

Capstone Project Report

“Price Momentum Factors for the Worst Performing of Stocks”

Faculty Guide: Prof. Yaacov Kopeliovich

Submitted by: Team 5 - Alpha Achievers

1. Hanzhang Fang (2806913)
2. He Zhu (2792576)
3. Ishita Manglani (2626669)
4. Liang Li (2806789)
5. Pingyu Zhou (2802238)
6. Weiying Huang (2803769)
7. Yutong Wu (2774936)

Table of Contents

1.	Introduction	3
2.	Using RSI Factor in Our Model	4
2.1.	RSI as Bool Factor in Pipeline	4
2.2.	Quadratic RSI Factor Out of Pipeline	6
2.3	Formulas	7
3.	Other Factors in Our Model	8
4.	Back-testing	9
4.1.	Back-testing under Momentum Regime	9
4.2.	Back-testing under Non-Momentum Regime	15
4.3.	Factor Analysis	17
5.	Summary	20

1.Introduction

This report can be divided into 5 parts. The first part is introduction, the second part is introduction to RSI momentum factor and how it is used in our model. The third part is how other factors are used in our model and the fourth part is the back-testing analysis, which will include short-side vingtile analysis, Alpha-Analysis and comparison analysis with one other simplified model. The last part of the report gives a conclusion of our analysis, giving a summary of all the factors analyzed and their results.

Our basic logic of this model is to use a mid-term bool factor or mid-term quadratic factor, RSI factor, to classify our stock pool into three parts - short-momentum part, long-momentum part and normal part. The difference between the usage of quadratic RSI factor and bool RSI factor will be discussed further.

After the classification of stocks, our model turns its focus on long-momentum part and short-momentum part. We developed a scoring system for stocks in these 2 parts, which considers short-term momentum factor such as MACD, MA or even simple linear return factor, and some fundamental factor such as EPS factor and Cap factor.

After scoring our stocks, we used the score rankings to get our target long and short stocks. In brief, our model focuses more on mid-term RSI momentum factor, which will directly influence our target stock pools and then uses a scoring system to determine our investment framework.

2.Using RSI Factor in Our Model

In our model, RSI (Relative Strength Index) is used as the most important technical indicator to catch the momentum. It is a classical technical indicator used to catch the strength or weakness of a stock. Traditionally, RSI is used on a half month timeframe, and measured between 0 and 100, and people usually regard it as trading signal. Different from most of the other investors who use RSI just to make their investment decision, we used it as a classifier for distinguishing momentum stocks from a big stock pool. And we found that when the window length of RSI is 2 or 3 months, the momentum classification function of RSI can be better displayed. We have 2 methods to use this RSI factors. One method is using RSI in pipeline steps (Bool Factor), and another one is to use it after pipeline steps (Quadratic Factor).

2.1. RSI as Bool Factor in Pipeline

When RSI is used in pipeline, it plays a role as a filter. The steps are as follows:

1. Determine the stock pools: In our case, we used Q1500US stocks as our target pool.
2. Determine the window length of RSI and the window length of stock prices. We calculated each stocks' RSI values.
3. Rank the stocks We picked top 15-25% percent of stocks and bottom 15-25% stocks in the pool to construct our daily investment target stocks.
4. Use stocks' short-term momentum factors like short-term MACD, short-term RSI etc. or fundamental factors such as capitalizations, EPS, and others to assign scores to picked stocks. In our case, we used linear return to assign the scores.
5. Rank the stocks using scoring system and then construct the long-short investment framework.

This method is very strong and will give our portfolio more than 3%-6% additional alpha and to some extent will reduce retracement compared to our other model without this factor.

One limitation of this factor is that the mid-term momentum factor value will not change much in daily period. This will make our investment scope smaller, even if we use the Q1500US universe in

our model. Another method which will reduce the alpha a little but give us more flexibility in our stock pool construction is to use Quadratic type of RSI factor.

2.2. Quadratic RSI Factor Out of Pipeline

To reduce the limitation of stock pool construction in bool type RSI factor, we can use quadratic RSI factor, which to some extent will reduce our possible profit. The steps are as follows:

1. First, we rank all stocks again in our Q1500US universe based on their RSI factor value.
2. Output the RSI factor values directly with other factors.
3. The most important part of this method is normalization of factor. For this, we need to compute the z-scores of rankings. It may seem a little strange to z-score rankings but surprisingly can give us a good result.
4. Compute the positive square root of quadratic RSI rankings' z-scores and compute other factors' z-scores. This is very important. The reason we use positive square root of quadratic RSI rankings' z-score is to make sure that the RSI factor values can be compared with other factors' z-scores. The larger the RSI

ranking z-score is, the better we can catch the long momentum and short momentum.

5. Then we can combine all the factors' z-scores in linear or non-linear method to generate our model. In our case, we simply used the linear model.

This kind of RSI factor can help reduce the limitation of Bool RSI Factor which seems like to limit the scope of our investment. Also, its mathematical formula is much easier to work with. But it indeed reduces our alphas.

2.3. Formulas

This small part gives the formulas used in our model.

Quadratic RSI Factor Model:

$$y = \beta_1 * F_{\sqrt{RSI\ Ranking\ Z-Score^2}} + \beta_2 * F_{Short-term\ Mom} + \beta_3 * F_{Fundamentals}$$

Bool RSI Factor Model:

$$y = I_0 * (\beta_1 * F_{Short-term\ Mom} + \beta_2 * F_{Fundamentals})$$

Where $I_0 = 1$ if the stock is in the top or bottom RSI rankings. Otherwise, this stock will not be considered.

3. Other Factors in Our Model

Apart from mid-term RSI Momentum factor, our model also uses short-term momentum factor. MA, short-term RSI, KDJ and other general technical indicators can be more significant under the mid-term momentum factor-based world. In our model, we just used the simple linear return. And we also used the short-term moving average variance which could make our portfolio more profitable.

Then we considered some fundamental factors like Cap, Book to Price Ratio and EPS which can give more significant returns under the mid-term RSI momentum world. One thing we need to notice is the normalization of fundamental data. EPS can be more significant when it is normalized in its absolute original value, but cap can be more significant when using the rankings. Different types of fundamental data need different normalization ways. We need to adjust our calculation to maximize our profit.

4. Back Testing

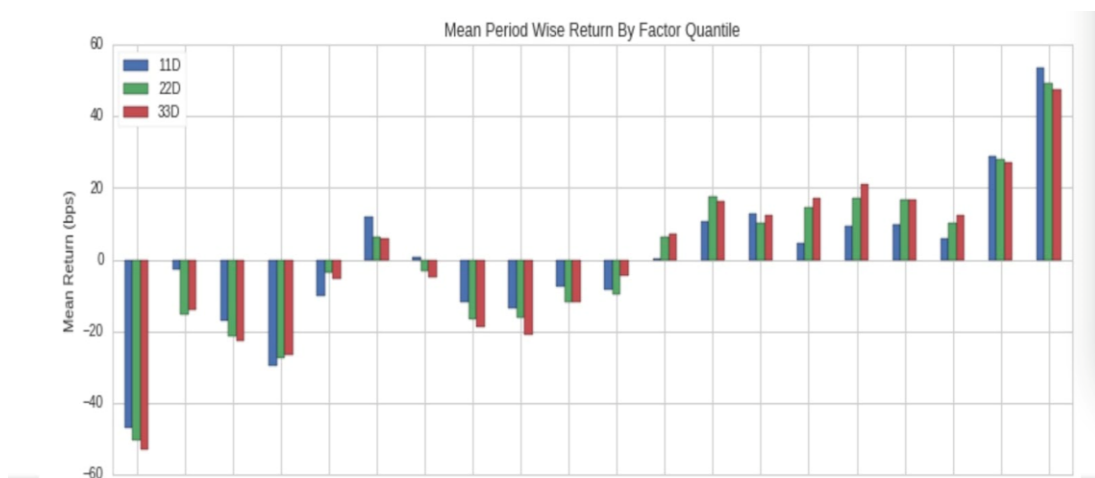
4.1 Back Testing under Momentum Regime

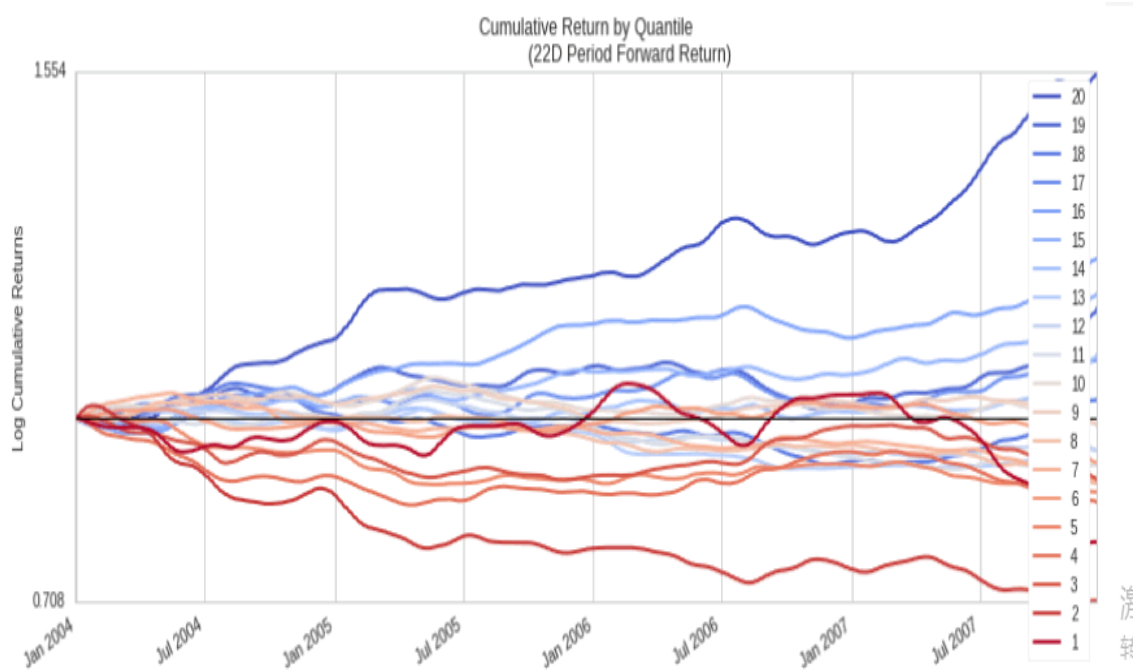
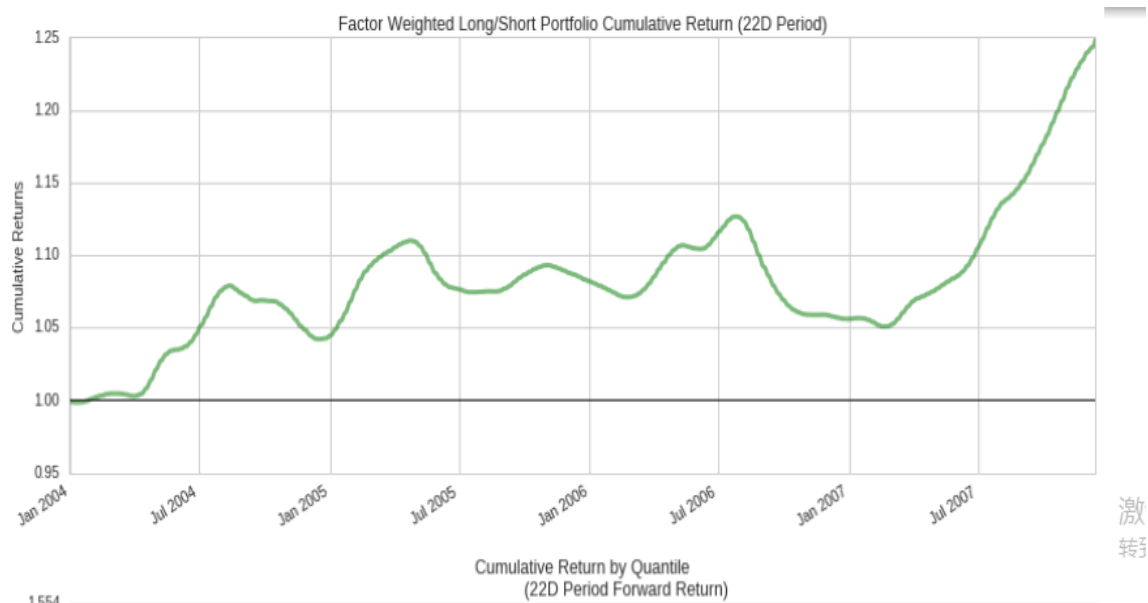
Our model is very significant in DA's momentum regime. Because of the limitation of the available history data, we can only run back-testing in three most recent momentum periods. The momentum periods period we run are 12/31/2003 - 12/31/2007, 12/31/2013 - 07/31/2015 and 12/30/2016 - 03/29/2019.

Momentum Regime 12/31/2003 - 12/31/2007

Returns Analysis

	11D	22D	33D
Ann. alpha	0.068	0.082	0.087
beta	-0.156	-0.179	-0.210
Mean Period Wise Return Top Quantile (bps)	53.390	49.193	47.532
Mean Period Wise Return Bottom Quantile (bps)	-46.796	-50.515	-53.100
Mean Period Wise Spread (bps)	100.186	100.370	101.709

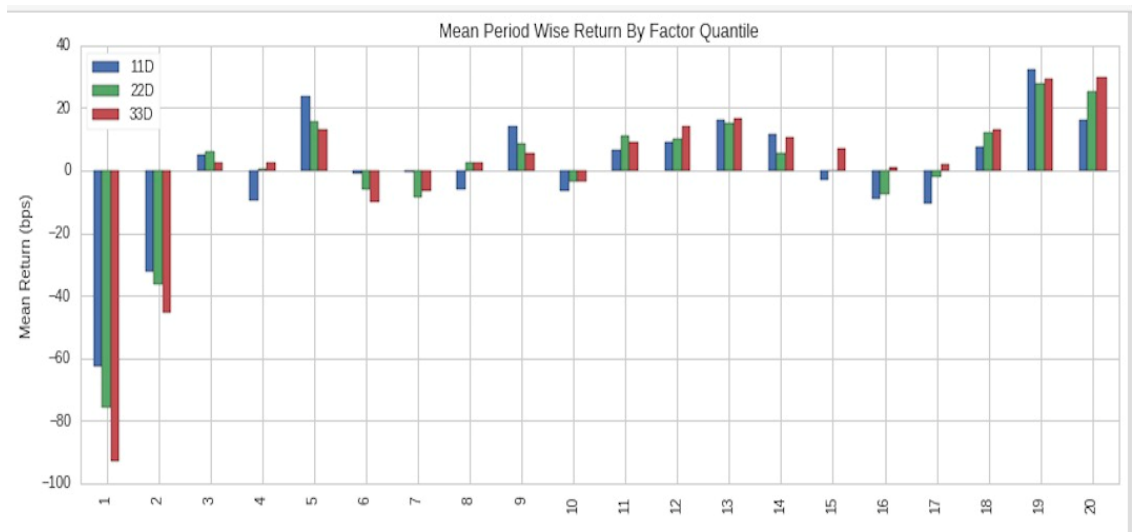


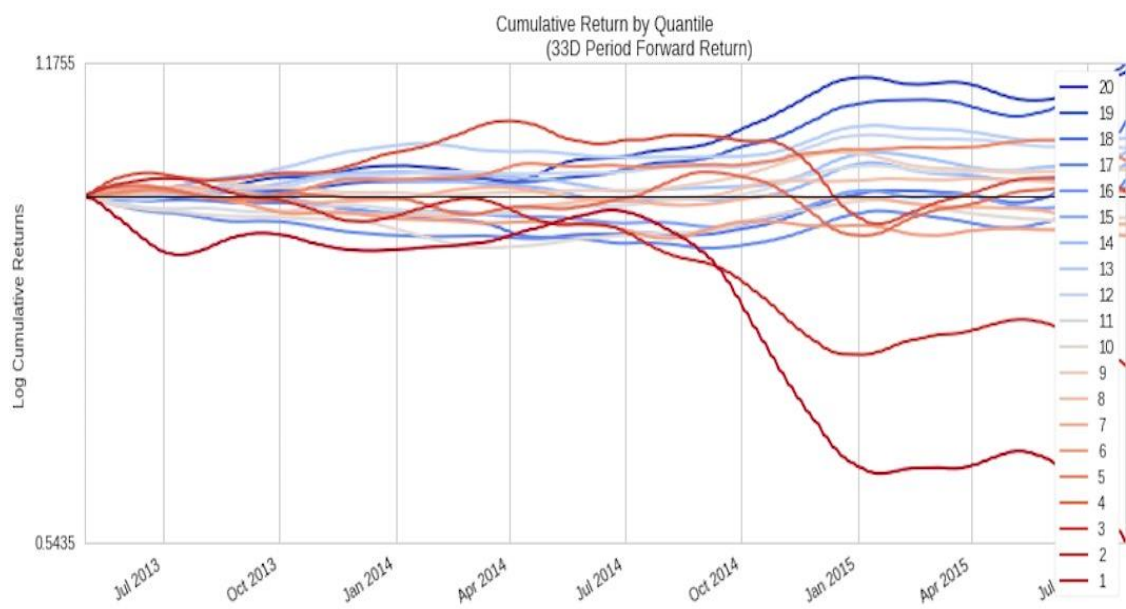
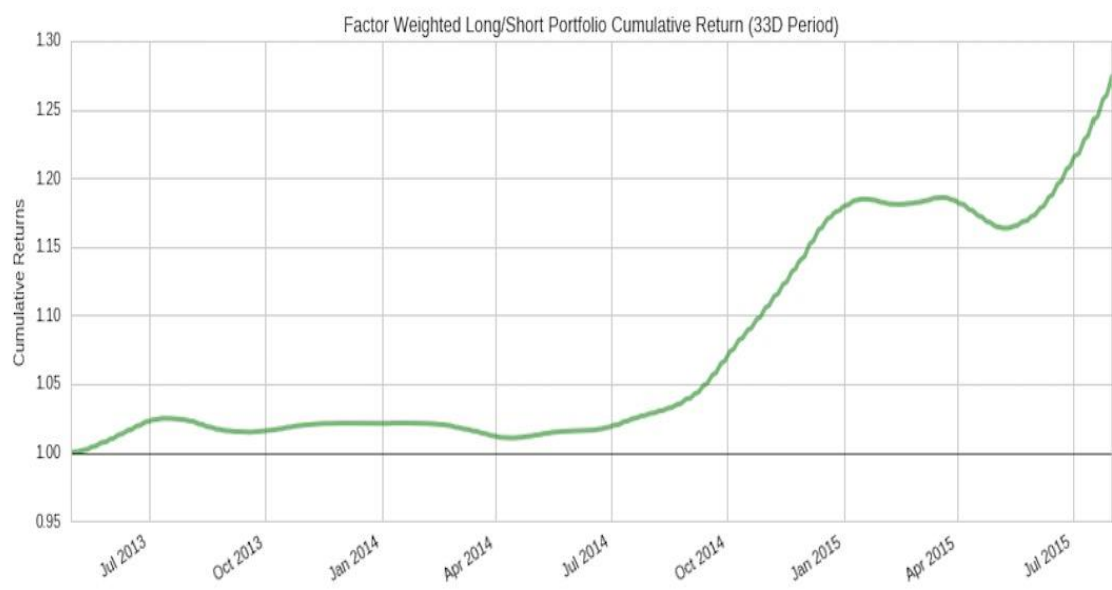


Momentum Regime 12/31/2013 - 07/31/2015

Returns Analysis

	11D	22D	33D
Ann. alpha	0.124	0.140	0.148
beta	-0.307	-0.357	-0.315
Mean Period Wise Return Top Quantile (bps)	15.955	25.130	29.604
Mean Period Wise Return Bottom Quantile (bps)	-62.541	-75.814	-93.016
Mean Period Wise Spread (bps)	78.497	104.515	127.672

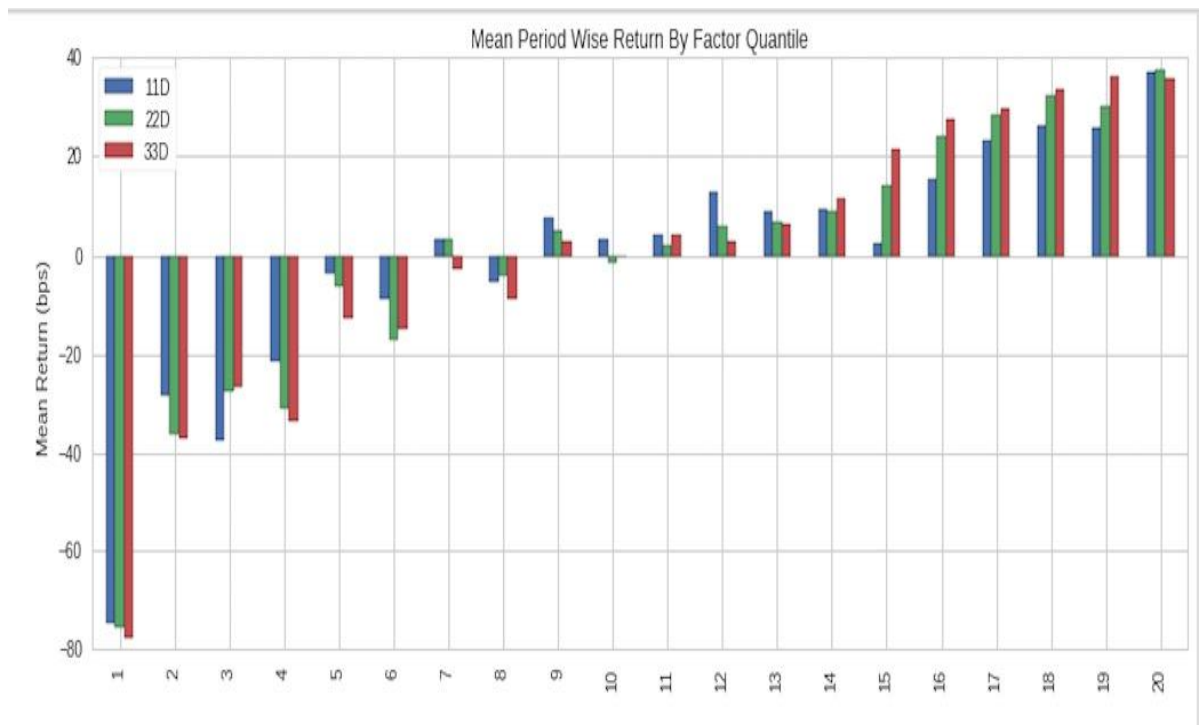


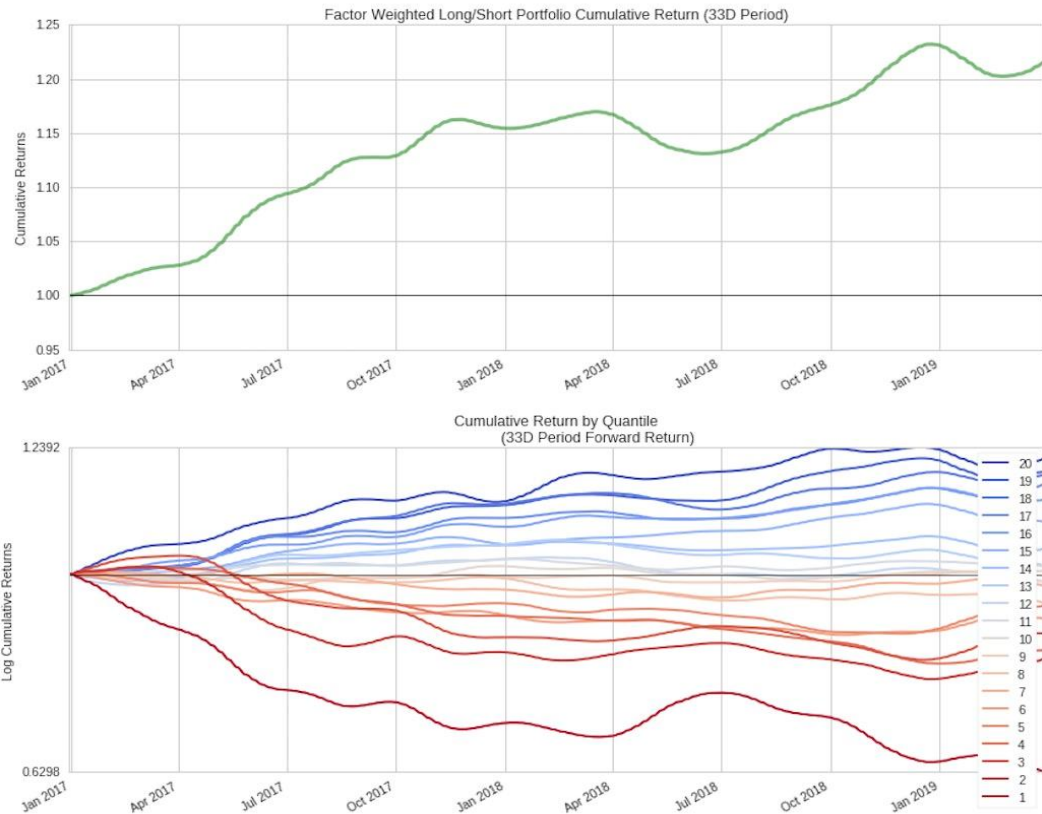


Momentum Regime 12/30/2016 - 03/29/2019

Returns Analysis

	11D	22D	33D
Ann. alpha	0.108	0.114	0.119
beta	-0.313	-0.291	-0.267
Mean Period Wise Return Top Quantile (bps)	36.958	37.426	35.671
Mean Period Wise Return Bottom Quantile (bps)	-74.529	-75.378	-77.447
Mean Period Wise Spread (bps)	111.487	115.944	116.834





As we can see, in all momentum regimes, our model performs very strongly, with clear divergent vingtiles, consistent positive cumulative factor weighted Long/Short Portfolio Cumulative Return, and strong down tendency of worst vingtiles. So, we can say our model is strong in momentum regimes.

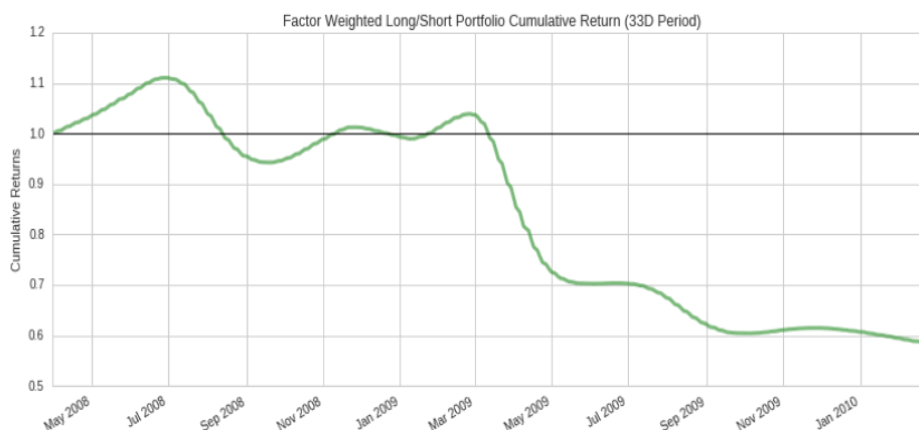
Then we compare our model result with the reference data provided by DA we still find that our worst vingtile can be a very strong short vingtile.

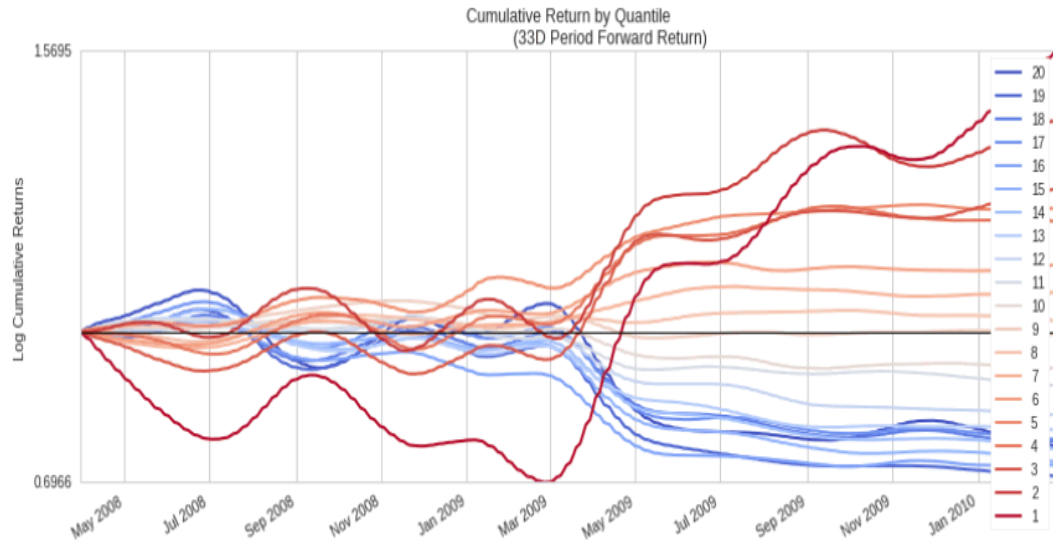
		Time period	Portfolio return	DA	Difference
1V	Momentum	04/30/2013-07/31/2015	0.5435	1.13717	-0.59367
		12/31/2003-12/31/2007	0.6164	1.71466	-1.09826
		12/30/2016-03/29/2019	0.6077	1.13717	-0.50459
	Value	01/31/2003-06/30/2003	0.8972	1.30400	0.59367
		03/31/2008-02/26/2010	0.6178	1.01944	1.09826
	Neutral	03/31/2010-03/31/2011	0.8482	1.24135	-0.39315
		07/29/2011-03/28/2013	0.8650	1.00290	-0.13790
		08/31/2015-11/30/2016	0.7690	1.20409	-0.43509
20V	Momentum	04/30/2013-07/31/2015	1.1755	1.31728	-0.14178
		12/31/2003-12/31/2007	1.5304	1.82053	-0.00388
		12/30/2016-03/29/2019	1.2601	1.62839	-0.36829
	Value	01/31/2003-06/30/2003	1.4548	1.11184	-0.36441
		03/31/2008-02/26/2010	1.5576	0.99516	0.56244
	Neutral	03/31/2010-03/31/2011	1.1391	1.25466	-0.11556
		07/29/2011-03/28/2013	1.1710	1.25466	-0.08366
		08/31/2015-11/30/2016	1.1880	1.25466	-0.06666

4.2. Back-testing under Non-Momentum Regimes

Under value regimes, our model performs totally oppositely as compared to its performance in momentum regimes. Some important figures for value regimes from 03/31/2008 to 02/26/2010 and 01/31/2003-06/30/2003 can be seen below:

Value Regime 03/31/2008–02/26/2010





Returns Analysis

	11D	22D	33D
Ann. alpha	-0.173	-0.192	-0.198
beta	-0.515	-0.519	-0.547
Mean Period Wise Return Top Quantile (bps)	-42.225	-38.973	-49.895
Mean Period Wise Return Bottom Quantile (bps)	156.323	165.989	169.476
Mean Period Wise Spread (bps)	-198.548	-188.289	-194.021

Since the available historical data is very limited, we cannot directly conclude that our model can be a short model in value regimes. Also, in 01/31/2003-06/30/2003 value regime, though the model still performs strong in short side, the limitation of window length makes it less robust to support the model.

In the neutral regimes, our model's performances are irregular, no significant patterns could be found.

In conclusion, our model can be a strong model in momentum regimes, for value regimes and neutral regimes, more data and research should be done in future.

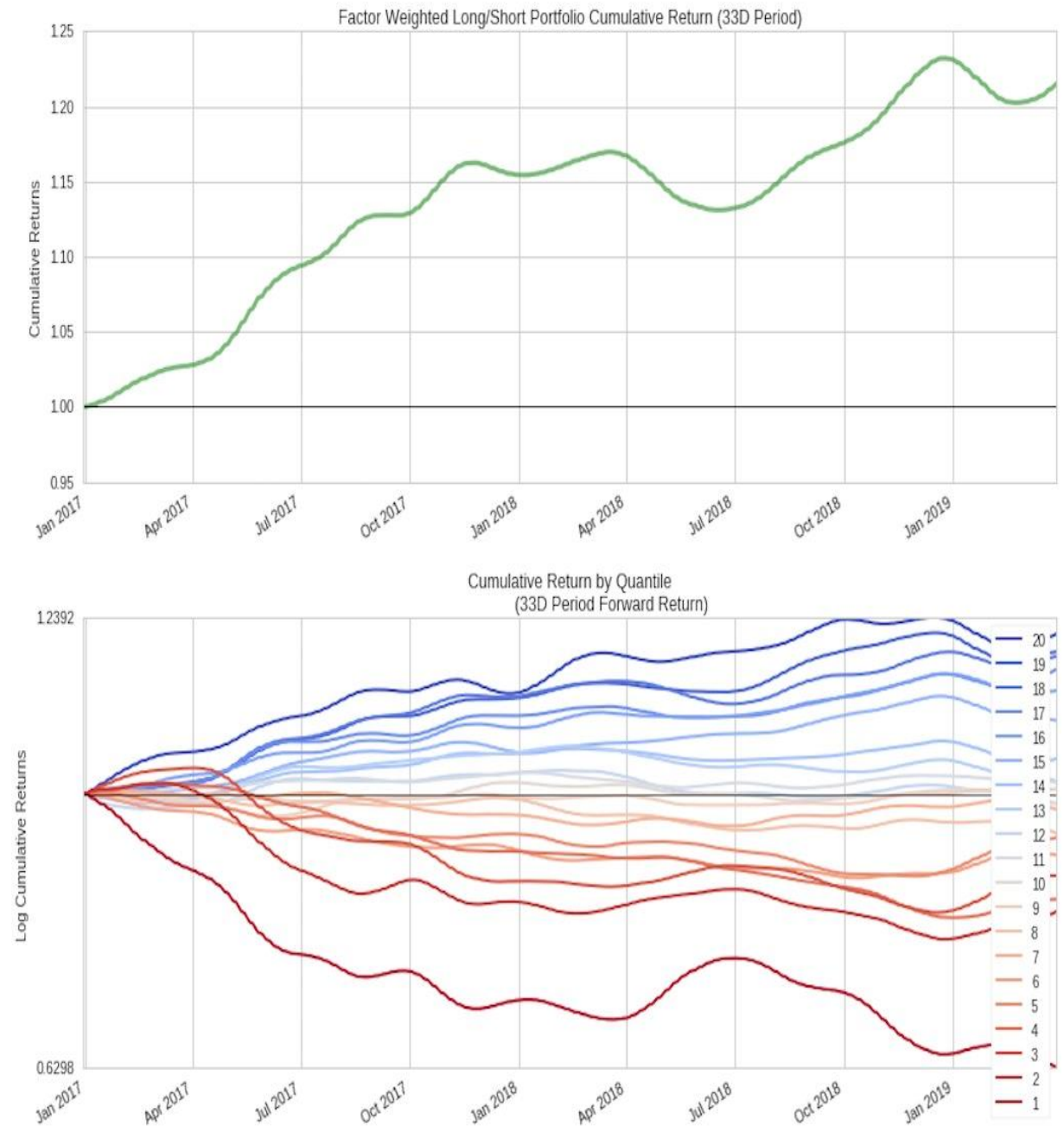
4.3. Factor Analysis

The most important factors, from most significant to less significant, can be RSI Mid-Term Momentum Factor, EPS Factor, Linear Return (or Other Simple Short-term Momentum Factor), PB Ratio and Caps. Here we will talk about RSI-Mid Term Momentum Factor.

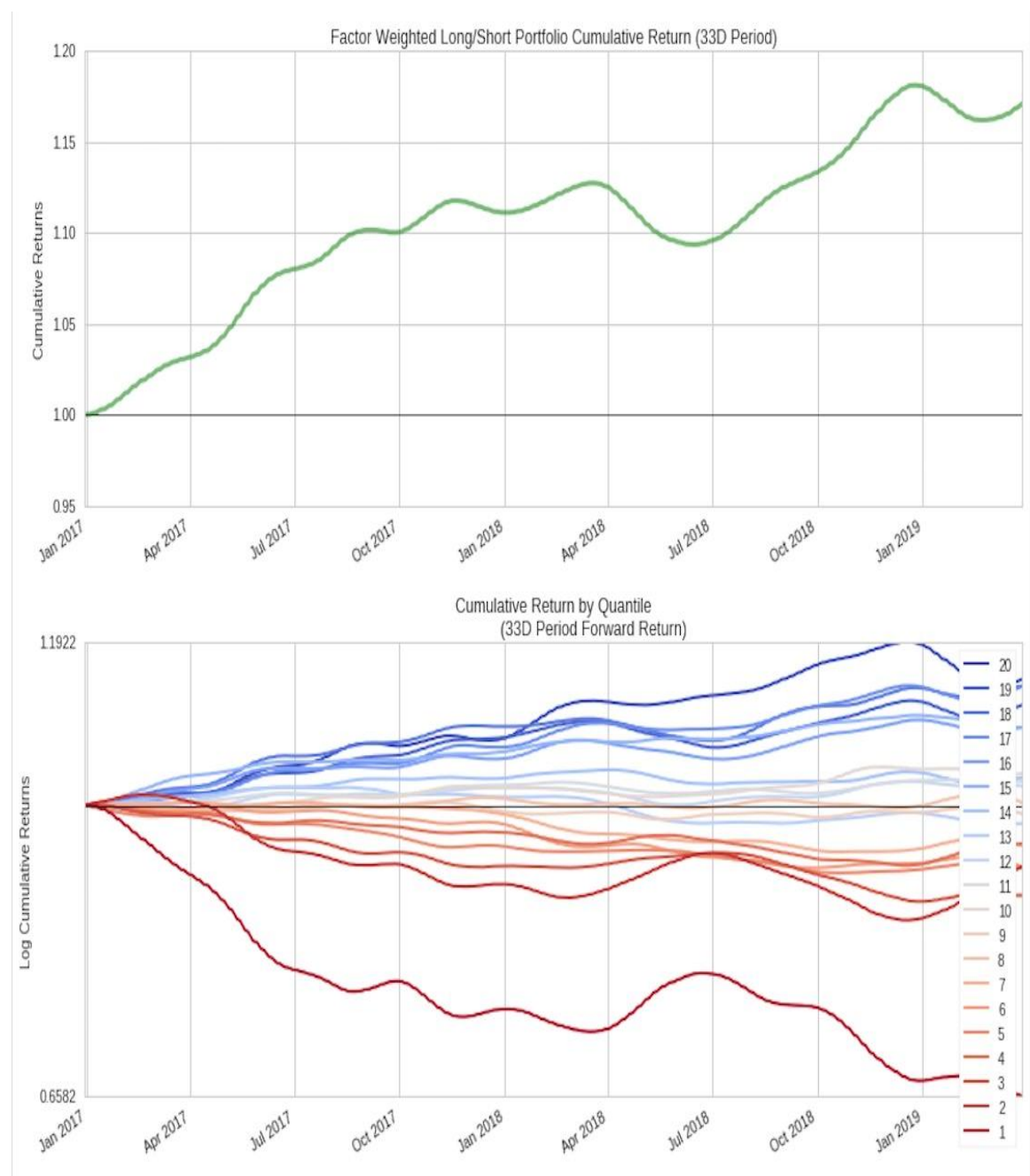
We first analyzed the mid-term momentum factor's influence on model. We then compared the performance of our model with this momentum factor with the one without the momentum factor.

For simplicity we only analyzed one momentum period because the conclusion of comparison holds true in other periods. We take the period 31/12/2003-31/12/2007 as an example.

The Model with RSI Mid-Term Momentum Factor



The Model without RSI Mid-Term Momentum Factor



We can easily find that without this momentum-factor, not only the factor weighted long/short portfolio cumulative return decreases by 5%, its 1st vingtile and 20nd vingtile both underperform as compared to the model with this momentum factor.

For other factors, such as EPS or other earning factors, we can say that these factors in themselves are not very strong but when combined with our model, can become very strong factors for long-short equity strategy. Another thing to should mention is that the cumulative return and alpha will be maximum when our model is only combined with EPS and mid-term momentum factor, but its retracement is more significant because this two-factor model may not consider many short-term momentum factors, so it cannot be adjusted quickly to strong market dynamics. We believe with a better market circumstance prediction technique; our model can perform better.

5. Summary

Our model uses a combination of both the momentum factor and fundamental factors. Without our best momentum factor i.e. Mid-Term RSI Momentum factor, our model cannot generate significant additional high alpha and without our short-term momentum factor, the retracement of cumulative returns will be higher. Again, some fundamental factors,

especially earning indicators such as EPS can significantly increase the returns in our model. Apart from this, our model's scoring system can clearly help us distinguish the worst vingtile of stocks. It can be a very strong short model when it comes into DA's momentum regimes.

The limitation of our model is also apparent. First, the history data of our quantopian platform is limited, so we can only back-test 3 momentum periods. Second, our model's performance in value and neutral regime is undetermined, so we need more history data to run back-testing.