Group Project Final Report

Crocodile Fund

Summary

Our stock-based strategy uses a combined signal based on value, reversal and price opportunity strategy, achieving a daily return of 0.1070% and a sharp ratio of 1.29. To select the most fitting assets for our strategy, we implement it on assets with different risk, market value and industry sectors. We find that this strategy works best for stocks with low risk and small market capitalization in the technology sector and those with high risk and small market capitalization in the non-technology sector. In the testing process, we compare the returns of using the single signal, two-combined signal and our thee-combined signal, and we find that our three-combined signal outperforms any single signal and two-combined signal because it has the highest average daily return, a high sharp ratio and the best investment performance over time.

1. Design

1.1 Design of the Signal

Our strategy selects the stocks to perform daily transactions based on the combination of value, reversal and price opportunity signals. We choose the book-to-market ratio as the value signal to find stocks with a higher valuation; we choose the excess return two days ago as the reversal signal, which is more realistic to implement in real life, to select stocks with a reverting short-term trend; we use the comparison of the moving average price of the previous week and that of the previous three months as the price opportunity signal. The price opportunity signal helps us identify mispriced stocks and find arbitrage opportunities by comparing short-term and long-term moving average prices. If the average short-term price is lower than the average long-term price, we buy the stocks; vice versa, we sell the stocks.

1.2 Mechanism of Combined Signal

We combine these three signals because each of them identifies different profit aspects of stocks and complements the other strategies. The value strategy helps us identify firms with good valuations. It is usually a long-term strategy, and it requires relatively less frequent adjustments of the stocks because the book-to-market ratio has relatively small fluctuations over one year. The reversal strategy captures short-term reversal trends quickly over two days and capitalizes on the reversal impact. And the price opportunity strategy helps us make profits and avoid risk by trading on short-term mispriced opportunities. We will buy stocks at a lower price and sell stocks at a higher price, so we can avoid the price crash when the price rises. Although we gain less from selling stocks at a higher price, we control the risks by following a more conservative strategy.

1.3 Assets Selection Process

To figure out the best condition and the best assets for our strategy, we divide the stocks into different categories according to risk (low risk vs high risk), industry (technology vs non-technology), and market capitalization (small assets vs large assets), implement the strategy in these categories over two periods (2010-2014 vs 2015-2019) and compare their performance in single and cross dimensions. After comparison, we select the cross dimension combining risk, market capitalization and industry in which our strategy performs the best.

1.4 Trading

We execute this strategy by using US stock daily transaction data from CRSP and financial data from COMPUSTAT from 2010 to 2019. Our asset pool consists of US stocks with a market value higher than 50 million dollars exclusive of stocks of financial firms. In daily transactions, we first sort stocks and rank them into quintiles according to value, reversal and price opportunity signals respectively, and we buy the stocks with a buy signal from the price opportunity strategy, the highest valuation and the most downward short-term trend, and sell stocks with a sell signal from the price opportunity strategy, the lowest valuation and the most upward short-term trend.

2. Research

2.1 Data Processing

We only focus on stock data by filtering the data from the CRSP dataset by setting “SHRCD” equal to 10 and 11. And we filter out the financial stocks because investing in financial institutes follows different principles and methods. There are three reasons why we may face more unpredictable risks if we keep financial stocks in our portfolio. Firstly, the products that financial institutes offer are complicated and investing in a company with products that we do not understand is like walking in the dark. We will not be able to adjust our strategy correctly and promptly if we are not familiar with the assets and industry. Secondly, the financial statements of banks are more complicated to interpret performance. The financial statements of banks are unlike any other business because banks are in the business of money. For example, the balance sheets look different because the deposits are liabilities and loans are assets for banks. Investing in businesses with financial statements that we barely understand will add more uncertainty and risk to our strategy. Finally, constant regulatory scrutiny is also a major risk of investing in banks and other financial stocks. Removing the banking or financial stocks from our asset pool will help us better monitor the risk of our portfolio and adjust the strategy.

2.2 Statistical Research

2.2.1 Market Capitalization

We only invest in companies with a market capitalization over 50 million by cutting off 15% of the portfolio since stocks with small market capitalization are more vulnerable to negative events and bearish sentiments. Companies with small market capitalization carry more risks than those with larger market capitalization even though they have greater growth potential and higher return.

```
stocks_etf['MV'].describe()

count    1.155852e+07
mean     5.058828e+06
std      2.398954e+07
min      2.970000e+01
25%      1.021935e+05
50%      4.728697e+05
75%      2.157984e+06
max      1.288147e+09
Name: MV, dtype: float64

stocks_etf['MV'].quantile(0.15)

49250.544954818484
```

Graph 2.1: statistical description of MV (Market Capitalization)

2.2.2 Risk

We keep the standard deviation of the excess return of the past 6 months within the range of 0.01 and 0.2 to avoid outliers. Volatility control can help us better manage the risk.

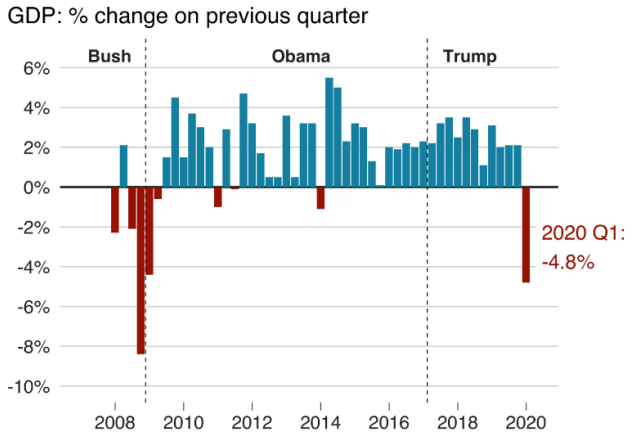
```
stocks_etf['lag_SD'].describe()

count    1.065955e+07
mean     3.306406e-02
std      2.640329e-02
min      8.048366e-04
25%      1.771558e-02
50%      2.629592e-02
75%      3.997590e-02
max      1.715383e+00
Name: lag_SD, dtype: float64
```

Graph 2.2: statistical description of lag_SD (Risk)

2.2.3 Time Period

We choose the period between 01/01/2010 and 01/01/2020 because we try to avoid the impact of the great recession in 2008 and the recent economic recession during the Covid-19 pandemic. The economic downturn led to a sharp drop in stock prices and incurred great losses. We are more conservative in investing to avoid the risk incurred during a recession.



Graph 2.3: US Economic Growth during 2008-2020. Reference (1)

2.2.4 Fama-MacBeth Regression

We run Fama-MacBeth regression to understand the relationship between excess return and each of the trading signals (value, reversal and price opportunity). We run regression using daily data, aggregate parameters of these regressions, average the parameter estimates and then compute the corresponding standard errors and t-statistics. The mean of the coefficients of book-to-market ratio is 0.00001, which indicates that the value signal is positively correlated with the excess return; the mean of the coefficients of the excess return two days ago is -0.001397, which indicates that the reversal signal is negatively correlated with the excess return.

	Intercept	lag_bm
count	2892.000000	2892.000000
mean	0.000478	0.000010
std	0.014423	0.000993
min	-0.110710	-0.021412
25%	-0.005631	-0.000074
50%	0.001081	-0.000002
75%	0.007485	0.000060
max	0.101976	0.034607
stderr	0.000268	0.000018
tstat	1.782507	0.534482

Graph 2.4: Coefficient of Fama-MacBeth Regression between Excess Return and lag_bm(Value)

	Intercept	LAGRET
count	2892.000000	2892.000000
mean	0.000500	-0.001397
std	0.013414	0.093832
min	-0.091383	-0.497800
25%	-0.005555	-0.050439
50%	0.001142	-0.000977
75%	0.007255	0.048243
max	0.078078	0.782458
stderr	0.000249	0.001745
tstat	2.004325	-0.800702

Graph 2.5: Coefficient of Fama-MacBeth Regression between Excess Return and LAGRET(Reversal)

3. Implementation

3.1 Risk Dimension

We divide stocks into high-risk and low-risk sectors and test our strategy performance in these sectors. And we use lag standard deviation of the excess return of the past 6 months to represent risks and divide and rank the assets into quintiles. We only focus on stocks in the 1st, 2nd, 4th and 5th quintiles and we categorize stocks in the 1st and 2nd quintiles into low-risk stocks and those in the 4th and 5th quintiles into high-risk stocks.

Our strategy works better for high-risk stocks. We evaluate the performance of our strategy on high-risk and low-risk stocks and the buy-and-hold strategy for two periods.

From 2010 to 2014, the average return of our strategy is better on high-risk assets although the Sharpe ratio is better for low-risk assets. From the accumulative return plot below, we find that the

accumulative return on high-risk assets has stronger fluctuations, but it has much higher peaks than low-risk assets and the buy-and-hold strategy (as high as 2.5 times of the others). Overall, the performance of our strategy for low-risk assets is similar to that of the buy & hold strategy, but sometimes the performance is worse than the buy-and-hold strategy.

From 2015 to 2019, the average return of our strategy is better on high-risk assets, but the Sharpe ratio is better for low-risk assets. For accumulative return plot, we find an outstanding performance of our strategy with high-risk assets. The peak of accumulative return on high-risk assets is about 10 times higher than the others. The peak happened around the beginning of 2019 and then the return went down quickly. But overall, the performance of our strategy outperforms the buy-and-hold strategy, and our strategy still works better for high-risk stocks.

Graph 3.1: Cumulative Return of Low-Risk Assets, High-Risk Assets and Buy and Hold Strategy from 2010 to 2014

Graph 3.2: Cumulative Return of Low-Risk Assets, High-Risk Assets and Buy and Hold Strategy from 2015 to 2019

Period	2010-2014		2015-2019	
Risk	**low risk**	**high risk**	**low risk**	**high risk**
Mean(%)	0.0533	0.075	0.0528	0.1507
STD(%)	0.8894	2.1464	0.9756	3.4466
T-Stats	2.1105	1.2254	1.8956	1.5044
Sharpe Ratio	0.9522	0.5544	0.8584	0.6940

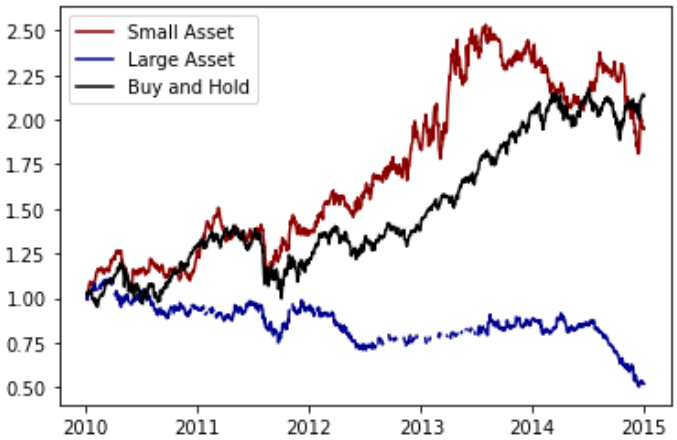
Table 3.1: Result of Low-Risk Assets vs High-Risk Assets

3.2 Market Capitalization Dimension

We divide stocks into large and small assets according to market capitalization and test our strategy performance in these sectors. We define the stocks with a market capital smaller than or equal to 2 billion dollars as small assets and those with a market capital larger than or equal to 10 billion dollars as large assets. We only focus on these two asset categories.

Our strategy works better on small assets. We evaluate the performance of our strategy on large and small assets and the buy-and-hold strategy for two periods.

From 2010 to 2014, our strategy performs better for small assets because they have a higher Sharpe ratio and higher average return. The large assets do not perform so well because they have a negative average return. From the accumulative return plot, we find that our strategy performs much worse for large assets than small assets and performs even worse than the buy-and-hold strategy. The performance of our strategy on small assets is the best among these three categories. From 2015 to 2019, our strategy still performs better for small assets than large assets even though implementing our strategy on large assets brings a positive average return and a better sharp ratio. From the accumulative return plot, we find that the performance of our strategy on large and small assets is both better than that of the buy-and-hold strategy. Our strategy especially performs well for small assets. The peak of accumulative return of our strategy on small assets is about 6 times higher than the others. Although the peak happened around the beginning of 2019 and then went down quickly, our strategy overall still shows better performance for the small assets.



Graph 3.3: Cumulative Return of Small Assets, Large Assets and Buy and Hold Strategy from 2010 to 2014

Graph 3.4: Cumulative Return of Small Assets, Large Assets and Buy and Hold Strategy from 2015 to 2019

Period	2010-2014		2015-2019	
Market Capitalization	**Small Asset**	**Large Asset**	**Small asset**	**Large Asset**
Mean(%)	0.0612	0.0537	0.1325	0.0441
STD(%)	1.2827	1.4634	2.1717	1.4641
T-Stats	1.6918	-1.1677	2.1523	0.9977
Sharpe Ratio	0.7575	-0.5830	0.9683	0.4784

Table 3.2: Result of Small Assets vs Large Assets

3.3 Industry Dimension

We divide stocks into technology and non-technology sectors and test our strategy performance in these sectors. Stocks in the technology sector have the SICCD codes which either start from “35”, “36”, “38” or “48” or belong to one of these following numbers: “7370”, “7371”, “7372”, “7373”, “7374”, “7377”. Any stock not in the technology sector is categorized into the non-technology sector.

Our strategy works better for stocks in the technology sector. We evaluate the performance of our strategy on tech and non-tech stocks and the buy-and-hold strategy for two periods (2010-2014 vs 2015-2019).

Our strategy has a higher average excess return and a higher Sharpe ratio for tech stocks than non-tech stocks for both two periods. Comparing these two periods, our strategy has better performance in early periods from 2010 to 2014.

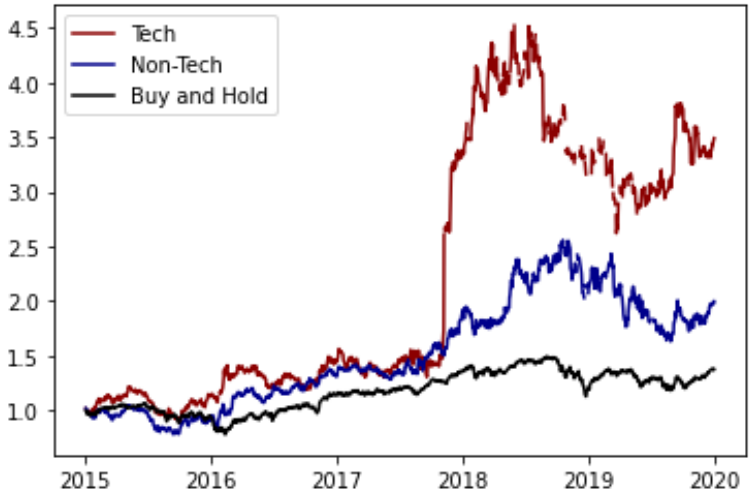
From 2010 to 2014, the average excess return on tech stocks is 0.0012, and the Sharpe ratio is 1.0919. The average excess return on non-tech stocks is 0.0008, and the Sharpe ratio is 1.0003.

From 2015 to 2019, the average excess return of our strategy on tech stocks is 0.0013, and the Sharpe ratio is 0.8857. The average excess return of our strategy on non-tech stocks is 0.0007, and the Sharpe ratio is 0.6822.

Period	2010-2014		2015-2019	
Industry	**Technology**	**Non-technology**	**Technology**	**Non-technology**
Mean(%)	0.1157	0.0751	0.1319	0.0680
STD(%)	1.6821	1.1925	2.3634	1.5821
T-Stats	2.3876	2.2350	1.9093	1.5169
Sharpe Ratio	1.0919	1.0003	0.8857	0.6822

Table 3.3: Result of Technology vs Non-technology Asset

Graph 3.5: Cumulative Return of Technology, Non-technology and Buy And Hold Strategy From 2010 to 2014



Graph 3.6: Cumulative Return of Technology, Non-technology and Buy And Hold Strategy From 2015 to 2019

3.4 Cross-Dimension Analysis

We combined the risk and industry dimensions to further analyze the cross-dimension effects. We only conduct analysis on the small assets with a market capitalization of less than or equal to 2 billion dollars. One reason is that those small assets have better investment performance and generate a higher excess return and Sharpe ratio. Another reason is that we want to capitalize on the higher risk and volatility of small assets. Therefore, we only focus on small assets to cross-evaluate the effect of risk and technology.

The result below indicates that our strategy has a higher average excess return for small assets in the high-risk non-tech and low-risk tech sectors. If we have a higher risk tolerance level and want a higher return, we can implement our strategy on high-risk non-technology small assets. If we have a lower risk tolerance level, we can implement our strategy on low-risk technology small assets since they have a higher Sharpe ratio and a relatively good average excess return.

Cross Dimensions	Mean%	Std%	Sharpe Ratio
Low risk technology small asset	0.11	1.32	1.2883
Low risk non-technology small asset	0.03	2.04	0.2592
High risk technology small asset	-0.04	3.06	-0.2000
High risk non-technology small asset	0.27	3.73	1.1395

Table 3.4: Result of Cross Dimension Testing

4. Testing

4.1 Average Daily Performance

Based on our implementation process, we decide to implement our strategy on stocks with low risk and small market capitalization in the technology sector and those with high risk and small market capitalization in the non-technology sector. Next, we try all single signals and combination signals and test to see if using the combination of the three signals is the best option. The following table shows the statistical investment performance of implementing our strategy on various signals.

	Reversal	Value	Price opportunity	Reversal + Value	Reversal + Price Opportunity	Value + Price Opportunity	Reversal + Value + Price Opportunity
Mean(%)	0.0324	0.0325	0.0394	0.0376	0.0801	0.0624	0.1070
STD(%)	0.6486	0.5455	0.3841	1.0970	0.8264	0.7454	1.3186
Sharp Ratio	0.7936	0.9456	1.6302	0.5445	1.5381	1.3286	1.2883
t-stats	2.5075	2.9878	5.1511	1.6991	4.8524	4.1981	3.8366

Table 4.1: Statistical Results of Using Various Signals in the Strategy

According to the statistical results, although using the combination of the reversal signal, value signal and price opportunity signal gives the highest average daily return rate, only using the price opportunity signal shows the best sharp ratio. The price opportunity strategy exhibits great importance when trading our selected assets. Here are several explanations for its outstanding performance.

Firstly, the price opportunity strategy works better when the market fluctuates. It shows a better performance when the market shows reverting trends. And it avoids loss when the market drops, and it gains more returns when the market rises back after the drops because it captures the opportunity during market drops by buying stocks at a low price.

Additionally, the reversal strategy supports the price opportunity strategy by recognizing reversal patterns. The reversal pattern in the future is important for the price opportunity strategy. We have a high return when the stocks rise after we buy them at a low price, and the reversal strategy helps us select such stocks.

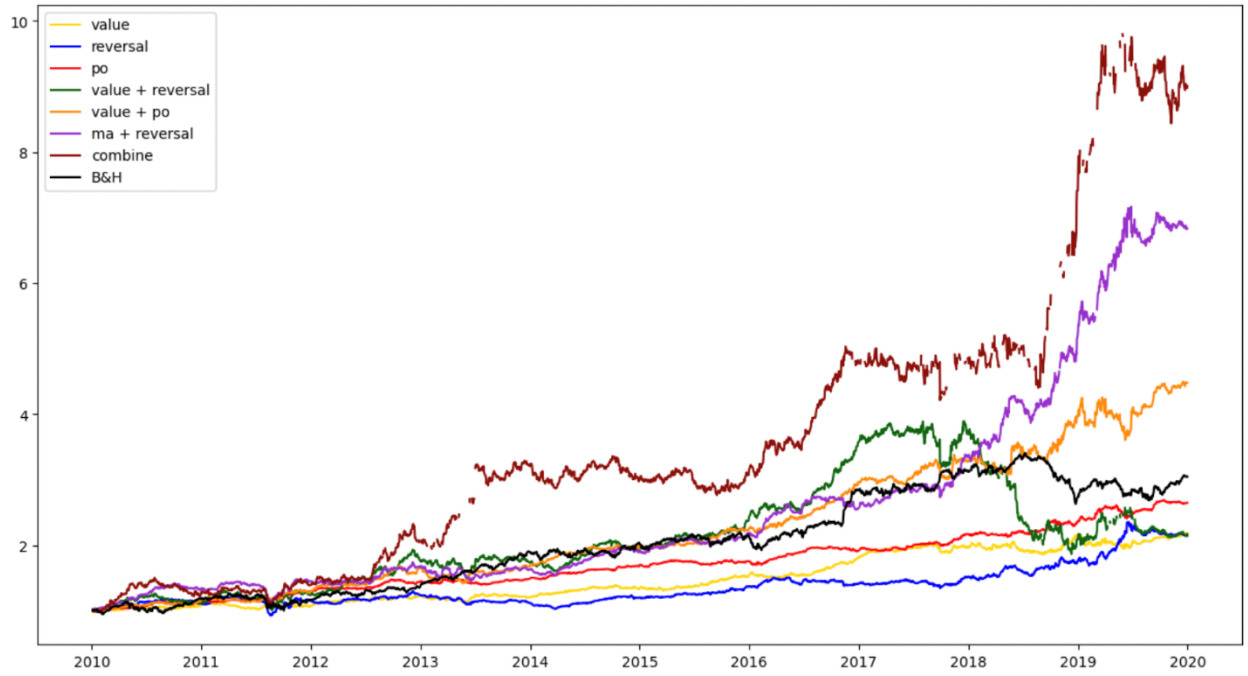
Thirdly, the function of the value strategy is limited in daily transactions. Value strategy is usually a long-term trading strategy based on valuation variables (here we use the book-to-market ratio). The book values do not change frequently, so the value strategy does not affect our trading decision a lot when trading daily.

4.2 Accumulated Performance

From the accumulated return table and plot below, we can see the effect of the combined signal.

	B&H	Reversal	Value	Price opportunity	Reversal + Value	Reversal + Price Opportunity	Value + Price Opportunity	Reversal + Value + Price Opportunity
Accumulated Returns	3.0459	2.1443	2.1813	2.6474	2.1706	6.8351	4.4809	9.0070
Times of B&H	1	0.7040	0.7161	0.8692	0.7126	2.2440	1.4711	2.9571

Table 4.2: Accumulated Returns of Using Various Signals in the Strategy



Graph 4.1: Accumulated Returns of Using Various Signals in the Strategy

Firstly, the price opportunity signal helps us to avoid marking crashes. For example, from mid 2018 to 2019, we trade less frequently because of fewer price opportunity trading signals, which protects us from the decreasing and fluctuating market. Moreover, the price opportunity strategy can still perform well in a market recession by selling out the stocks in our portfolio.

Secondly, the reversal strategy can work well in a fluctuating market. In a fluctuating market, lots of unconfirmed news causes people to overreact, which leads to more market reversals. The reversal strategy helps select better assets and works better when the price opportunity strategy gives the right trading timing.

Thirdly, the value strategy helps identify and keep value stocks, strengthening the steadiness and profitability especially when the market performs badly.

In summary, the three-combined signal shows the best return. From the accumulated return plot, the strategy performs best when there are small fluctuations in the market and when market crashes happen. Although the three-combined signal does not provide the best sharp ratio, it is still the best signal and shows the best investment performance over time in all trading signals.

Reference

(1). https://www.bbc.com/news/business-52466864