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Comparison of China Three-factor Model and Fama-French Three-factor: An Empirical Analysis

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Abstract: Fama-French factors model (FF-3) is a famous model derivate from CAPM to explain the stock return. However, in China, in consideration of A-shares, a more suitable model for Chinese market is in need, thus a China three-factor model (CH-3) was constructed. There was no doubt that China three-factor model dominated Fama-French three-factor model from 2000 to 2017. Nevertheless, in recent year, due to the COVID-19 and the change of world situation, China Stock Market had also changed. In this paper, we tried to use our knowledge and extended the data to 2021 to test the effectiveness of each model. According to the analysis, the effectiveness of Fama-French factors model is almost equivalent to China three-factor model in recent year based on the data validation, while China model can still dominate Fama-French model if one includes the data since 2000. Overall, these results shed light on guiding further exploration of model selection for assets evaluations.

Keywords: CH-3, FF-3, factors model, effectiveness

1. Introduction

Stock valuation is a complex process as there are various factors which can impact the stocks. There are no uniform standards to define the way to value stocks. Many methods can be used for stock valuation. Using factors like the expected return of investors, corporate profitability or corporate asset value is a commonly way to value stocks. On the basis of asset portfolio theory and capital market theory, William Sharpe, Jack Treynor, John Lintner, Jan Mossin, et al. created the capital asset pricing model (CAPM), a fundamental theory in contemporary finance, in 1964. However, it has many restrictions. There are many academic studies have proved that β alone cannot explain stock return. When Eugene Fama and Kenneth French investigated the variables that affect the variance of stock returns in the US stock market, they discovered that the CAPM could be used to build a three factors model to explain the stock return rate. Fama and French discover that the beta of the CAPM has little explanatory power, even when applied as a single component. The CAPM is wanted, dead or alive. Fama and French used both the CAPM and the Fama- French 3-factor (FF3) model to find that the two models both cannot forecast precisely. In the recent years, there are lots of evidence shows that the Fama-French model perform poor power to explain many capital markets abnormity [1].

Hundreds of other factors have been given in the literature. 'Factor zoo' has been proved by many recent studies where a lot of new factors and models has been given [2]. Except the best-known

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model--Fama French 3-factor model which includes the market, size and value factors, Carhart proposed a momentum factor and argued that FF3 with momentum factor better predicts the cross-sectional average return. Lu proposed the q-factor model consisting of the market, size, investment, and return on equity factor. The model with these new factors has better performance than the Carhart four-factor model in portfolios formed on earnings surprise, idiosyncratic volatility, net stock issues and so on [3]. Whereas Omar et al take Morocco for example and find that the C4F Model did not exhibit a better explanatory than FF3 Model. Both models cannot be fully relied on in order to predict cross-sections of return [4].

After the proposal of q-factor model, Fama and French added two new factors, i.e., profitability factor and investment factor, which are similar to q-factor model, so the 3-factor model extends to a 5-factor model. The 5-factor model fails to catch the small stocks' low average returns. With the addition of profitability and investment factors, it is redundant for the value factor of the FF 3-factor model to describe average returns in the sample [5]. An alternate three-factor model is put out by Chen, Robert, and Lu. It contains the market excess return (MKT), the difference between the returns of high and low investment portfolios, and the difference between the returns of low and high return-on-equity portfolios [6]. The new three-factor model can be used to lower the amount of the abnormal returns of a wide range of anomalies-based trading techniques.

The Chinese stock market has become one of the most important equity markets in the Asia-Pacific region, even in the world. As an emergent market developed in the economy's transition process, the Chinese stock market exhibits unique characteristics, e.g., frequent political intervention, severe information asymmetry and the investor structure, predominated by retail investors [7]. First, the equity structure reform was established in April 2005 in China to legally convert non-tradable shares into marketable shares. Second, China has two major boards for companies to list, the Shanghai Stock Exchange and the Shenzhen Stock Exchange. Third, many publicly traded Chinese companies have issues several category shares [8]. Moreover, China largely prohibits foreign investors participating in its domestic stock market and domestic investors participating in foreign markets [9]. Since China has its own special economic and financial system, the Fama French three factors model cannot be simply used in Chinese stock market. Many studies devoted to finding the optimal factors to adapt the Chinese unique environment.

Zhang finds that the particular characteristics of China have some obvious effect on the three factors and also on the explanatory power of the three-factor model [10]. Liao and Shen inspect the reaction of the share price after the Chinese listed companies had completed the reform of the split share structure which launched in April 2005 [11]. Liu and Yang discuss the explanatory strength of the Fama-French three-factor model for China bond yields. They estimate that the two factors, SMB and HML, do not make a significant contribution to explaining the returns of Chinese bonds [12]. Liu, Robert, and Yuan establish a new three factors model applicable to China, CH-3, including the market factor, size factor and value factor including the above Chinese special elements. To build the alternative model, they simply reproduce the Fama and French research procedure, and then they find that CH-3 is completely superior to FF-3 [13].

However, there are several papers which discuss the comparison between the Fama French three factors model (FF-3) and the China three factors model (CH-3) using the recent data. We use the data from 2017 to 2021 to make comparison between the FF-3 and the CH-3 and provide the empirical evident whether the CH-3 is still effective in recent years or not. The remainder of the paper proceeds as follows. The second part discusses the data sources and how to construct the samples. The third part describes the model and the factors. The fourth part shows the result that we run regression on the two models for each other's factors. The fifth part we make a conclusion about what we have found.

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2. Data & Method

2.1. Data

The data source used were from the JingGuan Forum. The data collected were from 2000 to 2021. Risk free interest rate adopts one-year fixed deposit interest rate. The circulation market value was taken as market value index. The market return rate was calculated by weighted average method of circulating market value. All A-shares, including Shanghai Shenzhen Main Board, SME Board and GEM were chosen. According to size and value in China, shell value will pollute the listed companies with the smallest 30% of the market value in China's stock, thus those smallest 30% of the market value will be excluded. Furthermore, stocks that listed less than six months as well as ST, *ST and PT stocks were eliminated.

2.2. Model

The two models we plan to make comparison are FF-3 and CH-3. FF-3 is an improvement of CAPM, which was made on the premise that the price of stocks is related to a series of risk factors. These risk factors were constructed into three factors in FF-3 model. The excess return of the return rate of the portfolio weighted by the market value of the stocks in the stock pool relative to the one-year deposit interest rate was used as the market factor (MKT). The size and value factors were calculated by the following step: Firstly, the stocks were grouped into two groups by size whose grouping point is median. The top 50% were big size groups (B), the bottom 50% were small size groups (S). Secondly, the book-to-market (BM) ratios were grouped into three groups whose grouping points are individually the 30th and 70th percentiles. The top 30% were high BM ratio groups (H), the middle 40% were medium BM ratio groups (M), the bottom 30% were low BM ratio groups (L). Finally, the size factor and value factor were calculated by the following formulas:

$$FFSMB = \frac{\left(\frac{S}{L} + \frac{S}{M} + \frac{S}{H}\right)}{3} - \frac{\left(\frac{B}{L} + \frac{B}{M} + \frac{S}{H}\right)}{3} \tag{1}$$

$$FFHML = \frac{\left(\frac{S}{H} + \frac{B}{H}\right)}{2} - \frac{\left(\frac{S}{L} + \frac{B}{L}\right)}{2} \tag{2}$$

Then these factors were used to constructed the regression equation as given:

$$R_{it} - R_{ft} = \alpha + \beta_{MKT} MKT_t + \beta_{SMB} FFSMB_t + \beta_{HML} FFHML_t + \epsilon_t \tag{3}$$

China three-factor model was constructed based on FF-3 model that is suitable for A-shares. CH-3 model used the same market factor as FF-3. For the other two factors CH-3 model calculated by the following step. Firstly, stocks were grouped into two groups by size in the same way as FF-3 model. Then the Earning-to-Price ratios were grouped into three groups whose grouping points are individually the 30th and 70th percentiles. The top 30% were value groups (V), the middle 40% were middle groups (M), the bottom 30% were growth groups (G). Finally, the value and size factors were constructed by the following formulas:

$$SMB = \frac{\left(\frac{S}{V} + \frac{S}{M} + \frac{S}{G}\right)}{3} - \frac{\left(\frac{B}{V} + \frac{B}{M} + \frac{S}{G}\right)}{3} \tag{4}$$

$$VMG = \frac{\left(\frac{S}{V} + \frac{B}{V}\right)}{2} - \frac{\left(\frac{S}{G} + \frac{B}{G}\right)}{2} \tag{5}$$

The three factors were used to constructed the regression equation as given:

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$$R_{it} - R_{ft} = \alpha + \beta_{MKT} MKT_t + \beta_{SMB} SMB_t + \beta_{VMG} VMG_t + \epsilon_t \quad (6)$$

Here, R_{it} and R_{ft} represent the same as FF-3 model. Without loss of generality, we use yields of ten-year treasury bonds as R_f.

Table 1: Factors' correlations of FF-3 model.

		FFSMB	FFHML	MKT
FFSMB	Correlation	1	-.327*	0.137
	Significance		0.011	0.297
FFHML	Correlation	-.327*	1	-0.239
	Significance	0.011		0.066
MKT	Correlation	0.137	-0.239	1
	Significance	0.297	0.066	

Table 2: Factors' correlations of CH-3 model.

		MKT	SMB	VMG
MKT	Correlation	1	0.048	-.290*
	Significance		0.717	0.024
SMB	Correlation	0.048	1	-0.244
	Significance	0.717		0.060
VMG	Correlation	-.290*	-0.244	1
	Significance	0.024	0.060	

3. Results

We respectively made the Pearson correlation analysis to FF-3 model and CH-3 model as shown in Table. 1 and Table. 2. FFSMB has negative moderate significant correlation with FFHML but was not significantly correlated to MKT. FFHML either was not significantly correlated to MKT. SMB has no significant correlations with neither MKT or VMG, while MKT has negative weak significant correlation with VMG. We run the regressions about the explanation power of the two models for each other's factors and found that they both had a similar explanation power, which is given in Table 3.

Table 3: Explanation Regression (2017-2021).

			independent variable			
Dependent Variable	α	MKT	FFSMB	FFHML	SMB	VMG
FFSMB	-0.09	0.00			0.92	-0.30
(t stat)	-2.03	-0.07			61.46	-22.83
FFHML	-0.50	-0.01			0.13	0.84
(t stat)	-1.73	-0.08			1.29	9.48
SMB	0.20	-0.03	0.96	0.19		
(t stat)	2.01	-1.07	28.98	6.45		
VMG	0.37	-0.07	-0.34	0.65		
(t stat)	1.47	-1.21	-4.21	8.88		

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Table 4: GRS test from 2017 to 2021.

GRS F-statistics(p-value)	CH-3	FF-3
FFSMB, FFHML	2.6740702	
	0.0779322	
SMB, VMG		2.1792592
		0.12279764

We further used GRS test to analysis two models and surprised to found the result in Table. 4. After considering each other's two factors, both CH-3 and FF-3 could not deny the assumption that the pricing error is zero, after considering SMB and VMG, FFSMB and FFHML had a slight advantage compared to that SMB and VMG. This was not our expected result. Hence, we decided to extend our data to 2000 to 2021 and make the GRS test to the models again.

Table 5: GRS test from 2000 to 2021.

GRS F-statistics(p-value)	CH-3	FF-3
FFSMB, FFHML	0.1718925	
	0.8421657	
SMB, VMG		6.7711097
		0.0013603

As shown in Table 5, the result was similar with previous studies, where the p-value equaled to 0.0013. It means that even after considering the two factors of FF-3, SMB and VMG can still obtain the significant non-zero pricing error, in the other side, FFSMB and FFHML still could not deny the original assumption. The two different results obtained from two different time periods were quite nonintuitive. Our assumptions are as follows. The novel coronavirus since 2019 (COVID-19) has severely affected all markets in China. Due to the epidemic policy, China's economy once fell into a downturn, the spread of the epidemic has impacted the confidence of A-share investors, the trend of A-share is worrying, and the market is teetering. Owing to the impaction of COVID-19, A-shares may not perform the way it supposed, and there may be some factors CH-3 model did not take into account the explanatory power. The influence did not affect the data before 2019, thus the GRS test was still as expected after include data from 2000 to 2021.

There is also a possibility that, Liu et al. published their CH-3 model in 2018, CH-3 can dominate FF-3 with the data from early Chinese stock market since 2000, but in recent years, China's stock market has changed so much that CH-3 has gradually lost its effectiveness. The basis is that the GRS test was only taking the data since 2000. Without loss of generality, the regression of FF-3 and CH-3 both used data from 2000 to 2021. According to the research of Fama and French [14], the stocks were divided into five equal parts according to size and were divided into five equal parts according to BM ratio. Then 25 portfolios for FF-3 were constructed with double sort. The construction of portfolios for CH-3 followed a similar way, the stocks were departed into five equal parts based on size and also into five equal parts based on PE ratio. The results are listed in Table 6 and Table 7.

Table 6: The standard error and adjusted R square of regression of 25 portfolios with FF-3.

	Adj-R^2					s(e)				
Low	0.919	0.958	0.964	0.960	0.949	2.869	2.011	1.866	1.940	2.174
2	0.938	0.953	0.951	0.962	0.957	2.489	2.084	2.077	1.922	1.913
3	0.942	0.955	0.954	0.956	0.948	2.271	1.983	2.009	1.997	2.057
4	0.928	0.937	0.940	0.947	0.948	2.400	2.363	2.235	2.145	2.059
High	0.933	0.925	0.909	0.909	0.930	2.136	2.258	2.618	2.505	2.095

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Table 7: T standard error and adjusted R square of regression of 25 portfolios with CH-3.

	Adj-R^2					s(e)				
Low	0.961	0.965	0.953	0.950	0.913	2.101	1.846	2.077	2.075	2.750
2	0.950	0.964	0.948	0.951	0.923	2.254	1.859	2.173	2.020	2.534
3	0.939	0.950	0.939	0.938	0.930	2.467	2.127	2.363	2.192	2.399
4	0.922	0.922	0.919	0.936	0.950	2.887	2.559	2.507	2.253	1.991
High	0.896	0.888	0.854	0.897	0.942	3.114	2.895	2.988	2.482	1.991

Table 8: Descriptive statistics of R square for both FF-3 and CH-3.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
R square of FF-3	25	0.91	0.96	0.9429	0.01580
R square of CH-3	25	0.85	0.97	0.9320	0.02655
Valid N (listwise)	25				

The standard error and R square of two models for their 25 portfolios are almost the same, but CH-3 is at a disadvantage for the top 20% size. On the basis of the adjusted R square in both tables, we made a further descriptive statistics. As summarized in Table 8, Although both models had high fitness for their portfolios, the overall performance of FF-3 is slightly better than that of CH-3, with a slower std. and a higher mean.

4. Limitation

Liu et al. had proved the domination of CH-3 toward FF-3 through comparing both models' explanation power to anomalies in China [13]. Ascribed to the limitation of our knowledge and ability, even if we had run the GRS test and compared the explanation power between CH-3 and FF-3 models, it's hard to said that the domination of CH-3 model is diminishing, for that we had just simply analysis the adjusted R square for 25 portfolios of each model. Although they had come to a CH-4 model, we don't have much left to test it. However, it should be noted that the effectiveness of CH-3 model in recent years should be paid more attention. In the future, one may know in the comparison of these models again and make more detailed regression of market anomalies. If there's anything going through here, the return rate of each stock in China's stock market may be predicted more efficiently.

5. Conclusion

In summary, CH-3 and FF-3 are both quite famous models, they try to explain stock return with their market factor, size factor and value factor. According to our explanation regressions, they both had an almost equivalent explanation power to each other's factors. The two different GRS tests show that only in the situation that the data was extended from 2000 to 2021 can CH-3 dominates FF-3, if we run the GRS test during 2017 to 2021, FF-3 had advantages over CH-3. The descriptive statistics of the adjusted R square of each other's 25 regressions of 25 portfolios also showed that FF-3 had slight advantages over CH-3. The result makes us to think that if CH-3 can only be effective while testing early China stock market. Due to the limitation of our knowledge, we could not make more further analysis to the models' explanation power to the China market anomalies, which means that we could not obtain more details of CH-3 and FF-3. It's quite meaningful to test the effectiveness of two models, which help us make better prediction of the stock return and know about the market trends. In the future, after the epidemic is over, CH-3 may recover its effectiveness without the impact

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of the epidemic. This could be easier for us to test the models in that time. Overall, these results offer a guideline for the effectiveness of CH-3 and FF-3 from 2000 to 2021.

References

[1] *Berk, J. B.: Sorting Out Sort. The Journal of Finance, February, 2000, (2000).*

[2] *David, B.: How to navigate the equity 'factor zoo', 2020, https://www.robeco.com/en/insights/2020/03/how-to-navigate-the-equity-factor-zoo.html (2020).*

[3] *Hou, K., Xue, C., Zhang, L.: Digesting Anomalies: An Investment Approach. Working Paper Series, (2012).*

[4] *Omar, T., Samir, A., Jawad, A.: A Comparative Study of the Fama-French Three Factor and the Carhart Four Factor Models: Empirical Evidence from Morocco. International Journal of Economics and Financial Issues, Econjournals, vol. 12(1), pages 58-66 (2022).*

[5] *Eugene, F. F., Kenneth, R. F.: A five-factor asset pricing model. Journal of Financial Economics, Volume 116, Issue 1 (2015).*

[6] *Chen, L., Novy-Marx, R., Zhang, L. An alternative three-factor model. Available at SSRN 1418117 (2011).*

[7] *Zhang, J.: Analysis of three-factor pricing models for stock return. Dissertation of Zhejiang University (2019).*

[8] *Xu, J., Zhang, S.: The Fama-French Three Factors in the Chinese Stock Market. Chinese Accounting and Financing, 16(002):210-227 (2014).*

[9] *Allen, F., Qian, J., Qian, M.: Law, finance,and economic growth in China. J. Financ. Econ. 77(1), 57-116 (2005).*

[10] *Zhang J. The Fama-French three factors in Chinese stock market. Chinese Accounting and Financing, 2014, 16(2):18 (2014).*

[11] *Liao, L. Shen, H. B.: Fama-French Three Factors Model and the Effect of the Split-share Structure Reform', The Journal of Quantitative and Technical Economics 9: 117-125 (in Chinese) (2008).*

[12] *Liu, G. M., Yang, C.: Application of Fama-French Multi-factor Model in China's Bond Market during Recent Financial Crisis', Journal of Zhejian University (Science Edition) 4: 396-400 (in Chinese) (2010).*

[13] *Liu, J., Stambaugh, R. F., Yu, Y. Size and Value in China. NBER Working Papers, (1), 2018.*

[14] *Fama, E. F., and Kenneth, R. F.: Common risk factors in the returns on stocks and bonds. Journal of Financial Economics, 33(1), 3-56 (1993).*