Frontiers in Business, Economics and Management
ISSN: 2766-824X | Vol. 16, No. 2, 2024

Prediction and Evaluation of Investment Portfolios Using Multi-Factor Models: A Case Study of Engineering & Construction and Insurance-Reinsurance Industries

Yiqiang Fan

Monash University, Petaling Jaya, 47500, Malaysia
fan0080@student.monash.edu

Abstract: This analysis evaluates the performance of a portfolio selected from 20 common stocks across two industries: Engineering & Construction and Insurance-Reinsurance, covering period from 2020 to 2023. By utilizing historical data, a rigorous multi-factor approach is employed to assess the financial return and risk characteristics of the assets. Key metrics include the stocks and the total portfolio return and risk. These metrics provide empirical insights into the performance of the portfolio.

Keywords: Investment Portfolios, Multi-Factor Models, Engineering & Construction, Insurance-Reinsurance Industries.

1. Introduction

Our task in this evaluation is constructing and managing a common stock portfolio with an initial capital of $100 million. This portfolio was formed by selecting stocks from 20 companies across two industries: Engineering & Construction, and Insurance-Reinsurance.

The primary objective set by our client is to maximize the Sharpe ratio of the portfolio, our final portfolio consists of 12 stocks: six from the Engineering & Construction industry and six from the Insurance-Reinsurance industry.

This portfolio will be evaluated using the Sharpe ratio and Treynor Measure. The performance of this portfolio is evaluated against the Russell 3000 benchmark, with the portfolio's weights constrained to sum to one.

To meet client's objective, we employed the Fama-French three-factor model to guide our portfolio construction. The selected stocks include ACA, ACM, EME, FLR, J, MTZ, EG, GLRE, OXBR, RGA, RNR, and SPNT.

Based on our analysis, the expected return for the portfolio in the next year is 0.19, with an expected risk of 0.0514. However, the actual return of portfolio is 17.49 %, and actual risk is 8.36% during the first four months in 2024.

2. Methodology and Results

2.1. Methods and Data

2.1.1. Data collection

To ensure the transparency of the data in this evaluation, all data in the report were selected from Yahoo Finance and Fred. The data used in this report are all from monthly data from 2020 to 2023 and daily data for the first four months of 2024, and there are not any structural breaks for each stocks' data during this period. Using monthly data for portfolio evaluation and forecasting alleviates the impact of frequent trading and monthly data can reduce the amount of data to be processed compared to daily data, making computation and storage more efficient. In addition, monthly data can better capture long-term trends, helping to develop forward-looking investment strategies.

In terms of stock selection, as a high stock price usually means a high maturity of the enterprise, and it has stable profitability and low operational risk. Therefore, we focused on the top 10 stocks with high stock prices in the two industries.

2.1.2. The choice of method

This report adopts the multi-factor model as the main analytical tool. The multi-factor model has several advantages over other approaches. It provides more comprehensive portfolio analysis and risk management, better captures market complexity, and improves forecast accuracy. It also has a statistically higher adjusted R-square compared to the one-factor model. This means that there is more variation in the dependent variable in the regression model that can be explained by the independent variables. However, multi-factor models tend to have higher complexity and data requirements, as well as the risk of overfitting and interpretation difficulties.

2.1.3. Process of prediction

To evaluate a portfolio, we need to determine its expected annual return, annualized standard deviation (expected risk), and Sharpe ratio. Using the Fama & French three-factor model, we calculate the expected return and risk for each stock. The formular show as below.

$$E(Ri) - Rf = \alpha + b_i\big(E(R_m) - R_f\big) + s_i E(SMB) + h_i E(HML) + error \quad (1)$$

The model uses three factors: the market risk premium (E(Rm)-Rf), the size premium (SMB), and the value premium (HML), with their respective betas presented. We run multi-factor regressions in Excel to obtain these betas, annualized alphas, and firm-specific variances. The expected return for each stock is the sum of the risk-free rate and the total risk premium, the factor premium and the alpha. For portfolios, we calculate the annualized variance of alpha, beta, and residuals using Excel's "MMULT" function. The expected risk of a portfolio is the square root of its annualized variance, derived from the sum of the squared betas of the portfolio and the annualized variance of the market. We also use a multi-factor model to determine the weight of each stock and use the S&P 500 index as the benchmark. The objective is to maximize the Sharpe ratio, implemented using the Excel solver. This comprehensive approach ensures an accurate

assessment of risk-adjusted returns. In addition, when calculating the expected selling price of each stock, we make the calculation according to the following formula.

$$E(Ri) = \frac{E(P_i)+E(D_i)}{P_0} - 1 \quad (2)$$

2.1.4. Risk-adjusted performance indicators

We choose Sharpe ratio and Treynor measure to evaluate each stock and portfolio selected. The Sharpe ratio for each stock we obtain by calculating the average excess return for that stock divided by the variance of the excess return. The Treynor measure is then obtained by calculating the average excess return of the stock divided by the Beta.

2.1.5. Benchmarks

We discuss the S&P 500 and the Russell 3000 as benchmarks. The S&P 500 index tracks the stock performance of the 500 largest companies listed on U.S. stock exchanges. The Russell 3000, on the other hand, contains companies of all sizes and types, notably many engineering and construction companies as well as insurance and reinsurance company stock indexes. Thus, the Russell 3000 is a more appropriate benchmark for our discussion. Then, we calculate the gap between the average monthly return (Ri) and the average monthly risk-free interest rate (Rf) in each year from 2020 to 2023 to obtain the value of (RI-RF). This step is repeated in the benchmark test to obtain the value of (Rm-Rf). Then a regression model with (Ri-Rm) as the dependent variable and (Rm-Rf) as the independent variable is established.

2.1.6. Process of evaluation

We first calculate the monthly return, current return, and risk, including dividends, for each stock from January 2, 2024 to April 30, 2024. The portfolio value is calculated by summing the values of all stocks and deriving the monthly portfolio return. Using four months of data, we determine the standard deviation of monthly excess returns for portfolios and individual stocks. Finally, we use these four-month returns and betas to calculate Sharpe ratios and Treynor ratios.

2.2. Results

2.2.1. Prediction of portfolio's performance

Through the above methods and data, the expected return and risk of the portfolio are shown below (Table 1). Overall, this portfolio is a relatively high risk and high return portfolio, with an expected annual return of about 20% and an expected annual risk of 19%. In addition, the Sharpe ratio of the portfolio is 0.7995, higher than the market Sharpe ratio of 0.7018. This illustrates that the portfolio has the advantage of being more efficient because it can provide higher returns than the market for the same level of risk.

Table 1. The prediction of portfolio

estimted the three-factor (general) model for 20 stocks			
Non-zero Alpha for some stocks		Exclude the market portfolio. Use the rescaled weightages	
Portfolio's expected annual return	0.192119	Portfolio's expected annual return	0.2033
Portfolio's expected total annual risk premium	0.140719	Portfolio's expected total annual risk premium	0.1519
Portfolio's expected annual risk premium on Factor 1	0.131676	Portfolio's expected annual risk premium on Factor 1	0.1298
Portfolio's expected annual risk premium on Factor 2	0.004377	Portfolio's expected annual risk premium on Factor 2	0.0108
Portfolio's expected annual risk premium on Factor 3	0.004557	Portfolio's expected annual risk premium on Factor 3	0.0113
Portfolio's annualized variance	0.037102	Portfolio's annualized variance	0.0361
Portfolio's annualized standard deviation	0.192618	Portfolio's annualized standard deviation	0.1900
Portfolio's Sharpe ratio	0.730562	Portfolio's Sharpe ratio	0.7995
Portfolio's alpha	0.00011	Portfolio's alpha	0.0000
Portfolio's beta 1	0.991352	Portfolio's beta 1	0.9773
Portfolio's beta 2	0.232335	Portfolio's beta 2	0.5751
Portfolio's beta 3	0.23099	Portfolio's beta 3	0.5718
Portfolio's annaulized variance of residuals	0.001903	Portfolio's annaulized variance of residuals	0.0019
Risk-free rate (per year)	0.0514	Risk-free rate (per year)	0.0514
The stock market's expected annual return	0.184224	The stock market's expected annual return	0.18422447
The stock market's annualized variance	0.035815	The stock market's annualized variance	0.03581516
The stock market's annualized standard deviation	0.189249	The stock market's annualized standard deviation	0.18924895
The stock market's Sharpe ratio	0.701851	The stock market's Sharpe ratio	0.70185053
Factor 1's expected annual risk premium	0.132824	Factor 1's expected annual risk premium	0.13282447
Factor 2's expected annual risk premium	0.018838	Factor 2's expected annual risk premium	0.0188375

2.2.2. Performance of stocks' prediction

Table 2. A portfolio of stocks as of 2 January 2024

Stock	Purchase Price	No of Shares	Weight	Expected Selling Price	Expected Dividend	Expected Return	Expected Risk
ACA	81.68	120180.2	0.0397	92.2484	0.05	0.13	0.0460076
ACM	91.75	84169.63	0.0312	110.8375	0.18	0.21	0.036303039
EME	213.68	55246.16	0.0477	254.0992	0.18	0.19	0.03484519
FLR	38.74	42318.39	0.0066	50.5694	NONE	0.31	0.260341806
J	129.04	65068.06	0.0339	148.136	0.26	0.15	0.027444425
MTZ	74.57	408541.9	0.1231	94.7036	NONE	0.27	0.083091791
EG	355.01	15318.37	0.0220	406.5615	1.70	0.15	0.057638117
GLRE	11.31	320265.7	0.0146	13.1196	NONE	0.16	0.061657137
OXBR	1.1	24000330	0.0107	1.221	NONE	0.11	0.772868505
RGA	162.01	104706.3	0.0685	191.9669	0.825	0.19	0.06058784
RNR	196.95	5528.46	0.0044	218.2345	0.38	0.11	0.067410326
SPNT	11.58	22630.07	0.0011	13.5486	NONE	0.17	0.118503143

2.2.3. The actual performance of stocks

Table 3. A portfolio of stocks as of 30 April 2024

Stock	Current Price	Current-to-date Dividend	Current-to-date Return	Current-to-date Risk	Revised Expected Return	Revised Expected Risk
ACA	76.02	0.05	-0.0733	7.95%	-0.0533	8.95%
ACM	92.36	0.22	0.0085	7.21%	0.0285	8.21%
EME	357.17	0.215	0.6786	15.75%	0.6986	16.75%
FLR	40.85	NONE	0.0781	8.58%	0.1058	9.58%
J	143.53	0.29	0.1216	6.72%	0.1416	7.72%
MTZ	88.69	NONE	0.1966	16.42%	0.2166	17.42%
EG	366.41	1.75	0.0132	7.73%	0.0332	8.73%
GLRE	12.12	NONE	0.0841	6.03%	0.1041	7.03%
OXBR	1.065	NONE	0.0143	7.76%	0.0343	8.76%
RGA	186.99	0.85	0.146	5.37%	0.166	6.37%
RNR	219.25	0.39	0.0955	9.08%	0.1155	10.08%
SPNT	11.78	NONE	0.0235	5.38%	0.0435	6.38%
Russell 3000	2878.12	NONE	0.0539	4.18%	0.0739	5.18%

2.2.4. The actual performance of portfolio

The current-to-date return of portfolio is 17.49% and current-to-date risk of portfolio is 8.36%. And the Sharpe ratio of the portfolio is 0.9507 and the Treynor Measure is 0.1626, both indicating strong risk-adjusted performance for the first four months of 2024. A high Sharpe ratio reflects a good return relative to the risk taken, while the Treynor measure shows an effective management of market risk.

Table 4. the evaluation of portfolio

observation_date	Portfolio	Monthly return	Monthly excess return	All calculations below are specific for a case in which an investor buys and holds the asset from Day 1 until the end of the holding period of one year. It is for the purpose of reporting the current-to-date performance.		
2024-01-02	99625924.88			Current-to-date return (four months)	0.1749	
2024-01-31	98317999.4	-0.01	-0.017	Variance of monthly returns using four months of monthly returns	0.0070	
2024-02-29	108714450.2	0.11	0.102	Standard deviation of monthly returns using four months of monthly returns	0.0836	0.0836
2024-03-28	122219762.2	0.12	0.120	Four-month variance of monthly return	0.0279	
2024-04-30	117052298.7	-0.04	-0.046	Four-month standard deviation of monthly return	0.1672	0.1672
				Market yield on U.S. Treasury Securities at 1-Year Constant Maturity on 2 Jan 2024	0.0480	
				The one-month risk-free rate converted from the market-yield on the 1-year bond on 2 Jan 2024 as the baseline	0.0040	
				Current-to-date excess return (four months)	0.1589	
				Variance of monthly excess returns using four months of monthly excess returns	0.0070	
				Standard deviation of monthly excess returns using four months of monthly excess returns	0.0836	0.0836
				Four-month variance of monthly excess return	0.0279	
				Four-month standard deviation of monthly excess return	0.1672	0.1672
				Sharpe ratio for the current-to-date period (four months)	**0.9507**	
				Beta of (Mt-Rf)	**0.9773**	
				Treynor Measure	0.162603	

2.2.5. Evaluation of the difference between prediction and actual situation

However, there were some differences between the forecast and the actual results for each stock, and the actual results were generally worse than the forecast. This could be due to macroeconomic conditions, market trends, and company performance. The first is that high inflation in the U.S. has led to higher interest rates, raising companies' borrowing costs and reducing consumer spending, which has compressed stock valuations (Molenaar, Sénéchal, Swinkels& Wang, 2024). Secondly, industry-specific challenges such as reduced infrastructure spending and supply chain disruptions have also affected sectors (Yu et al., 2021). Such as construction and engineering (e.g. ACA, ACM). Increased market volatility has affected insurers (e.g. RGA, RNR) through higher claim costs and lower investment returns (Koijen & Yogo, 2022). Finally, firm-specific factors, including earnings reports, management changes, and strategic adjustments, further influence stock performance (Maher Azzam Ghaleb Al-Qadi et al., n.d.). For example, ACA's actual rate of return is -0.0733 compared to the forecast of 0.13, reflecting the slowdown in project financing costs and infrastructure investment.

2.2.6. Commentary for these assets

As for the performance of each asset, according to Table 3 and Table 5, most assets perform well, while a small number of assets need investors' attention. The stock returns of ACA, ACM and SPNT compared with 2023 decreased. Four stocks - FLR, GLRE, OXBR, SPNT - are less risky compared to 2023. Compared with the benchmark, EME, FLR, J, MTZ, GLRE, RGA, RNR, this a few stocks better returns than the benchmark, but in terms of risk, the risk of portfolio of all stocks are higher than the benchmark. This requires investors to pay attention to in the corresponding risk control.

Table 5. the expected risk-adjusted performance

	Average(RI-Rf)	Beta	Sharp Ratio	Treynor Measure	Return 2023	Risk 2023
ACA	0.014364997	0.64909	0.18844231	0.022130982	0.03757196	0.067407
ACM	0.018931704	1.195502	0.20704259	0.015835779	0.00903015	0.066618
EME	0.00452335	0.021148	0.25260414	0.213886675	0.03391597	0.071176
FLR	0.0309472	1.948148	0.16094473	0.015885448	0.0145001	0.09582
J	0.008356407	0.12698	0.1284056	0.065808817	0.00747464	0.046183
MTZ	0.011894635	1.653184	0.01189463	0.007194986	0.00160077	0.155937
EG	0.00711237	0.598044	0.08560233	0.011892727	0.00797508	0.072915
GLRE	0.005263552	0.842351	0.05829506	0.006248648	0.03074584	0.072469
OXBR	0.039101284	0.893415	0.14255389	0.043766087	0.03320658	0.332107
RGA	0.003755323	0.898978	0.03673017	0.004177324	0.01207597	0.051392
RNR	0.00176739	0.334304	0.0219647	0.00528677	0.00776931	0.074871
SPNT	0.006833351	0.89247	0.0604493	0.007656672	0.0628383	0.107743

3. Conclusion

Through this portfolio management project, we successfully constructed and evaluated a portfolio based on US common stock for our client. And we ensure the best balance of the portfolio between return and risk and maximize the Sharpe ratio. Our analysis shows that, although there is a slight difference between expectations and reality, the portfolio performs well during the evaluation period and meets the client's expected investment objectives.

References

[1] Koijen, R. S., & Yogo, M. (2022). The fragility of market risk insurance. The Journal of Finance, 77(2), 815-862.

[2] Maher Azzam Ghaleb Al-Qadi, P., Abdul-Hamid, M. A., Saidin, S. F., & Abdelrehim, M. Analyzing the Impact of Real and Accrual Earnings Management on the Cost of Equity: Evidence from the Jordanian Amman Stock Exchange.

[3] Molenaar, R., Sénéchal, E., Swinkels, L., & Wang, Z. (2024). Empirical Evidence on the Stock–Bond Correlation. Financial Analysts Journal, 1-20.

[4] Yu, Z., Razzaq, A., Rehman, A., Shah, A., Jameel, K., & Mor, R. S. (2021). Disruption in global supply chain and socio-economic shocks: a lesson from COVID-19 for sustainable production and consumption. Operations Management Research, 1-16.