**Project 1: Beating the market with factor investing**

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**1.**

Chart

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The Momentum yields the highest return of all factors and the lowest in performance is Profitability. The second best is Value and it outperforms the other factors in the periods of crisis, - the period of late eighties to the early nineties, it has pattern asymmetrical to the Market portfolio.

The Profitability has lower yields, lower volatility and smoother performance. The same we can observe on the graph of the Investment, although it has much higher returns. On the other hand, the factors with higher variance of returns outperform the latter two. The returns of all factors, except the Profitability are centered in the figure with similar temps of growth.

We observe growth in the period of late eighties to the end of early 20s, until the recession. Also we observe the growth of returns from the beginning to the end of total period, and the total rise in returns has grown to 300% There are 6 major falls in the returns – 4 during nineties and eighties (recessions at 80th, 90th) and 2 after 2000 (recession early 20 and crisis of 2007-8).

**2.**

The Market has one of the lowest sharp ratio, and the Investment and Value have the highest ratios of Sharpe return. Hence, these factors have higher return in relation to volatility and are potentially more valuable to the investor. All 'factors' outperform the 'market', except the 'profitability' factor, which has very poor potential performance.

Intuitively, the market portfolios have potential to improve the performance of an investor holding the market portfolio, if the behavior of the factors in the portfolio represent the true positive to the value of the investor patterns.

|  |  |
| --- | --- |
| Factor | Sharpe Ratio |
| Market | 0.192350 |
| Value | 0.302484 |
| Momentum | 0.424514 |
| Investment | 0.386271 |
| Profitability | 0.063746 |

**3.**

The market has the highest value of VaR of all styles, and the highest potential loss and the investment has the lowest. We observe the corresponding highest and lowest deviations of the styles, which could mean the highest potential return or loss. The market style has much higher mean return and also outperforms the profitability in Sharpe Ratio, but is worse than the Value factor in terms of VaR95 and Sharpe Ratio. The Investment potentially is the best according to the Sharpe Ratio and has second lowest VaR, but much higher value of return than Profitability factor, hence is better choice.

|  |  |
| --- | --- |
| Factor | VaR95 |
| Market | 0.071895 |
| Value | 0.047778 |
| Momentum | 0.041051 |
| Investment | 0.028043 |
| Profitability | 0.027173 |

**4.**

1. There are few observed known anomalies, which could be exploited for achieving higher returns. The smaller companies grow faster than bigger ones, and one could extract value from the difference in the speed. The second anomaly, the growing in value factors tend to continue to grow, hence it is less riskier to invest in them. The stocks with higher volatility could drastically fall in value, on other hand could produce much higher return than more stable, although smaller holdings. Also, the more profitable firms giver higher return than the poorer companies. One could exploit these and other known and researched factors to extract much higher value from the portfolio.
2. The equally weights portfolio does not account for the patterns in the data and makes a guess and a bet on its function. The Mean-Variance minimizes the variance of the portfolio and we can’t guess, would it return higher valued portfolio, than the aforementioned method. Although, since the volatility of the stocks returns is minimized, the risk is minimized and the higher variance stocks potentially give higher returns, although the more stable portfolio is more attractive for the less riskier investor. The Mean-Variance portfolio should beat the equally weights portfolio out-of-sample.

Mean-Variance problem:

The Min-Var problem:

The CVaR problem:

CVaR1−β(−rp) = E (−rp| − rp > VaR1−β),

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|  |  |  |
| --- | --- | --- |
| Factor | Sharpe Ratio | VaR95 |
| Market | 1.486951529889714 | 0.905327707865 |
| Equall weights | 0.3852982887517138 | 0.070156886755 |
| Min-Var | 0.6333759294399322 | 0.07831396456999998 |
| Mean-Var | 0.6650618031935756 | 0.08482615852399997 |
| CVaR | 2.0029556620193807 | 3.976017047241346 |

The CVaR has highest Sharpe Ratio and VaR95 portfolio and it outperforms all other portfolios. The market portfolio is the second best, although it stays much lower than CVaR.

Chart, line chart

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The cumulative sums of returns of the other portfolios stay below the 2 percent and have similar pattern of growth. The Mean-Variance portfolio outperforms the equally weights and min-var portfolios. The second one has the worst performance, although outperforms the min-var in the beginning of the age. The Sharpe Ratios of these portfolios have same descending order and equally weights portfolio has the same lowest ratio of all.

**5.**

Chart

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The Portfolios assessment with Sharpe Ratio and VaR95:

|  |  |  |
| --- | --- | --- |
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The Mean-Variance with shrinkage estimator

|  |  |  |
| --- | --- | --- |
| Mean-Var – Shrikage – 0.0 | 1.9879198029752019 | 4.000544493706894 |
| Mean-Var – Shrikage – 0.2 | 1.978528056211668 | 4.0004791140123475 |
| Mean-Var – Shrikage – 0.4 | 1.9552106847590638 | 4.000340473764219 |
| Mean-Var – Shrikage – 0.6 | 2.0084443163994528 | 3.8272399176819647 |
| Mean-Var – Shrikage – 0.8 | 1.9579780865928424 | 3.8268888307530164 |

I considered 5 shrinkage coefficients for an estimator based on the whole dataset:

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where The same procedure I applied to the covariance

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where

The higher the shrinkage coefficient, the better the performance of the Mean-Variance. The mean of the Mean-Variance portfolio increased in 3 times, although the same effect we observe on the maximum loss. The performance of the portfolio increased to the same extent and is almost the same as of the CVaR portfolio.

Overall the performance is much better with shrinkage coefficients than without, the Mean-Variance with shrinkage estimator outperforms all portfolios, with exception of CVaR.

**6.**

(1)

Regressed on CVaR portfolio:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Value | Momentum | Investment | Profitability |
| Coefficients | -4.1194851 | -2.82091933 | 2.91779804 | 6.91650071 |
| T stat. | -5.18689198 | -4.45678765 | 2.74225066 | 7.31949239 |

The profitability factor increases the returns with the highest extent of almost 7. percent. All factors are statistically significant, but Value and Momentum on average have negative effect on the return, on average decreasing the return by 4 and 2.8 points respectively. The Investment increases the return on average by 3 points.

The Value and Profitability factors are profitable and valuable for investment.

(2)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Size | Value | Momentum | Investment | Profitability | Low volatility |
| Coefficients | -9.57579616 | -1.17071869 | 9.98764929 | 5.69807422 | -6.68291399 | -6.93883113 |
| T stat. | -3.37452474 | -0.39349087 | 17.44398316 | 1.49429064 | -2.55120627 | -5.20021397 |

There are two factors, which have positive effect on the return – Investment and Momentum. The Momentum on average increases the return by almost 10 points ~ 9.98 and the investment by almost 6 percent ~ 5.69. The Momentum is very statistically significant and the Investment is of much lower statistical significance. Increasing investment on the other factors have negative effect on the return, the Profitability and Low volatility decrease the return on average by 6.67 and 6.93 percent. The Value factor has very low statistical significance and Size, Profitability and Low volatility have strong effect on the regression target.

Comparing to the task (1) the coefficients of the Momentum and Profitability switched the signs and have reverse effect on the return, on the other hand the Value coefficient has same sign, but decreases the return almost 4 time lower and the Investment factor has twice lower positive effect in the Equall weights portfolio than in CVaR.

**7.**

Without transaction cost

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Equall weights | Min-Variance | Mean-Variance | CVaR |
| VaR5 | 0.0736406888 | 0.0678628165125 | 0.08305792774 | 3.97601704 |
| Mean | 0.0250857626 | 0.0302111733099 | 0.02313374652 | 2.45336241 |

With transaction cost

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Equall weights | Min-Variance | Mean-Variance | CVaR |
| VaR5 | 7.0852689e-232 | 1.6832450874e+212 | -5.486126e+303 | 3.96531721384 |
| Mean | -5.251009123e+303 | -3.918666129e+303 | -7.602206181e+303 | -1.1753615146e+61 |

The values of returns turn negative with transaction costs and the order of the portfolios by loses and mean stay the same, the CVaR has the highest mean and Equall weights has the lowest. The latter one expects very low losses and VaR95 for CVaR stays in the same range. The CVaR preserves the place of the best portfolio by the performance.

**8.**

In the situation of poor market performance we should be more careful in investment choices and look for stability and consistency. The historically profitable firms give better returns than less profitable, on the other hand the companies with good performance preserve the growth and outperform the losing stocks. Investing in the profitable firms with history of stable performance, would be a good strategy for preserving once resources. Also the less aggressive investment firms statistically outperform the aggressive ones, which is consistent with the aforementioned approach and factors. The firms with low Value are undervalued by the stakeholders, the high book-to-market indicates high level of valuing to the firm. The reliable information of trust is valuable if we want to make the best choice in time of crisis. Choosing reliable, consistent, conservative stocks returns the lower level of risk and higher level of stability, which is critical for good performance and the higher level of success.

**9.**

The high return does not always mean the retrieval of high profit, the investing in the stability should not mean we gain enough to cover the loses. We are investing in high value firms with high profitability. Right now we are observing very drastic fall on the market and virtually all companies experience loses. We should stay consistent with the approach to preserve stability and lower the investments in the aggressive profitable firms to preserve the money for the future investing after the crisis ends and make an accent on the more conservative companies and stocks.