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Comparison of the Effectiveness of the Three-Factor Model and the Five-Factor Model Under the Esg Factor Premium

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Abstract. This article verifies the significant effectiveness of ESG factors in the Chinese security market based on the Fama-French three-factor and five-factor model, proving that three-factor model performs better than five-factor model in China. To better understand ESG factor, this article divides enterprises into different industries and different company attributes, which will affect the effectiveness of ESG factors.

Keywords: ESG; Three-Factor Model; Five-Factor Model.

1. Introduction

The Capital Asset Pricing Model (CAPM), introduced by William Sharpe in 1964, has long served as a foundational framework for understanding stock returns. However, as financial markets have evolved, it has become evident that stock returns are influenced by more than just market risk. The pioneering work of Fama and French expanded on this by developing the three-factor and five-factor models, which incorporate additional variables to explain the variations in stock returns. These models have become essential tools for investors seeking to comprehend the multifaceted nature of market performance.

Meanwhile, in recent years, the integration of Environmental, Social, and Governance (ESG) factors into investment strategies has gained significant traction. ESG ratings, which evaluate a company's sustainability and its impact on social values across environmental, social, and governance dimensions, have emerged as critical indicators of long-term corporate performance. Consequently, ESG considerations are increasingly being integrated into financial models to better capture the nuances of modern market dynamics.

This study aims to compare the effectiveness of the Fama-French three-factor and five-factor models within the context of the Chinese securities market, with a particular focus on the ESG factor premium. By examining the performance of these models, we aim to determine which model better captures the impact of ESG factors on stock returns. Furthermore, this study delves deeper by categorizing enterprises based on industry sectors and company attributes, such as state ownership, to assess how these classifications influence the effectiveness of ESG factors in predicting stock performance. Through this analysis, we seek to provide a comprehensive understanding of the role of ESG factors in the Chinese market and their implications for investment strategies.

2. Literature Review

2.1 Factor Model

CAPM is of great importance to investment in the field of asset pricing. However, in China, it has been proved by Drew and his colleagues that market factor itself can't describe the stock return in Chinese market well (Drew et al., 2003). Since Fama and French proposed their own three-factor model with value factor and book-to-market factor in 1992, Tianshu and Baek verified that three-factor model can explain the stock return in time series better than CAPM in China, especially in Shanghai market (Tianshu & Baek, 2016). But they also found that the value effect only happened in Shanghai, so Guo and his team tested five-factor model given by Fama and French in 2015, wishing to find new model that fit China market well. They eventually showed that five-factor model can pass GRS test, but investment factor didn't perform well while profitability factor acted perfectly (Guo et al., 2017). That's the reason why the investors continued to test the reliability of these three models, wondering which can fix in China market. Therefore, in 2018 and 2024,

Belimam's team and Li's team used stock return data from different time period to test all models and their results both showed the superiority of three-factor model (Belimam et al., 2018) (Li, 2024). Due to the imperfect behavior of three-factor model on value effect, this article will add ESG factor into models, trying to figure out whether new models will behave better than the normal ones.

2.2 ESG Factor Development Status

Porter proposed a corporate competitiveness evaluation model, proposing that a company's ability to respond to financial risks and environmental changes, as well as its performance in fulfilling social responsibilities, will affect the company's long-term performance, which is the theoretical basis for the development of ESG factors (Porter, 1997). As a hot research topic in today's academic circles, ESG factors have been widely used by fund institutions in many countries. For example, Limkriangkrai et al. separated ESG ratings into three dimension and verified that the differences of stock returns are statistically significant for the E and G groups (Limkriangkrai et al., 2017). Maiti used STOXX Europe 600 index across 17 European countries and found that three-factor models with market, size and ESG factors perform better than the Fama–French three-factor model (Maiti, 2020). However, there are few studies on ESG factors in China. Chinese institutional investors themselves account for a small proportion, and few use ESG factors to build models to assist in stock selection.

Therefore, the effectiveness of ESG factors in the Chinese market may be quite different from that in other market, and further exploration is needed. Therefore, based on Chinese stock market data, this article will use ESG factors to further improve the three-factor model and the five-factor model, verify the effectiveness of the three-factor model and the five-factor model under the condition of ESG factor premium, and compare these two, analyzing the reasons and the logic behind them.

3. Methodology

To prove the new ESG factor is useful and can make a difference to former models, we use data of all stocks in China market to do the regression tests. Since China Securities ESG rating data that we chose to represent the ESG factor started from 2009, all data being used to get Table 1 below is in the time interval from 2009 to 2024. To be specific, data of return of every stock is gotten from Wind as stock's daily return and the risk premium, smb, hml, rmw and cma factor data is from CSMAR, whose specific calculation method is shown below as Table 1. There are two special tips that the calculation of portfolio investment return rate adopts the weighted method of circulation market value and every variable's value is based on the FAMA 2 * 3 portfolio partitioning method.

Table 1. Variables Description

Variable	Variables Description
riskpremium_3	The difference between the daily market return of cash dividends reinvested and the daily risk-free interest rate (the benchmark interest rate for fixed deposits announced by the central bank in March)
smb_3	The difference in returns between small and large circulation market value portfolios.
hml_3	The difference in returns between high and low book to market ratio portfolios.
riskpremium_5	The difference between the daily market return of cash dividends reinvested and the daily risk-free interest rate (the benchmark interest rate for fixed deposits announced by the central bank in March)
smb_5	The difference in returns between small and large circulation market value portfolios.
hml_5	The difference in returns between high and low book to market ratio portfolios.
rmw_5	The difference in returns between high and low profit portfolios.
cma_5	The difference in return between a low and a high investment ratio stock portfolios.

Since the way to calculate the factor data are different between the three-factor model and the five-factor model, we download these two data files, making sure the data we used is as precise as possible. What's more, to group stocks by different variables, we also download circulation market value, ROE, growth rate of total assets, BM and ESG ratings from Wind or CSMAR. Next, we create descriptive statistical tables for all the data

mentioned above, which is shown as Table 2.

Table 2. Descriptive Statistical Table

Variables	N	Mean	SD	Min	Max	Var
return	11070000	0.0004	0.0326	-0.4740	20.6800	0.0011
riskpremium_3	11070000	0.0002	0.0124	-0.0937	0.0699	0.0002
smb_3	11070000	0.0002	0.0099	-0.0858	0.0596	0.0001
hml_3	11070000	0.0001	0.0067	-0.0376	0.0511	0.0000
riskpremium_5	11070000	0.0002	0.0124	-0.0937	0.0699	0.0002
smb_5	11070000	0.0002	0.0089	-0.0734	0.0566	0.0001
hml_5	11070000	0.0001	0.0067	-0.0376	0.0511	0.0000
rmw_5	11070000	0.0001	0.0052	-0.0307	0.0505	0.0000
cma_5	11070000	-0.0000	0.0043	-0.0340	0.0212	0.0000
circulation market value	11070000	10070000	20340000	347448	144000000	413700000000000
roe	11050000	3.7220	9.6890	-53.9500	30.4600	93.8700
growth rate of total assets	11070000	19.4500	40.4400	-32.8900	260.9000	1635.0000
bm	11070000.	0.4260	0.3000	0.0155	2.4500	0.0899
esg_3	11070000	-0.0005	0.0062	-0.0874	0.0345	0.0000
esg_5	11070000	-0.0004	0.0066	-0.1050	0.0447	0.0000

The most important step for this empirical test is the way to calculate ESG factor, since there hasn't been the only and correct way to get this factor. We use the formula below to do the calculation and the first one is for ESG factor for the three-factor model and the next one is for the five-factor model.

$$\text{ESG\_3} = \frac{1}{6}(\overline{R}_{SHY} + \overline{R}_{SMY} + \overline{R}_{SLY} + \overline{R}_{BHY} + \overline{R}_{BMY} + \overline{R}_{BLY}) - \frac{1}{6}(\overline{R}_{SHO} + \overline{R}_{SMO} + \overline{R}_{SLO} + \overline{R}_{BHO} + \overline{R}_{BMO} + \overline{R}_{BLO}) \quad (1)$$

$$\text{ESG\_5} = \frac{1}{12}(\overline{R}_{SHY} + \overline{R}_{SMY} + \overline{R}_{SLY} + \overline{R}_{BHY} + \overline{R}_{BMY} + \overline{R}_{BLY} + \overline{R}_{RHY} + \overline{R}_{RMY} + \overline{R}_{RLY} + \overline{R}_{CHY} + \overline{R}_{CMY} + \overline{R}_{CLY}) - \frac{1}{12}(\overline{R}_{SHO} + \overline{R}_{SMO} + \overline{R}_{SLO} + \overline{R}_{BHO} + \overline{R}_{BMO} + \overline{R}_{BLO} + \overline{R}_{RHO} + \overline{R}_{RMO} + \overline{R}_{RLO} + \overline{R}_{CHO} + \overline{R}_{CMO} + \overline{R}_{CLO}) \quad (2)$$

Specifically speaking, we use circulation market value, BM, ROE and the growth rate of total assets to group all the stocks daily. The one's circulation market value below intraday median circulation market value is B, otherwise is S. BM, ROE and the growth rate of total assets would be used to separate stock into H, M, L and R, M, W and C, M, A, whose rules is separating them into below 30%, in the middle place and over 70%. What's more, China Securities ESG rating data will give different companies 9 different ratings, respectively AAA, AA, A, BBB, BB, B, CCC, CC and C. In this article, we group the companies whose ratings are AAA, AA, A, BBB as Y and the companies whose ratings are B, CCC, CC and C as O, which means that the companies that don't have ESG rating would not be considered into this empirical test. Having got the grouping strategy, we calculate the mean of the return difference between different groups, which is the reason for us to respectively multiply the sum of returns by 1/6 and 1/12, and get ESG factor data for models.

Next, we will perform regression analysis on the return with various combinations of factors, showing as four models below. The results will be shown in next chapter.

$$R_{i,t} = \text{const} + \beta_1 \text{riskpremium\_3}_t + \beta_2 \text{smb\_3}_t + \beta_3 \text{hml\_3}_t \quad (1)$$

$$R_{i,t} = \text{const} + \beta_1 \text{riskpremium\_3}_t + \beta_2 \text{smb\_3}_t + \beta_3 \text{hml\_3}_t + \beta_4 \text{esg\_3}_t \quad (2)$$

$$R_{i,t} = \text{const} + \beta_1 \text{riskpremium\_5}_t + \beta_2 \text{smb\_5}_t + \beta_3 \text{hml\_5}_t + \beta_4 \text{rmw\_5}_t + \beta_5 \text{cma\_5}_t \quad (3)$$

$$R_{i,t} = \text{const} + \beta_1 \text{riskpremium\_5}_t + \beta_2 \text{smb\_5}_t + \beta_3 \text{hml\_5}_t + \beta_4 \text{rmw\_5}_t + \beta_5 \text{cma\_5}_t + \beta_6 \text{esg\_5}_t \quad (4)$$

4. Main Results

The results of these four models' regression are shown in Table 3, in which we show the coefficients, their t-values and the R-squares and adjusted R-squares of models. It is worth noting that we only keep the listed companies that are rated by China Securities, which is reasonable because only these companies will be affected by the ESG factor.

The result of the regressions shows that the ESG factors being added into three-factor

model and five factor model are both efficient, since their P values are both 0.0017, which can prove their efficiency. We also notice that other factors are all efficient as well, which can match the basic theory given by Fama and French.

Table 3. Regression Result of Models

	Model (1)	Model (2)	Model (3)	Model (4)
Name of model	three-factor model	three-factor model with ESG	five-factor model	five-factor model with ESG
const	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
riskpremium_3	1.0277***	1.0235***		
	(0.0007)	(0.0007)		
smb_3	0.7726***	0.8089***		
	(0.0009)	(0.0011)		
hml_3	-0.2834***	-0.2668***		
	(0.0014)	(0.0014)		
esg_3		0.0929***		
		(0.0017)		
riskpremium_5			1.0425***	1.0377***
			(0.0007)	(0.0007)
smb_5			0.7922***	0.8237***
			(0.0016)	(0.0017)
hml_5			-0.3237***	-0.3144***
			(0.0016)	(0.0016)
rmw_5			-0.0985***	-0.1011***
			(0.0027)	(0.0027)
cma_5			0.0359***	0.0569***
			(0.0029)	(0.0029)
esg_5				0.0792***
				(0.0017)
_cons	0.0000***	0.0001***	0.0000**	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	11067690	11067690	11067690	11067690
R-sq	0.25592	0.25614	0.25526	0.25541
adj. R-sq	0.25592	0.25614	0.25526	0.25541
F	1.27e+06	9.53e+05	7.59e+05	6.33e+05

Standard errors in parentheses: * p<0.05; ** p<0.01; *** p<0.001

Besides, the R-square and adjusted R-square results is also meaningful. It's known that the more factors added into model, the more efficient the model should be, whose R-square should be higher. However, we can notice that R-square of Model (3) is lower than Model (1) and Model (4) is lower than Model (2). This phenomenon shows that comparing with five factor model, three-factor model works better in China Security market, no matter whether ESG factor is added in or not. It can also be confirmed that ESG factor improve the behavior of three and five factor model, since adjusted R-square of Model (2) is higher than Model (1) and Model (4) is higher than Model (3). What's more important, the improvement of Model (2) is more significant than Model (4), which verifies the previous conclusion from the other side and shows that the three-factor model is more suitable for the Chinese market.

5. Further Analysis

5.1 Regression by Industry

Having verified the efficiency of the ESG factor in both three-factor and five-factor models, we are also curious about whether this efficiency would be different among industries, since some industries such as mining industry will inevitably pollute the environment during their production, while some service industry will not directly cause environmental pollution. It means that the ESG factor may have

different impact on the daily returns of the companies in different industries.

In order to verify the conclusions drawn above, we use the industry classification and industry name released by the China Securities Regulatory Commission in 2012 to classify each stock, and then perform group regression on two models. The regression results are shown in Table 4 below.

Table 4. Regression Result by Industry

	three-factor Model			five-factor Model		
	esg_3	t values	p values	esg_5	t values	p values
Mining industry	-0.4021	-42.8222	0.0000	-0.2745	-29.2125	0.0000
Electricity, heat, gas and water production and supply	-0.1926	-23.3478	0.0000	-0.1659	-20.0122	0.0000
Agriculture, forestry, animal husbandry and fisheries	-0.1867	-12.9751	0.0000	-0.1901	-13.0821	0.0000
Transport, warehousing and postal services	-0.0048	-0.5540	0.5796	0.0317	3.6586	0.0003
Comprehensive	-0.0147	-0.4809	0.6306	0.0224	0.7408	0.4588
Resident services, repairs and other services	0.2240	1.6638	0.0963	0.2037	1.4139	0.1576
Accommodation and catering industry	0.0528	1.8819	0.0599	0.0781	2.7625	0.0057
Construction industry	0.0216	2.4180	0.0156	0.0223	2.4471	0.0144
Water, Environment and Public Facilities Management	0.0458	4.3210	0.0000	-0.0123	-1.1245	0.2608
Real estate industry	0.0917	5.5486	0.0000	0.0365	2.2150	0.0268
Health and social work	0.1426	5.9680	0.0000	0.1132	4.6820	0.0000
Wholesale and retail trade	0.0522	6.3987	0.0000	0.0782	9.4990	0.0000
Education	0.3126	9.8618	0.0000	0.2390	7.4593	0.0000
Leasing and business services	0.1859	17.2490	0.0000	0.1920	17.5567	0.0000
Scientific research and technical service industry	0.2649	18.6346	0.0000	0.2289	15.4055	0.0000
Financial industry	0.2387	24.6843	0.0000	0.3204	32.6235	0.0000
Culture, Sports and Entertainment	0.4209	30.4154	0.0000	0.4564	32.3432	0.0000
Manufacturing	0.0650	33.0672	0.0000	0.0395	19.5836	0.0000
Information transmission, software and information technology services	0.5475	73.9423	0.0000	0.5578	72.9437	0.0000

According to Table 4, among 19 industries, ESG factor doesn't works well in 7 industries, while only 5 industries if only seen the result of three-factor models. This result make sense because these five industries are related to the service industry in varying degrees. Take other look at the biggest t-value in all industries, it is information transmission, software and information technology services and the reason of this result might be a big amount of electricity resources consumption. Meanwhile, the electricity resources are mainly generated by thermal power, which leads to pollution emissions.

However, we can also notice the first 3 rows data, showing that low ESG rating may be good news for these three industries, which is different from what we expect. The reason may be, take mining industry as an example, if one company focuses too much on the pollution control but not the profit gaining, the investors will not pay for this stock and will switch to other companies who care less about environmental protection and earn more for the owners. In these three industries, the pollution level might be related to their ability to gain outfit from the production and that makes high ESG rating represents poor company performance.

5.2 Analysis by Company Attributes

Since for Chinese companies, whether they are state-owned or not is a very important factor, which will affect their profits attribution and their management objectives. Companies that are state-owned would prefer work that may not gain enough profit. Because they are supported by China government, there is less need for them to gain money and care about the public comments, which means that ESG ratings from third-party organizations might not be efficient for them.

To prove this hypothesis, we separate all companies into four groups, seven kinds of

enterprises and perform regression tests again. To be specific, the first group is central and local state-owned enterprises, who are without doubt state-owned. And the second group is collective and public enterprises, refers to the companies that would affect the whole society directly and hugely and belong to the public, who are not state-owned but get similarities to the first group. What's more, the third and last group is some companies belong to private people or foreigners and are totally different from state-owned enterprises, who need the support from investors and care more about the ESG ratings.

Table 5. Regression Result by Company Attributes

	three-factor Model			five-factor Model		
	esg_3	t values	p values	esg_5	t values	p values
Central state-owned enterprises	-0.0418	-10.3770	0.0000	0.0254	6.2801	0.0000
Local state-owned enterprises	-0.0142	-4.6440	0.0000	0.0040	1.3030	0.1926
Collective enterprises	0.0245	1.3692	0.1710	0.0158	0.8676	0.3856
Public enterprise	0.1514	21.5448	0.0000	0.1670	23.3646	0.0000
Private enterprises	0.1513	62.3665	0.0000	0.1119	44.5460	0.0000
Foreign-funded enterprises	0.2151	25.1848	0.0000	0.1838	20.8614	0.0000
Other enterprises	0.1436	7.2434	0.0000	0.1648	8.1485	0.0000

Checking the result showed in Table 5, it is obvious that ESG factor don't works well to collective enterprises, since the p values are 0.171 and 0.386, which are much higher than 0.001. It means that collective enterprises will not pay too much attention to ESG rating but focus on their own work plan. Besides, ESG factor with five-factor model also not works well for local state-owned enterprises, which matches the hypothesis given before. Through in three-factor model, ESG factor is efficient for central and local state-owned enterprises, the t values of it are much lower than private and foreign-funded enterprises, which also happens in five-factor model. This phenomenon shows that the hypothesis is verified and the state-owned enterprises care less about ESG factor and the more need for the enterprises to gain profit and attract investors, the more the ESG rating can affect them.

6. Conclusion

In this article, we used regression tests to verify the effectiveness of ESG factors and compare the Fama French three-factor model and five-factor model, showing that the three-factor model performs better in Chinese security market with higher R-squares and less variables. This conclusion is consistent with the conclusions given by .

Apart from the basic empirical tests, we also use industry affiliation and company attributes to classify companies and use this classification for regression analysis. We verify that industries related to service industry will be less likely to be affected by ESG rating and there are three industries that higher ESG rating, instead of raising it, would lower their return, which also makes sense. Besides, considering the special group of enterprises that are state-owned in China, we prove that these kinds of enterprises will care less about ESG rating but pay attention only to their priorities.

In conclusion, this article proves the higher effectiveness of the three-factor model in the Chinese market compared to the five-factor model. And we prove the effectiveness of the ESG factor, and compare and analyze the similarities and differences in its effectiveness in different industries and companies, which can bring new evidence to the academic field.

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