Analysis of the Fama-French Model (FF5) Factor on the Food Industry under the COVID-19 Epidemic

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Abstract. Due to the impact of the COVID-19 epidemic, the global economy has been affected to some extent in all aspects, with the food industry bearing the brunt. However, the specific research on the stock market segmentation industry is relatively lacking. This article aims to analyze the food industry's current status and development prospects by discussing the Fama-French three-factor model and five-factor model before and after the epidemic in the food industry and put forward constructive opinions on this. The analysis will use the method of coefficient comparison and effectiveness comparison to analyze the food industry's coefficients before and after the epidemic in the same model and model differences and combine the background of the industry to get the reasons for these differences.

Keywords: COVID-19; Food Industry; Fama-French Model.

1. Introduction

1.1 Background

For predicting the performance of different stocks and investment portfolios, asset pricing models have undergone a certain evolution and continue to improve to help investors predict the potential returns of asset portfolios in the stock market better. At first, Markowitz proposed the Modern portfolio theory [1], which used the mean-variance analysis method to determine the optimal investment portfolio. The American scholar Sharpe cited the concept of market combination, assuming a linear relationship between asset returns and market combination [2]. Lintel and Mosin established the Capital Asset Pricing Model (CAPM) [3], the core idea of which is that the expected rate of return from split assets or securities portfolios has a linear relationship with systemic risk. After the 1980s, through continuous research and practice, studies have shown that it is not rigorous to simply use the β value of CAPM to explain income, and CAPM cannot explain some abnormal phenomena outside of system factors. Eugene F. Fama and Kenneth R. French proposed the Fama-French three-factor model in 1993 based on the reference arbitrage pricing model [4], which added the scale factor and book-to-market value ratio factor to more accurately predict the portfolio expectations Excess returns after this model was widely used. However, in recent years, relevant evidence has shown that the three-factor model cannot explain the changes in the average return of stocks related to profitability and investment style. Fama and French proposed a five-factor model based on the discussion framework of the dividend discount model, adding profitability and investment style Factor, which better describes the expected return rate of the stock portfolio on the cross-section and has been tested in the international market.

1.2 Related Research

In different countries and different market environments, the Fama French model's results also have certain changes, and comparative analysis needs to be carried out based on actual conditions and results. Mardy Chiah and others' research A Better Model? An Empirical Investigation of the Fama–French Five-factor Model in Australia investigates the performance of the five-factor model

in pricing Australian equities and finds that the five-factor model can explain more asset pricing anomalies than a range of competing asset pricing models, which supports the superiority of the five-factor model [5]. Qi Lin's research Noisy prices and the Fama–French five-factor asset pricing model in China analyzed the five-factor model's operation and the three-factor model in the Chinese stock market and find that the five-factor model consistently outperforms the three-factor model in the Chinese equity market [6]. Based on evidence from 18 countries, this paper finds that the Fama and French size (SMB) and book-to-market (HML) portfolios are correlated with future innovations in macroeconomic variables consistent with factor-mimicking portfolios of Merton ICAPM state variables [7]. However, the specific research on the stock market segmentation industry is relatively lacking.

1.3 Objective

This paper mainly focuses on analyzing how was the food industry affected by the COVID-19 pandemic. At the beginning of the pandemic, many people were storing a large amount of food to prevent food shortage since it is safer to stay inside and not contact others. As a result of this, the food industry's stock market will likely be influenced by the pandemic positively. Fama-French model will be adopted to identify the changes in the food industry before and after the pandemic.

2. Method

2.1 Fama-French Model

Sharp, Lintner, and Black's Capital Asset Pricing Model (CAPM) [3] stated that the return on a stock was only linearly related to the systemic risk of the entire stock market: Rit-rft = I (RMT-RFT). However, Banz [8] found that stock returns are also correlated with their market value. Then, in subsequent studies, a series of indicators, such as book-to-market ratio (BE/ME) and reciprocal price-earnings ratio (E/P), have been employed to explain stock price changes.

In 1993, Fama and French developed a three-factor model to explain the return on stocks. According to the model, the excess return of a portfolio (including individual stocks) attributes to three factors: the market portfolio (Rm−Rf), the market value factor (SMB), and the book-to-market ratio factor (HML). This multi-factor equilibrium pricing model can be expressed as:

$$E(R_i) - R_f = \beta_M (E(R_M) - R_F) + \beta_{SMB}SMB + \beta_{HML}HML \quad (1)$$

Where Rf represents the risk-free rate of return at time T, Rm represents the market return rate at time T, Ri represents the return on the asset I at time T, E(Rm) − Rf is market risk premium, SMB is the size premium (small minus big), and HML is the value premium (high minus low).

In 2015, Eugene F. Fama and Kenneth R. French proposed the five-factor model, adding profitability and investment style factors based on the three-factor model to better describe the stock portfolio's expected return rate cross section.

The five-factor model is as follows:

$$R_{it} - R_{Ft} = a_i + b_i (R_{Mt} - R_{Ft}) + s_iSMB_t + h_iHML_t + r_iRMW_t + c_iCMA_t + e_{it} \quad (2)$$

Where ri is the return on the security, Rft is the risk-free rate, Rmt is the market return, SMB is the return spread between small-capitalization stocks and large-capitalization stocks, HML is the return spread between high book-to-market companies and low book-to-market companies, RMW is the return spread between profitable and unprofitable companies, and CMA is the return spread between companies that invest conservatively versus companies that invest aggressively.

2.2 Results

Data that were used and analyzed in this article were taken from Kenneth R. French's web, founded by Professor Kenneth R. french. Data of Rm-Rf, SMB, HML, RMW, CMA was provided on this website and analyzed using the Fama-french models. The data adopts the food industry of 30 industry portfolios, and the method mentioned above is used to yield the coefficients. After multiple linear regression, the results of 5 factors are obtained.

Table 1. Food Industry FF5 Factor Regression Results-Before the Epidemic

Table Head	Table Column Head			
	Coefficients	***Standard error***	***t Stat***	***P-value***
MKT	0.61	0.04	15.21	0.01
SMB	0.24	0.07	3.32	0.01
HML	-0.14	0.07	-2.01	0.045
RMW	-0.01	0.11	-0.11	0.92
CMA	0.78	0.14	5.50	0.01

As shown in Table 1, it is obvious from the five-factor table that the RMW is not significant. There is no validity in the calculation of the profitability rate. The factor coefficient βMKT<1 indicates that the food industry was less sensitive than the market before the epidemic, and its variability was smaller than the market trend. βSMB is the result of subtracting large market capitalization companies from small market capitalization companies. It can be seen from the table that it is greater than 0, indicating that market investment tends to be small market capitalization companies. βHML <0, indicating that companies with a low book value in the food industry before the epidemic have better returns.

Table 2. Food Industry FF5 Factor Regression Results-After the Epidemic

Table Head	Table Column Head			
	Coefficients	***Standard error***	***t Stat***	***P-value***
MKT	0.71	0.02	26.03	0.01
SMB	0.36	0.07	4.84	0.01
HML	-0.01	0.06	-0.09	0.937
RMW	-0.34	0.12	-2.70	0.01
CMA	0.61	0.17	3.63	0.01

For the data analysis of the five-factor model after the epidemic, it can be seen that the profitability factor RMW and the investment style factor CMA are both significant. HML after the epidemic is not significant; the SMB coefficient has increased, indicating smaller companies' investment earnings have increased.

3. Discussion

This article analyzes the effectiveness of the Fama-french three-factor model and five-factor model before and after the epidemic in the food industry and evaluates which model can better predict the stock returns of the corresponding industry; the analysis will use the method of coefficient comparison and effectiveness comparison to analyze the coefficients of the food industry before and after the epidemic in the same model and model differences and combine the background of the industry to get the reasons for these differences. It provides investors with some feasible suggestions by enriching the effectiveness of different models in the stock market.

3.1 MKT Coefficient

This article indicates that the MKT of the food industry pre-COVID is around 0.6; however, it has increased to 0.7 after-COVID. To begin with, the food industry is a relatively stable market because food is relatively inelastic. Before the outbreak of the epidemic, it is safe to conclude that the food industry's stock market should have a relatively stable risk-free return rate compared to other industries such as automobiles, technologies, etc. Next, the food industry is made up a huge portion of the U.S economy itself. It contributed around $1.109 trillion to the GDP in 2019.

After the epidemic outbreak, many were frustrated and concerned about not having enough food stored in their household. To follow strict COVID-19 protocol, many tried to decrease the frequency of leaving the household to get groceries and avoid physical contact with others. This concern has led many to purchase food on a large scale causing many stores to face a shortage of food-related products. The epidemic affects the food industry and made it harder to predict the food industry's stock market. The dramatic increase in the food demand and low supply has caused a large scale of food shortage in the U.S market. All these reasons might lead to a lower risk-free rate compare to pre-COVID.

3.2 SMB Coefficient

After Covid-19, the SMB of the food industry increases, which demonstrates that the stock returns in the food industry market are more inclined to small businesses. To avoid crowd infection, the government set up compulsory policies of short turn closure of offline catering companies, bring enormous impulse and influence especially to many large retailers which possess a large number of supermarkets. Besides, outbreaks in processing and transshipment for fresh food of animal origin domestic and abroad also aroused consumers' concerns. They affected the supply chain of the relevant large companies in the food industry. Besides, the large business also experiences a labor force shortage when many labor-intensive food enterprises return to work and production. On the contrary, those small businesses which sell snacks and convenience food through the Internet and e-commerce platforms as the main sales channels face fewer challenges, and their products seized the market more quickly during the epidemic.

3.3 HML Coefficient

By observing the HML variables, it can be found that the HML coefficient before the epidemic is negative, and the HML coefficient after the epidemic is not significant, which is also a sharp contrast analysis group. First, the food industry had a low book-to-market value ratio before the epidemic, a relatively good development prospect, low investment risks, and high returns. The food industry has always occupied a pivotal position in the world economy. New retail industries such as hypermarket chains, convenience stores, and specialty retail stores dominated by low-market value companies have developed rapidly around the world. Especially in large and medium-sized cities, the sales of new retail businesses account for the total retail sales of consumer goods in the whole society. The proportion has increased rapidly.

After the epidemic, HML is not significant. Bloomberg said that the epidemic might have a major impact on global food transportation. Under this premise, the impacts suffered by large and small enterprises are consistent. According to the British "Guardian" report on April 27, Tyson Foods, one of the largest meat producers in the United States, warned that during the new crown epidemic, "the food supply chain is breaking." There are more than 10 million employees in the foodservice/catering industry in the United States. At present, many big cities have ordered restaurants to only provide take-out services, and workers' wages will reach billions of dollars, many of which are hourly workers.

3.4 RMW Coefficient

RMW factor indicates the industry's profitability, and it represents the difference between the high profitability firms and the low profitability firms. Before the epidemic, the food industry's profitability is relatively stable because food is a relatively inelastic product. The coefficient of the

RMW factor shown in the table is also consistent with the observation that the food industry has relatively stable profitability. It has a coefficient of -0.01.

The coefficient of the RMW factor after the outbreak of the epidemic has decreased to -0.3 from -0.01. This indicates that the profitability of the food industry has increased by a large amount [9]. In other words, the food industry has become much more profitable under the influence of COVID-19. This could result from the high demand for food during the pandemic. At the same time, high profitable firms will have more consumers than usual because they are the industry's main producers. Based on the data and current situation, investing in the food industry's stock market will be profitable.

3.5 CMA Coefficient

CMA factor denotes the return spread between companies that invest conservatively versus companies that invest aggressively. According to the graph, which shows the value of CMA has decreased significantly, it demonstrates that the food market prefers companies that employ aggressive investment strategies to those of conservative strategies.

After Covid-19, the coefficient of the CMA factor decreased from 0.78 to 0.61. As the epidemic forces companies to expand online selling and develops online applications, companies in the food market recognized the importance of investing in innovations. Confronting with the collapse of traditional business model, such as retailing, those companies that have already invested in intelligent manufacturing, unmanned distribution, and online shopping gained higher profit and larger market share with Internet support. Moreover, companies with aggressive investments recuperate more quickly and successfully from the impact of COVID-19 [10]. According to Professor Luo of the Agricultural University of China's food research center, under the unpredictability of the epidemic, the obvious distinctions between food companies are strengthened. Those rapidly expanding companies will have advantages in market stability as well as resumption.

4. Conclusion

This article analyzes the Fama-French three-factor model's effectiveness and the five-factor model before and after the food industry epidemic. It evaluates which model can better predict the stock returns of the corresponding industry. It provides investors with some feasible suggestions by enriching the effectiveness of different models in the stock market. The dramatic increase in the food demand and low supply has caused a large scale of food shortage in the U.S market. All these reasons might lead to a lower risk-free rate compare to pre-COVID. A small business that sells snacks and convenience food through Internet and e-commerce platforms as the main sales channels face fewer challenges. Their products seized the market more quickly during the epidemic. Meanwhile, the food market prefers companies that employ aggressive investment strategies to those conservative strategies. From the results, the smaller companies performed better during the Covid-19 epidemic, and investing in the stock market of the food industry will be profitable.

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