



Impact of COVID-19 and Vaccine on Agric, Soda, Smoke Industry Based on Fama-French Five-Factor Model

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Abstract. COVID-19 has tremendous impacts worldwide. The global economy was severely damaged. Based on the Fama-French five-factor model, this paper selects agricultural, soda, and smoke industries in U.S. stock market and analyzes the market changes after the outbreak of Covid-19 and after the successful experiment of the vaccine. Data from Kenneth R. French Data Library is used in the research. It is found that none of the three industries were outside the impact. After the Covid-19, firms with value stock in agricultural industry, soda-related firms in small size with strong profitability, and big-sized smoke companies with value stock are recommended to the investors.

Keywords: COVID-19, Vaccine, Fama-French five-factor model, Agricultural industry, Soda industry, Smoke industry

1 Introduction

Estimating the expected return of assets is vital to many financial decisions such as those relating to portfolio management, capital budgeting, and performance evaluation. Capital Asset Pricing Model (CAPM), proposed by Sharpe and Lintner [1-2], is one of the main models for this purpose and it is favored by many practitioners. However, many CAPM contradictions and criticisms have emerged over time. Chan, Hamao and Lakonishok find that BtM book-to-market equity is directly related to the expected returns [3]. Jegadeesh finds that stock returns are more likely to show short-term momentum and it is confirmed by a study by Jegadeesh and Titman [4-5]. Another contradiction is that the stocks of companies with low market capitalizations have higher average returns than high capitalization stocks, as found by Banz [6]. In view of the limitations of the CAPM, Fama and French introduced the Fama-French Three-Factor model [7]. Though some research demonstrates the better explanatory power of the Fama-French three-factor model than of the CAPM [8-9], with the development of the social economy, the model is being challenged. Therefore, Fama and French introduced a new model, with profitability and investment style factors added to the three-factor model, which aims to have better performance in assessing the profitability, and investment patterns than the three-factor model [10].

Many researchers have conducted the Fama-French model in different areas and industries. Hou and Chen conducted multiple regression analyses to investigate the factors that changed in the American steel industry before and after Covid-19 based on Fama-French five-factor model. The research found that the pandemic brought serious impacts on the industry, causing a significant drop in the industry, leading the stock less sensitive to the movement of the market and the RMW ineffective [11]. Duan and Li applied both the Fama-French three-factor model and the Fama-French five-factor model to the 30 industries in America before and during the Covid-19 to analyze the relative changes. It is found that the market becomes less complicated during the disease and the strength of the Fama-French model is positively affected by the epidemic conditions [12]. Osad and Gabriel examined the Fama-French three-factor model using Nigerian data from 2003 to 2012. The findings indicated the capability of the Fama-French three-factor model in explaining the variation of stock returns in the Nigerian stock market. The results also reveal the existence of the size and value premium effect of the Nigerian stock market [13].

Trimech et al. investigated the French stock market by combining the wavelet multi-resolution analysis and the Fama-French three-factor model. Research shows that the explanatory power of the Fama-French three-factor model is positively related to the wavelet scale. Another finding is that the time horizon is a crucial condition when considering the relationship between the portfolio returns and the risk factors [14]. Nartea et al. used Hong Kong stock market data over the period of 1982 to 2001 to assess the durative of the size and value premium and the explanatory power of the Fama-French three-factor model in the variation in stock returns. A relatively persistent negative size-return relationship was reported in the research. It also implies the higher explanatory power of the Fama-French model than the CAPM model but the Fama-French model is misspecified for the Hong Kong market [15]. Malin and Veeraraghavan investigated the three-factor model on England, France and German, the three main European markets with the data from 1992 to 2001. The results show a small firm effect in France and Germany but a big firm effect in the UK. Their results also demonstrate the inexistence of evidence of a value effect in the selected markets and rejected the view that seasonal effects can explain the multifactor model results [16].

Charitou and Constantinidis tested the Fama-French three-factor model of stock returns using Japanese data from 1991 to 2001. A clear relationship between the three factors and the expected stock returns is found in the Japanese market. The findings additionally show that the market factor is the primary factor when considering the variation of stock returns. The size factor was shown to be more effective than the BE/ME factor (HML) when examining the portfolios consisting of big stocks [17]. Drew and Veerarachavan test the Fama and French three-factor model in Hong Kong, South Korea, Malaysia and the Philippines. They find that the size and value effects can be identified in the four markets using a cross-section approach and the Fama-French model has stronger power than the single-index model in explaining the variation in returns [18]. The COVID-19 crisis caused dramatic damage worldwide. The macroeconomic consequences of this crisis include its unprecedented impact on the stock markets [19].

The purpose of this study is to discuss the impact of Covid-19 and of the vaccine on the agriculture, soda and smoke industries based on the Fama-French five-factor model, meantime analyzing the reasons and providing corresponding investment suggestions.

2 Method

CAPM is widely used to estimate assets' returns, but this model has flaws and many contradictions have appeared [1,2]. Fama and French find that besides the elements in CAPM, the firm size and book-to-market ratio play an important role in explaining the expected stock returns. Therefore, Fama and French added the size risk and value risk factors based on the CAPM and constructed the Fama-French three-factor model, as follows:

$$R_i - R_f = \beta_{11}(R_m - R_f) + \beta_{21}SMB + \beta_{31}HML \quad (1)$$

where R_i and R_f represent the risk-free return rate and market return, and their difference indicates the expected return of a portfolio. R_m is the market average return rate. The difference between R_m and R_f shows the market risk premium. SMB is the return rate of the scale factor of the portfolio, and HML measures the excess returns of small caps over big caps and of value stocks over growth stocks. The $\beta_{1,3}$ is the coefficient of the market risk, the size factor and the book-to-market ratio factor respectively.

However, some research indicates that there are certain phenomena that the three-factor model fails to explain. Therefore, Fama and French developed a new model, with profitability and investment style factors added to the three-factor model, which can be represented as:

$$R_i - R_f = \beta_{11}(R_m - R_f) + \beta_{21}SMB + \beta_{31}HML + \beta_{41}RMW + \beta_{51}CMA \quad (2)$$

Here RMW is the profitability factor, which shows the difference between the returns of companies with robust and weak operating margins. CMA is the investment factor, meaning the difference between the returns of firms that invest conservatively and firms that invest aggressively.

To study the impact of the global pandemic and of the advent of the vaccine on agriculture, soda and smoke the three industries, the daily data from From Kenneth R. French - Data Library of the periods of 2019.06.25-2020.03.11 (before the pandemic), 2020.03.12-2020.11.24 (during the outbreak of the pandemic and the advent of the vaccine) and 2020.11.25- 2021.08.13 (after the advent of the vaccine) are selected to perform multiple linear regressions to get the coefficients of the five factors.

3 Results

The results of each industry are represented in the following tables respectively.

Table 1. Coefficient of 5-factor model of Agric industry

Item	Coefficients			Standard Error			t Stat			P-value		
	before	during	after	before	during	after	before	during	after	before	during	after
Rm-Rf	1.13	0.83	0.93	0.10	0.07	0.12	10.89	12.17	7.96	0.00	0.00	0.00
SMB	0.29	0.23	0.28	0.24	0.17	0.15	1.18	1.34	1.90	0.24	0.18	0.06
HML	0.15	0.42	0.64	0.23	0.14	0.12	0.65	3.00	5.47	0.52	0.00	0.00
RMW	0.10	0.09	-0.11	0.42	0.30	0.20	0.25	0.30	-0.56	0.81	0.77	0.57
CMA	-0.13	-0.45	-0.61	0.51	0.38	0.23	-0.26	-1.20	-2.66	0.80	0.23	0.01

For the Agric industry, the coefficients of Rm-Rf decreased during the Covid-19 and rose after, but not as large as before the pandemic. The coefficient of HML started to be significant during Covid-19 and peaked after. The coefficient of CMA became significant after the epidemic and it was negative. The other coefficients were insignificant in all the periods.

Table 2. Coefficient of 5-factor model of Soda industry

Item	Coefficients			Standard Error			t Stat			P-value		
	before	during	after	before	during	after	before	during	after	before	during	after
Rm-Rf	0.76	0.79	0.69	0.05	0.04	0.07	14.80	19.02	10.18	0.00	0.00	0.00
SMB	-0.59	-0.11	-0.24	0.12	0.10	0.09	-4.89	-1.06	-2.76	0.00	0.29	0.01
HML	0.06	0.14	-0.01	0.11	0.09	0.07	0.56	1.60	-0.10	0.58	0.11	0.92
RMW	-0.46	0.17	0.41	0.21	0.18	0.12	-2.23	0.93	3.56	0.03	0.35	0.00
CMA	0.51	0.69	0.13	0.25	0.23	0.13	2.01	3.02	0.99	0.05	0.00	0.32

Clearly, the coefficients of Rm-Rf of the soda industry plateaued during the Covid-19 and dropped to a lower level than the first stage. The coefficient of SMB was significant before and after the epidemic and became larger. Similar to the coefficient of RMW, but with a greater increase, from negative to positive. The coefficient of CMA was only significant during the disease and was positive. Only the coefficient of HML was insignificant throughout the three periods.

Table 3. Coefficient of 5-factor model of Smoke industry

Item	Coefficients			Standard Error			t Stat			P-value		
	before	during	after	before	during	after	before	during	after	before	during	after
Rm-Rf	0.79	0.81	0.72	0.08	0.05	0.09	10.35	17.60	8.15	0.00	0.00	0.00
SMB	-0.22	-0.07	-0.18	0.18	0.12	0.11	-1.20	-0.58	-1.63	0.23	0.56	0.10
HML	-0.09	0.28	0.26	0.17	0.10	0.09	-0.52	2.96	2.87	0.61	0.00	0.00
RMW	-0.41	-0.40	0.16	0.31	0.20	0.15	-1.33	-2.00	1.05	0.19	0.05	0.30
CMA	0.98	0.99	0.07	0.38	0.26	0.17	2.57	3.87	0.38	0.01	0.00	0.70

Same to the other two industries, the coefficients of Rm-Rf of the smoke industry had a little increase during the Covid-19 and fell to be lower than before the epidemic. The coefficient of HML became significant since the appearance of the Covid-19 and had a little drop after. The coefficient of RMW was significant only during the pandemic, which was negative. The coefficient of CMA was significant until the “after” period, and had a small increase during the epidemic. The coefficient of SMB was the only one that was insignificant in all the periods.

4 Discussion

4.1 Agriculture

The results show that the agricultural industry was deeply influenced by Covid-19. Before the pandemic, the market risk premium was the only factor affecting the agricultural industry. The coefficient of Rm-Rf of the agricultural industry was greater than one, indicating that this industry was sensitive to the market. This is expected as quite a number of industries rely on agriculture, such as food, forestry and fishing. The contribution to the American GDP of the agricultural and its related industries showed an increasing trend from 2010 but had a sharp decrease in 2020. It is reasonable to ascribe that it was the appearance of Covid-19 that changed the situation. In the “during” period, the coefficient of Rm-Rf dropped to lower than one, showing the industry became less sensitive. This might be explained by people’s rigid demand for food. And the coefficient of HML started being significant, meaning that the value effect began to affect the industry. After the advent of the Covid-19 vaccine, the investment style became a new factor affecting the industry. The negative CMA coefficient reveals people’s optimism and positive attitudes towards the agricultural industry.

4.2 Soda

The soda industry was not very sensitive to the market, as demonstrated by the small coefficient of Rm-Rf, which is smaller than one and only had small fluctuations in the three periods. The size effect affected the soda industry before and after the pandemic, the negative coefficients suggest that the big companies tend to perform better than the small companies in this industry. This result aligns with a study by Breneiser and Allen, who conclude that people tend to rate the national brand as their first choice [20]. The decrease in the magnitude may be explained by people’s attempts at soda from small companies, as they did not have many choices during the pandemic period. The profitability factor was significant before and after the pandemic. The negative coefficient before the Covid-19 shows businesses that have small profits performed better and the situation reversed after. The coefficient of CMA during the Covid-19 suggests that people were very conservative during that period. The result is supported by a study by Ortmann, Pelster and Wengerek [21].

4.3 Smoke

Similar to the soda industry, the smoke industry was not very sensitive to the market and the Covid-19 and the vaccine did not change that fact. Considering the HML factor, which started to affect the industry in the latter two periods and its coefficients have no big difference. Its positive coefficients show that the market and the public have low expectations of businesses with growth stock. The investment style factor was significant until the introduction of the vaccine. The coefficients of the factor in the two periods were positive and very close to one, which reveals people's conservative attitude in this field.

5 Conclusion

COVID-19 was obviously a black swan event to the global market. This paper selects the three industries in the U.S, including agricultural, soda and smoke. It also evaluates the impact of the global pandemic and of the advent of the vaccine on them based on the Fama-French five-factor model. The results indicate that the two events have changed the factors affecting each industry to various extents. Another finding is that the three industries became less sensitive to the market compared to how they behaved before the Covid-19. Considering the factors and their related coefficients after the Covid-19, businesses with value stock in the agricultural field are recommended for the investors. The listed Soda-related companies with big size and high operating margins are worthwhile investing in. As for the smoke industry, investors should avoid big-sized companies with growth stocks. With the fast development of the e-cigarettes industry, big-sized traditional smoke companies are likely to be hit hard.

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