An Empirical Analysis on the China's Medical Industry under Covid-19 Based on Fama-French model

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Abstract. The global financial markets have been seriously affected by the Covid-19 pandemic, causing widespread and deep-reaching effects since the latter part of 2019. The medical industry, being one of the fundamental sectors, has not been spared from its effects. This empirical study focuses on Chinese A-share medical industry companies as a sample and the Fama-French three-factor and five-factor models were evaluated to determine their effectiveness pre- and post-pandemic, aiming to investigate how the epidemic has impacted the stock prices of China's medical industry. The results indicate that the epidemic has significantly affected the Chinese A-share medical industry, and the Fama-French model's capability of explaining market returns has diminished following the outbreak of the epidemic. These findings provide guidance for investors and policymakers to make informed decisions regarding investments and policies related to the medical industry, as well as insights into examining the effectiveness of China's medical industry stock price. These results also provide ideas and methods for related research in other fields.

1 Introduction

Since the beginning of 2020, global financial markets have been severely affected by Covid-19, and the performance of the pharmaceutical sector is of particular interest in light of this major public health event. Most of the major themes of the Chinese a-share industry continue to fall in share prices, but the pharmaceutical industry is still on the rise, which shows that the new coronavirus outbreak has an objective positive impact on the pharmaceutical industry, so the study of its share price changes will have reference significance.

In terms of addressing the impact of the Covid-19 epidemic on the financial market, Zhang et al. found that the capital market was greatly impacted by the Covid-19 over the short run, and the degree of impact varied very much among different industries, with the stronger impact effect being felt by industries that were more affected by the epidemic [1]. Yang found that the atypical pneumonia event and COVID-19 pandemic significantly affected the stock prices of the biopharmaceutical industry in the Chinese A-share market, resulting in the sample stocks generating significant positive excess returns during the window period [2]. According to Xu and Pu's research, the outbreak of the Covid-19 pandemic had a significant adverse effect on the equity market, resulting in a W-shaped trend. The main board market was hit the hardest, and all industries experienced negative effects except for the pharmaceutical industry [3]. As for asset valuation models, Zhang conducted an empirical study on the SSE 50 constituents with CAPM and Fama-French models and found that both CAPM and Fama-French models could explain the expected returns of individual stocks of the SSE 50 constituents and could also be used in the context of extreme stress tests and Covid-19 and the FF3F model could also be used in the context of extreme stress tests and Covid-19. French's three-factor model fits better than the CAPM model [4]. In addition, Li and Zhang discovered that while the three-factor model resolves several anomalies present in the CAPM model, it introduces new anomalies such as the accrued surplus anomaly [5]. Recent studies have suggested that the three-factor model may not adequately account for the fluctuations in average stock returns that are linked to factors such as earnings and investment style. For example, Aharoni et al. discovered that there is an inverse correlation between the projected yield on equities and the amount of capital that companies invest [6].

Fama and French introduced a five-factor model that incorporated the dividend discount model and included an earnings factor and an investment style factor to enhance the accuracy of predicting the anticipated yield of a collection of stocks across different market segments. This model has been widely referenced in academic and industry circles [7]. Carhart incorporated the momentum factor, MOM, into the Fama-French three-factor model, resulting in the creation of the CH4 model [8]. Li et al. conducted a study which found that the five-factor model was more effective in explaining the performance of Chinese A-share listed companies from 1994 to 2015 compared to the CAPM, three-factor, and Carhart four-factor models [9]. Xu and Xiong discovered that the Carhart four-factor model demonstrated greater explanatory ability in explaining stock returns in the Chinese stock market when

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compared to the three-factor model [10]. However, they did not conduct a comparison with the five-factor model.

An empirical analysis will be carried out in this paper to examine the stock prices of the Chinese pharmaceutical sector using the FF3F and five-factor models. The medical sector plays a crucial role in safeguarding the well-being and vitality of the entire population. Its significance in society cannot be overstated, as it directly impacts the health and longevity of all individuals. Given that medical services are accessible to all members of society, regardless of their background or status, every person's life and health are equally important. The medical sector experienced a downward trend throughout 2018 and 2019 due to a series of unexpected and unpredictable events, until the emergence of the Covid-19 pandemic in early 2020. In addition, as China's population continues to age, the need for medical services will only grow, making the medical market a promising area for investment. Analysing the trends in share price fluctuations can provide valuable insights for managing potential health-related risks.

2 Data & Method

2.1 Data processing

The research object selected for this paper is the stocks of listed companies in the Chinese medicine industry in Shanghai and Shenzhen A-shares. The time frame of this paper is daily data from January 1, 2018 to December 31, 2022, and all data are sourced from the Guotaian database (CSMAR database), and the following points were made to the data prior to modeling:

- Samples from the ST, *ST, and PT classes were eliminated due to significant irregularities in their financial data and the possibility of being delisted.
- The sample of stocks with sample size greater than 120 was retained (too small a sample of stocks would affect the credibility of the model regression and was therefore excluded).
- Excluding samples with missing values.

2.2 Variable selection and model design

The Fama-French model, as proposed by Fama and French [11], serves as the basis for the model presented in this paper. The FF3F model and the FF5F model are both derived from this general model, and their respective expressions are provided as:

$$R_{it} - R_{ft} = \alpha_i + \left(R_{mt} - R_{ft}\right) + s_i SMB_{it} + h_i HML_{it} + \varepsilon_{it} \quad (1)$$

$$R_{it} - R_{ft} = \alpha_i + \left(R_{mt} - R_{ft}\right) + s_i SMB_{it} + h_i HML_{it} + r_i RMW_{it} + \mu_i CMA_{it} + \varepsilon_{it} \quad (2)$$

Here, i denotes different is stock samples and t denotes different time. R_{it} denotes the return of individual asset portfolio, and this paper selects the individual stock return of GEM as the proxy variable. R_{ft} denotes the riskless rate of return, and this paper will use the one-year time deposit rate as the measurement due to its relevance in previous studies and availability of data. R_{mt} denotes the market return, to construct the market factor, this study uses the return of the A-share market as a proxy variable and calculates the excess return over the risk-free rate. In addition, the detailed description for variables are represented in Table 1.

Table 1. Selection of variables.

Variable Type	Variable Name	Variable Symbols	Variable Description
Dependent variable	Excess return	Rif	The difference between individual stock returns and risk-free returns
Independent variable	Market Factor	MKT	The difference between the market return and the risk-free rate of return
	Size factor	SMB	The difference between the average return of stocks in the small-cap group and stocks in the large-cap group
	Valuation Factor	HML	The difference between the average return of stocks in the high book-to-market ratio group and the low book-to-market ratio group
	Profit Factor	RMW	The difference between the average return of stocks in the high-earnings group and the low-earnings group
	Investment Factor	CMA	The difference between the average return of stocks in the low growth group and the high growth group

Table 2. Descriptive statistics.

Variable Name	Average value	Standard deviation	Minimum value	Median	Maximum value	Number of samples
Rif	0.001	0.043	-0.718	0	5.916	293571
MKT	0	0.012	-0.079	0	0.055	293571
SMB	0	0.008	-0.035	0.001	0.027	293571
HML	0	0.007	-0.024	-0.001	0.024	293571
RMW	0	0.005	-0.021	0	0.022	293571

2.3 Descriptive statistics

Table 2 provides a comprehensive overview of the variables, including mean value, standard deviation, minimum, median, maximum and sample size. The sample size of this study is 293571, and the small standard deviation of each variable suggests that the findings are not influenced by outliers. The explanatory variable Rif has a mean value of 0.001, with a minimum of -0.718 and a maximum of 5.916, reflecting significant variation in the excess return of each sample. Overall, the descriptive statistics in Table 2 offer valuable insights into the characteristics of the data and inform the conclusions drawn in this paper.

3 Results & Discussion

3.1 Correlation analysis & multicollinearity test

This paper further analyzes the variables by correlation test, and Table 3 gives the coefficients indicating the degree of correlation between the variables. From the table, it can be found that the correlation coefficients between the dependent and independent variables have positive and negative relationships, but all of them are significant at 1% significance level. Secondly, the correlation coefficients between the factors are mostly small, but there are some individually large ones. For example, the absolute value of the correlation coefficient between SMB and RMW reached 0.687, so it is not possible to determine whether there is a problem of multicollinearity between the factors initially.

Table 4 displays the variance inflation factors that were calculated to determine if there is multicollinearity among the selected variables in this study. As the correlation coefficient analysis may not provide an accurate assessment of multicollinearity, the variance inflation factor (VIF) was utilized to make a final determination. The average VIF for the variables is 2.57, which is below the critical value of 10. Thus, based on the variance inflation factor calculations, it can be concluded that there is no problem of multicollinearity present among the variables.

Table 3. Factor correlation coefficients.

	Rif	MKT	SMB	HML	RMW	CMA
Rif	1					
MKT	0.269***	1				
SMB	0.153***	0.093***	1			
HML	-0.181***	-0.408***	-0.191***	1		
RMW	-0.054***	0.002	-0.687***	-0.161***	1	
CMA	-0.064***	-0.273***	0.385***	0.610***	-0.667***	1

Note: *, **, *** denote 10%, 5% and 1% significance levels, respectively.

Table 4. Variance inflation factors.

Variable Name	Variance inflation factor	1/Variance inflation factor
CMA	3.62	0.276404
RMW	3.04	0.329448
HML	2.56	0.391068
SMB	2.43	0.410974
MKT	1.22	0.816347
Mean variance inflation factor	2.57	

3.2 Fama model regression

Table 5 presents the regression outcomes for both the FF3F model and the FF5F model. The number of samples is denoted by N, and the goodness of fit is represented by R2. The first column displays the regression outcomes for the FF3F model, while the second column shows the regression outcomes for the FF5F model. Since the value of adj. R2 in equation (2) is higher than that in equation (1), it can be found from the regression results that the five-factor model has slightly higher explanatory strength and better explanation for the excess returns of listed companies in the pharmaceutical industry in Shanghai and Shenzhen A-shares.

3.3 Fama model regression before and after the epidemic

As given in Table 6, presenting the regression outcomes of the FF3F model and the FF5F model before and after the Covid-19 pandemic. The sample size is denoted by N, the goodness of fit is represented by R2, and the significance levels of *, **, and *** correspond to 10%, 5%, and 1%, respectively. The Fama model regression results in columns 1 and 2 were obtained prior to the onset of the Covid-19 pandemic, while columns 3 and 4 display the regression outcomes of the Fama model after the pandemic. The obtained regression results reveal that the Fama model before the Covid-19 epidemic has higher explanatory strength and better explanation for the excess returns of listed companies in the pharmaceutical industry in Shanghai and Shenzhen A-

shares, and the explanatory power of the five-factor model has been found to be marginally stronger than that of the three-factor model both before and after the onset of the Covid-19 pandemic. It indicates that the new coronary epidemic negatively affects the overall explanatory power of the model, i.e., the epidemic weakens the applicability of the Fama model to explain the excess returns of the pharmaceutical industry in China's Shanghai and Shenzhen A-share markets.

Table 5. Fama model regression results.

	(1) Rif	(2) Rif
MKT	0.816***	0.825***
	(120.189)	(120.231)
SMB	0.648***	0.800***
	(66.329)	(53.539)
HML	-0.378***	-0.308***
	(-32.794)	(-18.540)
RMW		0.312***
		(12.481)
CMA		0.008
		(0.271)
_cons	0.0001***	0.0001***
	(5.155)	(4.400)
N	293571	293571
R^2	0.092	0.093
adj. R^2	0.092	0.093
F	9909.568	5990.106
p	0.000	0.000

Table 6. Setting Word's margins.

	Before Covid-19		After Covid-19	
	Rif	Rif	Rif	Rif
MKT	0.923***	0.939***	0.740***	0.747***
	(120.753)	(120.882)	(75.550)	(76.017)
SMB	0.512***	1.008***	0.653***	0.733***
	(35.070)	(37.838)	(50.373)	(39.449)
HML	-0.578***	-0.415***	-0.365***	-0.351***
	(-29.605)	(-15.770)	(-24.922)	(-16.315)
RMW		0.691***		0.333***
		(20.430)		(8.775)
CMA		-0.029		0.169***
		(-0.824)		(3.919)
_cons	0.0001*	0.0001	0.001***	0.0001***
	(1.747)	(0.317)	(4.759)	(4.509)
N	103190	103190	190381	190381
R^2	0.223	0.227	0.061	0.062
adj. R^2	0.223	0.227	0.061	0.062
F	9873.154	6052.479	4137.898	2499.803
p	0.000	0.000	0.000	0.000

4 Conclusion

In summary, as an important part of people's livelihood, the stable development of the medical industry market is the basic guarantee of people's life. This study presents a regression and analysis of the performance of the Chinese medical industry before and after the epidemic using the FF3F and five-factor models. In addition, the goodness-of-fit of the three- and five-factor models are compared for different periods. The results indicate that the explanatory power of the Fama-French model for China's medical industry has significantly decreased after the outbreak of the pandemic, and the pandemic has had a significant impact on China's A-share traditional Chinese medicine industry. Although the current five-factor model has a certain degree of explanatory power, considering that the Fama model is still under continuous updating and development, there may be factors that have not been taken into account that have not been put into the model, so there may be a possibility to improve the explanatory power. In the future, there is a need to continue monitoring the performance of the Chinese medical industry and consider incorporating new factors into the Fama-French model to improve its explanatory power. The results of this analysis can serve as a guideline for investors and policymakers to make informed decisions regarding investments and policies related to the medical industry. It is essential to recognize the impact of external factors such as epidemics on the performance of the medical industry and take appropriate measures to mitigate their effects. Overall, these results offer a guideline for a more comprehensive and robust approach to analyzing the performance of the Chinese medical industry.

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