ACADEMIC RESEARCH REVIEW

BEYOND CAPM: *AN INNOVATIVE FACTOR MODEL TO OPTIMIZE THE RISK AND RETURN TRADE-OFF*

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Journal of Business Economics and Management
2014 Volume 15(4): 615–630

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Overview

The authors seek to improve upon CAPM by considering a multi-factor model to achieve better risk optimization.

Motivation

The authors believe that CAPM is insufficient to explain asset returns. Their main hypothesis is that risk and returns are explained by different factors, thus a multi-factor model can better assess the risk and returns of assets. Markowitz himself admits that the market portfolio is no longer efficient if the premises do not hold. Ross (Arbitrage Pricing Theory (APT), 1972), Fama and French (Fama-French 3-factor model, 1992), and Carhart (Carhart four-factor model, 1997) have subsequently considered a multi-factor approach. But these models either lack specificity (Ross' APT), or considers only a few factors.

Thesis

The paper seeks to prove five hypotheses which lead to the conclusion that there exists a multi-factor based risk optimization model.

Hypotheses:

1. Risk and returns are explained by multiple different factors.
2. Not all investors are rational, thus they have different expectations. Investors do not only allocate assets according to the market portfolio, which means that not all factors are diversified. This will in turn imply Hypothesis 1.
3. Factors may have positive or negative effects on returns.
4. Factors have different significance, which they quantify using a "Relative Importance Index".
5. The impact of factors will change based on time (current events or news).

Methodology

Data overview

The authors analyzed 9260 European companies in over 40 major industries, over the 1965–2007 period (split into seven periods of 5 years and one period of 8 years). They picked over 300,000 factors which can be categorized into 4 main groups – business and macroeconomic variables, commodity prices, equity indices, and market indices.

2-step approach

The authors use a methodology similar to past works which attempts to incorporate CAPM into a multi-factor model. The first step is to pick a large number of viable factors and then filter out the redundant variables by considering the 'Factor Relevance' for every factor pairs. Factors with the highest Factor Relevance are kept as they have the most significance.

$$FR_k = \sum_{i=1}^{n} \rho_{k,i} \quad FR_i = \sum_{k=1}^{n} \rho_{k,i}$$

where n is the total number of factors and $\rho_{k,i}$ denotes the Pearson correlation coefficient between the kth and i^{th} factors

The next step is to carry out factor analysis. This is to identify key factors that affect asset returns. The regression analysis is as follows:

1. Defining the regression model for the return on the Gth asset:

$$r_G = \alpha + \sum_{i=1}^{n} \beta_i f_i + \varepsilon_i$$

2. Performing a stepwise time series regression. The stepwise criterion is as follows: a factor is added if its *p*-value < 0.01, and is removed if its *p*-value > 0.005.
3. Building a portfolio based on common factors.
4. Testing the validity of the model by performing cross-section regressions.

Results

Most importantly, the adjusted R^2 values are close to 1, indicating an accurate regression model. One of the main concerns is the possible outliers in the data used, since the analysis was conducted with 300,000 factors and 9,000 companies, over a long 50-year period. But the low *p*-values and the overall factors selected give good reason to ignore this concern. Business and macroeconomic factors turns out to be most influential (consistent with APT). The main market indices are key factors (consistent with CAPM and the Fama-French models). The other significant factors are shown in Table 1. Note that these factors are usually viewed as "market movers".

Table 1: First 15 Most Significant Factors Identified from 2000 to 2007

Factor name	Area	Type	Intertempora[1]l	Absolute Frequency	No. of companies
Currency rate	Asia(Japan)	Macroec.business	Yes	3385	2584
Balance of payments	United States	Macroec.business	No	-	2569
Banks' house loans	Germany	Macroec.business	Yes	3157	2448
European Market index	Europe	Equity Indices	Yes	4321	2648
Imports from western hemisphere	/	Macroec.business	Yes	2724	2154
Inflation rate	Europe	Macroec.business	Yes	3870	2255
Main Refinancing operation	Europe	Macroec.business	No	-	2428

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[1] Presence of factor in other time periods

Private fixed investment	United States	Macroec.business	No	-	2905
Public corp. gross disposable income	United Kingdom	Macroec.business	No	-	2174
Real GDP	United States	Macroec.business	Yes	3726	2982
Unit labor costs	OECD	Macroec.business	No	-	2782
US securities but treasury securities	United States	Macroec.business	No	-	2382
US unemployment	United States	Macroec.business	No	-	2428
Volume of exports	Asia & Middle East	Macroec.business	No	-	2569
Volume of exports-petroleum	Middle East	Macroec.business	No	-	2648

Conclusion

The results do support the authors' main hypothesis, most crucially that risk and returns are indeed affected by multiple factors. The authors then argued conversely for Hypothesis 2, which suggests that risk can be further decreased via a factor-based optimization process, since investors are not optimally diversified. This is supported by Hypothesis 3, with a similar idea from CAPM that negatively correlated factors allow for risk diversification. Finally, the authors assert that since the market is the largest portfolio and thus considers all factors, the factors that affect market returns are the only ones that can explain any portfolio returns.