. At the same time, the factor of the real estate industry also had significance after the emergence of the epidemic with a strong correlation coefficient. It can be seen that the epidemic has caused extensive influence on the financial industry, resulting in the differentiation of company scale. The market gives relatively low-risk compensation to the investors of large financial institutions, while the relative risk premium of smaller financial institutions is higher. One of the reasons might be the improvement of the anti-risk ability of large financial institutions and the upgrading of capital structure. In terms of anti-risk ability, different from the "Basel Accord II" mainly

adopted in the subprime mortgage crisis in 2008, the "Basel Accord III" and "Dodd-Frank Wall Street Reform and Consumer Protection Act" currently adopted by the U.S. central bank put forward higher requirements in terms of capital adequacy and leverage, which effectively improved the anti-risk capacity of large financial institutions. Secondly, since the subprime mortgage crisis, large financial institutions' disposal of non-performing assets and the rational adjustment of credit structure have significantly improved their risk resistance capacity. As of 2018, the overall non-performing asset ratio of the banking industry was 0.91%, which was at the low level before the subprime mortgage crisis. In addition, those financial institutions took the initiative to increase assets by expanding profit retention. Its core tier 1 capital adequacy ratio increased by 30% compared with 2008, which increased from 7.5% in 2008 to 9.7% in 2019, while the total capital adequacy ratio increased from 12.8% in 2008 to 14.6% in 2019.

On the other hand, the risk exposure of large financial institutions is decreasing. First, the asset structure of large financial institutions continued to be optimized after the subprime mortgage crisis in 2008. On the eve of the epidemic (the end of 2019), the asset-liability ratios of Morgan Stanley and Goldman Sachs were 90.76% and 90.74%, respectively, down 6.25% and 4.79% compared with the end of 2007. Second, the proportion of risk assets has also decreased significantly. Compared with the end of 2007, the investment proportion of J.P. Morgan Chase & Co and Goldman Sachs was 28% and 38%, respectively. At the end of 2019, which decreased by 9% and 38%, respectively. Therefore, after the subprime mortgage crisis in 2008, the structural risk of large financial institutions in the United States decreased and their anti-risk ability improved significantly. During the epidemic, investors' confidence in large financial institutions in dealing with the crisis will increase significantly compared with before the epidemic. Therefore, compared with small and medium-sized banks, the market will give lower risk compensation to large financial institutions, resulting in the coefficient of SMB factor increases.

4.3. *HML* coefficient

The results of the multiple linear regression analysis of the HML factor are very similar to the SMB factor. The coefficients of all sub-sectors have increased significantly. Banks, insurance, and brokers have remained significant before and during Covid-19, and their correlation coefficients have increased significantly with the outbreak of the epidemic. The coefficient of the real estate industry was redundant before the spring up of Covid-19, while it became an effective factor during the second period. The adjustment of market investors' risk appetite after the

outbreak can explain this financial phenomenon to a certain extent. Along with the expansionary economic policy around the world, some macroeconomic indicators are still deteriorating gradually, which will also cause investors to worry about the high valuation of growth companies. In the end, the adjusted risk preference will give higher B/M companies higher risk compensation. Meanwhile, compared to value companies, growth companies tend to have greater growth potential when market interest rates drop significantly, and the rate of earnings rise. During the COVID-19 period, the US government introduced a series of interest rate cuts and quantitative easing monetary policies, creating a more suitable financial market environment for value-based companies. On March 2, 2020, the Federal Reserve announced an emergency rate cut of 50 basis points, reducing the federal funds rate to 1%-1.25%. Immediately afterward, the Fed once again announced an emergency rate cut of 100 basis points on March 15, 2020, lowered its federal fund's rate range to 0~0.25%, and launched a US\$700 billion quantitative easing program. Therefore, when the government introduced a series of economic stimulus measures, growth companies have obtained higher sensitivity than value companies, resulting in a higher return rate.

4.4. RMW and CMA coefficient

According to the multiple linear regression analysis results, both the RMW and the CMA factors are redundant factors. After the epidemic period, the profitability RMW factor has almost completely lost its explanatory power for the financial industry. In contrast, the t-test results of the four industries all show that it is not statistically significant. The RMW factor only has a certain explanatory power in the first period with negative coefficients for banks and insurance. The research results point out that profitability may not be the main indicator of risk in the financial industry. In a specific time and market environment, the enhancement of profitability indicators will reduce the company's risk exposure due to a negative RMW factor.

The investment level CMA factor has always been at a relatively low level of explanatory power for the financial industry, representing that investors have a higher demand for yield. The unclear differentiation of the financial industry's investment level structure makes the market's sensitivity to this risk insignificant.

5. CONCLUSION

Through multiple linear regression analysis, this paper studies the influence of COVID-19 on the effectiveness of the Fama-French five-factor model in the financial industry and tries to find the underline reasons for the change of market-style in the financial

sector. This article believes that the epidemic outbreak has effectively improved the explanatory power of the FF-5 model for the U.S. stock market. Except for the redundant factors RMW and CMA, the coefficients of the other three factors had a massive boost in statistical significance. There is no doubt that the global spread of covid-19 has dealt a heavy blow to the U.S. financial industry, resulting in the sharp decline of the U.S. stock financial sector with a higher coefficient of the Rm-RF factor. In addition, the increased sensitivity of SMB and HML shows that the epidemic has made the market structure differentiation of the financial industry clearer.

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