Whether profitability and investment factors have additional explanatory power compared with Fama-French three-factor model: Empirical evidence on Chinese A-share stock market

Jiao Wenting, Jean-Jacques Lilti*

Fama and French propose a five-factor model containing the market factor and factors related to size, book-to-market equity ratio, profitability and investment, which outperforms the Fama-French three-factor model in their paper 2014. This study investigates the performance of Fama-French five-factor model and compare with that of Fama-French three-factor model on Chinese A-share stock market. The empirical results show that Fama-French five-factor model explanatory power has differences among different sets of portfolios. Compared with Fama-French three-factor model, the presence of profitability and investment factors donot seem to capture more variations of expected stock returns than the three-factor model except for six value-weighted portfolios formed on size and operating profitability.

Keywords: profitability factor, investment factor, Fama-French five-factor model, Chinese A-share stock market

1. Introduction

Fama and French (1993) propose a three-factor model including a size factor (SMB) and book-to-market equity factor (HML) in addition to market beta, which captures the cross-sectional variation in average stock returns. That is the famous Fama-French three-factor model (FF3F model hereafter). According to Fama and French (FF hereafter), firm size and book-to-market equity ratio are related to the systematic pattern of profitability and growth. They are potentially major sources of risk in return. These two mentioned variables are known in most studies as two specific market indicators that raise questions about the model. These findings diminished the credence of this model, and a new wave was formed in the development field of financial theories with the aim of explaining the causes of these special consequences.

Fama and French (2006) have studied for the three variables, B/M ratio, profitability, and investment effects, which are related to expected stock returns according to dividend discount model and the valuation equation. They confirm

* Jiao Wenting (Corresponding Author, email: wentingjiao@hotmail.com), IGR-IAE Université de Rennes 1, France; Jean-Jacques Lilti (email: jean-jacques.lilti@univ-rennes1.fr), IGR-IAE Université de Rennes 1, France.

the implications of valuation theory that high rates of investment are related to low expected returns when controlling B/M ratio and profitability, while controlling two other variables, high profitable stocks have higher expected stock returns.

Novy-Marx (2013) uncovers a positive relationship between profitable firms and expected returns. Haugen and Baker (1996) and Cohen *et al.* (2002) find that, controlling for book-to-market equity, average returns are positively related to profitability. Fairfield *et al.* (2003), Richardson and Sloan (2003) and Titman *et al.* (2004) show a negative relation between average returns and investment.

Especially, Hou *et al.* (2015) examine nearly 80 anomalies in the literature from January 1972 to December 2012 on U.S. market based on q-theory, but about one-half of the anomalies seem to have exaggerated their explaining power for average stock returns. They come to a conclusion that a four-factor model which includes the market factor, size factor, profitability factor and investment factor explains the cross-sectional average stock returns to a large extent, and outperforms the FF3F model and Carhart (1997) four-factor model.

Motivated by the 'Dividend Discount Model' and recent empirical findings on the strong profitability and investment effects in asset returns,[1] Fama and French (2014) propose a five-factor model that contains the market factor and factors related to size, book-to-market equity ratio, profitability and investment and tests the performance of the five-factor model on the U.S. market using the data from July 1963 to December 2013. They use three sets of factors[2] in order to examine whether the specifics of factor construction do have important impact on the results of the test of asset pricing models.

Their results suggest that a five-factor model performs better than the three-factor model of Fama and French (1993). But the five-factor model fails to capture low average returns on small stocks with high investment and low profitability. They also show that the model's performance is not affected by the way the factors are calculated. With two additional factors, their results also suggest that the value factor (HML) becomes redundant.

There is not much research on Fama-French five-factor model (FF5F model

[1] Recently, Novy-Marx (2013) identifies a proxy today that predicts expected earnings tomorrow - the profitability factor, which is strongly related to average stock return, and the investment factor was documented by Aharoni, Grundy, and Zeng (2013), see also Titman, Wei and Xie (2004). Although it has a high correlation with the value and profitability factors, the investment effect is perhaps half as strong, it is still reliable and significant.

[2] The three sets of factors are: 2x3 sorts on Size and B/M, or Size and OP, or Size and Inv; 2x2 sorts on Size and B/M, or Size and OP, or Size and Inv; and 2x2x2x2 sorts on Size, B/M, OP and Inv (see details in Fama and French, 2014). 2x3 sorts on Size and B/M is that the size and value factors independently sort stocks into two size groups and three B/M groups, and construct the size factor SMB and value factor HML as of FF3F model; the 2x3 sorts on Size and OP or Size and Inv are the same as Size and B/M except the sort for B/M groups are replaced by operating profitability or investment. 2x2 sorts method is similar as 2x3 sorts except that the stocks are all independently sorted into two groups. 2x2x2x2 sorts is that the size factor SMB equal weights high and low B/M, robust and weak OP, and conservative and aggressive Inv portfolio returns.

hereafter) outside of U.S. market. For instance, Fama and French (2015) perform the international tests of FF5F model in North America, Europe, Japan and Asia Pacific. Expected stock returns increase with the B/M ratio and profitability and decrease with investment for North America, Europe, and Asia Pacific, however, the average stock returns show little relation to profitability or investment factors.

Martinsa and Eid Jr (2015) test the performance of FF5F model on Brazilian market and find that FF5F model performs better than their previous work in three-factor model. The market factor, SMB and HML capture most of the variation in average returns in the time-series regressions, however, the profitability and investment factors have shown less explanatory power. Chiah, Chai, and Zhong (2015) investigate the FF5F model on Australia market, and the results indicate that the profitability and investment factors have significantly positive premium. FF5F model proved to be able to explain average stock returns better than FF3F model in Australia, in contrary to FF (2014) results, the value factor (HML) remains its explanatory power in the presence of the investment and profitability factors.

To the best of our knowledge, much literature that has examined the ability of FF3F model to predict the stock price movements in China. However, there is no such a work of applying FF5F model on Chinese stock market so far. This study constructs the profitability and investment factors and explores the Fama-Frech five-factor model on Chinese A-share stock market, providing the latest evidence of factor model and an update to the existing asset pricing literature on Chinese stock market. In addition, we compare the performance of FF5F model and FF3F model on Chinese A-share stock market; furthermore, we compare the empirical results between Chinese and U.S. stock market over the same time interval.

Following, we begin with a brief introduction of Chinese special features. Section 3 describes the data and construction of FF five factors and three sets of portfolios. The empirical results on Chinese stock market are presented in section 4, while the empirical results of FF5F model on U.S. stock market are shown in section 5. In section 6, we provide direction for further research. Conclusions of this study is in section 7.

2. Special features of Chinese stock market

The emerging empirical literature suggests that Chinese market has some special features, and it is inevitable to consider those special features if researchers want to have more accurate empirical results in China. Such as Chen (2004), Zhang and Xu (2013) and Hung *et al*. (2015) implement their researches considering one or several special features on Chinese stock market. We summarize two primary features which are also most frequently employed by literature.

Tradable and non-tradable shares: it is well known that China have substantial holdings of non-traded shares which means that these shares are not effectively valued.

Before April 2005, listed companies had two kinds of shares outstanding which are tradable shares and non-tradable shares (held by government agencies or government-related enterprises and were non-tradable in the public market). Chinese government started the share-structure reform in April 2005 to legally convert non-tradable shares to tradable shares. Almost all Chinese listed companies completed the reform by the end of 2006. Using only tradable shares to value weight stock returns is the right way to proceed.

Segmentation of Chinese stock market: more than 170 Chinese listed firms have issued multiple class shares which have the same cash flow and voting rights but are traded in different markets. Some of them have A-shares and B-shares, some have A-shares and H-shares and others have the A-shares and shares in other foreign markets. Since these shares share the same cash flow and voting rights, they usually have the same claim on the firm's book value of equity. Our research focus only on the Chinese A-share stock market, in order to obtain the book-to-market equity ratio per A-share of a company with multiple class shares, it is incorrect to divide the firm's total book value equity from its balance sheet by the total market value. Instead, the correct way is to calculate the book value equity per share divided by the A-share price.

On account of the special features of Chinese stock market, the value-weighted stocks are constructed using their tradable shares, and B/P ratio is used instead of B/M ratio in this study.

3. Data and methodology

3.1. Data[1]

Chinese A-share stocks contain both A-share stocks of Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE). We choose all the firms on Chinese A-share stock market excluding financial firms and firms with negative B/P ratio. In addition, a firm is eliminated if the relevant information is missing in a particular month or period, and the obvious errors are corrected manually.

For the period of July 2010 to May 2015 (59 months), monthly index prices and stock prices are obtained from Bloomberg, such as their market capitalization, book value per share, total shares outstanding and listed shares outstanding. Furthermore, risk-free rate (RF rate) is a typical proxy for the return on a one-month Treasury bill. But in China, the one-month Treasury bill has never been issued until February 2007. To keep it consistent with our sample period, we replace it with 'Three-Month Treasury Bill Rate (3M rate)' and the one-month risk-free rate is then equal to the 3M rate divided by three.

[1] All the original data on Chinese stock market is collected from Bloomberg, the construction of portfolios and factors, the regressions are done by us.

3.2. Construction of Fama-French five factors

Fama and French (2014) five-factor model contains the market factor and factors related to size, book-to-market equity ratio, profitability and investment:

$$R_{i,t} - R_f = a_i + b_i\,(R_{M,t} - R_f) + s_i SMB + h_i HML + r_i RMW + c_i CMA + e_{i,t} \quad (1)$$

Where, $R_{i,t} - R_f$ is the excess returns of portfolio i at time t; a is the constant; b, s, h, r and c are respectively the coefficient for corresponding factors; $e_{i,t}$ is the error term for portfolio i at time t. $R_{M,t} - R_f$ is the excess market returns (market factor); *SMB* and *HML* are factors related to size and B/P ratio. While *RMW* is the factor related to firm's profitability which is the difference between the returns on portfolios of robust (high) profitability and weak (low) profitability firms; and *CMA* is the one related to investment, which is the difference between the returns of conservative (low) investment portfolios and aggressive (high) investment portfolios.

Table 1 shows the annual number of firms that have available data of firm size, B/P ratio, OP and Inv on Chinese A-share stock market. The OP numbers are always less available than Inv numbers, and there are even few (less than 30) available OP numbers before 2009. To be more accurate and reduce the bias generated because of the very few firm numbers, the research period of this study is from 2010 to 2014.

The operating profitability (OP) for June of year t is calculated as annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses divided by book equity for the last fiscal year end in t-1. The Investment portfolios are formed on the change in total assets from the fiscal year ending in year t-2 to the fiscal year ending in t-1, divided by t-2 total assets at the end of each June.[1]

Table 1
Annual firm numbers which have available data of size, B/P ratio, OP and Inv

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Size	1105	1158	1175	1254	1352	1408	1662	1977	2189	2248	2224
B/P	929	1020	1008	1106	1218	1286	1500	1846	2069	2110	2040
OP	12	17	24	26	27	131	294	392	777	1043	2417
Inv	1154	1237	1346	1402	1624	1981	2241	2355	2361	2525	2525

Notes: Table 1 presents the annual firm numbers of six Size-B/P ratio (Panel A), six Size-OP portfolios (Panel B) and six Size-Inv portfolios (Panel C) from 2009 to 2014. Across the first row is the years. Across the first column of Panel A are the six Size- B/P portfolios (SL, SM, SH, BL, BM and BH), across the first column of Panel B are the six Size-OP portfolios (SW, SN, SR, BW, BN and BR), and across the first column of Panel C are the six Size-Inv portfolios (SC, SN, SA, BC, BN and BA).

[1] Details are available on Kenneth R. French's website.

The size breakpoint for year *t* is the median Chinese A-share equity at the end of June of year *t*. The construction of portfolios on OP and investment are similar with that of portfolios on book-to-price ratio. At the end of each June, the firms are sorted into three OP portfolios based on the breakpoints of the 30th and 70th percentiles, and the three investment portfolios are formed in the same way using breakpoints-30th and 70th percentiles.

Similar to FF three factors that are constructed using the 6 value-weighted portfolios formed on size and book-to-market equity ratio,[1] the Fama-French five factors are constructed on Chinese A-share stock market using the 6 value-weight portfolios formed on size and book-to-price (Size-B/P portfolios), the 6 value-weight portfolios formed on size and operating profitability (Size-OP portfolios), and the 6 value-weight portfolios formed on size and investment (Size-Inv portfolios). The Size-OP portfolios and Size-Inv portfolios are formed in the same way as the Size-B/M portfolios, except the second sort variable that is operating profitability or investment. At the end of each June, the intersections of two portfolios formed on size - small (S) and big (B), and 3 portfolios formed on profitability – weak profitability (W), neutral profitability (N) and robust profitability (R) are constructed into six "Size-OP" portfolios: SW, SN, SR, BW, BN and BR.[2] Similarly, the "Size-Inv" portfolios, which are also constructed at the end of each June, are the intersections of 2 portfolios formed on size and 3 portfolios formed on investment- conservative investment (C), neutral investment (N) and aggressive investment (A). Thus, the six Size-Inv portfolios are constructed: SC, SN, SA, BC, BN and BA.[3]

In FF5F model, the market factor which is the excess market return computed as the difference between the value-weighted returns of all A-shares and the risk-free rate, and value factor remains the same as in three-factor model, while the size factor SMB needs to be reconstructed with profitability and investment factors, which is the average return on the nine small stock portfolios minus the average return on the nine big stock portfolios. The two additional factors are directed at capturing the

[1] In June of each year *t*, the stocks are sorted into two size groups: small firms (S) and big firms (B), according to their total market value. Independently stocks are sorted into three B/P groups instead of B/M ratio at each December of year *t*-1: low B/P ratio (L), medium B/P ratio (M) and high B/P ratio (H) firms, according to the breakpoint 30% and 70% of values of B/P equity for all the stocks. The intersections of these groups are constructed into six portfolios: small low (SL), small medium (SM), small high (SH), big low (BL), big medium (BM), and big high (BH) portfolios. The value-weighted monthly returns are calculated from July of year *t* to June of year *t*+1, during which the portfolios remain the same, and the portfolios are reconstructed in July of year *t*+1.

[2] Portfolio SW contains firms with small size and weak profitability, SN contains firms with small size and neutral profitability, SR contains firms with small size and robust profitability, similarly to BW, BN and BR, which contains firms with big size and weak profitability, neutral profitability and robust profitability separately.

[3] Portfolio SC contain firms with small size and conservative investment, SN contains firms with small size and neutral investment, SA contains firms with small size and aggressive investment, similarly to BC, BN and BA portfolios.

profitability and investment patterns, which are indicated by RMW and CMA. RMW is the difference between returns on portfolios with robust (SR and BR) and weak profitability (SW and BW), and CMA is the difference between returns on portfolios of the stocks of low (SC and BC) and high investment (SA and BA) firms, which is called conservative and aggressive, separately.

FF (2014) performs the regressions using 25 Size-B/M Portfolios, 25 Size-OP portfolios and 25 Size-Inv portfolios. Following the same method, we firstly construct the three sets of 25 portfolios on Chinese A-share stock market. However, there are portfolios which contain no firms or less than five firms. So we choose to sort portfolios into six Size-B/P portfolios, six Size-OP portfolios and six Size-Inv portfolios, the annual number of firms in the three sets of portfolios are displayed in Table 2. The small size groups of Size-OP portfolios relatively have less stocks than that of big size groups and the SR portfolio has no stocks in year 2009 and only one stock in SN portfolio. Therefore, because of the lack of data on firm numbers of Chinese A-share stock market, the interval of our research to processing FF5F model is from July 2010 to May 2015 (59 months).

Table 2
Annual number of stocks in three sets of six value-weighted portfolios

Year	2009	2010	2011	2012	2013	2014
Panel A: Size-B/P portfolios						
SL	193	200	227	265	267	254
SM	280	286	391	446	488	510
SH	192	192	241	301	350	322
BL	206	206	288	342	395	392
BM	252	257	296	363	396	360
BH	207	215	275	307	313	324
Panel B: Size-OP portfolios						
SW	5	11	22	92	154	488
SN	1	7	7	52	107	483
SR	0	5	9	7	13	146
BW	34	76	95	140	157	233
BN	51	104	147	210	255	468
BR	28	57	93	87	121	403
Panel C: Size-Inv portfolios						
SC	328	374	392	404	457	465
SN	262	288	310	380	412	444
SA	105	167	289	314	258	244
BC	187	203	244	277	274	268
BN	301	373	468	492	496	479
BA	206	251	276	330	358	409

Notes: Table 2 presents the annual firm numbers of six value-weighted Size-B/P portfolios (Panel A), six value-weighted Size-OP portfolios (Panel B) and six Size-Inv portfolios (Panel C) from 2009 to 2014. In the first column of each panel presents correspondingly the six portfolios.

4. Empirical results

The empirical results of FF5F model on Chinese A-share stock market during the period July 2010 to May 2015 are reported in this section. Furthermore, we also provide the empirical results of FF3F model over the same time interval for comparison.

Table 3 reports the summary statistics of FF five factors and their correlation coefficients. Panel A is the summary statistics of FF five factors on Chinese stock market, the mean, standard deviation, standard error, sample variance, etc. Panel B is the correlation coefficients among the FF five factors, the profitability and investment factors are both positively related to market factor with low correlation coefficients (0.0418 and 0.1190) and negatively related to size factor (-0.2227 and -0.2199). RMW is negatively related to value factor HML (-0.0217), while CMA is positively and relatively highly related to HML with correlation coefficients of 0.4621. And the correlation coefficients between RMW and CMA is -0.3121.

Table 3
Summary statistics of Fama-French five factors (period: July 2010-May 2015)

	RM-RF	SMB	HML	RMW	CMA
Panel A: Summary statistics of FF five Factors					
Mean	-0.0014	0.0106	-0.0059	-0.0061	0.0008
Standard error	0.0084	0.0038	0.0046	0.0036	0.0025
Median	-0.0024	0.0117	-0.0075	-0.0128	0.0001
S.D	0.0646	0.0294	0.0355	0.0273	0.0196
Sample Variance	0.0042	0.0009	0.0013	0.0007	0.0004
Kurtosis	0.2068	6.4386	5.9071	-0.4204	-0.2635
Skewness	0.1439	-1.2015	0.5658	0.3288	0.2217
Panel B: Correlation coefficients among FF five factors					
RM-RF	1				
SMB	0.1165	1			
HML	-0.0013	-0.6970	1		
RMW	0.0418	-0.2227	-0.0217	1	
CMA	0.1190	-0.2199	0.4621	-0.3121	1

Notes: In Table 3, Panel A summarizes the mean, standard deviation and standard error of FF 5 factors, and Panel B is the correlation coefficients among those factors.

Table 4 presents the average excess return of six value-weighted Size-B/P portfolios (Panel A), six value-weighted Size-OP portfolios (Panel B) and six value-weighted Size-Inv portfolios (Panel C). It is apparent that there is the size effect, the big size portfolios always have lower returns than the small size portfolios in each panel. Across the OP groups in Panel B, it is strange that the robust portfolios have lower returns than weak portfolios, perhaps the few data of OP cause the bias. Across the Inv

groups in Panel C, it seems the neutral investment portfolios have the highest excess returns (0.0158 for small size and neutral investment portfolio, 0.0050 for big size and neutral investment portfolio) than the conservative and aggressive investment portfolios.

Table 4
Average monthly excess returns for portfolios formed on Size-B/M, Size-OP and Size-Inv

Panel A: Excess returns of size-B/P portfolios			
	L	M	H
Small	0.0236	0.0231	0.0207
Big	0.0151	0.0092	0.0061
Panel B: Excess returns of Size-OP portfolios			
	W	N	R
Small	0.0172	0.0170	0.0081
Big	0.0046	0.0082	0.0016
Panel C: Excess returns of Size-Inv portfolios			
	C	N	A
Small	0.0136	0.0158	0.0121
Big	0.0033	0.0050	0.0031

Notes: In Table 4, the average excess returns of six Size-B/M portfolios, Size-OP portfolios and Size-Inv portfolios are presented in panel A, B and C respectively. Across the columns are the two size groups and across the rows are the three B/M groups, three OP groups and three Inv groups, respectively.

The time-series regressions results of the three sets portfolios are demonstrated in Table 5, Panel A, Panel B and Panel C are the results for the six value-weighted Size-B/P portfolios, Size-OP portfolios and Size-Inv portfolios, separately. All the t-statistics reported are corrected for heteroscedasticity and autocorrelation using the Newey-West estimator with five-lags. The coefficients of excess market return are similar for all the three sets of portfolios, the coefficients of market factor are always around 1 and highly significant at 5% confident level.

Table 5
Time-series regressions of three sets of portfolios on FF5F model, Chinese A-share stock market
Regression: $R_{i,t} - R_f = a_i + b_i\,(R_{M,t} - R_f) + s_i SMB + h_i HML + r_i RMW + c_i CMA + e_{i,t}$

Panel A: Time-series regressions of six value-weighted Size-B/P portfolios						
	Book-to-Price (B/P) ratio					
	L	M	H	L	M	H
		a			t (*a*)	
S	0.0102	0.0105	0.0108	7.4308	4.4938	5.6696
B	0.0124	0.0091	0.0118	6.8522	3.8634	6.4458
		b			t (*b*)	
S	0.9637	0.9964	0.9703	41.1513	36.2183	35.8284
B	0.8361	1.0214	0.8295	27.6969	28.5669	20.8687
		s			t (*s*)	
S	1.0039	0.9383	0.8557	15.9153	16.3385	11.3131

Panel A: Time-series regressions of six value-weighted Size-B/P portfolios						
	Book-to-Price (B/P) ratio					
	L	M	H	L	M	H
B	-0.1946	-0.2434	-0.0465	-2.8370	-2.4971	-0.5165
		h			t (*h*)	
S	-0.5849	-0.5197	-0.2689	-6.2171	-6.9004	-3.9751
B	-0.9928	-0.6007	0.6912	-12.4860	-7.2244	5.1532
		r			t (*r*)	
S	-0.0695	-0.1448	-0.0617	-1.1264	-1.9122	-0.7331
B	0.0188	-0.0456	0.0110	0.2597	-0.6538	0.1965
		c			t (*c*)	
S	0.2515	0.1051	0.3064	2.6156	1.0264	2.3582
B	0.1114	0.2802	0.0565	1.2338	3.4851	0.5584
		Adj. R square			Residual standard error	
S	0.9782	0.9714	0.9606	0.0120	0.0137	0.0148
B	0.9625	0.9609	0.9513	0.0122	0.0136	0.0134
Panel B: Time-series regressions of six Size-OP portfolios						
	Operating Profitability					
	W	N	R	W	N	R
		a			t(*a*)	
S	0.0012	0.0020	-0.0018	0.5498	0.4592	-1.0778
B	-0.0009	0.0028	0.0021	-0.5008	1.4503	0.6190
		b			t (*b*)	
S	1.0075	1.0408	1.0492	35.8879	20.1490	31.7018
B	1.1300	1.0253	1.0883	26.7879	34.3991	25.3012
		s			t (*s*)	
S	1.1712	0.9800	1.5637	13.2828	5.5382	18.1679
B	0.2480	0.2628	-0.1445	2.3517	3.3480	-1.1030
		h			t (*h*)	
S	-0.4482	-0.7244	-0.2020	-4.5108	-3.9157	-1.9726
B	-0.4560	-0.5496	-0.7022	-4.4978	-5.9760	-6.6825
		r			t (*r*)	
S	-0.3429	-0.2601	1.1319	-4.6763	-2.5519	15.7233
B	-0.2265	-0.1198	0.2987	-3.5011	-1.3591	3.4009
		c			t (*c*)	
S	0.2644	0.1610	0.5398	2.4244	0.7310	4.2483
B	0.4613	0.0414	0.1860	5.8956	0.3561	1.3955
		Adj. R square			Residual standard error	
S	0.9720	0.9301	0.9653	0.0143	0.0238	0.0172
B	0.9643	0.9640	0.9486	0.0150	0.0139	0.0172
Panel C: Time-series regressions of six Size-Inv portfolios						
	Investment					
	C	N	A	C	N	A
		a			t (*a*)	
S	-0.0017	0.0018	-0.0016	-1.0068	0.8186	-0.9026
B	-0.0029	0.0003	-0.0030	-1.5573	0.1566	-1.5819
		b			t (*b*)	
S	1.0274	1.0548	1.0708	35.4151	33.9728	31.3516
B	1.1116	1.0704	1.0683	27.7982	32.5243	27.9726

Panel C: Time-series regressions of six Size-Inv portfolios						
	Investment					
	C	N	A	C	N	A
		s			t (*s*)	
S	1.1998	1.1137	1.2837	14.5888	14.7519	18.0777
B	0.4978	0.3165	0.4139	5.5174	4.7070	4.0713
		h			t (*h*)	
S	-0.5135	-0.5369	-0.2393	-4.8437	-6.2005	-2.2282
B	-0.3527	-0.4482	-0.6269	-3.2055	-5.6888	-5.9485
		r			t (*r*)	
S	-0.0871	-0.0789	-0.1329	-0.9804	-0.8737	-1.3784
B	0.0023	-0.0330	0.0481	0.0249	-0.5768	0.5404
		c			t (*c*)	
S	0.5330	-0.0210	-0.7507	3.2129	-0.2007	-4.8137
B	0.4623	0.0445	-0.2540	3.7475	0.4260	-1.9740
		Adj. R square		Residual standard error		
S	0.9739	0.9713	0.9722	0.0141	0.0149	0.0148
B	0.9595	0.9680	0.9607	0.0160	0.0135	0.0157

Notes: Table 5 presents the time-series regressions results of six value-weighted Size-B/P portfolios, six value-weighted Size-OP portfolios and six value-weighted Size-Inv portfolios on FF5F model on Chinese A-share stock market during the period July 2010 to May 2015 (59 months). In each panel, the regression intercept *a*, the regression coefficients *b*, *s*, *h*, *r* and *c* of market factor, size factor, value factor, profitability factor and investment factor, adjusted R-square are respectively presented in the left part of the table, the corresponding t-statistics corrected for heteroscedasticity and autocorrelation using the Newey-West estimator with five-lags and residual standard error are presented in the right part. Panel A is the regressions on six value-weighted Size-B/P portfolios, across the columns are the two size groups (Small and Big) and across the rows are the three B/P groups (Low, Medium and High). Panel B is the regression results of six Size-OP portfolios, same as Panel A, across the columns are the two size groups and across the rows are the three OP groups (Weak, Neutral and Robust). Panel C is the regression results of six Size-Inv portfolios, across the columns are the two size groups and across the rows are the three Investment groups (Conservative, Neutral and Aggressive). Numbers in bold are the t-stats which are significant at 5% confidence level.

In Panel A, the intercepts are significantly distinguishable from zero, which means that FF5F model may not completely capture the expected returns of Size-B/P portfolios. The regression coefficients of size factor SMB are all significant at 5% confidence level except the portfolio of big size and high B/P ratio, and the sign of slopes indicate that portfolios of small size have returns that are positively related to size factor, while returns of big size portfolios are negatively related to size factor. The increase slopes of HML (*h*) across the size groups state that return of portfolios are positively related to B/P ratio. However, only one of the coefficients of profitability factor is marginally significant, and three out of six coefficients of investment factor are significant at 5% confidence level.

In Panel B, the regression results for market factor, size factor and value factor are fairly the same, the big difference is in profitability factor RMW, all coefficients are

significant BN and across size groups, more profitability portfolios tend to have higher excess returns. Three out of six coefficients of investment factor CMA are significant, two are the Weak portfolios (0.2644 for portfolio SW with t-stats 2.4244 and 0.4613 for portfolio BW with t-stats 5.8956) and one is the portfolio SR (coefficients 0.5398 with s-tats 4.2483). In Panel C, the regression results of market factor, SMB and HML factor are all satisfactory significant. The results for RMW is like Panel A, none of which is significant. And for the CMA factor, the result is similar as six Size-OP portfolios in Panel B, three coefficients of portfolio SC, BC and SA are significant. And the investment effect is similar to the results of 25 Size-Inv portfolios in (Fama and French, 2014), which the aggressive investment portfolios have lower excess returns.

To summarize, market beta always plays an important role in explaining time-series variation of excess portfolio returns. For all the three sets of portfolios, there exists size effect that the excess returns are negatively related to firm size. And the value effect exists only in Size-B/P portfolios not in Size-OP and Size-Inv portfolios. For RMW, the coefficients are only significant in the Size-OP portfolios, but not in two other groups of portfolios. As to the CMA factor, the portfolios which have the weak profitability in Size-OP portfolios and portfolios which have the conservative investment in Size-Inv portfolios have positive coefficients, in addition, there is positive coefficient for the small size-robust OP portfolio and negative coefficient for the small size-aggressive investment portfolio. However, for the Size-B/M portfolios, the CMA significant coefficients are relatively dispersive. FF5F model explains the Size-OP portfolios better than the other two sets of portfolios.

In order to investigate whether profitability and investment factors have additional explanatory power beyond FF3F model and compare the performance of both FF3F model and FF5F model on Chinese A-share stock market during our research period, we implement the time-series regressions of the same three sets portfolios (six value-weighted Size-B/P portfolios, six value-weighted Size-OP portfolios and six value-weighted Size-Inv portfolios) on FF3F model over the same time interval (July 2010-May 2015). The regressions results are presented in Table 6.

In Panel A of Table 6, (Five out of six) Loadings on SMB and HML are highly significant at 5% confidence level, and there exists stable size and value effect. In comparison with the results of FF5F model (Panel A of Table 5), the explanatory power of size and value factor are much alike with or without the presence of profitability and investment factors. Though three out of six loadings on CMA are statistically significant, comparing the adjusted R-squares, FF5F model seems not perform better than FF3F model during the research period. Thus profitability and investment factors do not increase the explanatory power of FF three factors when regressions are implemented for six value-weighted Size-B/P portfolios.

Table 6

Time-series regression of three sets portfolios on FF3F model, Chinese A-share stock market

Regression: $R_{i,t} - R_f = a_i + b_i (R_{M,t} - R_f) + s_i SMB + h_i HML + \varepsilon_{i,t}$

Panel A: Time-series regression of six value-weighted Size-B/P portfolios						
	Book-to-Price (B/P) ratio					
	L	M	H	L	M	H
		a			t (*a*)	
S	0.0113	0.0113	0.0112	7.4842	4.5837	6.1412
B	0.0123	0.0092	0.0123	6.2322	3.3146	6.4849
		b			t (*b*)	
S	0.8979	0.9231	0.9059	32.6701	27.0157	32.2014
B	0.8504	1.0340	0.8424	27.3918	22.4104	22.1472
		s			t (*s*)	
S	0.9057	0.8874	0.8548	27.9738	15.5660	19.8422
B	-0.1441	-0.1149	-0.0931	-3.4693	-1.3686	-2.7201
		h			t (*h*)	
S	-0.4025	-0.3497	-0.0262	-5.0751	-4.3756	-0.4383
B	-0.9630	-0.4761	0.6607	-15.1937	-5.5671	7.1594
		Adj. R square			Residual standard error	
S	0.9803	0.9782	0.9746	0.0114	0.0120	0.0119
B	0.9623	0.9545	0.9542	0.0122	0.0147	0.0130
Panel B: Time-series regression of six value-weighted Size-OP portfolios						
	Profitability					
	W	N	R	W	N	R
		a			t (*a*)	
S	0.0038	0.0042	-0.0022	1.3466	0.7791	-0.5303
B	0.0000	0.0027	0.0010	-0.0179	1.5449	0.3059
		b			t (*b*)	
S	0.9236	0.9733	1.0657	24.3001	17.2826	17.4507
B	1.0967	0.9896	1.1164	19.0453	34.3179	20.3752
		s			t (*s*)	
S	1.0674	0.8611	0.7540	7.9772	5.1362	5.5995
B	0.4230	0.3508	-0.1688	3.8493	7.9956	-1.5525
		h			t (*h*)	
S	-0.2302	-0.5825	-0.4059	-1.8362	-3.4193	-2.2086
B	-0.1523	-0.4188	-0.7060	-1.3302	-4.9840	-6.5449
		Adj. R square			Residual standard error	
S	0.9456	0.9158	0.8514	0.0200	0.0261	0.0356
B	0.9520	0.9698	0.9388	0.0174	0.0127	0.0188
Panel C: Time-series regressions of six value-weighted Size-Inv portfolios						
	Investment					
	C	N	A	C	N	A
		a			t (*a*)	
S	-0.0002	0.0024	-0.0015	-0.1061	1.1784	-0.7269
B	-0.0025	0.0000	-0.0038	-1.3087	0.0310	-2.4503
		b			t (*b*)	
S	0.9521	0.9745	0.9667	34.0437	37.7947	50.2415
B	1.0796	1.0393	1.0323	26.3027	37.0603	31.6716

	Panel C: Time-series regressions of six value-weighted Size-Inv portfolios					
	Investment					
	C	N	A	C	N	A
		s			t (*s*)	
S	1.1180	0.9787	1.0170	19.8524	22.2040	16.8657
B	0.5370	0.3491	0.3535	8.8230	7.1627	5.0630
		h			t (*h*)	
S	-0.2089	-0.4312	-0.3873	-2.3319	-5.7192	-3.2013
B	-0.1090	-0.3505	-0.6595	-0.9868	-4.6239	-7.1360
		Adj. R square			Residual standard error	
S	0.9701	0.9778	0.9508	0.0151	0.0131	0.0197
B	0.9595	0.9742	0.9621	0.0160	0.0121	0.0155

Notes: Table 6 reports the time-series regression of six value-weighted Size-B/P portfolios, six value-weighted Size-OP portfolios and six value-weighted Size-Inv portfolios on FF3F model on Chinese A-share stock market, across the columns are the two size groups and across the rows are the three B/P ratio groups. The left part of the table is the coefficients obtained from the regressions (*b* is the intercept, *b*, *s* and *h* are the regression slopes of FF three factors separately) and adjusted R-square. Correspondingly, the right part of the table is t-statistics corrected for heteroscedasticity and autocorrelation using the Newey-West estimator and the standard error of the estimation $\varepsilon_{i,t}$. Numbers in bold are the t-statistics which are significant at 5% confidence level.

Comparing Panel B of Table 5 with Table 6, the presence of RMW and CMA factors captures more time-series variation of average excess portfolio returns, FF5F model explains average excess returns of six Size-OP portfolios better than FF3F model regarding to the adjusted R-squares. Though four out of six loadings on CMA are significant in Panel C of Table 5, the values of adjusted R-squares are very close for FF3F model and FF5F model. We cannot tell the big difference between the ability of two models in capturing the time-series variation of returns of six value-weighted Size-Inv portfolios.

In general, comparing with the empirical results of FF3F model, especially for the adjusted R-square term, the FF5F model does not improve a lot and is only slightly better in explaining the six value-weighted Size-OP portfolios.

5. Fama-French five-factor model on U.S. stock market

We implement the same time-series regressions on FF5F model as reported in Table 5 using data of U.S. market. The three sets of portfolios are downloaded directly from Kenneth R. French's website,[1] and the time-series regression results are reported in Table 7. The slopes of excess market return are always close to 1, and strongly positive for all three sets of portfolios of both countries. The slopes of SMB are strongly positive for small stocks and slightly positive or negative for big stocks, there exists size effect on both stock markets.

[1] Since the data amount is huge, it is available upon request.

Table 7

Time-series regressions of three sets portfolios on FF5F model on U.S. stock market

Regression: $R_{i,t} - R_f = a_i + b_i (R_{M,t} - R_f) + s_i SMB + h_i HML + r_i RMW + c_i CMA + e_{i,t}$

Panel A: Time-series regressions on six Size-B/M portfolios						
	Book-to-Market (B/M) ratio					
	L	M	H	L	M	H
		a			t (*a*)	
S	-0.2123	-0.0328	0.2391	-1.2440	-0.3040	1.4394
B	0.0339	-0.0369	0.0197	0.2766	-0.2794	0.1673
		b				
S	0.9867	1.0036	0.8091	18.0426	37.3893	18.0305
B	1.0715	1.1142	1.0577	30.4708	21.6453	42.6438
		s				
S	0.7036	0.7975	0.4312	13.4733	17.5148	5.5548
B	0.2231	0.1980	0.1550	4.6577	3.4748	2.2473
		h				
S	-0.2137	0.2549	0.3912	-2.0573	4.1878	3.8325
B	-0.2152	0.0582	0.6456	-4.9748	0.9063	9.2306
		r				
S	-0.7327	-0.1351	-0.3846	-5.4871	-2.2599	-3.0270
B	-0.1506	-0.0322	0.0110	-2.7377	-0.3318	0.1531
		c				
S	-0.3047	-0.2155	-0.0974	-2.7655	-2.3334	-0.7657
B	-0.2294	-0.0887	-0.1666	-2.3567	-1.1923	-1.4554
		Adj. R square			Residual standard error	
S	0.9517	0.9733	0.9084	1.152	0.7979	1.251
B	0.967	0.9591	0.958	0.7727	0.8809	0.8895
Panel B: Time-series regressions on Size-OP portfolios						
	Operating Profitability					
	W	N	R	W	N	R
		a			t (*a*)	
S	-0.0188	0.0898	-0.0396	-0.3438	1.1708	-0.4349
B	-0.0842	0.0989	-0.0640	-0.7461	2.2880	-1.9871
		b				
S	0.9812	0.9853	1.0646	81.0285	51.1117	32.7726
B	1.1136	0.9412	1.0298	27.2225	50.5000	97.2971
		s				
S	0.8675	0.9675	0.9317	33.4687	20.9395	14.3934
B	-0.0693	-0.0541	-0.1339	-1.0857	-1.2950	-4.5316
		h				
S	-0.1143	0.2669	0.2011	-4.5007	6.3486	3.9980
B	0.2443	0.0392	-0.0708	4.5818	1.0984	-2.7060
		r				
S	-0.6348	0.2597	0.4475	-18.4610	5.1374	9.5450
B	-0.5864	-0.1016	0.3304	-8.4796	-2.7847	12.2607
		c				
S	0.0768	-0.0627	-0.1247	1.6662	-1.0611	-1.5351
B	-0.2849	0.1389	-0.0839	-3.0221	2.6995	-2.0856
		Adj. R square			Residual standard error	

Panel B: Time-series regressions on Size-OP portfolios						
	Operating Profitability					
	W	N	R	W	N	R
S	0.9945	0.9851	0.9826	0.3928	0.5772	0.629
B	0.9775	0.9863	0.9903	0.6871	0.4101	0.3345
Panel C: Time-series regressions on Size-Inv portfolios						
	Investment					
	C	N	A	C	N	A
		a			t (*a*)	
S	-0.0540	0.1144	0.0071	-0.8730	2.3620	0.1573
B	0.0831	-0.0428	0.0259	1.1236	-0.7299	0.4733
		b				
S	1.0880	0.9710	0.9681	81.6853	35.9423	47.1125
B	0.9326	0.9912	1.0521	32.4959	48.6599	77.8118
		s				
S	0.8760	0.8942	0.9702	19.7427	26.8312	30.5318
B	-0.0835	-0.0167	-0.1786	-2.1632	-0.9118	-5.7904
		h				
S	-0.0163	0.1754	0.0238	-0.3663	5.4018	0.7234
B	-0.0260	0.0615	-0.0658	-0.4450	1.3401	-1.4661
		r				
S	-0.2339	0.1339	-0.2181	-5.6108	3.5684	-4.7274
B	-0.0001	0.0573	-0.0174	-0.0013	1.1884	-0.3659
		c				
S	0.3567	0.1159	-0.4264	5.2777	2.0770	-7.7210
B	0.6429	0.1819	-0.5734	7.3145	3.4479	-8.1165
		Adj. R square			Residual standard error	
S	0.9908	0.9879	0.9907	0.5122	0.5121	0.4829
B	0.9764	0.9872	0.9799	0.5425	0.4094	0.5188

Notes: Table 7 presents the time-series regressions results of six value-weighted Size-B/P portfolios, six value-weighted Size-OP portfolios and six value-weighted Size-Inv portfolios on FF5F model on U.S. stock market. In each panel, the regression intercept *a*, the regression coefficients *b*, *s*, *h*, *r* and *c* of market factor, size factor, value factor, profitability factor and investment factor, adjusted R square are respectively presented in the left part of the table, the corresponding t-statistics corrected for heteroscedasticity and autocorrelation using the Newey-West estimator and residual standard error are presented in the right part. Panel A is the regressions on six Size-B/M portfolios, across the columns are the two size groups (Small and Big) and across the rows are the three B/M groups (Low, Medium and High). Panel B is the regression results of six Size-OP portfolios, same as Panel A, across the columns are the two size groups and across the rows are the three OP groups (Weak, Neutral and Robust). Panel C is the regression results of six Size-Inv portfolios, across the columns are the two size groups and across the rows are the three Investment groups (Conservative, Neutral and Aggressive). Numbers in bold are the t-stats which are significant at 5% confidence level.

We next compare between each panels of Table 5 (Chinese market) and Table 7 (U.S. market). Comparing 'Panel A' of both tables, there exists value effect on both stock markets. As to the profitability factor RMW, four out of six loadings on RMW are statistically significant and especially all three loadings on small portfolios are negative

significant in U.S.; while none of the loadings on RMW is significant at 5% confidence level in China. The slopes on RMW and CMA do not show clearly relationship between portfolio returns and profitability or investment.

Comparing Panel B, the regression results of six Size-OP portfolios are approximately close. All the slopes on profitability factor RMW are strongly significant, among which the slopes are strongly negative for the weak OP portfolios (low profitability) and strongly positive for the robust OP portfolios (high profitability) on U.S. stock market, while five out of six loadings on RMW are significant on Chinese A-share stock market with the same pattern as U.S. market. It is noticed that the loadings on CMA factor are significant only for the three big size portfolios in U.S., and the slopes are not related to portfolios profitability. We find no apparent value effect when regressing the six Size-OP portfolios on FF5F model on both stock markets.

The regression results for the six Size-Inv portfolios are quite different comparing Panel C of both markets. First, most loadings on HML lose their significance (only one out of six is significant) in U.S.; while all the portfolios have strong negative exposure to HML on Chinese stock market but no value effect. Then the small size portfolios always have significant exposure to RMW in U.S.; while none of the loadings on RMW is significant on Chinese A-share stock market for the Size-Inv portfolios. Last, CMA factor explains more time-series variation of excess stock returns in U.S. than in China, since all the loadings on CMA are significant while only loadings of conservative and aggressive portfolios are significant on Chinese stock market. The slopes of conservative (low investment) portfolios are positive and the slopes of aggressive (high investment) portfolios are negative on both markets, which is consistent with FF's expected pattern.

Furthermore, the adjusted R-squares of six Size-OP portfolios and six Size-Inv portfolios are slightly bigger in U.S than that in China, which indicates that FF5F model explains the two sets of portfolios slightly better on U.S. stock market than on Chinese A-share stock market. In addition, the profitability factor and investment factor are able to capture partially time-series variation of all three sets of portfolios' returns on U.S. stock market, while on Chinese stock market, the profitability factor seems to be an explanatory factor only for the six Size-OP portfolios, where the portfolios are sorted by OP.

6. Discussion

Though having less explanatory power than on U.S. stock market, FF3F model is able to capture more than 90% of time-series variation of average excess stock returns on Chinese A-share stock market during the research period. However, it remains less than 10% of average returns that cannot be explained by FF3F model. This study

investigates two augmented factors proposed by FF recently, profitability factor and investment factor, but we find no significant improvement of FF5F model compared to FF3F model except for the six value-weighted Size-OP portfolios.

Since there exist several special features on Chinese stock market, the determinants for asset returns might be different from those in developed countries such as U.S. One possible extension of this study is to consider alternative factors instead of profitability and investment factors, such as factors related to macroeconomic variables (GDP growth, money supply and interest rate, etc.) and industry factors (such as industrial production), or particularly country factors considering Chinese special characteristics (such as policy of Chinese government), which is beyond the scope of this study but is our research in process.

7. Conclusions

To investigate the explanatory power of profitability and investment factors, we apply FF5F model on Chinese A-share stock market during the period July 2010 to May 2015 and construct three sets of portfolios, six value-weighted Size-B/P portfolios, six value-weighted Size-OP portfolios and six value-weighted Size-Inv portfolios. For all the three sets of portfolios, market factor, size factor and value factor have strong explanatory power for the expected excess returns in the presence of profitability and investment factors. There always exists size effect that the excess returns are negatively related to firm size, and the value effect exists only in Size-B/P portfolios. The CMA factor does have explanatory power for certain portfolios in all three sets of portfolios. However, the RMW factor seems not so convincible, profitability effect exists only in six Size-OP portfolios, which excess returns are positively related to firms' profitability.

In comparison with FF3F model, in the presence of profitability factor RMW and investment factor CMA, the value factor HML has been well explained in all three sets of portfolios. However, augmenting FF3F model with profitability and investment factors seems not capture more time-series variation of average excess stock returns than FF3F model alone except for the six value-weighted Size-OP portfolios. Overall, we cannot draw conclude that FF5F model performs better than FF3F on Chinese A-share stock market during the research period July 2010 to May 2015.

We also implement the regressions over the same period using U.S. data. The empirical results reveal that FF5F model explain time-series variation of average excess stock returns slightly better on U.S. stock market than on Chinese A-share stock market. As for the two new factors, profitability factor and investment factor are able to capture partially time-series variation of all three sets of portfolios' returns on U.S. stock market, while on Chinese stock market, the profitability factor seems to be an explanatory factor only for the six Size-OP portfolios. Thus we propose to augment

FF3F model with factors considering special features of Chinese stock market for future research.

References

Ahlgren, N., Sjö, B., & Zhang, J. (2009). Panel cointegration of Chinese A and B shares. *Applied Financial Economics*, *19*(23), 1859-1871.

Carhart, M. M. (1997). On persistence in mutual fund performance. *The Journal of Finance*, *52*(1), 57-82.

Chen, C., Hu, X., Shao, Y., & Wang, J. (2015). Fama-French in China: Size and value factors in Chinese stock returns. University of Hong Kong Working Paper.

Chen, G.-M., Lee, B.-S., & Rui, O. (2001). Foreign ownership restrictions and market segmentation in China's stock markets. Journal of Financial Research, *24*(1), 133-155.

Chen, Z. (2004). Cross-sectional variations and three factors asset pricing model: Empirical evidences from China A share market. Chinese Journal of Management Science, 12(6), 12-17.

Chiah, M., Chai, D., & Zhong, A. (2015). A better model? An empirical investigation of the Fama-French five-factor model in Australia. In 2015 Financial Markets & Corporate Governance Conference.

Cohen, R. B., Gompers, P. A., & Vuolteenaho, T. (2002). Who underreacts to cash-flow news? Evidence from trading between individuals and institutions. *Journal of Financial Economics*, *66*(2-3), 409-462.

Drew, M. E., Naughton, T., & Veeraraghavan, M. (2003). Firm size, book-to-market equity and security returns: Evidence from the Shanghai Stock Exchange. *Australian Journal of Management*, *28*(2), 119-139.

Eun, C. S., & Huang, W. (2007). Asset pricing in China's domestic stock markets: Is there a logic? *Pacific-Basin Finance Journal*, *15*(5), 452-480.

Fairfield, P. M., Whisenant, J.S., & Yohn, T. L. (2003). Accrued earnings and growth: Implications for future profitability and market mispricing. *The Accounting Review*, *78*(1), 353-371.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, *33*(1), 3-56.

Fama, E. F., & French, K. R. (2006). Profitability, investment and average returns. *Journal of Financial Economics*, *82*(3), 491-518.

Fama, E. F., & French, K. R. (2014). A five-factor asset pricing model, Fama-Miller Working Paper (September).

Fama, E. F., & French, K. R. (2015). International tests of a five-factor asset pricing model. Fama-Miller Working Paper.

Fernald, J., & Rogers, J. H. (2002). Puzzles in the Chinese stock market. *Review of Economics and Statistics*, *84*(3), 416-432.

Fung, H.-G., Lee, W., & Leung, W. K. (2000). Segmentation of the A-and B-share Chinese equity markets. Journal of Financial Research, *23*(2), 179-195.

Gibbons, M. R., Ross, S. A., & Shanken, J. (1989). A test of the efficiency of a given portfolio. *Econometrica*, *57*(5) 1121-1152.

Haugen, R. A., & Baker, N. L. (1996). Commonality in the determinants of expected stock returns. *Journal of Financial Economics*, *41*(3), 401-439.

Hou, K., Xue, C., & Zhang, L. (2015). Digesting anomalies: An investment approach. *Review of Financial Studies*, *28*(3), 650-705.

Hung, C.-H. D., Chen, Q., & Fang, V. (2015). Non-tradable share reform, liquidity, and stock returns in China. *International Review of Finance*, *15*(1), 27-54.

Martinsa, C. C., & Eid, Jr, W. (2015). Pricing assets with Fama and French 5–factor model: A Brazilian market novelty. In XV Encontro Brasileiro de Finanças.

Novy-Marx, R. (2013). The other side of value: The gross profitability premium. *Journal of Financial Economics*, *108*(1), 1-28.

Richardson, S. A., & Sloan, R. G. (2003). External financing and future stock returns. Rodney L. White Center for Financial Research Working Paper.

Sun, Q., & Tong, W. H. (2000). The effect of market segmentation on stock prices: The China syndrome. *Journal of Banking & Finance*, *24*(12), 1875-1902.

Titman, S., Wei, K.J., & Xie, F. (2004). Capital investments and stock returns. *Journal of Financial and Quantitative Analysis*, *39*(4), 677-700.

Wang, Y., & Di Iorio, A. (2007). The cross section of expected stock returns in the Chinese A-share market. *Global Finance Journal*, *17*(3), 335-349.

Zhang, S., & Xu, J. (2013). The Fama-French three factors in the Chinese stock market. *Ssrn Electronic Journal*, *16*(2), 210-227.