

# The Impact of Fama-French Five Factor Model on Retail Industry During the Outbreak of COVID-19

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**Abstract:** COVID-19 has been shocking to the global economy. The majority of industries suffer from heavy loss. During this period, investors, who need to withstand this huge financial risk, desire to seek different capital asset pricing models to estimate the performance of various stock portfolios. To help them achieve this goal, this article adopts the Fama-French five-factor model to analyze the change of performance of the retail industry from September 2019 to August 2020. Through the regression towards selected data, coefficients of five factors can be calculated. The coefficient of total market portfolio return (MKT) is close to 1, which conveys that the performance of retail industry is similar to that of the whole US market. The coefficient of Small Minus Big Size (SMB) changes a little and is still larger than 0. Most small-size companies perform better than big-size ones. After the epidemic, Robust Minus Weak Operating Profitability (RMW) and Conservative Minus Aggressive investment (CMA) become redundant factors. This fact reflects that the profitability of companies and investment style weakly affect the return rate of investing in retail industry. However, High Minus Low B/M (HML) becomes a significant factor, and its coefficient keeps larger than 0. The book-to-market ratio becomes a valuable investment indicator, and investing in companies with high ratios is more profitable. Investors are recommended to invest in some retail companies with small size and high book-to-market ratios. Also, it is of great importance to focus on the retail companies that take active action in adopting advanced technology and joining in e-commerce.

## 1. Introduction

For investors, capital asset pricing is of great importance, because it can help them to make the right decisions towards investment. In order to predict the performance of different stock portfolios, the asset pricing model has been evolving constantly. At first, Markowitz proposed an asset portfolio theory, which utilized Mean-Variance analysis to determine the optimal portfolio [1]. Afterwards, CAPM was constructed, and its beta value was proved to be efficient to interpret the rate of stock returns [2-4]. Then based on the limitation of CAPM to some abnormal phenomenon, Fama and French presented Fama-French three-factor model to better predict excess returns of portfolios [5]. To further describe the expected return rate of stock portfolios, Fama and French put forward Fama-French five-factor model [6].

In different countries and economic environments, the measurements of Fama-French five-factor model will be different. Chiah et al. analyzed the performance of five-factor model in pricing Australian stocks and concluded that the five-factor model could explain more asset pricing anomalies than other models [7]. Foye evaluated the performance of Fama-French five-factor model in three emerging markets-- Eastern Europe, Latin America and Asia and discovered five-factor model was successful in Eastern Europe and Latin America, but lacked improvement in Asia compared with three-factor model [8]. Huang applied the five-factor model in the Chinese market and identified some pitfalls associated with the applications of this model to Chinese stocks [9]. Horváth and Wang examined the performance of Fama-French five-factor model in the US stock market during the period containing the outbreak of COVID-19 [10]. They concluded that the strike

caused by the pandemic had a significantly negative impact on the model's ability to explain the performance of the US stock market. Makridis and Hartley analyzed the impact of COVID-19 on US GDP growth and estimated that the GDP growth rate would decline 5 percent for each month [11]. McKibbin and Fernando investigated COVID-19's global economic impact and concluded that this disease could cause a range of possible economic costs both in the short term and long term [12]. Hao, Xiao and Chon reviewed the impact of COVID-19 on China's hotel industry and proposed some practical solutions towards the disease's influence based on the management framework [13]. However, there lacks an article to analyze one industry's change caused by COVID-19 through utilizing Fama-French five-factor model.

This article focuses on using Fama-French five-factor model to analyze the strike of COVID-19 towards the retail industry. Retail industry is highly dependent on customer flow, but this pandemic prevents people from going out. Some restrictions caused by COVID-19 towards citizens would lead to the huge fluctuations in this industry, which is investigated in this article.

## 2. Introduction of the model

### 2.1 Fama-French five-factor model

In 2015, Eugene F. Fama and Kenneth R. French constructed this five-factor model [6]. On the basis of three-factor model, this model adds profitability factor and investment style factor to better describe the expected return rate of stock portfolios in the cross-section. This five-factor model is presented below as:

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

In this formula,  $R_f$  means risk-free return rate;  $R_m$  means market return rate;  $R_i$  means return rate of asset  $i$ ;  $E(R_m) - R_f$  is market risk premium;  $SMB$  is the simulated portfolio return rate of size factor;  $HML$  is the simulated portfolio return rate of book-to-market factor.

$MKT - R_f$  means the rate of one market portfolio of randomly diversified risk subtracts the return of risk-free assets.  $SMB$  means the return of small-size companies subtracts the return of large-size companies. Companies with small asset sizes have higher risks, and thus their investors can enjoy a higher return, whereas companies with large asset sizes have lower risks, so their investors can only acquire lower returns. In this case, the calculating result of  $SMB$  should be positive, because small-size companies generally have higher revenues than large-size ones. In addition,  $\beta_{SMB} > 0$  indicates that the market value of this industry is relatively low, and this industry tends to consist of more small-size companies.  $HML$  represents the premium of one enterprise's development opportunities, and it can be calculated by subtracting the revenue of companies with low book-to-market from the revenue of companies with a high book-to-market ratio. Companies with high book-to-market are the ones that perform poorly in fundamental analysis, have weak financial situations. In that case, it is of both higher risks and higher returns for investors to invest in them. In contrast, stocks of companies with low book-to-market ratios are the growth stocks. They have sufficient space for development. Thus, it is of both lower risk and lower return for investors to invest in them. Based on the above analysis, the calculating results of  $HML$  should be positive. Additionally,  $\beta_{HML} > 0$  indicates that this industry tends to consist of companies with a high book-to-market ratio, which have limited space for development.

The factors mentioned above consist of Fama-French three-factor model. Based on this model, the two additional factors are  $RMW$  and  $CMA$ .  $RMW_t$  is the profitability factor, which is the difference between the high operating margin of one stock portfolio and the lower one. This factor reflects the premium, comparing high-profitability stock portfolios and low-profitability stock portfolios. In general, the industry with relatively high profitability possesses higher risks.  $CMA_t$  is an investment style factor, which is the difference between the conservative investment style of one stock portfolio and the radical one. This factor reflects the premium, comparing the pattern of high investment proportion with low investment proportion. In general, companies with low investment rates has higher risks. For these companies, investors have higher requirements towards return rates. In

contrast, companies with higher investment rates have lower risks.

## 2.2 Data selection and processing

The data selected in this article is from the database of Kenneth R. French's web. This database is constructed by French -- founder of the Fama-French model. He acquired the data according to relevant information presented on American stock market. Based on the market sizes of listed companies, they are divided into small-size stock and big-size stock, and each one takes up 50%. Then based on the year-end book-to-market ratios of listed companies, they are divided into H (high book-to-market ratio), M (medium book-to-market ratio), L (low book-to-market ratio), and each one takes up 33%. By intersecting these stocks, the combinations—SL, SM, SH, BL, BM, BH—can be acquired.

Table 1. Constitution of each factor

	H(33%)	M(33%)	L(33%)
S(50%,small size)	S/H	S/M	S/L
B(50%,big size)	B/H	B/M	B/L

$$SMB = \frac{SLt + SMt + SHt}{3} - \frac{BLt + BMt + BHt}{3} \quad (2)$$

$$HML = \frac{BHt + SHt}{2} - \frac{BLt + SLt}{2} \quad (3)$$

$$RMW = \frac{SRt + BRt}{2} - \frac{SWt + BWt}{2} \quad (4)$$

$$CMA = \frac{SCt + BCt}{2} - \frac{SAt + BAAt}{2} \quad (5)$$

As shown in Table 2 and Table 3, it is found that the coefficient of MKT-RF keeps lower than 1. It indicates that the retail industry remains insensitive to the market before and after the COVID-19. Also, the significance of HML factor increases, and its coefficient keeps lower than 1. It presents that investors are recommended to focus on companies with high book-to-market ratios before and after the epidemic situation. However, the coefficient of SMB changes from larger than 1 to lower than 1. This reflects the phenomenon that companies with large market sizes are more able to withstand the strike caused by COVID-19 and investors can make more profits through investing in those companies. It is obvious that both the significance and coefficient of RMW largely decreases, and especially the significance becomes lower than 2. It shows that after the pandemics, RMW loses significance and becomes a redundant factor in the retail industry's five-factor model, and the profitability of the whole retail industry declines. Also, the significance of CMA keeps non-significant and belongs to a redundant factor. The coefficient of CMA changes from larger than 0 to lower than 0, which indicates that investors are recommended to adopt an aggressive investment style to invest in the retail industry.

## 3. Result

The data of retail industry is extracted from September 2019 to August 2020. It is processed based on the above approach, and through multiple linear regression, the results of five factors are stated below.

Table 2. Retail industry's regression result of Fama-French five-factor. (From September 2019 to February 2020)

	Coefficients	Standard Error	t Stat
MKT-RF	0.863	0.072	11.995
SMB	1.029	0.132	7.794
HML	0.227	0.134	1.702
RMW	0.755	0.232	3.256
CMA	0.011	0.265	0.043

Table 3. Retail industry's regression result of Fama-French five-factor. (From March 2020 to August 2020)

	Coefficients	Standard Error	t Stat
MKT-RF	0.941	0.044	21.512
SMB	0.967	0.118	8.200
HML	0.260	0.099	2.618
RMW	0.114	0.204	0.558
CMA	-0.292	0.272	-1.075

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#### 4. Discussion

This article adopts Fama-French five-factor model to analyze the performance of retail industry before and after the COVID-19. To provide investors some references, it focuses on contrasting the difference of coefficients during two periods and proposing the reasons why those changes happened.

Coefficient of MKT tends to be close to 1. This indicates that the return rate of retail industry is more associated with the fluctuation of the whole US market, and the sensitivity of retail industry to the market increases. Retail industry is directly related to citizens' consumption. However, this epidemic largely impacted their daily activities and previous consumption style, which caused a decline in the whole consumption level. For example, in March 2020, Standard & Poor's 500 went down over 500. Meanwhile, the total sales of retail industry declined by 8.7%. These two figures reflected that the retail industry becomes more sensitive to the US market.

HML becomes significant, and its coefficient remains larger than 0. It means that it begins to distinguish the difference in return rates between retail companies with high book-to-market and low ratios, and investors can earn more profits by investing in retail companies with high ratios. Retail industry can be subdivided into numerous kinds of stores. Stores with high book-to-market ratios include department stores, general merchandise stores, automotive stores, etc.; others with low ratios involve gasoline service stores, nurseries, lawn & garden supply stores, bakeries, etc. Examples of department stores that largely outperformed during the outbreak of the epidemic are Walmart and Costco. The total revenues of Walmart's second term of 2020 increase by 5.6%, compared with the same period last year. This outperformance mainly arises from its early input into e-commerce and the application of artificial intelligence and machine learning to improve its operating efficiency and reduce the cost of managing storage. Also, Costco showed its strong resilience under the strike of COVID-19. Costco's revenues mainly rely on membership fees, and the sales of its merchandise take up only 29% of its total revenues. In that case, although in April its sales declined compared with the same month last year, the income of membership fees kept consistent during the first three terms of 2020. Depending on their unique advantages, these two department stores with high book-to-market ratios achieve the aim of preventing economic loss. However, bakeries like Maison Kayser have to shut down some of their stores due to the epidemic. Since March, due to a shutdown in the dining of

the government policy, Maison Kayser has closed down 16 stores in New York City and basically left New York's market. This action reflected that some bakeries were caught in trouble when developing their business in the US and retail companies with low book-to-market ratios had difficulty in earning profits during the outbreak of the epidemic.

Coefficient of RMW becomes insignificant. It reflects that the profitability of the whole retail industry declines a lot, which is caused by the strike of COVID-19, and RMW becomes a redundant factor. From March to August, sales of US retail industry decreased by around 19%. This huge fall caused most retail companies' stocks to go down, no matter how profitable they were. For example, before the outbreak of COVID-19, the stock price of Macy's Inc kept around \$15 yet decreased from \$12.99 to \$6.97 during the period of March to August.

Coefficient of CMA keeps insignificant before and after the epidemic. It indicates that CMA is a redundant factor, and investment style has little impact on the return rate of investing in the retail industry. The coefficient of SMB changes a little. Compared with big-size companies, small-size ones usually have a smaller number of inventories and varieties of merchandise in the retail industry. In that case, small size companies can suffer less economic loss and possess higher flexibility to deal with the epidemic. After the epidemic, SMB becomes smaller than 1. It proves that small-size companies still have the potential to grow and develop. Their performance is partly supported by Shopify, a Canadian company providing a platform for e-commerce. This company mainly cooperates with small-size retail companies in the US and provides online distribution channels for them. In that case, although the saleroom of those companies' physical stores decreased significantly in March due to the block, their online shops can help return 94% revenues. Also, the majority of reports presented that only 30% of sales came from e-commerce. This situation reminds that if small-size retail companies desire to survive in the epidemic, they must consider selling more kinds of merchandise. To deal with this obstacle, some e-commerce companies cooperating with small-size dealers published some mobile applications to strengthen the connection between dealers and customers. Thus, those small-size companies can possess development potential.

## 5. Conclusion

This article introduces the Fama-French five-factor model to analyze the change of performance of the retail industry from September 2019 to August 2020. Through comparing and analyzing the differences among coefficients of five factors, investors are recommended to invest in some retail companies with small size and high book-to-market ratios. Also, companies equipped with cutting-edge technology and e-commerce platform are worth being noticed.

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