Size and Value Factors in China
An Empirical Test of a Revised Fama-French Three-factor Model with Chinese Characteristics

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ABSTRACT
This paper evaluates the validity of a newly proposed three-factor model with Chinese characteristics in the recent Chinese stock market. For comparison purposes, we also conduct a test of the applicability of the classic Fama-French three-factor model (FF-3) and of the CAPM to the Chinese market. Our results show that the replacement of B/M ratio with E/P ratio indeed improves the explanatory power of the model, making the new three-factor model superior to FF-3 and CAPM. However, we do not observe a robust value effect, with size effect being only moderately detectable. We speculate that the existence of such an anomaly is due to a change of investment style in the recent Chinese stock market.

Keywords*-China; size; value; factors; E/P ratio*

1.INTRODUCTION

1.1. Research background

China, as a rising power in the international arena, has the second largest stock market in the world totaling 12.21 trillion US dollars, a size that enables China to finance its rapid social and economic development. It is thus not surprising that, although the Chinese stock market is still not yet developed, there have been voluminous research articles that center on its performance and its impact on the whole economy. For instance, Huang and Song [1] conducted a comparative study of bankruptcy cost in the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE), in which they found that the bankruptcy cost for companies listed on the SSE is potentially lower compared to that in the SZSE. Other examples include an examination of the existence of herding behavior in the Chinese stock market by Hilliard and Zhang [2], an empirical analysis of different anomalies in the China A-share market by Jansen, Swinkels and Zhou [3] and a discovery of the periodic mutual transformation between the momentum effect and the reversal effect in the China SZSE A-share market by Shu, Xiao and Wang [13], to name just a few.

Despite the fact that the current literature dealing with the Chinese stock market is relatively rich and comprehensive in the sense that it touches upon a variety of topics ranging from investigating effects of policies on market performance to examining different market anomalies, it is not the case when it comes to empirical asset pricing analysis using Fama-French-type factor models, a much narrower yet increasingly important scope of the research on stock markets. Two features worth emphasizing in the literature regarding asset pricing analysis of China’s stock market are as follows.

First of all, the academic community thus far has not yet reached a consensus about the presence of factor premiums and the validity of the Fama-French three-factor model (hereafter this text will be abbreviated as FF-3) in China. On the one hand, articles such as Xie and Qu [4] confirmed the existence of significant size and value premiums in China and concluded that the FF-3 can satisfactorily explain the cross-sectional variations in stock returns of the SSE A-share market. On the other hand, some scholars (e.g. Yi, Huang, Wang and Yang [14]) did not document a significant value effect, thus concluding that the FF-3 is not applicable to the Chinese stock market.

The inconsistency in conclusions can be partly explained by differences in sample time selection, for the Chinese stock market has undergone major changes since its establishment. Compared to markets in developed countries, China's stock market is still nascent and inferior in many respects. To improve the market's functioning, the China Securities Regulatory Commission (CSRC) has initiated a series of programs of financial reform since the establishment of the SSE in 1990, among which the most transformative one is presumably the Split-Share Structure Reform commencing in 2005. Before the reform, there were two classes of shares – tradable shares and non-tradable shares – traded in China's A-share market, the transactions of which were segregated from each other. Such a market segmentation to a large extent retarded the early development of China's A-share market, making the 2005 share reform a move of necessity. Since the initiation of the reform, the proportion of A-share market value in circulation to total A-share market value has considerably increased, from about 28% in April 2005 to nearly 80% in October 2021. Unique characteristics such as the coexistence of A, B and H shares and the abovementioned split-share structure make the robustness of results sensitive to the choice of sampling period. Therefore, it should not be surprising to see that different scholars (e.g. Hu, Chen, Shao and Wang [6] and Xie and Qu [4]) could draw diametrically opposite conclusions on the same matter.

Second, when conducting empirical tests of various asset-pricing models in the Chinese stock market, some researchers failed to make necessary adjustment to the procedure, thus making their analysis framework unable to incorporate features unique to China.

As mentioned earlier, the Chinese stock market possesses a number of features that separate itself from the developed markets as well as all the other emerging markets. It is therefore important to take into account these features when conducting empirical tests. Failure to do so may bias the results and derive fallacious conclusions.

After reading copious works on the empirical analysis of asset-pricing models in China, we noticed that a fair share of studies failed to appropriately adjust the FF-3/FF-5 model to the uniqueness of China's stock market, hence negating the presence of a robust value effect in China, an effect that may be otherwise confirmed if proper modifications to the Fama-French procedure are made. To be specific, a major shortcoming in current literature is the mechanical use of B/M ratio as a value indicator. Few articles mentioned the necessity of accommodating the special needs of China's A-share market by making slight modifications to the definition of B/M ratios or turning to the search for a better value indicator; one such example is the paper by Xiu and Zhang [5] in which B/P ratios were used in place of B/M ratios when calculating the value factor.

1.2.A new factor model with Chinese characteristics

In fact, the failure to reach a consensus about the performance of the FF-3 model and the mechanical application of the Fama-French procedure for some researchers, to some extent, are interrelated to one another.

As an attempt to propose a factor model with Chinese characteristics and to provide a uniform framework for future studies on asset pricing analysis in the Chinese stock market, Liu, Stambaugh and Yuan [7] used monthly data from January 2000 to December 2016 and revised the classic FF-3 model such that the original B/M ratio was replaced with a new indicator called earnings-price ratio (E/P). In addition, Liu, Stambaugh and Yuan [7] took into consideration the shell-value contamination of small-size firms, thus excluding the firms with the smallest 30% market capitalization throughout the study. The newly proposed three-factor model (hereafter CH-3), according to Liu, Stambaugh and Yuan, dominates FF-3 in all aspects, thus making it preferable when it comes to pricing Chinese stocks.

1.3. Research purpose

In the current literature, however, it is rare to find articles that focus on the robustness of CH-3. Moreover, Liu, Stambaugh and Yuan [7] used data taken from 2000 through 2016, meaning that the Chinese stock market before and after the Split-Share Structure Reform was considered altogether. Considering the massive impact of the share reform on China's stock market and the rapid development of the Chinese market these years, it is necessary to re-examine the validity of CH-3 using data taken from more recent Chinese stock market, a practice that is exactly the main purpose of our study and appears even more significant when taking into account the enormous impact of the COVID-19 pandemic. To make our analysis rigorous and convincing, we took a two-pass approach when testing the validity of CH-3 by first confirming that E/P ratio indeed is superior to other candidates before we moved on to regression analysis. For comparison purposes, we also reported summary statistics and regression results for CAPM and FF-3 in later sections, followed by a GRS test of all the three models aiming to ascertain the relative explanatory power of CH-3 in absorbing excess returns of portfolios.

Testing the validity of CH-3, however, is not our sole purpose, for we also included a test of the existence of size and value effects in the recent Chinese stock market. We regard this extra step as crucial in that it can inform us whether the Fama-French factors have the ability to reflect same or similar stock market effects when applied to China's market, and if not, whether the introduction of E/P ratio as value indicator can ameliorate the situation. In fact, failure to detect a significant size and value effect by using either the Fama-French factors or the new three factors lends credence to our conjecture that there has been a shift in investment style in the recent Chinese market.

2.METHODOLOGY AND DATA

2.1. Sample specification

Throughout our study, for the sample for explanatory variables we used data obtained from the China Stock Market Accounting Research (CSMAR) from April 2010 to April 2021 covering monthly returns and other financial indicators of individual stocks in China's A-share market excluding the SSE Science and Technology Innovation Board (STAR Market) and the SZSE Growth Enterprise Market (GEM); for the sample for dependent variables we used a subset of China's A-share market – the SSE A-share market excluding the STAR Market.

Our sample period starts from April instead of June or July, because according to the related regulations on the reporting of financial statements for firms in China, every firm is required to release their annual financial statements by the end of April of the following year. We thus sorted each stock based on their size ME which refers to market value in circulation every year t at the end of April. The sorting of stocks based on their value indicator (B/M ratio in FF-3 or EP in CH-3) remains the same, with each stock sorted by using the B/M ratio or EP every year t-1 at the end of December. The intersection of stocks with this double-sorting method produces 6 and 25 portfolios, the first being portfolios to be used in the construction of the two risk factors and the second being portfolios to be explained by the three factors.

2.2. Process description

To test the validity of CH-3, we started by replicating the Fama-French procedure to examine the performance of the classic FF-3 in the recent Chinese stock market (for a detailed explanation of the construction of SMB and HML as well as the sorting method used by Fama and French, refer to Fama and French [8]), a step which could provide us with helpful results to be used in later comparison among the CAPM, FF-3 and CH-3. We then followed the methodology used in Liu, Stambaugh and Yuan [7] to construct the two mimicking factors SMB (which stands for "high minus low") and VMG (which stands for "value minus growth"). One difference between our method and theirs is the proportion of stocks excluded when constructing factors and calculating portfolio returns. Specifically, we dropped the firms listed on the STAR Market and the GEM instead of the firms with the smallest 30% market capitalization for two reasons. First, directly eliminating companies listed on the STAR Market and the GEM is a practice that better fits our data structure in that every stock in our downloaded database has a label denoting its market type. Second, since the use of 30% as the cutoff point in the paper by Liu, Stambaugh and Yuan [7] is somewhat arbitrary, it is necessary to change the numerical value of this critical point. Back-of-the-envelope calculations told us that the proportion of stocks on the STAR Market and the GEM altogether ranged from about 10% to 23% during our sample period. Thus, the practice of eliminating stocks on the STAR Market and the GEM could still to a large extent alleviate the problem of shell-value contamination in small-size firms, since according to the finding of Liu, Stambaugh and Yuan [7] 83% of the reverse mergers in the 2007-2016 period come from the bottom 30%, and more than half come from the bottom 10%.

It is worth noting that the construction of the two risk factors of CH-3 is in fact a two-pass process, with the first stage being the confirmation of the superiority of E/P over other candidate valuation ratios and the second being the construction of the value factor using E/P.

In the first stage, we adopted the Fama-MacBeth regression (hereafter this text will be abbreviated as FMB regression) to test whether E/P dominates the other two valuation ratios (B/M and A/M). When constructing E/P, B/M and A/M, we divide a firm's net profit, its total equity value, and its total asset value by the market value in circulation of that firm respectively. We did not follow suit by using the total market value of a firm in view of the split-share structure mentioned earlier that still exists in the current Chinese stock market.

To run the two-stage FMB regression, the first thing we did is to obtain estimates of exposures of individual stocks to different factors. For each of the individual stocks from our sample, the post-ranking betas are estimated by:

$$\mathrm{R}_{it} - R_{ft} = \alpha_i + \beta_i^{M}(R_{Mt} - R_{ft}) + \beta_i^{ME} \ln ME + \beta_i^{BM} \ln BM + \beta_i^{AM} \ln AM + \beta_i^{EP^+} \ln EP^+ + \beta_i^{D(EP)} D(EP) + \epsilon_{it}, \quad (1)$$

where $t = 1, 2, \ldots, T$ for each i and R_{it} is the monthly return of each individual stock i; this regression was run from May 2010 to April 2021.

We then run a cross-section regression at each month t:

$$\mathrm{R}_{it} - R_{ft} = \alpha_i + \beta_i^{M}\gamma_t^{M} + \beta_i^{ME}\gamma_t^{ME} + \beta_i^{BM}\gamma_t^{BM} + \beta_i^{AM}\gamma_t^{AM} + \beta_i^{EP^+}\gamma_t^{EP^+} + \beta_i^{D(EP)}\gamma_t^{D(EP)} + \varepsilon_{it}, \quad (2)$$

where $i = 1,2, \ldots, N$ for each t and γ_t^{M}, $\gamma_t^{ME}, \gamma_t^{BM}, \gamma_t^{AM}, \gamma_t^{EP^+}$ and $\gamma_t^{D(EP)}$ are estimates of monthly slopes.

In an FMB regression, the factor premiums are then calculated as follows:

$$\gamma^{M} = \sum_{t=1}^{N} \gamma_t^{M},$$

$$\gamma^{ME} = \sum_{t=1}^{N} \gamma_t^{ME},$$

$$\gamma^{BM} = \sum_{t=1}^{N} \gamma_t^{BM},$$

$$\gamma^{AM} = \sum_{t=1}^{N} \gamma_t^{AM}, \quad (3)$$

$\gamma^{EP^+} = \sum_{t=1}^{N} \gamma_t^{EP^+}$,

$\gamma^{D(EP)} = \sum_{t=1}^{N} \gamma_t^{D(EP)}$

In the second stage of testing CH-3, we used EP as our value indicator when constructing the two zero-cost portfolios SMB and VMG. We also replaced the B/M ratio with EP when forming the 25 portfolios to be used as dependent variables in our time series regressions, with the rest of the construction the same as the Fama-French procedure which, according to the original paper by Fama and French [8], is the double-sorting of size and value factors, with stocks divided into 5 groups for each factor, giving us an intersection of 25 portfolios. Considering the fact that it is highly likely for regression residuals to be serially correlated with one another on the timeline, we chose the time series regression with four-lag Newey-West standard errors. The selection of lags in the Newey-West adjustment is determined by the following formula for automatic selection of lags put forward by Newey and West [12]:

$$L = 4 \times (\frac{T}{100})^{2/9}, \quad (4)$$

where T is 132 in our case.

As a last part of our research, we compared the performance of each of the three candidate models – the CAPM, FF-3, and CH-3 – by calculating the average absolute alphas of the regression results of each model and conducting the Gibbons, Ross and Shanken [15] test (GRS test).

3. RESULTS AND DISCUSSION

3.1. Performance of FF-3 and the CAPM

Before running the time series regression with four-lag Newey-West standard errors 25 times for FF-3, we first took a look at the summary statistics for each of the 25 portfolios formed on size and B/M ratios.

Table I reports the excess value-weighted average returns of the 25 portfolios formed on the two Fama-French factors (size and B/M ratio). Looking down from the top within each of the five value quintiles, the pattern of excess returns in each column is not evident to see. In other words, the existence of a significant size premium in the Chinese stock market cannot be confirmed by just copying the Fama and French procedure. Meanwhile, we were surprised to detect an approximate monotonically decreasing trend within each size quintile as the value increases, a finding that was exactly the opposite of what had been documented in the paper by Fama and French [8]. Note that nine out of ten excess returns in the first two columns are statistically significant at the 5% level, whereas there is only one excess return that is statistically significant at the 10% level. In face of the existence of such a "value effect anomaly" and the distribution of statistical significance, we guess that the reason behind is that the market style in recent years favors large market cap stocks. As a reference, the coefficients on the FF-3 value factor HML might be negative on a large scale.

TABLE I. AVERAGE EXCESS RETURNS OF 25 PORTFOLIOS FORMED ON ME AND B/M RATIOS

Size quintiles	value quintiles				
	Low	2	3	4	High
	Excess Return (%)				
Small	2.94***	1.88**	1.27	1.53*	0.87
	[3.453]	[2.104]	[1.521]	[1.704]	[1.043]
2	3.25***	1.77**	1.18	0.61	1.33
	[3.684]	[2.218]	[1.595]	[0.842]	[0.890]
3	2.48***	1.71**	1.02	0.64	0.35
	[3.054]	[2.294]	[1.369]	[0.894]	[0.514]
4	2.87***	1.33*	1.13	0.63	0.31
	[3.503]	[1.928]	[1.594]	[0.906]	[0.447]
Big	2.87***	1.42**	0.99	0.61	1.83
	[3.906]	[1.997]	[1.307]	[1.016]	[0.367]

Sample Twenty-five portfolios are formed every year at the end of April from 2010 to 2021, on the basis of underlying stocks' size or B/M ratios. Returns are the time-series averages of the monthly portfolio returns, reported in percent, for the period from May 2010 to April 2021. The corresponding t-values on portfolio average excess returns are reported in square brackets. *, **, and *** denote the statistical significance at the 10%, 5% and 1% level, respectively.

With this presumption bearing in mind, we did the time series regression with four-lag Newey-West adjusted standard errors 25 times and then reported the coefficients on different regressors as well as the intercepts in table 2, with the slopes and intercepts obtained from regressing portfolio excess returns on the CAPM provided in table 3 for comparison purposes. To evaluate the overall explanatory power of FF-3 and the CAPM as well, we also included the adjusted coefficients of determination (adjusted R^2) of each regression in table 2 and table 3.

From table II, we can see that our previous presumption that a large share of the slopes on HML may be negative is only partially confirmed: although there are twelve (of 25) coefficients on HML that are negative, merely 4 of them are significantly less than zero. The trend observed in Fama and French [8] that the slopes on HML increase monotonically from strong negative values for the lowest value quintile to strong positive values for the highest value quintile in every size quintile of stocks cannot be determined as well. For the performance of the explanatory variable SMB, it is a whole new story. With four exceptions, the t-values on the SMB slopes are greater than 2; most are greater than 4. SMB, the mimicking return for the size factor, clearly captures shared variation in stock returns that is omitted by the market factor and by HML. Furthermore, the slopes on SMB are related to size. Within every value quintile, the slopes on SMB decrease perfectly monotonically from smaller- to bigger-size quintiles, excepting the slope on SMB for the portfolio S2L5. Similarly, the vast majority of market β^Ms for portfolios are statistically significant at the 1% level, having t-values greater than 2.

TABLE II. THE FAMA-FRENCH THREE-FACTOR MODEL IN CHINA

Size	Value quintiles					Value quintiles				
quintiles	Low	2	3	4	High	Low	2	3	4	High
	Estimate					t-statistics				
	Panel A: Intercept (%)									
Small	2.36***	0.85***	0.42	0.52***	-0.09	3.73	3.54	0.78	1.69	-0.35
2	2.41***	0.83***	0.42	-0.14	0.08	6.68	4.57	1.36	-0.54	0.11
3	1.82***	1.09***	0.24	-0.12	-0.31	5.01	3.45	1.45	-0.67	-1.27
4	2.52***	0.71***	0.47**	-0.02	-0.33*	4.90	4.08	2.06	-0.13	-1.74
Big	2.59***	1.00***	0.61	0.32	-0.09	7.51	3.86	1.49	1.95	-0.72
	Panel B: Coefficient on Mkt									
Small	0.420	1.00***	0.72***	0.95***	0.98***	1.51	20.23	4.33	17.29	18.27
2	1.14***	1.01***	0.82***	0.99***	1.00***	20.52	21.79	6.01	17.45	5.39
3	0.85***	0.70***	1.05***	1.08***	1.08***	8.73	4.02	29.85	36.12	27.13
4	0.56**	1.03***	1.05***	1.14***	1.19***	2.22	27.05	19.53	28.00	33.28
Big	1.04***	1.23***	1.08***	1.06***	0.86***	17.60	14.17	11.50	30.40	38.91
	Panel C: Coefficient on SMB									
Small	0.71***	1.12***	1.03***	1.14***	1.02***	4.09	10.92	6.93	6.01	8.19
2	0.65***	0.96***	0.80***	0.64***	1.49**	5.71	14.19	8.78	4.69	2.13
3	0.50***	0.60***	0.63***	0.61***	0.46***	3.48	4.80	11.18	7.87	4.89
4	0.12	0.33***	0.40***	0.40***	0.38***	0.42	4.95	4.51	5.79	4.92
Big	-0.39***	-0.13*	-0.06	-0.20***	-0.01	-3.35	-1.70	-0.43	-2.92	-0.17
	Panel D: Coefficient on HML									
Small	-0.25	-0.15	0.10	-0.10	0.03	-0.88	-1.25	0.72	-0.66	0.18
2	-0.30	0.03	0.25**	0.01	-0.24	-1.88	0.28	2.07	0.05	-0.52
3	-0.60***	-0.13	-0.10	0.11	0.36***	-2.86	-0.92	-1.24	0.92	2.78
4	-0.80***	-0.30***	-0.16	0.23**	0.48***	-3.20	-3.30	-1.47	2.16	4.26
Big	-0.98***	0.07	0.10	0.35***	0.81***	-4.50	0.58	0.51	2.84	10.29
	Panel E: Adjusted R^2									
Small	0.38	0.91	0.59	0.84	0.87					
2	0.80	0.93	0.64	0.84	0.45					
3	0.69	0.52	0.92	0.91	0.86					
4	0.32	0.91	0.88	0.89	0.91					
Big	0.76	0.86	0.58	0.89	0.94					

The FF-3 formula is given as: $R_i - R_f = \alpha_i + \beta_i(R_M - R_f) + s_i SMB + h_i HML + \varepsilon_i$.

The corresponding t-values based on four-lag Newey-West standard errors on portfolio average excess returns are reported in square brackets. *, **, and *** denote the statistical significance at the 10%, 5% and 1% level, respectively.

Given the strong slopes on the size factor SMB, notwithstanding the puny t-values on the slopes of HML, FF-3, compared to the conventional CAPM, still has greater adjusted R^2 values. As is illustrated in table II and table III, the CAPM itself produces none (of 25) adjusted R^2 values greater than 0.9; the number for the FF-3 regressions is seven (of 25), with quite a few adjusted R^2 having values close to 0.9.

In sum, however, the overall performance of FF-3 is barely satisfactory, as the role of the value factor HML in explaining shared variation in stock returns cannot be not confirmed, making HML seem to be a redundant explanatory variable. This finding, however, should not be surprising in that HML is highly correlated with SMB, thus making it entirely possible that the power of HML in accounting for the cross-sectional variation in stock returns is absorbed or overshadowed by that of SMB (table IV).

TABLE III. THE CAPM IN CHINA

Size quintiles	Value quintiles					Value quintiles				
	Low	2	3	4	High	Low	2	3	4	High
	Estimate					t-statistic				
	Panel A: Intercept									
Small	2.75	1.42	0.93	1.05	0.41	3.41	2.36	1.35	1.64	0.75
2	2.70	1.28	0.81	0.18	0.79	5.06	2.70	1.50	0.45	0.60
3	2.04	1.34	0.52	0.17	-0.09	3.41	2.24	1.42	0.51	-0.31
4	2.56	0.80	0.65	0.17	-0.10	3.48	2.66	1.94	0.62	-0.74
Big	2.35	0.89	0.53	0.21	-0.10	5.65	3.28	1.06	0.79	-0.36
	Panel B: Coefficient on Mkt									
Small	0.59	1.21	0.88	1.17	1.16	4.50	12.65	8.05	11.41	13.41
2	1.30	1.18	0.93	1.09	1.31	15.21	15.64	10.81	17.08	6.18
3	1.03	0.83	1.18	1.17	1.11	10.78	8.74	20.00	22.45	23.92
4	0.70	1.14	1.14	1.18	1.19	5.93	23.71	21.52	27.50	31.22
Big	1.12	1.20	1.06	0.97	0.74	16.85	27.67	13.36	22.54	16.16
	Panel C: Adjusted R^2									
Small	0.14	0.55	0.33	0.50	0.58					
2	0.64	0.65	0.47	0.69	0.22					
3	0.47	0.37	0.75	0.79	0.81					
4	0.21	0.81	0.78	0.85	0.88					
Big	0.69	0.85	0.58	0.80	0.67					

The CAPM formula is given as: $R_i - R_f = \alpha_i + \beta_i(R_M - R_f) + \varepsilon_i$.

The corresponding t-values based on four-lag Newey-West standard errors on portfolio average excess returns are reported in square brackets. *, **, and *** denote the statistical significance at the 10%, 5% and 1% level, respectively.

TABLE IV. PAIRWISE CORRELATIONS FOR THE THREE FACTORS IN FF-3

	Mkt	SMB	HML
Mkt	1.00		
SMB	0.22	1.00	
HML	-0.24	-0.74	1.00

3.2. Performance of CH-3

Before discussing the performance of CH-3, we shall first present the Fama-MacBeth regression results for our three chosen valuation ratios (i.e. B/M, A/M, and E/P ratios). In this horse race, E/P ratio clearly dominates the other two candidates, as is evidenced by the figures in column 8 in table V.

TABLE V. FAMA-MACBETH REGRESSIONS OF INDIVIDUAL STOCK RETURNS ON BETA, SIZE, AND VALUATION RATIOS

Quantity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.0055	-0.7237	-0.0714	-0.0855	-0.1019	-0.0924	-0.0751	-0.0834
	(1.01)	(-1.82)	(-2.06)	(-1.77)	(-2.18)	(-1.90)	(-1.56)	(-1.78)
β	0.0067		0.0066	0.0042	0.0043	0.0043	0.0044	0.0045
	(1.59)		(1.59)	(0.62)	(0.64)	(0.63)	(0.65)	(0.66)
lnME		0.0037	0.0035	0.0034	0.0045	0.0042	0.0029	0.0034
		(2.33)	(2.54)	(1.75)	(2.38)	(2.13)	(1.49)	(1.80)
lnBM				-0.0110			-0.0123	-0.0076
				(-6.35)			(-7.59)	(-5.43)
lnAM					-0.0097			-0.0053
					(-5.93)			(-2.95)
EP+						-0.0245	0.0288	0.0364
						(-1.93)	(4.25)	(6.47)
D (EP<0)						-0.0024	-0.0059	-0.0048

						(-0.89)	(-2.48)	(-2.13)
R2	0.1587	0.0210	0.1751	0.2294	0.2299	0.2205	0.2336	0.2368

The table reports average slopes on different independent variables from month-by-month FMB regressions. The columns correspond to different regression specifications, with nonempty rows indicating the included regressors. The last row reports the average adjusted R^2 values for each regression specification. The t-values on the corresponding slope coefficients based on four-lag Newey-West standard errors are reported in parentheses.

After selecting the best candidate (E/P in our case) for indicating a firm's value, we then follow a similar analysis framework used in section 3.1. to examine the performance of CH-3. It can be seen that, compared to FF-3 and the CAPM, the improvement in the explanatory power of CH-3 is threefold. First of all, the correlation between SMB and VMG has reduced from -0.74 to -0.47 (table VI), making it less likely the case for multicollinearity in the regressions. Second, there are now altogether fourteen (of 25) slope coefficients on VMG statistically significant at the 5% level, a number that has increased moderately from the previous ten (of 25) as compared to the number for FF-3. Last but not least, in terms of the adjusted R^2 values, the number of values greater than 0.9 has risen from seven to ten; besides, the minimum value of adjusted R^2 also increased from 0.32 in FF-3 to 0.76 in CH-3.

TABLE VI. PAIRWISE CORRELATIONS FOR THE THREE FACTORS IN CH-3

	Mkt	SMB	VMG
Mkt	1.00		
SMB	0.10	1.00	
VMG	-0.30	-0.47	1.00

The CH-3 formula is given as: $R_i - R_f = \alpha_i + \beta_i(R_M - R_f) + s_i SMB + h_i VMG + \varepsilon_i$.

One thing worth mentioning is that the presence of robust size and value effects is still not clear to see (table VII). Specifically, the pattern of excess returns in each size quintile of stocks from lower- to higher-value quintiles is flatter compared to that in the FF-3 case, yet still giving us negative excess returns of long-short portfolios that long the highest value quintile of stocks and short the lowest value quintile of stocks in each size quintile (table VIII). Similarly, the average excess returns in each value quintile of stocks seem to demonstrate a more evident decreasing trend as portfolio size increases, yet with several exceptions.

We then hazard a guess that the above findings regarding size and value effects in recent Chinese A-share market are due to a switch in market preference from favoring small-size firms to larger-size firms.

TABLE VII. AVERAGE EXCESS RETURNS OF 25 PORTFOLIOS FORMED ON ME AND E/P RATIOS

size quintiles	value quintiles				
	Low	2	3	4	High
	Excess Return (%)				
small	2.23***	2.21***	1.38*	1.70**	1.70**
	[2.69]	[2.63]	[1.73]	[2.02]	[2.11]
2	2.11***	1.84**	2.12***	1.53*	2.18
	[2.61]	[2.37]	[2.91]	[1.96]	[1.30]
3	1.66**	1.71**	1.50**	1.19*	1.25*
	[2.07]	[2.25]	[2.08]	[1.79]	[1.76]
4	1.60**	1.59**	1.49**	1.26	0.97
	[2.17]	[2.19]	[2.17]	[1.88]	[1.42]
Big	1.70**	2.23***	1.38**	0.78	0.58
	[2.18]	[3.00]	[2.01]	[1.32]	[1.13]

Twenty-five portfolios are formed every year at the end of April from 2010 to 2021, on the basis of underlying stocks' size or E/P ratios. Returns are the time-series averages of the monthly portfolio returns, reported in percent, for the period from May 2010 to April 2021. The corresponding t-values on portfolio average excess returns are reported in square brackets. *, **, and *** denote the statistical significance at the 10%, 5% and 1% level, respectively.

TABLE VIII. THE CH-3 MODEL IN CHINA

Size quintiles	Value quintiles					Value quintiles				
	Low	2	3	4	High	Low	2	3	4	High
	Estimate					t-statistics				
	Panel A: Intercept (%)									
Small	1.03***	1.09***	0.38	0.73	0.89**	3.14	2.92	1.07	2.56	2.60

2	1.01***	0.84***	1.13***	0.58**	1.82	3.97	3.08	3.01	2.30	1.50
3	0.50**	0.67**	0.59***	0.35*	0.63*	2.10	2.11	2.73	1.89	1.86
4	0.74**	0.65**	0.59**	0.53*	0.40*	2.55	2.26	2.29	1.93	1.91
Big	0.89***	1.35***	1.07***	0.47**	0.58***	2.80	4.05	3.01	2.31	3.30
	Panel B: Coefficient on Mkt									
Small	1.00***	0.98***	1.01***	1.10***	1.08***	18.10	20.81	23.42	15.21	25.49
2	1.06***	1.09***	0.95***	1.11***	1.46***	22.18	27.67	18.94	28.57	5.40
3	1.08***	1.03***	1.05***	0.97***	1.15***	28.89	18.16	35.57	17.18	19.40
4	1.17***	1.07***	1.02***	1.12***	1.15***	19.51	20.90	29.08	25.71	22.11
Big	1.22***	1.05***	1.12***	1.05***	0.91***	15.68	13.01	8.59	24.17	23.54
	Panel C: Coefficient on SMB									
Small	0.74***	0.83***	0.79***	1.02***	1.05***	8.97	8.30	6.36	8.94	6.76
2	0.52***	0.61***	0.58***	0.74***	2.89**	5.35	6.99	6.29	8.37	2.48
3	0.57***	0.45***	0.57***	0.45***	0.50***	5.04	3.59	4.94	6.07	4.00
4	0.50***	0.27**	0.33***	0.30***	0.11***	2.70	2.10	3.89	3.24	1.68
Big	0.12	-0.01	-0.46***	-0.27***	-0.26***	0.76	-0.10	-3.77	-4.90	-2.60
	Panel D: Coefficient on VMG									
Small	-0.65***	-0.45***	-0.27*	0.04	0.30	-6.52	-3.94	-1.82	0.40	1.57
2	-0.63***	-0.35***	-0.48***	-0.15	2.87**	-4.49	-2.74	-4.39	-1.38	2.09
3	-0.66***	-0.61***	-0.26	-0.30***	0.24*	-4.26	-3.25	-1.58	-2.67	1.72
4	-0.44	-0.54***	-0.47***	-0.14	0	-1.62	-3.30	-2.99	-1.21	-0.02
Big	-0.41***	-0.69***	-0.06	0.03	0.47***	-2.92	-3.84	-0.23	0.57	3.58
	Panel E: Adjusted R^2									
Small	0.85	0.95	0.91	0.84	0.83					
2	0.93	0.92	0.83	0.92	0.90					
3	0.89	0.84	0.89	0.86	0.84					
4	0.83	0.86	0.89	0.87	0.85					
Big	0.90	0.76	0.94	0.90	0.91					

The corresponding t-values based on four-lag Newey-West standard errors on portfolio average excess returns are reported in square brackets. *, **, and *** denote the statistical significance at the 10%, 5% and 1% level, respectively.

3.3. Comparison of the CAPM, FF-3 and CH-3

In this section, we conducted the GRS test and also calculated the average absolute alphas of each model, with results reported in table IX.

The GRS F-statistics with associated p-values denoted by the asterisk mark given next to the value and the average absolute monthly alphas inform us from another dimension about the relative performance of each model in terms of accounting for shared variation in portfolio excess returns.

From table IX, it is evident that CH-3 outperforms FF-3 and the CAPM because it has the smallest values in both GRS F-statistics and $A|\alpha_i|$ among the three models, an evidence that serves as another proof of the superiority of CH-3 over FF-3 and the CAPM in our analysis framework.

TABLE IX. COMPARISON OF THE ABILITIES OF EACH MODEL TO EXPLAIN ANOMALIES

201005-202104	GRS	$A\|\alpha_i\|$ (%)
CAPM		
Mkt	5.72***	1.09
FF-3		
Mkt. SMB. HML.	7.55***	0.82
CH-3		
Mkt. SMB. VMG.	5.39***	0.78
Mkt. SMB.	5.60***	0.84
Mkt. VMG.	5.41***	0.80
SMB. VMG.	1.16	0.89
SMB	1.28	1.27
VMG	1.13	0.91

4. CONCLUDING REMARKS

4.1. Conclusions

In our study, we followed the Fama-French procedure and methodology used in the paper by Liu, Stambaugh and Yuan [7] in an attempt to re-evaluate the validity and relative performance of CH-3 in the recent Chinese A-share market. In sorting stocks into groups and constructing risk factors, however, we made some necessary modifications to the original procedure to take into account some of the unique features of China's stock market. One of these modifications, as mentioned earlier, is the choice of April every year as the base month when sorting stocks based on their sizes. Our main conclusions are as follows:

As a classic asset-pricing model put forward by Nobel laureate Eugene F. Fama and his colleague Kenneth R. French, the FF-3 model fails to show a satisfactory explanatory power in the Chinese context.

In comparison, the value factor VMG, which is constructed by longing portfolio with the highest E/P ratio and shorting portfolio with the lowest E/P ratio, dominates the B/M ratio used by Fama and French in their empirical test of the US market and the A/M ratio as well, thus making the overall explanatory power of CH-3 improved compared to FF-3 and the CAPM. This conclusion can be corroborated by the increased number of adjusted R^2 *values greater 0.9 and by the smallest GRS F-statistic and* $A|\alpha_i|$ *in the regression analysis of CH-3.*

However, we shall note that no matter in the newly proposed CH-3 or the classic FF-3, neither a robust size effect nor a robust value effect can be observed with sufficient certainty. Moreover, we even detected a "reverse value effect" in some of the size quintiles of stocks, a newly discovered anomaly which we conjectured that may be due to a change in investment preference in recent Chinese stock market.

4.2. Prospects for future research

Our research primarily contributes to the current literature on empirical test of asset-pricing models by examining the applicability of the Nobel-winning Fama-French three-factor model to the recent Chinese stock market and by evaluating the validity of a newly proposed three-factor model with Chinese characteristics with most up-to-date data used. In addition, we give support to the claim with evidence that there is not a robust value effect in the recent Chinese market.

However, our analysis is perforce subject to some deficiencies. For future studies that would like to follow a procedure similar to ours, we suggest the following improvements:

Conducting a robustness test by running the same type of regression on various subperiods; a consideration of the Chinese stock market before the Split-Share Structure Reform is preferable.

Conducting a similar analysis of the SZSE A-share market (excluding/including the GEM) would be a good complement to our study.

Exploring the potential existence of a new valuation ratio that dominates all the current available ones including E/P ratio. We regard this improvement as of paramount importance since we should get back to basics when doing the Fama-French factor model analysis by first singling out the valuation ratio that best fits the Chinese market before moving on to the rest of the study.

REFERENCES

[1] Guihai Huang, Frank M. Song, "The determinants of capital structure: evidence from China," China Economic Review, vol. 17, No.1, 2006, pp. 14-36.

[2] J. Hilliard, H. Zhang, "Size and price-to-book effects: evidence from the Chinese stock markets," Pacific-Basin Finance Journal, vol. 32, 2015, pp. 40-55.

[3] M. Jansen, L. Swinkels, W. Zhou, "Anomalies in the China A-share market," Pacific-Basin Finance Journal, vol. 68, 2021, https://doi.org/10.1016/j.pacfin.2021.101607.

[4] S. Xie, Q. Qiu, "The three-factor model and size and value premiums in China's stock market," Emerging Markets Finance & Trade, vol. 52, 2016, pp. 1092-1105.

[5] J. Xiu, S. Zhang, "The Fama-French three factors in the Chinese stock market," China Accounting and Finance Review, vol. 16, No.2, 2014, pp. 210-227.

[6] Grace X. Hu, C. Chen, Y. Shao, J. Wang, "Fama-French in China: size and value factors in Chinese stock returns," International Review of Finance, vol. 19, No.1, pp. 3-44.

[7] J. Liu, Robert F. Stambaugh, Y. Yuan, "Size and value in China," Journal of Financial Economics, vol. 134, 2019, pp. 48-69.

[8] Eugene F. Fama, Kenneth R. French, "Common risk factors in the returns on stocks and bonds," Journal of Financial Economics, vol. 33, 1993, pp. 3-56.

[9] Eugene F. Fama, James D. MacBeth, "Risk, return, and equilibrium: empirical tests," Journal of Political Economy, vol. 81, No.3, 1973, pp. 607-636.

[10] Eugene F. Fama, Kenneth R. French, "The cross-section of expected stock returns," The Journal of Finance, vol. 47, No.2, 1992, pp. 427-465.

[11] Hong Wu, "The value and size effect – are there firm-specific-risks in China's domestic stock markets," International Journal of Economics and Finance, vol. 3, No.3, 2011, pp. 26-37.

[12] Whitney K. Newey, Kenneth D. West, "Automatic lag selection in covariance matrix estimation," Review of Economic Studies, vol. 61, 1994, pp. 631-653.

[13] J. Shu, Q. Xiao, S. Wang, "Transformation of momentum effect and reversal effect: an empirical research on Chinese Shenzhen A-share stock market," Management Review, No.1, 2012, pp. 52-57.

[14] C. Yi, X. Huang, N. Wang, T. Yang, "An analysis of the three-factor model in China's stock market (translated from Mandarin)," Journal of Nanjing University of Economics, No.5, serial No.110, 2001, pp. 43-47.

[15] Gibbons M.R., Ross S.A., Shanken J., "A Test of the Efficiency of a Given Portfolio," Econometrica, vol. 57, No.5, 1989, pp. 1121-1152.