Empirical Investigation of CAPM and Fama-French Five-Factor Model in China Stock Market

FMA4200 Financial Data Analysis Group 5 Project

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Abstract

This report provides an empirical investigation of the Fama-French five-factor model. The five-factor model captures the size, value, profitability, and investment patterns in average stock returns, which is argued to have a better performance than the three-factor model. To test its performance in China Stock market, we use an extensive sample over the period 2010 to 2019. We find that though it outperforms the three-factor model in the Chinese equity market, the difference is not significant. Moreover, in contrast to the findings of Fama and French, the newly introduced two factors do not show obvious significance.

1 Introduction

What factors determine the return of stocks has always been a question pursued by researchers and investors, and the relationship between expected return and risk has always been a topic of research and discussion. Throughout history, researchers have tried to find patterns in the average return of stocks. Many asset pricing models have been proposed to explain stock returns. Therein, the most famous of these models is the CAPM model, which describes the relationship between systemic risk and the expected return on assets, especially stocks, claiming that investors will only be compensated for non-dispersible risk and the time value of their money. However, many empirical tests of CAPM show that CAPM is not applicable to the real market. For example, it fails to account for anomalies such as scale effects and value effects. Considering that risk might be a multidimensional factor, a variety of multi-factor models are proposed in subsequent studies. Fama-French three-factor model is one of the most widely used models. In 2015, two new factors related to profitability and investment were introduced into the traditional three-factor model, and the deviation of average return caused by price noise was considered to construct the five-factor model.

China is emerging as the second largest economy in the world, and its stock market also presents an interesting study, because it has obvious differences with traditional western markets, such as government regulation, investor behavior, and information transparency. Previous studies show that this model is also applicable to the Chinese stock market. Past studies show that this model also works in the Chinese stock market. In our project, considering the special features of Chinese markets, we re-evaluate this model using extensive data sample of stocks in A share market from 2010 to 2019, and choose CSI300 as the benchmark, to examine the performance of each factor in Chinese stock market.

The research approach adopted in this report is to examine the relation between firm characteristics and the cross-section of stock returns. The report is divided into three parts. First of all, we test CAPM model using 50 blue-chips stocks which are selected to construct SSE50 Index, and check whether CAPM model holds in China stock market and how its performance is. Secondly, we use A share stocks and sort them into subgroups based on their size and value, and then we calculate the five factors to test. In the final part, we also test the three-factor model and compare its result with the five-factor model to see whether the five-factor model outperforms three-factor model in China stock market.

2 Capital Asset Pricing Model (CAPM)

2.1 Data and Sample Selection

Data of this research is from CSMAR. This research selects 49 A-shares from stocks in SSE50 as stock samples. We use 10-years data of monthly closing pricing from January 2010 to December 2019 to approximate the stock return. The risk free rate is the monthly yield of one-year Treasury bill. The 49 A-shares of SSE50 are the top 50 leading companies, and they are the most representative A-shares with large scale and good liquidity in Shanghai stock market. A 10-years study ensures the reliability of the research since the applicability test of CAPM performs better over long time span.

2.2 Method

The CAPM model is

$$E(R_i) - R_f = \beta_i[E(R_m) - R_f] \tag{1}$$

Where $E(R_i)$ is the expected return of the i_{th} A-share, R_f is the risk free rate, β_i is the sensitivity of the expected excess asset returns to the expected excess market returns, $beta_i$ = $Cov(R_i, R_m)/Var(R_m)$, $E(R_m)$ is the expected month;y return of the CSI 300, $E(R_m) - R_f$ is the market risk premium.

Using CAMP model, We firstly regress monthly excess return of each stock on the market excess return to get their betas. Secondly, we calculate the average monthly rate of return and regress average return on beta for each stock.

2.3 Results

Coefficient β reflects the level of systemic risk of each stock. If β is greater than 1, the risk of this stock is greater than the market average. Conversely, if β is less than 1, the risk of a stock is less than the market average. According to our results in table 1, the beta value of most of the banks are lower than 1, and most of the securities companies is higher than 1.

The result corresponds to the fact that in general, banks are more stable investments than securities companies or construction companies. Comparing to banks, securities companies and construction companies turn out to be more volatile. This result proves that CAPM model fits the Chinese market well. In this research, 97.92% P values are less than 0.05, so it can be proved that the results are significant. Through the analysis of linear regression, we believe that most of the values can be used as effective estimates of the systematic risk of sampling stocks.

In the linear regression result, R^2 is the determination coefficient, which equals to the ratio of system risk to total risk. In our research result, R^2 is 0.066. On the one hand, this indicates that the proportion of system risk to the total risk is only about 6.6%. Since R^2 is small, it implies that the explanatory ability of system risk to the expected return of stocks is weak. On the other hand, the result indicates that non-systemic risks account for 93.4% of the total risks. It implies that the main part of stock returns is not compensation for systemic risks, but compensation for non-systemic risks, which is inconsistent with the hypothesis. Therefore, CAPM fails in China stock market.

Table 1: CAPM: Second Step Results

R	0.256
R^2	0.066

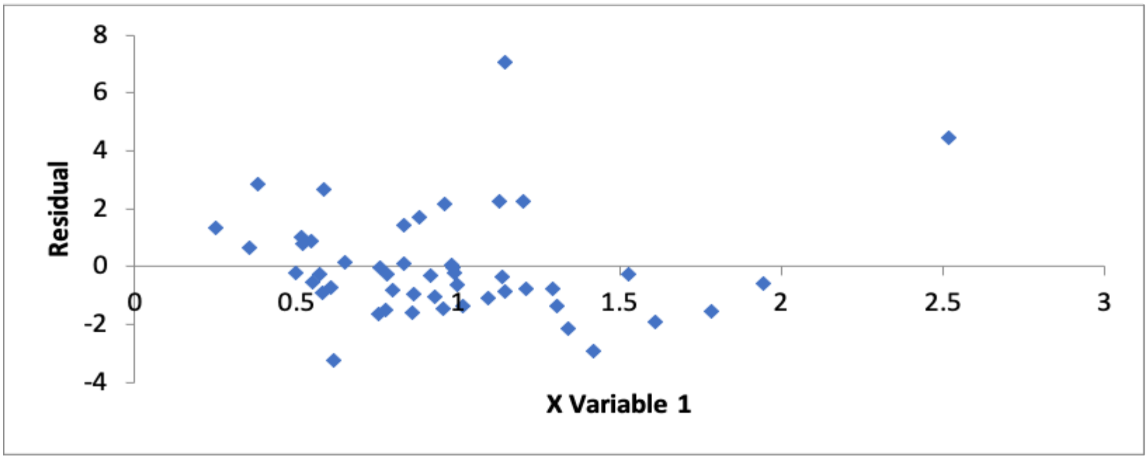

Figure 1: X Variable 1 Residual

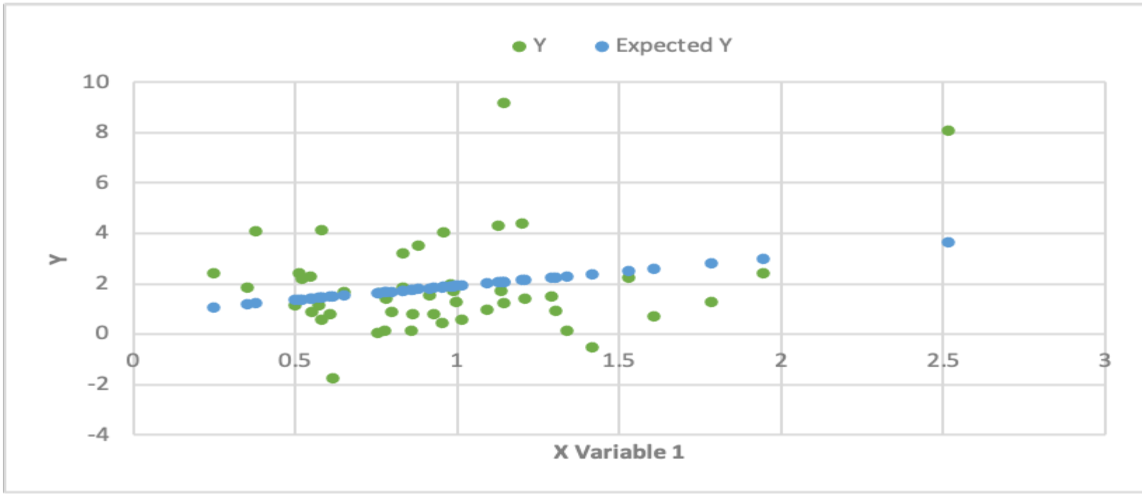

Figure 2: X Variable 1 Line Fit.png

Table 2: CAPM: First Step Results

Code	Beta	R squqre	P-value	Monthly Return
600000.SH	0.86193010	0.626688883	5.2072E-27	0.8133625
600009.SH	0.65159722	0.557224602	5.7255E-13	1.698346667
600016.SH	0.92598885	0.669913065	3.5430E-30	0.817182500
600028.SH	0.75502907	0.519177853	1.7427E-20	0.032000000
600030.SH	1.78492556	0.760737091	1.8922E-38	1.261486667
600031.SH	1.29292775	0.559539356	9.5253E-23	1.481766667
600036.SH	0.99751628	0.725717617	6.1237E-35	1.299249167
600048.SH	1.21025097	0.644830669	2.7169E-28	1.417800833
600050.SH	0.95235462	0.380927205	6.0495E-14	0.432040833
600104.SH	0.79858337	0.404249354	6.1007E-15	0.901915833
600196.SH	0.49717438	0.535069744	3.6389E-05	1.159665833
600276.SH	0.24854398	0.644932571	2.0100E-27	2.426209167
600309.SH	0.83097170	0.332413861	5.5358E-12	1.856081667
600340.SH	0.83127978	0.504102957	2.2263E-07	3.192574167
600519.SH	0.51420639	0.672933573	2.3182E-06	2.409129167
600547.SH	0.55104902	0.496879886	0.00053955	0.902695833
600585.SH	0.98838803	0.490254384	5.6239E-19	1.702358333
600588.SH	0.54462268	0.570112568	0.00347125	2.290220833
600690.SH	0.76005036	0.583687238	3.8107E-10	1.639585833
600703.SH	0.35413279	0.545250651	0.01966778	1.843657500
600745.SH	0.88146896	0.109002319	0.00023084	3.521921667
600837.SH	1.60886333	0.799326383	5.7509E-43	0.725725833
600887.SH	0.51923951	0.766095664	3.8400E-36	2.185435833
601012.SH	0.95816289	0.176262982	3.0988E-05	4.042456522
601066.SH	2.51667667	0.315607778	0.01525315	8.082638889
601088.SH	0.85662097	0.641513466	4.7138E-28	0.162350833
601138.SH	1.01472556	0.211654219	0.05472488	0.568688889
601166.SH	1.09202433	0.737540229	4.5145E-36	0.956971667
601186.SH	1.30422402	0.554525879	1.8654E-22	0.928401667
601211.SH	1.41803316	0.772774014	2.3089E-18	-0.510738889
601236.SH	0.58341308	0.033643059	0.76777802	4.120560000
601288.SH	0.60808745	0.631200379	8.5678E-26	0.784160177
601318.SH	1.13543776	0.753341672	1.1457E-37	1.705902655
601319.SH	1.94518305	0.617814818	0.01697807	2.431776923
601328.SH	0.77509614	0.603933837	1.7400E-25	0.157384615
601336.SH	1.14392431	0.556414816	4.3340E-14	1.250084615
601398.SH	0.57089012	0.573824896	1.3450E-23	1.160884615
601601.SH	0.98336059	0.624172787	7.7549E-27	1.872600000
601628.SH	1.12834195	0.653527492	6.2518E-29	4.323769231
601668.SH	1.33970872	0.642157723	4.2371E-28	0.149015385
601688.SH	1.52788803	0.652362642	2.2127E-28	2.246030769
601818.SH	0.91528082	0.724042048	1.5677E-32	1.524884615
601857.SH	0.61568116	0.550124735	3.3448E-22	-1.75490000
601888.SH	0.37865061	0.573016894	0.00283743	4.096638462
601988.SH	0.58161068	0.543009705	8.4956E-22	0.565115385
601989.SH	0.98149811	0.356530649	6.1076E-13	1.978238462
603160.SH	1.14514468	0.100456482	0.05251934	9.169176923
603259.SH	1.20145880	0.235215551	0.03531923	4.398792308
603993.SH	0.78117014	0.687589227	3.1103E-05	1.407530769

2.4 Limits of CAPM model application in Chinese Market

In practice, The CAPM model has inherent defects such as strict assumptions, single assets as the research object, and neglect of non-systemic risks, all of which lead to a certain randomness and one-sidedness in the research results.

Firstly, assumptions about the capital market in CAPM assumed an idealization of the capital market, which holds that an ideal market should be complete and frictionless, so that the allocation of resources is effective. Such ideal markets do not exist in reality.

Secondly, assumptions about investors holds that all investors are rational; sufficient, free, and all investors are risk averse. However, these assumptions fail in most of the time. For example, not every investor is risk-averse in reality. When faced with the temptation of a very high yield, investors are more likely to consider the desire for return than the probability of its occurrence.

3 Fama-French Five Factor model (FF5)

3.1 The five-factor model

The Fama-French Five-Factor model is designed to capture the relation between average return and size, the relation between average return and price ratios like B/M, the relation between average return and profitability, and the relation between average return and investment.

The FF5 model is:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + \varepsilon_{it} \tag{2}$$

Where R_{it} is the return on portfolio i for period t, R_{ft} is the risk-free return, R_{Mt} is the return on the value-weight (VW) market portfolio, SMB_t is the difference of returns on diversified portfolios of small stocks minus big stocks, HML_t is the difference of returns on diversified portfolios of high and low B/M stocks, RMW_t is the difference between the returns on diversified portfolios of stocks with robust and weak profitability, CMA_t is the difference of returns on diversified portfolios of low and high investment firms' stocks, ε_{it} is the zero-mean residual. If the exposures to the five factors, bi,si,hi,ri,ci, capture all variation in expected returns, the intercept a_i is zero for all securities and portfolios i.

3.2 Data, variable definitions and methodology

3.2.1 Sample Selection

We construct are sample from all firms listed in A-share markets over the period 2010 to 2019 in the China Stock Market & Accounting Research (CSMAR) Database. Following previous research, we exclude financial firms, and we also eliminate the smallest 30% companies based on market capitalization to avoid shell-value contamination.

Table 3: Sample Selection

Object	The FF5F model-based approach	Modified approach
Number of stocks in the portfolio	Use of stock information with many shares and optimal factor-based allocation	-Eliminating the last 30% stocks by market capitalization -Excluding all stocks classified by the China Securities Regulatory Commission as ”Monetary and Financial Services” and ”Insurance Industry”
Threshold for the Size factor	50:50 of NYSE Median breakpoint	50:50 Market Capitalization
An indicator of the RMW factor	Operating profitability	ROE
An indicator of the CMA factor	Change in Total Assets Y-o-Y basis	ROA

In this study, we select the subject's total market capitalization data disclosed during the period from January 2010 to December 2019 to represent the company's size factor, and the book-to-market value obtained by dividing the owner's equity by the total market value data. Value ratio represents the company's value factor, ROE represents the company's profit factor, and the year-on-year growth rate of total assets represents the company's investment factor.

For the risk-free rate, according to the compound interest calculation method, we select one-year Treasury bond and convert the annual risk-free interest rate into monthly data.

For the return rate of market portfolio part, we select CSI300 as benchmark. The CSI 300 ensures the regular adjustment range of the sample, improves the stability of the sample stocks, and also enhances the predictability of adjustments, the transparency and accuracy of index management, and the operability. Although the CSI 300 Index does not have a clear industry selection standard, the industry distribution of the sample stocks is basically close to the industry distribution of the market, which is relatively representative. Therefore, the monthly return data of the Shanghai and Shenzhen 300 Index from January 2010 to December 2019 is selected as the market return rate.

3.2.2 Construction of factors

1. Portfolio excess return R_{it} - R_{ft}. According to Fama and French, to disentangle the dimensions of average returns, we sort jointly on Size, B/M, OP, and Inv, and we get 25 portfolios. The following table shows the excess return value of the 25 portfolios.

Table 4: Portfolio excess return R_{it} - R_{ft}

			B/M		
Size	Low	2	3	4	High
Small	1.627	1.020	0.692	0.209	-0.145
2	2.196	1.558	0.738	0.097	-0.360
3	3.006	1.392	0.789	0.199	-0.133
4	3.248	1.479	0.756	0.240	-0.227
Big	3.740	1.718	1.733	1.072	0.146
Small-Big	-2.113***	-0.698	-1.041*	-0.863	-0.291
	(-3.192)	(-1.061)	(-1.723)	(-1.260)	(-0.514)
			OP		
Size	Low	2	3	4	High
Small	0.270	0.673	0.783	0.997	1.299
2	0.186	0.766	0.843	1.299	1.795
3	0.516	0.857	1.215	1.086	1.936
4	0.498	0.970	0.999	1.418	1.752
Big	0.301	0.557	0.844	1.081	1.410
Small-Big	-0.031	0.116	-0.061	-0.083	-0.111
	(-0.049)	(0.214)	(-0.103)	(-0.119)	(-0.173)
			Inv		
Size	Low	2	3	4	High
Small	0.298	0.494	0.529	0.796	1.541
2	0.288	0.450	0.842	0.825	2.035
3	0.622	0.772	0.919	1.093	2.051
4	0.522	1.016	0.787	1.280	2.326
Big	0.066	0.616	0.626	1.512	2.511
Small-Big	0.232	-0.122	-0.097	-0.717	-0.970
	(0.361)	(-0.225)	(-0.145)	(-1.230)	(-1.246)

2. Market factor R_{mt} - R_{ft}. The market factor can be obtained by subtracting the risk-free rate of return from the market rate of return. As we mention before, we choose monthly return rate of CSI300 as our market portfolio, and we use one-year Treasury bond to derive the monthly risk-free interest rate.

3. Size factor SMB, Value factor HML, Profitability factor RMW, and Investment factor CMA. In this study, we use a simple two-dimensional sorting 2x3 of FF that uses independent sorts of stocks into two size group and three B/M, OP, Inv groups. We sort all stocks from small to large based on their market capitalization, then we choose the median as the dividing point to sort into Small group and Big group. We also sort the sample stocks into three groups (low 30%, median 40%, and high 30%) based on B/M, OP. and Inv. Using Size as one sorting criterion and one of the other three firm characteristics (B/M, OP, Inv) as the other sorting criterion, we construct 6 double-sorted VW portfolios from the intersection of the Size and B/M, OP, or Inv sorts to form HML, RMW, and CMA. The following table shows how we construct and calculate the factors.

Table 5: Small Size

Book to Market (BtM)	Profitability (ROE)	Investment (ROA)
High (SH)	Robust (SR)	Conservative (SC)
Neutral (SN)	Neutral (SN)	Neutral (SN)
Low (SL)	Weak (SW)	Aggressive (SA)

Table 6: Big Size

Book to Market (BtM)	Profitability (ROE)	Investment (ROA)
High (BH)	Robust (BR)	Conservative (BC)
Neutral (BN)	Neutral (BN)	Neutral (BN)
Low (BL)	Weak (BW)	Aggressive (BA)

The five factors used in the regression are calculated from the following equations:

$$SMB_{B/M} = \frac{SH + SN + SL}{3} - \frac{BH + BN + BL}{3} \tag{3}$$

$$SMB_{OP} = \frac{SR + SN + SW}{3} - \frac{BR + BN + BW}{3} \tag{4}$$

$$SMB_{Inv} = \frac{SC + SN + SA}{3} - \frac{BC + BN + BA}{3} \tag{5}$$

$$SMB = \frac{SMB_{B/M} + SMB_{OP} + SMB_{Inv}}{3} \tag{6}$$

$$HML = \frac{SH + BH}{2} - \frac{SL + BL}{2} \tag{7}$$

$$RMW = \frac{SR + BR}{2} - \frac{SW + BW}{2} \tag{8}$$

$$RMW = \frac{SC + BC}{2} - \frac{SA + BA}{2} \tag{9}$$

After the selection of sample and construction of factor, we get the monthly data which is used to do regression, representing all data of five factors from Jan 2010 to Dec 2019 (See appendix file).

3.3 Regression Results

Regressing portfolio return on these five factors, we get the following results.

Table 7: Regression Result of Fama-French Five Factor Model

Size	Low	2	3	4	High	Low	2	3	4	High
			a					t(s)		
Low	1.244***	0.519**	0.139	0.264*	0.619**	5.723	2.257	0.682	1.741	2.396
2	1.179***	0.293	0.024	0.055	0.422**	5.590	1.594	0.069	0.353	2.399
3	1.404***	0.446**	0.250	0.218	0.593*	7.410	2.131	1.147	0.983	1.763
4	1.167***	0.273	0.106	0.305	0.478**	4.226	1.207	0.521	1.293	2.084
High	0.264	0.049	0.713**	0.574*	0.926***	0.924	0.194	2.244	1.946	4.328
			b (MKT)					t(b)		
Low	0.955***	0.939***	0.979***	0.962***	0.961***	23.976	34.663	32.742	34.143	40.755
2	0.980***	0.999***	0.962***	0.970***	0.976***	29.587	41.447	37.129	66.947	44.929
3	0.981***	0.915***	0.971***	1.043***	0.993***	27.903	28.998	32.975	41.537	37.131
4	0.874***	0.896***	0.988***	1.037***	1.061***	20.728	23.772	46.306	29.195	59.137
High	0.804***	1.045***	1.147***	1.093***	0.833***	22.342	21.243	31.953	23.311	26.344
			s (SMB)					t(s)		
Low	1.155***	1.243***	1.128***	1.152***	1.182***	17.568	22.942	21.158	31.102	18.354
2	1.110***	1.063***	1.007***	0.990***	0.988***	14.202	22.129	23.620	28.533	16.790
3	0.910***	0.850***	0.901***	0.904***	0.949***	13.957	15.891	19.452	22.522	8.468
4	0.713***	0.735***	0.728***	0.667***	0.553***	9.415	12.766	16.595	10.539	13.432
High	-0.191**	-0.198*	-0.101	-0.133**	-0.027	-2.492	-1.854	-1.555	-2.051	-0.394
			h (HML)					t(h)		
Low	-0.554***	-0.389***	-0.312***	-0.103*	0.225**	-6.887	-5.148	-4.870	-1.804	2.068
2	-0.602***	-0.525***	-0.452***	-0.159***	0.113*	-9.795	-6.185	-3.556	-3.207	1.725
3	-0.778***	-0.527***	-0.344***	-0.116**	0.215	-7.152	-10.290	-4.680	-2.537	1.418
4	-0.827***	-0.480***	-0.371***	-0.146**	0.074	-9.592	-8.127	-6.544	-2.249	1.194
High	-1.167***	-0.563***	-0.354***	-0.081	0.372***	-14.345	-5.486	-3.310	-0.822	5.030
			r (RMW)					t(h)		
Low	0.394***	0.437***	0.311**	0.168*	0.098	3.062	3.576	2.338	1.799	0.907
2	0.495***	0.391***	0.40***	0.40***	0.265**	3.846	3.060	3.327	4.737	2.046
3	0.435**	0.202	0.248***	0.184*	0.276**	2.501	1.632	2.628	1.794	2.265
4	0.096	0.052	0.182	0.254	0.469***	0.619	0.338	1.343	1.652	3.687
High	0.167	0.170	0.426***	0.626***	0.140	0.759	1.108	2.680	3.242	1.223
			c (CMA)					t(c)		
Low	0.525***	0.157**	0.023	0.077	0.003	4.603	2.093	0.236	0.837	0.022
2	0.194**	-0.085	0.169	0.137**	0.238***	2.265	-1.011	1.318	2.067	2.892
3	0.136	0.164**	0.129	0.131*	0.044	1.152	2.109	1.137	1.772	0.273
4	-0.074	-0.065	0.135	0.258**	0.348***	-0.505	-0.711	1.464	2.580	3.048
High	-0.270**	-0.036	0.043	-0.058	-0.001	-2.504	-0.345	0.304	-0.443	-0.013
			Adj-R^2					s(e)		
Low	0.947	0.964	0.965	0.968	0.948	2.327	1.882	1.795	1.587	1.905
2	0.958	0.964	0.962	0.973	0.951	2.133	1.934	1.848	1.412	1.775
3	0.948	0.960	0.953	0.961	0.940	2.359	1.789	1.921	1.702	1.936
4	0.929	0.938	0.953	0.943	0.946	2.568	2.143	1.853	1.949	1.803
High	0.927	0.909	0.921	0.886	0.918	2.267	2.454	2.396	2.740	1.747

[1] t statistics in parentheses: * p ¡ 0.1, ** p ¡ 0.05, *** p ¡ 0.01

From the above table, we can see that the adjusted R-square value is averagely larger than 0.94582, which means these five factors can explain over 94% of portfolio excess return. Hence, we conclude that Fama-French Five-Factor model is applicable in China A-share stock market.

Moreover, through analyzing each factor's performance, we derive the following conclusions:

1. The size factor SMB is significantly non-zero, and the significance is strong, indicating that China's A-share market has a strong scale effect. The small-scale listed company stocks are more likely to obtain excess returns. It is the same as the empirical test result of the five-factor model in the US market. It shows that whether in the mature US stock market or in the late-developing Chinese stock market, stock portfolios of small-scale listed companies should be selected as the actual investment targets.

2. The value factor HML is also significantly non-zero, and the significance is strong, indicating that the value factor is equally effective in the Chinese A-share market, and the coefficients of some value factors are negative, indicating that the growth stocks with low book-to-market ratio in the Chinese A-share are more easier to achieve excess returns compared with high book-to-market ratio stock, which is opposite to the finding of Fama and French. It illustrates the particularity of the A-share market. There are a large number of high-quality growth companies. Increasing operating leverage can help companies accelerate growth, which can also be explained. The reason why a company's stock portfolio with a relatively low book-to-market ratio is easier to obtain excess returns.

3. The profitability factor RMW did not show a significant non-zero value in the regression results, indicating that in the Chinese A-share market, companies that can achieve high ROE may not necessarily achieve high excess returns.

4. The significant level of the investment factor CMA is pretty low, indicating that in the Chinese A-share market, the reinvestment rate of listed companies does not effectively represent the excess return of stocks.

5. Most of the intercept terms are not significantly different from zero, verifying that the five explanatory variables can well explain the asset return, and there is no risk-adjusted excess return rate.

From the above analysis, we conclude that the profitability factor RMW and investment factor CMA are not significant non-zero. Hence, we wonder if Fama-French Three-Factor model can actually perform better than Fama-French Five-Factor model in China stock market. To compare these two models, we use similar method to test the performance of Fama-French Three Factor model in the following part.

4 Fama-French Three Factor Model (FF3)

4.1 The Three-Factor Model

Since in FF5, the significant level of the investment factors RMW and CMA are low, we discard the two factors and reproduced this research using the Fama-French three factor model with only the first three factors of FF5. We conducted the research using the same data as which used in the FF5 regression.

The FF3 model is:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{Mt}) - R_{ft}) + s_i SMB_t + h_i HMI_t + \varepsilon_{it} \tag{10}$$

Fama and French three-factor models attribute investment risk to market factors, scale factors and value factors. Market factors reflect the risk of common movements in all share prices; The size factor indicates that listed companies with small market capitalization will, on average, provide higher investment returns. The value factor indicates that investing in companies with a higher book-to-market ratio will obtain a higher average return rate.

4.2 Data, variable definitions and methodology

4.2.1 Sample selection

See Table 8. We use the same data sample as before. (What we used in testing five-factor model, 3.2.1).

4.2.2 Construction of Factors

we use a simple two-dimensional sorting 2x3 of FF that uses independent sorts of stocks into two size group and three B/M groups. We sort all stocks from small to large based on their market capitalization, then we choose the median as the dividing point to sort into Small group and Big group. We also sort the sample stocks into three groups (low 30%, median 40%, and high 30%) based on B/M. Using Size as one sorting criterion and one of the other firm characteristic B/M as the other sorting criterion, we construct double-sorted VW portfolios from the intersection of the Size and B/M to form HML. The following table shows how we construct and calculate the factors.

Table 8: Sample selection of FF3

Object	The FF3 model-based approach	Modified approach
Number of stocks in the portfolio	Use of stock information with many shares and optimal factor-based allocation	-Eliminating the last 30% stocks by market capitalization -Excluding all stocks classified by the China Securities Regulatory Commission as ”Monetary and Financial Services” and ”Insurance Industry”
Threshold for the Size factor	50:50 of NYSE Median breakpoint	50:50 Market Capitalization
Threshold for the B/M factor	30:40:30 of NYSE breakpoint	30:40:30 Book-to-Market ratio

Table 9: Construction of Factors

Small-Size	Big-Size
Book to Market (B/M)	Book to Market (B/M)
High (SH) Neutral (SN) Low (SL)	High (BH) Neutral (BN) Low (BL)

Table 10: Factor Computation

Group	Factor Computation
2x3	$SMB = \frac{SH+SN+SL}{3} - \frac{BH+BN+BL}{3}$, HML = $\frac{SH+BH}{2} - \frac{SL+BL}{2}$

4.3 Regression Result

Regressing portfolio return on these three factors, we get the following results.

Table 11: Regression Result of Fama-French Three Factor Model

Size	Low	2	3	4	High	Low	2	3	4	High
			a					t(a)		
Low	1.097***	0.449*	0.104	0.219	0.595**	4.805	1.913	0.549	1.4	0
2	1.124***	0.302	-0.062	0.005	0.345*	4.588	1.251	-0.202	0.032	1.904
3	1.382***	0.392*	0.193	0.165	0.561	6.441	1.9	0.654	0.925	1.588
4	1.178***	0.28	0.067	0.228	0.381	4.133	1.195	0.393	0.879	1.227
High	0.313	0.051	0.683**	0.573*	0.914***	1.212	0.201	2.128	1.822	4.696
			b (MKT)					t(b)		
Low	0.931***	0.907***	0.948***	0.932***	0.929***	26.529	31.152	34.278	34.937	33.445
2	0.953***	0.969***	0.937***	0.945***	0.952***	28.596	35.413	32.234	43.774	41.199
3	0.959***	0.895***	0.948***	1.020***	0.968***	23.697	34.485	27.471	33.899	32.806
4	0.854***	0.875***	0.970***	1.022***	1.051***	21.804	25.394	33.267	32.662	43.316
High	0.805***	1.050***	1.150***	1.096***	0.834***	14.964	23.376	30.138	20.295	24.511
			s (SMB)					t(s)		
Low	1.188***	1.183***	1.046***	1.083***	1.096***	17.507	22.2	25.657	25.837	20.552
2	1.077***	0.969***	0.959***	0.949***	0.968***	16.886	21.363	19.338	29.498	18.563
3	0.886***	0.825***	0.860***	0.865***	0.888***	15.444	12.772	16.161	18.395	11.413
4	0.647***	0.669***	0.708***	0.674***	0.589***	12.61	15.67	18.463	9.824	11.694
High	-0.246***	-0.196*	-0.093	-0.144**	-0.031	-3.709	-1.926	-1.243	-1.996	-0.599
			h (HML)					t(h)		
Low	-0.487***	-0.504***	-0.470***	-0.239***	0.052	-7.275	-6.46	-9.088	-4.752	0.859
2	-0.674***	-0.717***	-0.532***	-0.243***	0.074	-12.188	-9.843	-4.194	-4.509	1.455
3	-0.844***	-0.578***	-0.421***	-0.191***	0.094	-15.532	-8.774	-4.69	-3.916	1.07
4	-0.964***	-0.616***	-0.415***	-0.129	0.148**	-15.082	-11.49	-8.987	-1.643	2.319
High	-1.265***	-0.553***	-0.326***	-0.092	0.371***	-26.135	-7.065	-3.256	-0.882	6.282
			Adj-R^2					s(e)		
Low	0.939	0.958	0.96	0.965	0.944	2.489	2.038	1.923	1.66	1.964
2	0.954	0.959	0.954	0.968	0.948	2.219	2.063	2.026	1.538	1.835
3	0.948	0.959	0.95	0.959	0.936	2.375	1.811	1.981	1.744	2.002
4	0.929	0.937	0.953	0.94	0.934	2.576	2.158	1.85	2.005	1.992
High	0.925	0.91	0.917	0.875	0.918	2.298	2.44	2.452	2.86	1.742

[1] t statistics in parentheses: * p ¡ 0.1, ** p ¡ 0.05, *** p ¡ 0.01

From the above table, we can see that the adjusted R-square value is averagely larger than 0.94156, which means these three factors can explain over 94% of portfolio excess return. Hence, we conclude that Fama-French Three-Factor model is applicable in China A-share stock market. Compared with the results from Fama-French Five-Factor model, we find that their difference is not significant. Therefore, we conclude that though Fama-French Five-Factor model outperforms the three-factor model, the significance is not obvious, and the newly introduced two factors do not perform well in China stock market.

5 Conclusion

From the above empirical investigation of CAPM, FF3, and FF5 model, we conclude that CAPM model cannot explain the excess return of stocks in China stock market. For Fama-French Five-Factor model and Fama-French Three-Factor model, they both can well explain the excess return of stocks in China stock market. However, though in some sense Fama-French Five-Factor model outperforms the three-factor model, the difference is not significant. Moreover, the newly introduced factors RMW and CMA show low significance in our research. Therefore, we conclude that the Fama-French Three-Factor model is enough to explain the excess return of stocks in China stock market, while the Fama-French Five-Factor model does not make the most of itself.

Reference

Fama, E.F., French, K.R., 2015a. A five-factor asset pricing model. J. Financ. Econ. 116, 1–22.

Lin, Qi. "Noisy Prices and the Fama–French Five-factor Asset Pricing Model in China." Emerging Markets Review 31 (2017): 141-63. Web.

Appendix. A. Monthly Factor Value from 2010 to 2019

Date	MKT	SMB	HML	RMW	CMA
2010-01	-10.576	5.344681	-4.36961	1.572213	-0.36521
2010-02	2.2335	6.747888	1.674916	-3.12032	-4.1518
2010-03	1.7628	2.149458	-1.93913	-1.95882	-1.91161
2010-04	-8.5022	-1.74962	-8.32716	-0.80207	-0.69841
2010-05	-9.7737	-0.40156	-5.50039	-2.74115	-5.00252
2010-06	-7.7649	-2.21051	0.86434	-2.31614	-0.49685
2010-07	11.7445	2.990342	-2.41155	1.185636	-2.26787
2010-08	1.0115	5.814292	-12.5595	2.324105	-2.03331
2010-09	0.9299	-0.99005	-7.47818	1.979735	-0.47502
2010-10	14.9531	-5.61218	-2.81312	0.140836	-0.59333
2010-11	-7.3953	4.159146	-8.36497	-1.56467	-2.99133
2010-12	-0.4841	-2.6557	-0.67216	-1.91143	-1.33315
2011-01	-1.8807	-3.90219	4.319467	1.464479	1.401033
2011-02	5.0736	4.774025	-5.10661	2.582336	-0.36697
2011-03	-0.7489	-0.65096	0.487741	-0.01526	0.405576
2011-04	-1.1949	-2.56116	1.142004	-2.54337	-0.33142
2011-05	-6.2545	-1.38281	-1.50764	-2.07585	-0.96873
2011-06	1.1501	1.036554	-2.61606	-0.96419	-3.05382
2011-07	-2.6325	2.959544	-5.36219	-1.36571	-1.87399
2011-08	-4.5031	2.247617	-2.0176	-4.21125	-3.41976
2011-09	-9.6108	-3.84255	2.499104	-0.93932	1.883589
2011-10	4.1275	-0.87738	1.049928	-1.5912	-0.40432
2011-11	-6.7349	0.547797	-4.24371	-0.82016	-0.10702
2011-12	-7.2582	-9.50823	7.198446	-7.49269	-3.40348
2012-01	4.7654	-4.99815	0.090641	2.911617	2.078
2012-02	6.6068	6.519373	-3.76134	2.584718	-0.77021
2012-03	-7.0917	-0.08198	-1.36314	-3.55943	-1.82314
2012-04	6.6891	0.694732	-2.97092	1.701297	-0.50833
2012-05	-0.063	1.019795	-3.46746	-0.60713	-1.65502
2012-06	-6.7623	-2.36287	-0.6314	-6.80591	-4.49703
2012-07	-5.4948	-3.45454	-0.63078	-5.19742	-3.91738
2012-08	-5.7356	6.261435	-1.55436	-0.71131	-0.9237
2012-09	3.7554	-3.1029	-3.6706	0.879612	-0.37057
2012-10	-1.9162	1.509598	0.047998	-0.66654	0.087537
2012-11	-5.3538	-6.16732	4.58629	-1.97298	-0.62935
2012-12	17.667	-0.608	0.20498	-1.04512	-2.01152
2013-01	6.2509	0.688054	-3.25306	-0.23591	-2.68482
2013-02	-0.7511	2.947038	-7.39177	-1.65112	-2.85748
2013-03	-6.9141	0.846062	-6.54908	-1.70694	-2.55272
2013-04	-2.1614	-1.18056	-1.87112	-3.33792	-3.16626
2013-05	6.2552	5.400308	-7.67118	1.89518	-5.29198
2013-06	-15.8153	-3.05345	-3.04126	-5.48758	-3.82605
2013-07	-0.5928	2.636019	-7.95937	0.935987	-2.74229
2013-08	5.2658	3.370856	-2.27908	1.9074	4.358672
2013-09	3.8645	-0.69329	-6.46329	1.32762	0.371429
2013-10	-1.7127	-0.38582	2.856675	-1.53044	0.315483
2013-11	2.5012	2.472148	-4.79528	3.264687	-0.54648

2013-12	-4.7124	0.575046	-1.84518	-2.41479	-2.69483
2014-01	-5.7219	5.350646	-6.94286	-1.55629	-5.15609
2014-02	-1.3126	3.97916	-0.46759	2.263649	2.130774
2014-03	-1.7457	-0.68757	2.90682	-0.50922	1.94126
2014-04	0.329	-1.77139	-0.19987	-2.58059	-2.17923
2014-05	-0.3483	1.631998	-2.76961	1.574901	0.129549
2014-06	0.1547	2.723588	-2.19491	0.192308	-0.93284
2014-07	8.304101	-0.97255	0.487487	2.156587	1.094498
2014-08	-0.7557	5.027359	-3.69546	3.42881	-0.55206
2014-09	4.5732	7.573884	-5.59459	6.861799	0.833582
2014-10	2.0927	-1.40247	-0.83678	-0.17251	0.229719
2014-11	11.7333	-7.48861	-2.51279	-3.10755	-5.54859
2014-12	25.5812	-28.1906	8.572489	-7.17398	0.023901
2015-01	-3.0368	3.380998	-12.0477	-0.37022	-6.59735
2015-02	3.8051	1.596366	-8.49482	1.718876	-5.77384
2015-03	13.1828	7.110508	-10.0019	3.564246	-5.18837
2015-04	17.0403	-1.62898	-4.14151	3.320339	-5.33069
2015-05	1.7086	15.60491	-29.5009	6.622372	-10.4636
2015-06	-7.7841	-3.61612	7.041375	0.384135	8.323169
2015-07	-14.8376	-7.14963	-1.14148	-7.56277	-3.89328
2015-08	-11.9598	-2.54415	-0.68987	0.848328	0.647863
2015-09	-5.004	1.307475	-3.75597	-5.28075	-6.47751
2015-10	10.1936	9.072039	-13.05	6.033315	-4.99404
2015-11	0.7908	8.558359	-12.2814	0.437132	-5.50521
2015-12	4.491	3.932004	-4.78307	-0.48946	0.63162
2016-01	-21.1617	-6.98704	4.132105	-5.45016	-0.29294
2016-02	-2.4534	-0.18958	0.318377	-1.04797	-0.66107
2016-03	11.7134	5.091435	-5.30037	1.418097	-2.85107
2016-04	-2.0303	1.145041	-1.58528	-1.15859	-0.92136
2016-05	0.2818	-1.89316	-1.25973	-2.20946	-2.06903
2016-06	-0.6175	4.63367	-3.83793	-1.01348	-4.06877
2016-07	1.4615	-3.49276	2.446786	-3.00808	-0.35967
2016-08	3.7419	1.025553	0.418457	-0.0744	-0.14145
2016-09	-2.3631	1.614597	-0.88201	0.054535	0.519476
2016-10	2.427	0.369849	-1.63486	2.787189	2.533309
2016-11	5.9223	-2.76698	1.331935	1.55947	2.060901
2016-12	-6.5662	0.451215	-1.12096	1.955589	3.088543
2017-01	2.2287	-5.41796	1.591592	-0.16141	1.099272
2017-02	1.79	1.470409	-0.56011	-1.62228	-2.0078
2017-03	-0.0304	-3.0359	-2.47495	-3.45248	-3.58356
2017-04	-0.5955	-4.9786	0.171248	-5.46628	-4.67819
2017-05	1.4205	-8.02971	0.862763	-5.02706	-1.67036
2017-06	4.855	-1.60686	-4.21717	-2.8942	-2.87573
2017-07	1.8143	-4.37555	2.863005	-0.32509	2.944102
2017-08	2.129	0.389507	-1.68797	-0.53522	-1.2198
2017-09	0.2529	-0.20988	-5.36864	-0.23716	-3.41235
2017-10	4.3127	-5.76686	-3.89503	-5.14604	-3.62793
2017-11	-0.1395	-5.77521	0.821727	-1.58451	-0.00662
2017-12	0.4938	-2.87398	-3.90186	-2.48779	-2.1088

2018-01	5.9551	-8.72732	5.022689	-6.85655	-0.66268
2018-02	-6.0236	0.445635	-3.34999	-1.34376	-2.73747
2018-03	-3.2343	6.246661	-7.4669	0.090533	-2.98574
2018-04	-3.7568	-1.61716	-1.82118	-2.89309	-1.09102
2018-05	1.087	-3.47658	-4.56222	-6.73486	-4.95981
2018-06	-7.7875	-4.91434	-0.59042	-6.07279	-2.53665
2018-07	0.0659	-1.14336	2.491318	-0.36726	0.949391
2018-08	-5.3308	-2.77698	1.53284	-1.96853	0.804025
2018-09	3.0056	-4.3542	1.556823	-1.20373	1.722619
2018-10	-8.4129	-2.25333	3.793661	-0.94502	1.399183
2018-11	0.4741	5.467255	-5.14136	3.612693	-1.32054
2018-12	-5.2313	-1.14738	-1.92665	-1.75564	-1.1957
2019-01	6.2194	-6.38675	0.1425	-6.02315	-5.47741
2019-02	14.4852	5.427484	-6.47535	10.33468	1.492265
2019-03	5.4074	3.728972	-7.58054	1.014582	-0.75925
2019-04	0.9313	-2.53561	-1.29612	-6.9029	-3.25631
2019-05	-7.3668	1.0293	-3.40781	0.062109	0.157645
2019-06	5.2701	-4.12325	-1.5878	-4.0377	-3.8878
2019-07	0.1313	-2.8715	-1.9614	-3.72161	-2.67179
2019-08	-1.0568	-0.98659	-7.92091	-2.62883	-3.54015
2019-09	0.2692	0.309894	-1.85244	-1.30078	-0.76105
2019-10	1.7693	-1.45022	-1.69587	-3.88829	-3.08579
2019-11	-1.6184	-1.55591	-1.00996	-0.55727	-0.54673
2019-12	6.8734	0.397689	-3.51727	1.789432	-0.29362