APM Assignment 2 99205472

1. What is Value Investing?

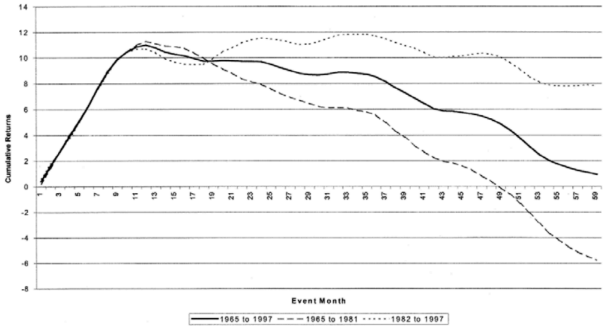
Value investing is based off of the belief that the Capital Asset Pricing Model (CAPM) is a poor indicator of asset returns, and that market inefficiencies exist (and it is not in equilibrium). Furthermore, value investing is the investment into these market inefficiencies and abnormalities, if consistently found, as a method of outperforming the market. Essentially, market inefficiencies have led to certain assets being over and undervalued and if we are able to determine the actual value of these assets, using performance indicators not usually screened for, we can invest in these undervalued stocks and receive above average returns. An example of value investing can be seen in Sanjoy Basu's 1997 study on the performance of stocks in relation the their price-to-book ratio. Since price-to-book return is unexplainable by CAPM and efficient market theory, its can be seen as an abnormal performance. Price-earnings ratios, and other abnormal stock performance measures are the basis from which value investing is conducted.



Why should it work?

The proven theory behind value investing is that a company's beta is not strongly related to its realized return, and that market anomalies do exist. The "proof," of issue with the CAPM model was found and published by Fama and French in 1992. If the beta of a stock does not have strong ties to its share price, then other forms of risk must exist that are not accounted for under the model. A number of value investing theories also lend the assumption that investors act irrationally commit errors in forecasting, these errors allowing for market anomalies to exist. If an investor is able to spot the inefficiencies and anomalies within the market, the investor can use this information to consistently outperform the market without taking on higher levels of risk, or risk unknown to the market.

How well did it work in the past?



A number of studies have been conducted in the past outlining the strategy and results of different value investing methods. Banz and Reinganum, in 1981, showed that returns are correlated with the market capitalization of a firm. Basu showed that accounting valuation ratios, specifically high earnings/price ratios, had higher returns than stocks with low ratios in his 1977 paper. Jegadeesh and Titman formalized the tendency for rising asset prices to rise further (as well as falling prices to fall further) in their 1993 paper on momentum, this phenomenon is shown in the graph to the left. And recently, in 2013, Novy-Marx outlined a correlation between firm profitability and share price, and how an increase in one led to the increase in another over an extended period of time. All of these studies point to the fact that above market results can be achieved through value investing. A value investing strategy, if correct, works best when it is not known as more investment in the anomaly brings the market back into equilibrium, therefore lending to strong results in the past.

2. Information Signal Backtest

Description

To construct a value investing strategy, data must first be screened for the value of each market anomaly. To screen the data a backtest will be conducted. Before undertaking the backtesting process, the parameters in which the process will take place must be set out.

- **The backtest is conducted from the year 1980 to 2010.** The reason for using a long period for backtesting is to ensure that the portfolio is not optimized towards extreme or rare market conditions. The years 2010 to 2017 have been left out to conduct an out of sample test later on.

- **The top 500 ranked stocks are used to create the universe of stocks.** Although our database allows access to a huge number of stocks, using the top 500 means that we can focus on top performers and still maintain a low level of specific risk.

- **The portfolio is rebalanced every 6 months.** The rebalancing of the portfolio is optimized later on in the process. Twice a year equals relatively low transaction costs whilst maintaining optimal investment periods.

- **The portfolio is equally weighted during this back-testing stage.**

With these parameters set out, the value signals can then be assessed. The signals tested in the process are Size, Gross Profitability, Book to Market Ratio, Ep12, EPQ, Earnings, Free Cash Flow, 1 Month Momentum, 3 Month Momentum and 12 Month Momentum. In order to assess the value signals, 3 steps were followed.

1. **Each stock within the test universe is screened and then ranked in accordance with its value signal.** For example, when screening for free cash flow as a value signal, the stocks will be ranked from the largest free cash flow to the smallest.

2. **From this ranking, three portfolios are created from the 500 hundred stocks**. The “Top,” portfolio of the best performing 200 stocks, the “Bottom,” portfolio of the worst performing 200 stocks and the “Benchmark,” portfolio of all 500 stocks.

3. **The performance of these three portfolios is back-tested in the said time period, revealing key diagnostics of their performance.**

The purpose of this backtest was to provide feedback as to the feasibility and success of each value signal, which can be seen in the diagnostics revealed in the last step. The key diagnostics are the mean return of the portfolios; The risk of the portfolios (using standard deviation); The risk-adjusted return (using the return risk ratio); . To quantify these three factors we will also add a market neutral portfolio, the difference between the top and bottom portfolios, and an active portfolio, the difference between the top and the benchmark, to the assess the diagnostics of the portfolios relative to the market. Using these diagnostics we can observe the signals that outperform the others, and should, therefore, be included in our portfolio. We can also observe the signals that have underperformed, which can be utilised when creating a portfolio with short positions.

2. Information Signal Backtest

Results

The following diagnostics reveal key information on each value signal. EPQ was the strongest performing value signal with the highest mean return and return/risk ratio. Conversely, one-month momentum turned out to be the weakest performing value signal, with the lowest return and return/risk ratio. Although some signals performed a lot better than others, this backtesting is still strong evidence that value signals can be used to get above market results.

EP12	Top	Bottom	Benchmark	MktNeutral	Active
Mean Return	15.07%	11.39%	13.21%	3.67%	1.86%
Standard Deviation	16.01%	20.22%	16.69%	12.93%	6.12%
RetRisk Ratio	94.12%	56.36%	79.16%	28.42%	30.37%

Free Cash Flow	Top	Bottom	Benchmark	MktNeutral	Active
Mean Return	13.92%	12.38%	13.08%	1.54%	0.84%
Standard Deviation	15.83%	17.91%	16.55%	6.85%	3.38%
RetRisk Ratio	87.96%	69.15%	79.02%	22.46%	24.91%

EPQ	Top	Bottom	Benchmark	MktNeutral	Active
Mean Return	15.23%	11.30%	13.22%	3.93%	2.01%
Standard Deviation	16.13%	19.90%	16.69%	11.93%	5.57%
RetRisk Ratio	94.43%	56.80%	79.19%	32.94%	36.12%

Size Premium	Top	Bottom	Benchmark	MktNeutral	Active
Mean Return	13.89%	12.49%	13.22%	1.40%	0.68%
Standard Deviation	17.76%	16.04%	16.70%	5.45%	2.78%
RetRisk Ratio	78.20%	77.87%	79.14%	25.66%	24.33%

1 Month Momentum	Top	Bottom	Benchmark	MktNeutral	Active
Mean Return	13.50%	12.66%	13.21%	0.84%	0.29%
Standard Deviation	17.72%	17.83%	16.70%	10.09%	5.44%
RetRisk Ratio	76.19%	70.98%	79.09%	8.35%	5.37%

3 Month Momentum	Top	Bottom	Benchmark	MktNeutral	Active
Mean Return	13.75%	12.42%	13.21%	1.33%	0.54%
Standard Deviation	17.67%	18.69%	16.68%	12.39%	6.39%
RetRisk Ratio	77.81%	66.46%	79.17%	10.76%	8.51%

Gross Profitability	Top	Bottom	Benchmark	MktNeutral	Active
Mean Return	14.76%	11.81%	13.16%	2.95%	1.60%
Standard Deviation	17.72%	16.60%	16.77%	7.46%	3.84%
RetRisk Ratio	83.33%	71.19%	78.52%	39.53%	41.72%

Book/Market Ratio	Top	Bottom	Benchmark	MktNeutral	Active
Mean Return	13.76%	12.84%	13.24%	0.92%	0.52%
Standard Deviation	16.38%	18.76%	16.69%	11.42%	5.61%
RetRisk Ratio	84.04%	68.46%	79.35%	8.09%	9.26%

Earnings	Top	Bottom	Benchmark	MktNeutral	Active
Mean Return	14.24%	11.96%	13.24%	2.28%	1.00%
Standard Deviation	17.19%	17.80%	16.69%	7.59%	3.80%
RetRisk Ratio	82.86%	67.20%	79.31%	30.09%	26.44%

12 Month Momentum	Top	Bottom	Benchmark	MktNeutral	Active
Mean Return	14.87%	11.92%	13.38%	2.94%	1.49%
Standard Deviation	18.05%	18.44%	16.63%	13.09%	6.77%
RetRisk Ratio	82.38%	64.66%	80.45%	22.49%	22.03%

3. Building a Multifactor Model

Description

The results from the backtesting reveal a number of information signals that have outperformed the market. Whilst selecting best performing signal works well, a single signal can be outperformed by a multifactor model as its weights can be routinely shifted to maximise the performance of the portfolio over an extended period of time. For the multifactor model, an Optimized Alpha Score is constructed. An Optimized Alpha Score, that uses mean-variance optimization, aims to invest high in signals that provide high returns, low in signals that have consistently high risk and low in signals that are highly correlated, so as to not double the impact of a single signal on the model.

After reviewing the results of the backtesting done in Part 2, and trying a variety of different combinations, four signals were selected for the multifactor model. Gross Profitability, One Month Momentum, Earnings and Book to Market Ratio combined to create the highest risk/return ratio. These four signals are highly uncorrelated, with a wide spread of performance existing between the four factors, making them ideal for a multi-factor model.

To create the Optimized Alpha Score, 5 steps are followed:

1. **Individual candidate signals are backtested, stocks are ranked and put into a specified portfolio.** This is done using the same methodology and parameters as Part 2 (1980 - 2010, 500 stocks, rebalanced every 6 months, equally weighted).

2. **The difference between the "Top," and "Bottom," portfolio is measured.** This is a measure of the possible performance of a strategy where a long position is taken in the "Top," stocks and a short position is taken in the "Bottom," stocks.

3. **The mean return, risk and risk/return ratio of each strategy is measured.** Like in Part 2, risk is a measure of standard deviation.

4. **A mean-variance optimization is run.** A portfolio is chosen with the best risk/return ratio.

5. **The weights are applied to the signals to create a combined score.**

Once the Alpha Model is constructed it is re-run under a number of different parameters, including portfolio rebalancing frequency, composition/number of portfolios as well as using only long positions to build the alpha. This is done to optimize the alpha score over the test period from 1980 to 2010.

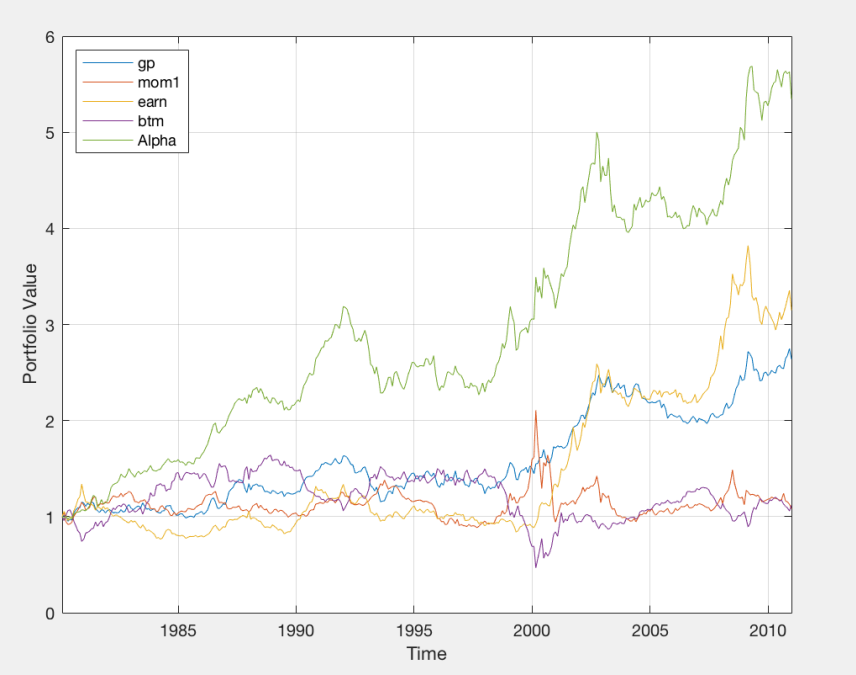
3. Building a Multifactor Model

Results

As a result of re-testing and optimizing the following parameters are used in the construction of the Alpha Model:

- **The model was created using the top 500 ranked stocks.**
- **The "Top," and "Bottom," portfolios consisted of the 100 best and worst performing portfolios.**
- Although the model allowed for both long and short positions, the optimal **Alpha consisted of only long positions in stocks.**

The following linear graph shows how well the combined Alpha signal outperformed the individual signals over the backtesting period from 1980 -2010. The top table shows the comparative performance of each signal over the test period using the new parameters. The bottom tables show the final weights of each signal in the optimized Alpha and the variance-covariance matrix of the signals.



	Gross Profitability	1 Month Momentum	Earnings	Book to Market	Alpha
Mean Return	3.58%	1.33%	4.38%	1.76%	5.89%
Risk	9.33%	14.65%	11.63%	16.52%	9.56%
RetRisk Ratio	38.35%	9.06%	37.69%	10.67%	61.60%

Signal Weights	Alpha
GP	47%
MOM1	18.94%
EARN	5.56%
BTM	28.48%

Variance / Covariance	GP	MOM1	EARN	BTM
GP	0.07%	0.01%	0.06%	-0.07%
MOM1	0.01%	0.18%	0.02%	-0.11%
EARN	0.06%	0.02%	0.11%	-0.04%
BTM	-0.07%	-0.11%	-0.04%	0.23%

4. The Smart Beta Portfolio

Description

Now that the alpha has been determined, the final portfolio can be constructed. A Smart Beta portfolio enhances the alpha by over-weighting investment into stocks with a high adjusted z-score and underweighting investment into stocks with a low adjusted z-score, the z-score representing the rate at which each stock outperforms the benchmark. A Smart Beta is an active strategy that relies on the implication that market capitalization does not reflect true value. Although Smart Beta is “inexpensive,” it also requires more trading than market weighted portfolios.

To create the Smart Beta the following steps are used:

1. **The Z-score of the stocks within the model universe is calculated.** This is how well each stock outperformed the benchmark.
    - The score is adjusted based on a power coefficient, relating to how aggressive the investment strategy is.
    - The coefficient 1 is used in this model.

2. **Using the adjusted Z-scores a vector of portfolio weights is created.**
    - Higher Z-score = Large investment
    - Low Z-score = Small investment

Now that the basic Smart Beta Model is created the diagnostics can be assessed, and the model is re-run under different parameters in order to determine the optimal model available.

- For this model, the power coefficient will remain constant at 1 and transaction costs will remain fixed at 0.002%.

- To optimize the model the composition of the portfolios will be tested by allowing the top 100, 500 and 1000 stocks into the test. To further enhance the model, it will be tested with portfolio rebalancing occurring every single, three, six and twelve months per year.

- The parameters that provide the optimal performance of the Smart Beta model will then be tested against the out-of-sample data from 2010 - 2017.

4. The Smart Beta Portfolio

Results (testing)

Running the Smart Beta with different pools of stocks produced the following results (All other parameters held constant form part 2):

Top 1000 Stocks	Portfolio	Benchmark	Active
Mean Return	13.96%	11.98%	1.98%
Risk	16.01%	15.42%	4.24%
RetRisk Ratio	87.18%	77.73%	46.59%

Top 500 Stocks	Portfolio	Benchmark	Active
Mean Return	13.49%	11.63%	1.86%
Risk	15.92%	15.29%	5.13%
RetRisk Ratio	84.75%	76.08%	36.24%

Top 100 Stocks	Portfolio	Benchmark	Active
Mean Return	13.49%	11.63%	1.86%
Risk	15.92%	15.29%	5.13%
RetRisk Ratio	84.75%	76.08%	36.24%

Running the model with **the top 1000 stock produces the highest profitability** and ratio to risk, as well as the highest active performance.

Running the smart beta with differing frequencies of rebalancing produced the following results (All other parameters held constant part 2):

Rebalanced Every 12 Months	Portfolio	Benchmark	Active
Mean Return	13.63%	11.92%	1.70%
Risk	15.86%	15.37%	4.15%
RetRisk Ratio	85.89%	77.59%	40.97%

Rebalanced Every 6 Months	Portfolio	Benchmark	Active
Mean Return	13.96%	11.98%	1.98%
Risk	16.01%	15.42%	4.24%
RetRisk Ratio	87.18%	77.73%	46.59%

Rebalanced Every 3 Months	Portfolio	Benchmark	Active
Mean Return	14.06%	11.98%	2.08%
Risk	15.84%	15.46%	4.22%
RetRisk Ratio	88.75%	77.49%	49.18%

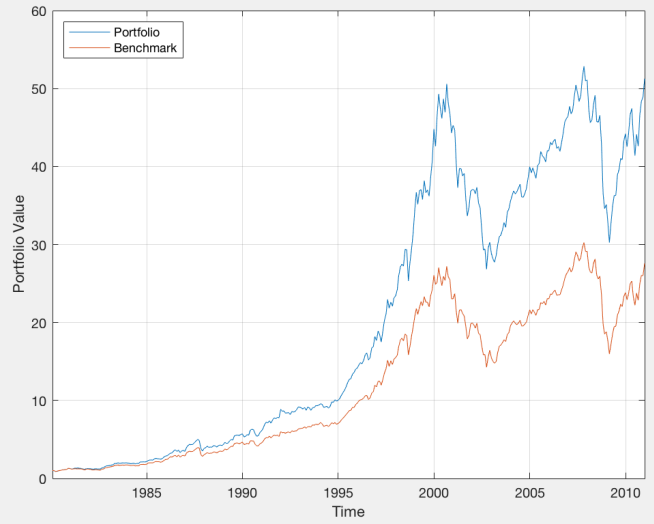
Rebalanced Every Month	Portfolio	Benchmark	Active
Mean Return	13.20%	11.88%	1.32%
Risk	15.74%	15.46%	4.23%
RetRisk Ratio	83.89%	76.85%	31.27%

Running the model with **rebalancing occurring every three months produces the highest profitability** and ratio to risk as well as the highest active performance.

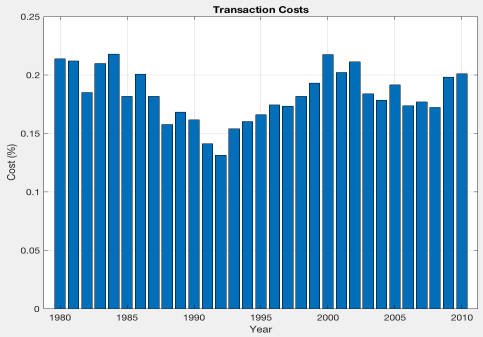
Using the results of the testing **the final Smart Beta Model will use the top 1000 stocks for stock selection and be rebalanced every three months.**

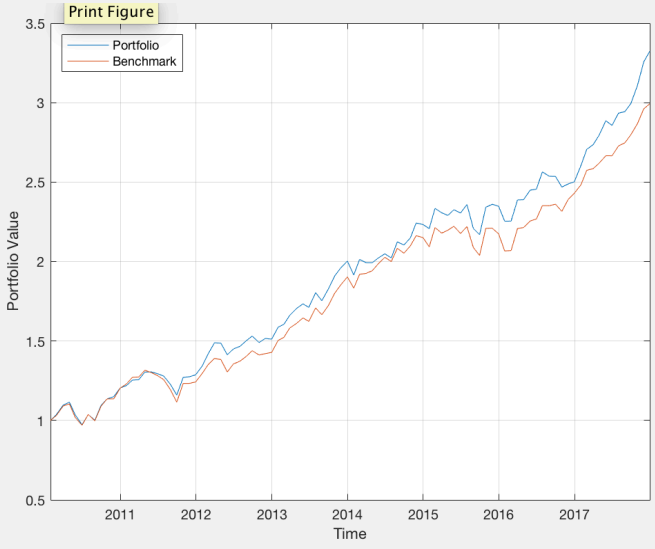
4. Smart Beta Portfolio

Results (final)

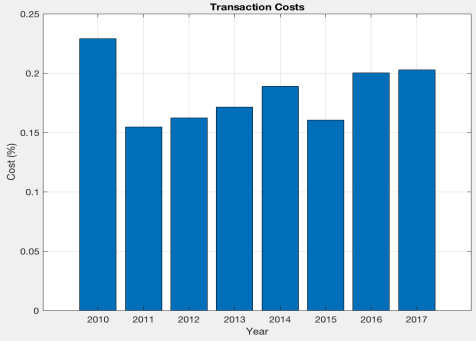


In Sample	Portfolio	Benchmark	Active
Mean Return	14.06%	11.98%	2.08%
Risk	15.84%	15.46%	4.22%
RetRisk Ratio	88.75%	77.49%	49.18%





Out of Sample	Portfolio	Benchmark	Active
Mean Return	15.91%	14.59%	1.32%
Risk	11.42%	11.61%	2.91%
RetRisk Ratio	139.26%	125.69%	45.31%



The final Smart Beta Model used the following parameters:

- **Made from the top 1000 ranked stocks**
- **Smart Beta weights were based upon the Alpha value signal**

(made up of gp, mom1, earn and btm)

- **Rebalanced every 3 months with a cost of 0.002%**
- **Invested at a power of 1 (balanced)**

The In-Sample backtest resulted in an active return over the benchmark of 2.08% and an Active Return/Risk Ratio was 19.18%. The transaction costs varied from just over 0.1% to just over 0.2%. Overall the in-sample beta model performed well of the given time period and gave returns above the market with relatively low transaction costs.

The out-of-sample backtest also turned out positive results, albeit not as strong the in-sample. The model returned an active 1.32% over the benchmark, on average, and an unusually strong Return/Risk ratio of 139.26%. The transaction costs were similar, ranging from 0.15% t0 0.25%. The out-of-sample validation shows that the model is not over-fitted to sample data and continues to return above market results even over a short period.