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Comparing Factor Models in European Stock Market

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Abstract
How to construct portfolios is a vital issue for investors and the effective use of asset pricing models can better achieve the goal of risk diversification. Given the large amount of asset pricing models, this paper intended to select a benchmark model that performs the best among a set of prominent asset pricing models in European stock markets. The candidate models included CAPM, the three-factor (FF3), five-factor, and six-factor (FF6) models of Fama and French (1993, 2015, 2018), the four-factor model of Carhart (1997), and a variant of FF6 that contains a more-timely value factor. This paper compared their abilities to explain size-B/M and size-momentum portfolios based on average absolute alphas and average absolute t-statistics. The empirical results showed that FF6 and its variant in general outperforms the other competing models.

Key words: Asset pricing factor model; European stock market; Model comparison

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1. INTRODUCTION

The varieties of portfolios are diversified with the development of capital market, and the investors who are risk averse all hope to gain higher returns after taking some risks in their investment behaviors. Therefore, the allocation of assets in a variety of investment products is very significant since investment products of high returns may cover the losses of other investment products. The effective use of asset pricing model can better balance between risks and returns to achieve the goal of risk diversification. This motivated us to compare different asset pricing factor models, which is important for constructing portfolios.

As early as the 1950s, H. M. Markowitz proposed the Mean-Variance Model (1952), which became the benchmark for the further study of factors and models. Markowitz instituted the calculation of expected returns and risks and the theory of efficient frontier in 1952. This method achieves the best balance effect in the multi-objective optimization of returns and risks. Sharpe (1964) and Lintner (1965) study the relationship of expected returns and risk assets in the light of the Mean-Variance Model. Capital Asset Pricing Model mainly contains market. CAPM pursues the investors should gain how much rate of return in order to compensate for a certain degree of risk. Fama and French (1993) presents a three-factor model and it incorporates market, size and value. The one of contributions of Carhart (1997) is to prove the momentum effect and reversal effect in the four-factor, and puts forward the four-factor model, which includes market, size, value and momentum. The five-factor model (Fama and French,2015) consists of market, size, value, investment and profitability. Fama and French add the investment and profitability to the Fama and French (1993) and adopt a deformation of the dividend discount model to construct the relationship of returns, investment and profitability. The last model is the six-factor model Fama and French (2018) proposes, there are market, size, value, investment, profitability and momentum. What's more, the six-factor model has the further improvement that it reflects in the value factor. We found many models so that we wanted to compare these models and know which one was the better.

We focus on the European stock market. The degree of integration in European stock markets is higher than other regions. Besides, there lacks research on the comparison of asset pricing models in European markets. For the purpose of model comparison, we diversified stocks for the European region on size and book to market equity (B/M) and on size-momentum, which was same as Fama and French (2012). And we used the breakpoints of size, B/M and momentum to sort the small and big stocks and constructed portfolios for forming the patterns of the size, value and momentum. Finally, we obtained the 5×5 size-B/M and size-momentum portfolios.

Our goal was to find the better one of models we tested. We hoped that we could offer more references with the help of our conclusions for investors in their investments. We applied the method of regressions to the different models. In the 25 size-B/M and size-momentum portfolios, the smaller average absolute α and average absolute t are, the better model is. Concerning the result, by comparing and analyzing, what we found was that the six-factor model could perform better than other models in our tests. Some statistics of the six-factor model were the minimum, particularly when the value factor of was improved. We mainly introduced the details of our data in section 2.1. As for the section 2.2 we detected the correlations of different factor we used in the regressions. According to the average absolute α and average absolute t-statistics, section 2.3 discussed the comparison of six models we tested. We turned to our conclusions in section 3.

2. DATA AND VARIABLES

2.1 Data

Based on the development of asset pricing factor models, we listed six factor models and showed their mainly constituent factors, which were exactly the objects we used in the subsequent regression. (Table 1)

In the Capital Asset Pricing Model, the main factor is market (MKT). We can get excess return from the difference between market rate (R_m) and risk-free rate (R_f). Market, size (SMB, Small Minus Big) and value (HML, High Minus Low) are components of the three-factor model (Fama and French,1993). It is a complement that the three-factor model also creates other problems while it solves the phenomenon of CAPM. In addition to momentum, there are investment and profitability, which also are considered by the five-factor model of Fama and French (2015). The four-factor model (Carhart,1997) is made up of market, SMB, HML and momentum (WML, winner minus loser). As for the five-factor model (Fama and French, 2015), there are market, SMB, HML, investment (CMA, Conservative Minus Aggressive) and profitability (RMW, Robust Minus Weak). Lastly (Fama and French, 2018) is the result of improvement about HML in the six-factor model, which deals well with the relationship between value and momentum. In a certain sense, the issue of required us to pay more attention to data of time series on monthly. Therefore, the improved six-factor model is composed of market, SMB, , CMA, RMW and WML. Fama and French (2013) elaborated the details of the value factor of and momentum. There were three approaches to calculate book-to-price (B/P) and how the book value affected B/P, which were related to the construction of value factor, models and portfolios. The article also illustrated the relationship of value and momentum so that we comprehend why the correlation of them was powerful. To mention momentum, we found the effect of momentum on time series and cross section, which could help us to keep robustness of returns in portfolios.

Table 1
The models of main factors

Models	Factors
CAPM	Market
FF3	Market、SMB、HML
Carhart	Market、SMB、HML、WML
FF5	Market、SMB、HML、CMA、RMW
FF6	Market、SMB、HML、CMA、RMW、WML
FF6m	Market、SMB、、CMA、RMW、WML

2.2 Correlation

The data we selected from January 1991 to March 2020 to analyze these factors about market, size, value, profitability, investment, momentum. And we updated HML more frequently according to the variation between value and momentum. We tested the correlation of the factors we descripted above. The correlation of these observed factors was not remarkable overall, which showed a weak correlation. Some factors even displayed the unrelated correlation. By comparison, we received the consequence hereinafter. Market had negative correlations with size, profitability, investment and momentum, which respectively were -0.132, -0.301, -0.256 and -0.329. Size correlated weakly with other factors. HML and the frequently updated had the powerful correlation with 0.746, which indicated the two factors had a substitution. And the dependence of HML and investment was 0.561. The negative correlation between and momentum was strong because had a better interpretation on momentum. The tests with frequently update of HML showed that this method was better, which could be observed from ‘s ability to capture recent returns in this model. The results of the specific correlation are in Table 2. We could observe most of the correlations we listed were in an acceptable range, which preliminarily these models were reasonable.

Table 2
The Correlation of factors

	Mkt-RF	SMB	HML		RMW	CMA	WML
Mkt-RF	1.000	-0.132	0.228	0.253	-0.301	-0.256	-0.329
SMB	-0.132	1.000	0.029	0.020	-0.014	0.016	0.071
HML	0.228	0.029	1.000	0.746	-0.549	0.561	-0.303
	0.253	0.020	0.746	1.000	-0.499	0.417	-0.657
RMW	-0.301	-0.014	-0.549	-0.499	1.000	-0.187	0.416
CMA	-0.256	0.016	0.561	0.417	-0.187	1.000	0.013
WML	-0.329	0.071	-0.303	-0.657	0.416	0.013	1.000

2.3 Empirical Analysis

The sample period about data was from January 1991 to March 2020. According to Fama and French (2012), the regressions we used was

In this regression, F was on behalf of these six models we needed to test, including CAPM, Fama and French (1993), Carhart (1997), Fama and French (2015) and Fama and French (2018). And if a, the slope, did not exist, which meant we could obtain all excess returns from our models. It was benefit for us to test our models and portfolios. We wanted to compare the average absolute α and average absolute t-statistics of different models. All portfolios used a same method. We divided separately size and book to market equity (B/M) quintiles. The same standard breakpoints divided size-B/M and size-momentum into 5×5 sorts in European region, and the 5×5 classification produced 25 portfolios. The reason why we chose the European market was its high degree of integration. All classified standards and breakpoints referred to the data of European stock market, which could greatly reduce errors and influences from other unimportant small stocks. We followed the same data groups and methods of construction in order to ensure the consistency of asset pricing factor models we tested. The intersection of 5×5 sorts resulted in 25 value-weight portfolios about the combination of size-BM and size-momentum, by analyzing regressions we obtained the average of absolute α and the average of absolute t so that we could evaluate the performance of these models in the portfolios. (Table 3)

As we could see from the table 3 with the amelioration of asset pricing factor models, as a whole the average of absolute α and the average of absolute t were inclined to decrease. In other words, the lower the average of absolute α and the average of absolute t were, the better model we studied was. It was obvious that the six-factor model performed better in our tests, particularly there was the improved six-factor model with the value factor of . In the outcomes of regressions, all six models had different manifestations in the portfolios of size-B/M and size-momentum. CAPM was reflected in the average of absolute α and the average of absolute t in size-momentum portfolios with 0.380 and 2.683, which illustrated CAPM could not explain momentum. With regard to the three-factor model (Fama and French,1993), it seemed worse than CAPM in failing to capture momentum. Carhart added momentum to the four-factor model so the average of absolute t was lower than the former we mentioned. In fact, the four-factor model (Carhart,1997) could rival the six-factor models. It presented good performance on size-B/M and size-momentum. We contrasted Carhart (1997) with the six-factor model, except the average of absolute t in the pattern of size-momentum, other three differences of the average of absolute α and the average of absolute t on size-B/M and size-momentum were all so small within 0.01. It was a result we wanted that the momentum effect could explain well the source of the excess returns and produce short-term reversal effect. The most remarkable advantage of the momentum factor was it performed steadily on time dimension. The representation of the five-factor model (Fama and French,2015) was not bad but no better than Carhart (1997). Those models prior to the six-factor model all did not explicate momentum well. Actually, the improved value of (Fama and French, 2018) had not more changes and distinctions with the impact on the model in regressions, because the correlation and substitution of HML and were great. As a consequence, its advantages of interpreting momentum were more obvious, in the regression what the average of absolute t reflected was smaller. It could be seen that it is important for stock prices to consider updating the data of HML in the more frequent manner in time, which testified Fama and French (2013) stated the method of update monthly and currently better than the lagged.

Table 3
Regression result

	Ave-α-bm	Ave-α-mom	Ave-t-bm	Ave-t-mom
CAPM	0.109	0.380	0.872	2.683
FF3	0.097	0.388	1.350	3.580
Carhart	0.078	0.170	1.043	2.110
FF5	0.079	0.254	1.080	2.269
FF6	0.078	0.164	1.048	1.928
FF6m	0.089	0.164	1.123	1.918

CONCLUSION

We studied the development of the factors and models on size-B/M and size-momentum, such as CAPM, Fama and French (1993) and Carhart (1997).On the basis of these, we added the five-factor model, the six-factor model and the improved six-factor model, which also were tested in the same way. We made further efforts that we considered the two factors of the five-factor model about CMA, RMW and the improved six-factor model (Fama and French, 2018). It was evident that the improved six-factor model was better than other models in the portfolios, which meant it could achieve greater average returns under the same conditions. Nevertheless, we also learned that the value factor of the three-factor model would be unnecessary from Fama and French (2015). If so, we could speculate the ability of one factor to capture average returns was covered by other factors probably, and wondered whether a designated factor could be substituted or not. Given momentum and value played a role in catching returns on size-B/M and size-momentum, we should take into account different dimensions besides time series and cross section, which might help us to gain better factor indexes to wield in our portfolios. And how often we replaced the value factor of HML properly was also a critical matter. In a fixed stock portfolio, we could predict the average returns of a portfolio. Meanwhile, what we paid more attention to was which one of models feasibly and accurately on the cross-section.

Each factor takes different risks in different portfolios. Factors represent different sources of risks, and factor models can well predict the benefits on the cross-section. For instance, the six-factor model can be a better investment tool to obtain appreciable returns when assets are allocated appropriately. Without doubt, we don't consider some unimportant stocks such as other microcaps when we construct the portfolios in our regressions to decrease the errors. In fact, we are likely to invest microcaps in our real transactions. The relations of one factor and other factors can act on individually the models and portfolios and hence we infer whether we optimize quotas of factors to have better models and portfolios. Although these factors and models themselves have some problems, particularly when their performances aren't good enough, these models can provide references of investment. The development of factors and models will be continuing, and we are looking forward to the further study about better factors and models to invest.

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