Technical Factor Performance report

08/18/20

Objective

This report aims to test the predictive power of technical factors in the global stock market. We built trading strategy to test the trading performance triggered by these factors and compare it with the benchmark MSCI All Country World Index. We also tested them by statistical methods such as correlation analysis.

Key takeaways

- High technical attribute portfolios with medium-term rebalancing frequency are very likely to outperform the market, while low technical attribute portfolios usually underperform the market.
- Monthly momentum with 5-day rebalancing frequency and daily momentum with longer rebalancing frequency perform the best in terms of return and risk metrics.
- The optimal setting for moving average indictor is 50MA vs 150 MA with a 126-day rebalancing frequency.
- Weekly overbought and oversold indicator is negatively correlated with forward returns at 99% significant level and is most effective when the rebalancing frequency is 5-day.

Overview

1.1. Stock Universe

The test is based on 2153 stocks in the global stock market. Stocks whose historical prices were below $1 are excluded from our stock universe because these stocks are possibly risky ones and are much more easily manipulated because a relatively small price movement could result in a huge percentage swing.

1.2 Maximum Time Period

The maximum time period is 2005-01-03~2020-06-04 (15 years in total). We removed time intervals from the whole back-testing period if only a few data are available for certain technical factors.

Deriving Technicals

2.1 Technical attributes

Technical attributes are technical indicators created by Nasdaq Dorsey Wright based on momentum using Point and Figure charting. The rating ranges from zeros (lowest strength) to five (highest strengths).

2.2 Momentum factors

Momentum factors reveal change in stock momentum daily, monthly and weekly. If the change is a positive signal, the value of momentum factors is 1. Otherwise, the value is 0.

2.3 Moving average indicators

In this report, moving average of stock prices over previous 50,150 and 200 days is calculated. If a short-term moving average exceeds a long-term moving average, this bullish trading signal is denoted as 1. Otherwise, the bearish trading sign is denoted as 0.

2.4 Weekly overbuy & oversold indicator

This indicator measures the magnitude of changes in stock prices to identify overbought and oversold conditions. To avoid statistical bias caused by outliners and distribution of the values, we make a treatment of extreme values by the below formulas and then normalize all these values.

$$X_I \begin{cases} X_{median} + 5 * MAD \; if \; X_i > X_{median} + 5 * MAD \\ X_{median} - 5 * MAD \; if \; X_i < X_{median} - 5 * MAD \\ X_i \quad if \; X_{median} - 5 * MAD < X_i < X_{median} - +5 * MAD \end{cases}$$

$$MAD(Median\ Absolute\ Deviation) = |X_i - X_{median}|_{median}$$

Performance Evaluation

3.1 Performance evaluation metrics for classified indicators

For classified indicators including technical attributes, momentum factors and moving average indicators, we mainly test them by implementing trading strategy and measuring the performance by cumulative returns, cumulative average growth return (CAGR) and risk metrics like Sharpe ratio and maximum drawdown. We also see the percentage of winning trades by success ratio.

3.2 Performance evaluation metrics for non-classified indicators

For non-classified indicators, besides the measures used by classified indicators, we can further see their correlation with forward returns by Spearman test and linear regression. The coefficient of the regression between forward returns and the value of the indicator can be regarded as the risk premium or average excess return of this indicator.

Performance Evaluation results

4.1 Technical attributes

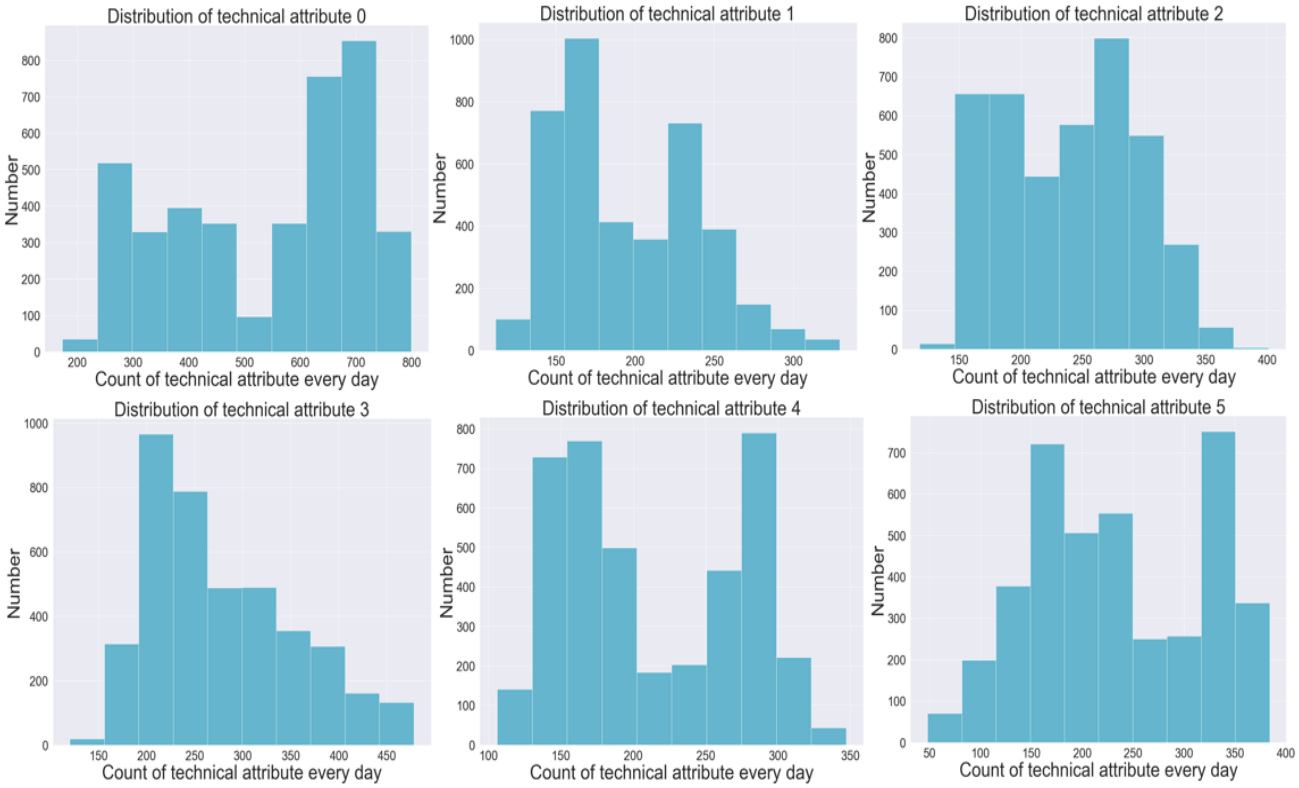
Key takeaways:

- Technical attribute can successfully discriminate investable stocks.
- Portfolio of high technical attribute stocks consistently outperforms the one of low technical attribute in terms of risk-adjusted return.
- Medium-term rebalancing frequency helps to achieve high CAGR level. Portfolio constructed by buying stocks with technical attribute 5 and rebalanced on a 126-day basis can beat the market
- The performance of portfolios of stocks with 0, 3 and 5 technical attribute rating is more robust than the others.

4.1.1 Descriptive Statistic of Technical Attributes

The number of stocks is not classified equally in the stock universe. The average number of stocks with technical attribute 0 is nearly 2 to 3 times greater than the average number of stocks with other technical attributes. The range of stocks with technical attribute 0 is the widest, about twice wider than the second largest one. Additionally, the histograms show that the number of stocks with each technical attribute in each trading day are not evenly distributed. The number of stocks with each technical attribute fluctuates from day to day and doesn't' highly cluster within a certain range.

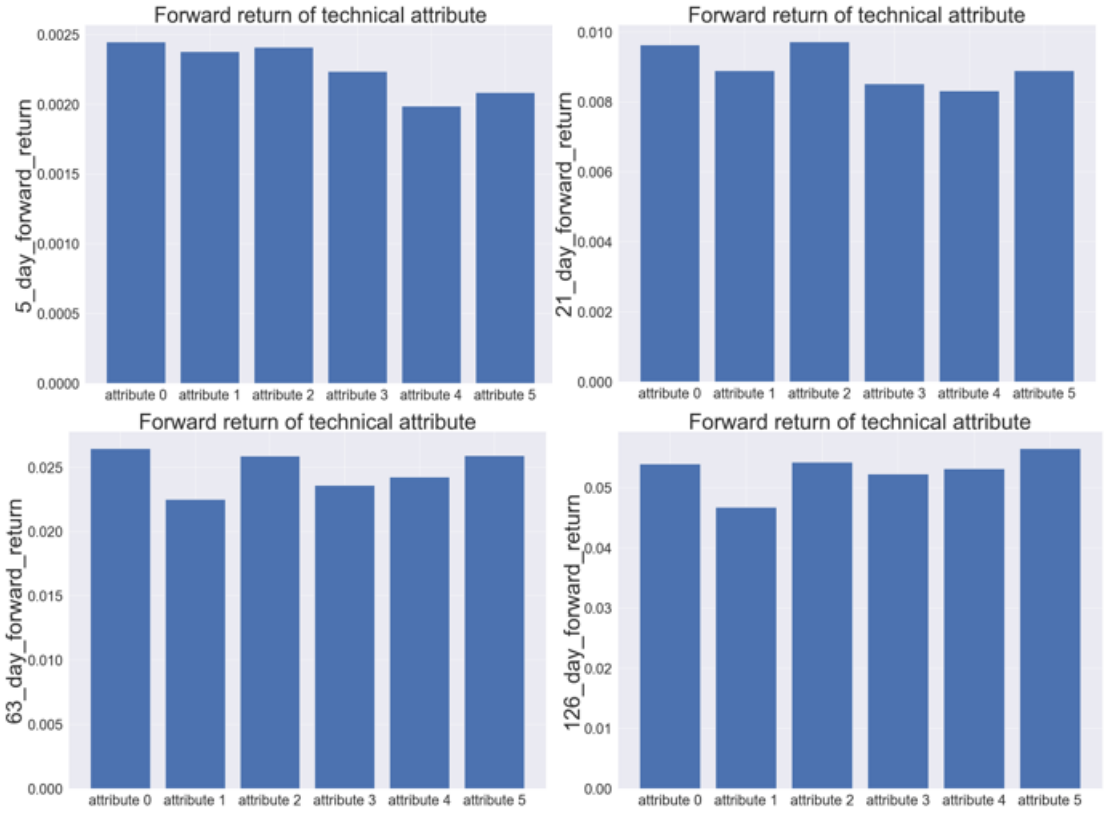
Statistics	Technical Attribute 0	Technical Attribute 1	Technical Attribute 2	Technical Attribute 3	Technical Attribute 4	Technical Attribute 5
Mean	538	195	240	278	213	234
Min	173	112	118	120	106	48
25th Percentile	377	159	188	219	158	169
50th Percentile	606	182	248	253	197	226
75th Percentile	687	234	282	330	277	324
Max	799	329	401	478	347	384



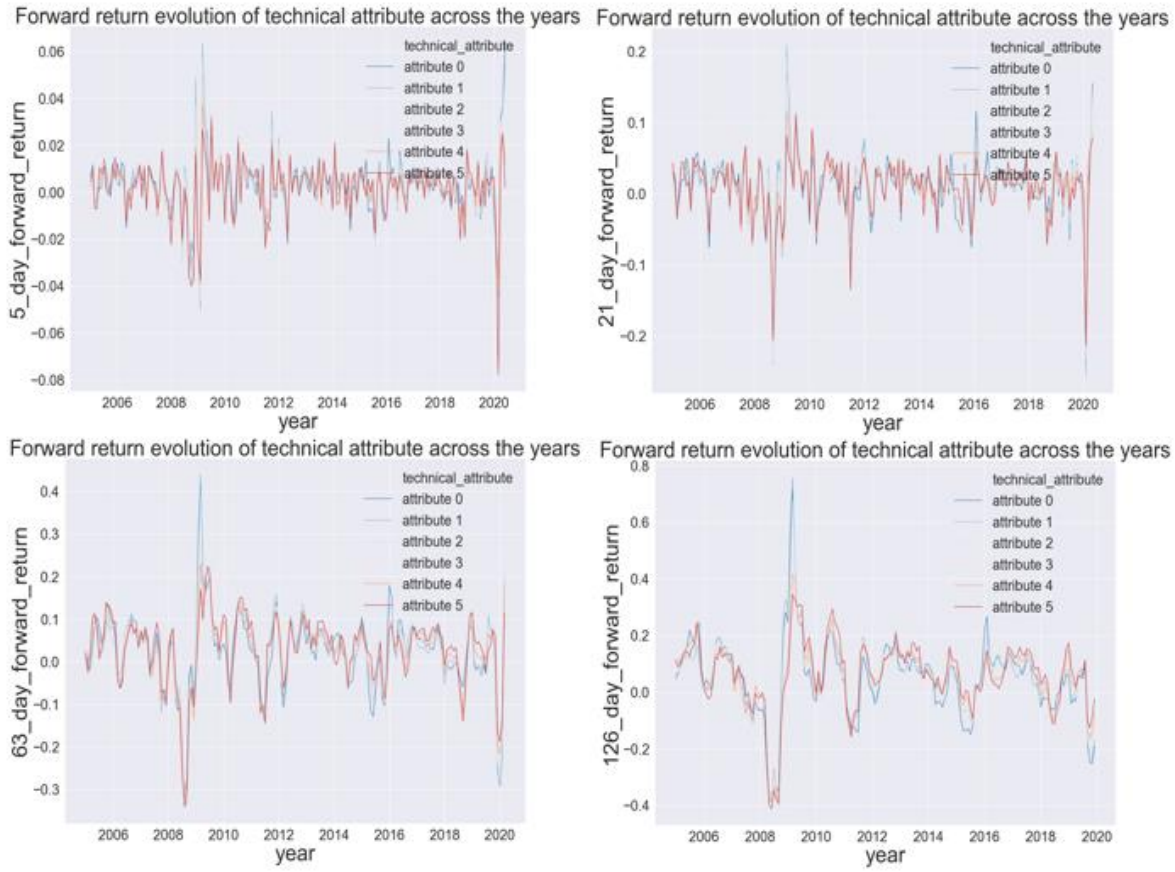
To determine how effective technical attributes are, we first explored the relationship between technical attributes and forward returns. Then we constructed equally weighted portfolios by buying every stock with these technical attributes separately on rebalancing day. We further built portfolios by randomly select 30 stocks with each technical attribute to avoid possible bias coming from uneven size and distribution of number of stocks grouped by technical attributes.

4.1.2 Relationship with forward returns

The below bar charts present the relationship between technical attributes and average forward return with different time horizons during the whole test period. Based on the overall results, we cannot discern a clear pattern that the higher the value of technical attribute is, the higher the forward returns are. Interestingly, average forward return of stocks with technical attribute 0 always ranked the first with different rebalancing frequency, but the others performed almost at the same level. However, we cannot roughly jump into the conclusion that technical attribute in the global stock market lose its predictive power just by looking into the average returns because mean is sensitive to extreme values.

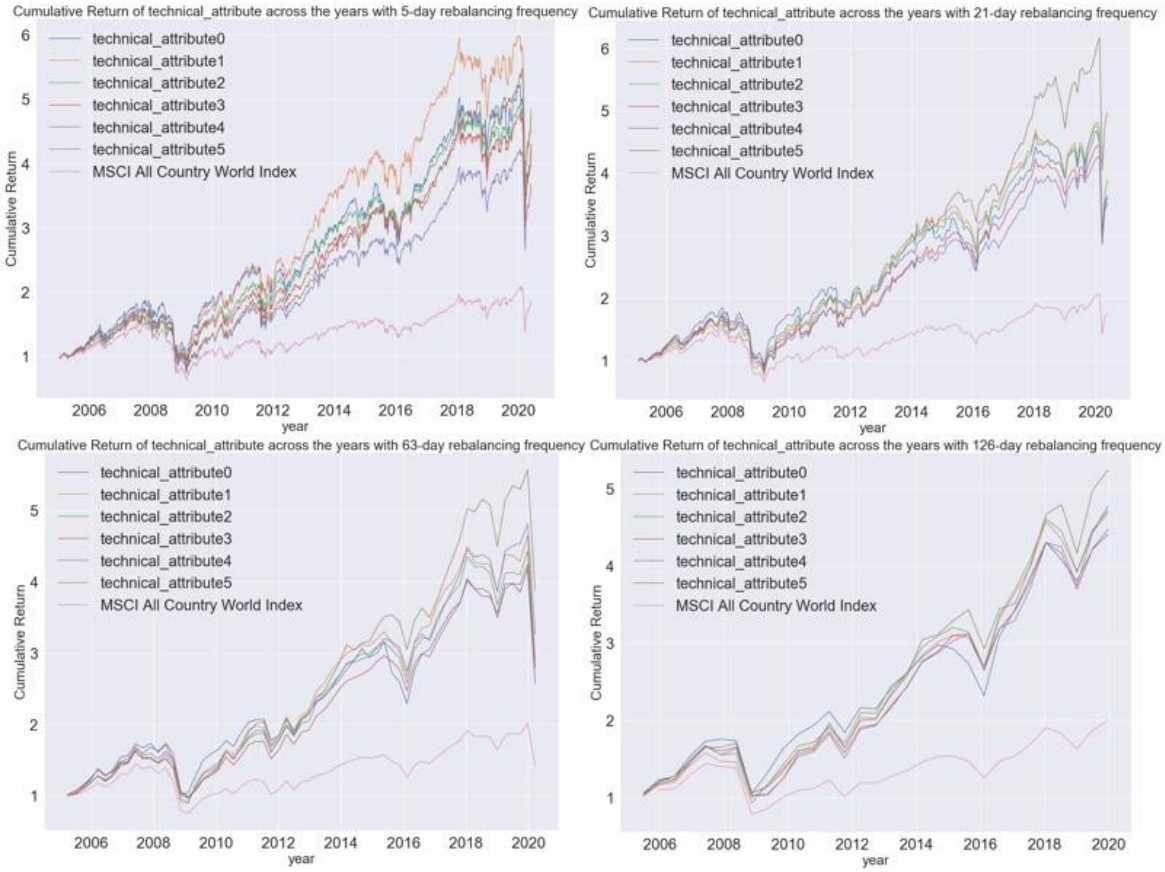


The evolution of changes in forward returns across years are shown in the line chats. We can see from the charts that the ability of technical attributes to differentiate stocks with different levels of forward returns is the strongest when the rebalancing frequency is 126 days. Generally, stocks with technical attribute 0 performs the worst, while it's the other way around for stocks with technical attribute 5. But this rule is reversed after market crash. Obviously, there were some surprise rises of forward returns in blue lines, indicating that stock with technical attribute 0 and technical attribute 1 tend to rebound dramatically especially after 2008 financial crisis. The huge increases driven by rally of stocks with these two attributes masked the general performance associated with technical attributes, so we can hardly see the relationship solely from the average of forward returns.



4.1.3 Back-testing results

Here, we implemented the trading strategy that we buy all the stocks with a technical attribute rating and hold them until the next rebalancing day. The graph below shows the cumulative return performance of portfolios constituted based on technical attributes and rebalanced with different frequency. The trend of the return change for each portfolio generally acts similar with the global benchmark index, suffering the biggest slump during both 2008 financial crisis and covid-19 period. Except the performance with 5-day rebalancing frequency, the portfolio of stocks with technical attribute 5 performed the best in terms of final returns. It seems that technical attributes may not make a clear distinction of the return performance stably because the rank of returns for each portfolio changed over the years and with different rebalancing frequency, but these back-testing results may be somewhat influenced by fluctuation of the number of holdings on each rebalancing day and individual stocks with extreme performance during special periods after crisis. Therefore, we further dived into the yearly performance next in this part and performance of random portfolios in the following part.



From the tables as follows, the negative cumulative average growth return (CAGR) of MSCI all country world index confirms that the market collapsed in four major historical periods, which are 2008 financial crisis, 2011 stock market fall due to European sovereign debt crisis and downgrade of US's credit rating, 2015 global stock market selloff at the end of quantitative easing in the US and 2018 stock market slide caused by Brexit and trade war between US and China. The portfolio of technical attribute 5 excelled the others in CAGR in most of the years regardless of the rebalancing frequency, but the low attribute portfolios would bounce back and thus had the highest CAGR in the following year when market tanked.

CAGR 5 day	Technical Attribute 0	Technical Attribute 1	Technical Attribute 2	Technical Attribute 3	Technical Attribute 4	Technical Attribute 5	MSCI All Country World Index
2005	0.2391	0.1539	0.1974	0.2177	0.2379	0.2004	0.1062
2006	0.2789	0.2321	0.1962	0.2325	0.1971	0.1700	0.1762
2007	0.1275	0.0587	0.0676	0.0847	0.1196	0.2211	0.0964
2008	-0.3420	-0.3400	-0.3402	-0.3391	-0.4251	-0.3753	-0.4379
2009	0.5407	0.6253	0.5619	0.3943	0.3177	0.2751	0.3149
2010	0.2135	0.2832	0.2232	0.2012	0.2320	0.2936	0.1042
2011	-0.0964	-0.0423	-0.0215	-0.0290	-0.0109	-0.0090	-0.0987
2012	0.2011	0.2142	0.2294	0.1832	0.1535	0.1816	0.1313
2013	0.2317	0.3534	0.2824	0.3183	0.3492	0.3804	0.2024
2014	0.0524	0.0806	0.0552	0.0635	0.0450	0.0907	0.0210

2015	-0.0566	0.0026	-0.0020	0.0223	0.0483	0.1066	-0.0426
2016	0.2361	0.1847	0.1686	0.1021	0.0746	0.0444	0.0563
2017	0.2652	0.2063	0.2322	0.2516	0.2681	0.3097	0.2111
2018	-0.0985	-0.1367	-0.1368	-0.1170	-0.0897	-0.0773	-0.1117
2019	0.2101	0.2264	0.2299	0.2203	0.2334	0.2589	0.2404
2020	-0.0912	-0.1135	-0.1030	-0.0592	-0.1132	-0.0942	-0.0645

CAGR 21 day	Technical Attribute 0	Technical Attribute 1	Technical Attribute 2	Technical Attribute 3	Technical Attribute 4	Technical Attribute 5	MSCI All Country World Index
2005	0.2231	0.1412	0.1832	0.1959	0.2292	0.1980	0.1004
2006	0.2783	0.2438	0.1946	0.2221	0.2225	0.1804	0.1846
2007	0.0839	0.0203	0.0631	0.0726	0.0925	0.1901	0.0693
2008	-0.3517	-0.3752	-0.3743	-0.3528	-0.3613	-0.3817	-0.4336
2009	0.5019	0.5795	0.5055	0.3701	0.2813	0.3124	0.2950
2010	0.1888	0.2555	0.2092	0.1890	0.2395	0.2983	0.0941
2011	-0.1168	-0.0569	-0.0334	-0.0549	-0.0308	-0.0185	-0.1125
2012	0.1996	0.2094	0.2384	0.1970	0.1409	0.1910	0.1387
2013	0.1967	0.3086	0.2555	0.2967	0.3009	0.3428	0.1732
2014	0.0334	0.0729	0.0653	0.0605	0.0583	0.0813	0.0236
2015	-0.0737	-0.0240	-0.0117	0.0030	0.0310	0.0785	-0.0553
2016	0.2085	0.1821	0.1662	0.1137	0.0606	0.0616	0.0604
2017	0.2552	0.2102	0.2380	0.2588	0.2768	0.3247	0.2078
2018	-0.1316	-0.1553	-0.1450	-0.1308	-0.1015	-0.0933	-0.1079
2019	0.2035	0.2274	0.2291	0.2174	0.2187	0.2412	0.2311
2020	-0.2051	-0.1933	-0.1252	-0.1269	-0.1312	-0.0790	-0.1031

CAGR 63 day	Technical Attribute 0	Technical Attribute 1	Technical Attribute 2	Technical Attribute 3	Technical Attribute 4	Technical Attribute 5	MSCI All Country World Index
2005	0.2223	0.1723	0.1803	0.1715	0.2427	0.2059	0.1004
2006	0.2689	0.2313	0.2261	0.2027	0.2142	0.1965	0.1846
2007	0.0881	0.0018	0.0697	0.0993	0.0702	0.1774	0.0693
2008	-0.3610	-0.3876	-0.3487	-0.3546	-0.3508	-0.4055	-0.4336
2009	0.4943	0.5509	0.4852	0.3212	0.3410	0.3473	0.2950
2010	0.1899	0.2590	0.1957	0.1983	0.2200	0.3064	0.0941
2011	-0.1120	-0.0384	-0.0254	-0.0506	-0.0469	-0.0421	-0.1125
2012	0.2053	0.2211	0.2273	0.1784	0.1677	0.1764	0.1387
2013	0.1989	0.3118	0.2585	0.3042	0.3097	0.3410	0.1732
2014	0.0318	0.0682	0.0751	0.0514	0.0666	0.0738	0.0236
2015	-0.0614	-0.0316	-0.0285	0.0099	0.0325	0.0923	-0.0553
2016	0.2168	0.1755	0.1840	0.1132	0.0749	0.0464	0.0604
2017	0.2633	0.1907	0.2228	0.2417	0.2696	0.3112	0.2078
2018	-0.0953	-0.1300	-0.1148	-0.1027	-0.0978	-0.0662	-0.1079
2019	0.1888	0.2229	0.2012	0.2267	0.2566	0.2387	0.2311
2020	-0.3459	-0.3443	-0.3100	-0.2635	-0.2613	-0.2058	-0.2127

CAGR 126 day	Technical Attribute 0	Technical Attribute 1	Technical Attribute 2	Technical Attribute 3	Technical Attribute 4	Technical Attribute 5	MSCI All Country World Index
2005	0.2232	0.1666	0.2177	0.1780	0.2304	0.1950	0.1004
2006	0.2611	0.2046	0.2265	0.2135	0.2023	0.1957	0.1846
2007	0.1000	0.0339	0.0668	0.1140	0.0523	0.1673	0.0693
2008	-0.3577	-0.3645	-0.3358	-0.3312	-0.3655	-0.4249	-0.4336
2009	0.4817	0.6395	0.4641	0.3117	0.3095	0.3366	0.2950
2010	0.1901	0.2292	0.2141	0.2067	0.2415	0.2877	0.0941
2011	-0.1254	-0.0612	-0.0656	-0.0524	-0.0131	-0.0021	-0.1125
2012	0.1973	0.2027	0.1906	0.2036	0.1926	0.1905	0.1387
2013	0.2137	0.2743	0.2763	0.3073	0.3204	0.3234	0.1732
2014	0.0325	0.0459	0.0878	0.0464	0.0658	0.0798	0.0236
2015	-0.0787	-0.0345	-0.0160	0.0016	0.0370	0.0890	-0.0553
2016	0.2536	0.1941	0.1876	0.1025	0.0652	0.0378	0.0604
2017	0.2448	0.2231	0.2389	0.2386	0.2613	0.3046	0.2078
2018	-0.0985	-0.1108	-0.1076	-0.1047	-0.0940	-0.0715	-0.1079
2019	0.1789	0.2195	0.1986	0.2231	0.2833	0.2521	0.2311

High technical attribute portfolios possessed high CAGR, success ratio and annualized Sharpe ratio but low maximum drawdown, so portfolio comprised by strong technical attribute ratings not only has higher returns and percentage of winning trades but also performs well from a risk perspective. Technical attribute 5's portfolio outperformed the worst portfolio, most by almost 300 basis points if rebalanced on a 5-day basis, but undertook less risk by 87 basis points, as measured by standard deviation (SD). Accordingly, its Sharpe ratio improved 28%.

Performance Metrics	Technical Attribute 0	Technical Attribute 1	Technical Attribute 2	Technical Attribute 3	Technical Attribute 4	Technical Attribute 5	MSCI All Country World Index
CAGR_5_day	0.0991	0.1077	0.0983	0.0980	0.0881	0.1061	0.0395
Sharpe_ratio_5_day	0.6665	0.6827	0.6562	0.6704	0.6203	0.7223	0.3529
SD_5_day	0.0282	0.0300	0.0286	0.0275	0.0273	0.0271	0.0262
Max_drawdown_5_day	0.5083	0.5171	0.5346	0.5325	0.5682	0.5439	0.5941
Success_ratio_5_day	0.5684	0.5597	0.5647	0.5871	0.5771	0.5896	0.5585
CAGR_21_day	0.0874	0.0868	0.0919	0.0848	0.0864	0.1096	0.0364
Sharpe_ratio_21_day	0.6097	0.5922	0.6329	0.6202	0.6279	0.7597	0.3432
SD_21_day	0.0581	0.0609	0.0584	0.0548	0.0547	0.0548	0.0524
Max_drawdown_21_day	0.4993	0.5190	0.5171	0.4997	0.5215	0.4938	0.5694
Success_ratio_21_day	0.6387	0.6178	0.6440	0.6597	0.6492	0.6859	0.6387
CAGR_63_day	0.0631	0.0708	0.0690	0.0689	0.0797	0.0918	0.0223
Sharpe_ratio_63_day	0.4860	0.5277	0.5280	0.5524	0.6150	0.6726	0.2627
SD_63_day	0.1032	0.1027	0.0988	0.0908	0.0913	0.0945	0.0890

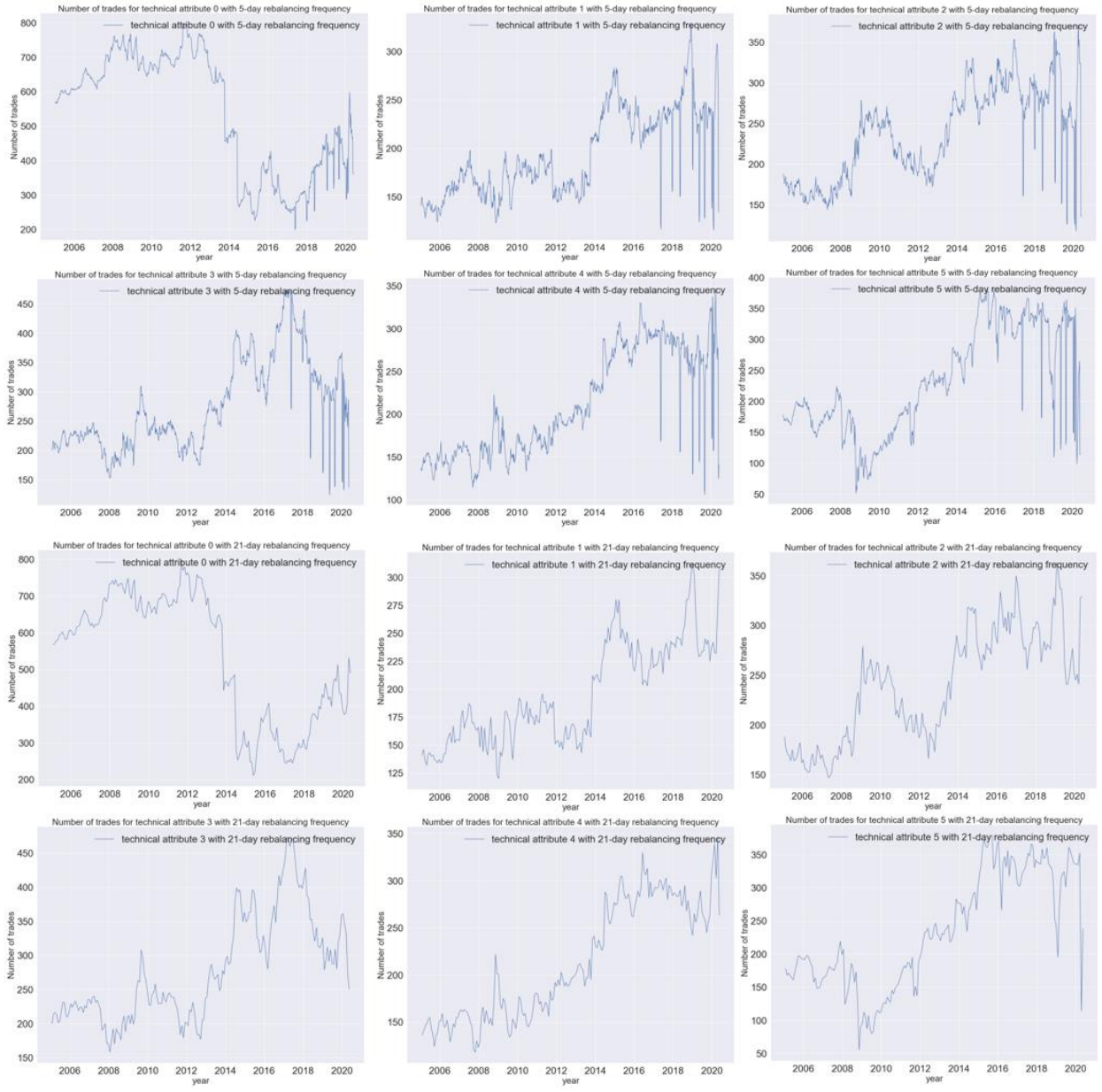
Max_drawdown_63_day	0.4135	0.4479	0.4414	0.4100	0.4235	0.4335	0.4794
Success_ratio_63_day	0.7143	0.6667	0.6825	0.6825	0.7143	0.7143	0.6508
CAGR_126_day	0.1010	0.1054	0.1059	0.1020	0.1067	0.1134	0.0457
Sharpe_ratio_126_day	0.7211	0.7675	0.7772	0.7897	0.7892	0.8070	0.4258
SD_126_day	0.1382	0.1326	0.1312	0.1231	0.1299	0.1355	0.1246
Max_drawdown_126_day	0.4019	0.4141	0.4101	0.3578	0.3854	0.3964	-0.4566
Success_ratio_126_day	0.7097	0.7097	0.7419	0.8065	0.8065	0.8387	0.6774

Other than the performance of 5-day rebalancing frequency, the portfolio yearly performance of high technical attribute exceeded the benchmark more times than of low technical attribute, with the best record of over 90%.

1-year outperformance	Technical Attribute 0	Technical Attribute 1	Technical Attribute 2	Technical Attribute 3	Technical Attribute 4	Technical Attribute 5
CAGR_yearly_5_day	0.81	0.69	0.75	0.81	0.88	0.75
CAGR_yearly_21_day	0.69	0.75	0.75	0.81	0.81	0.94
CAGR_yearly_63_day	0.81	0.69	0.81	0.88	0.94	0.94
CAGR_yearly_126_day	0.80	0.80	0.87	0.93	0.93	0.93

Average number of holdings were not greatly affected by rebalancing frequency but by technical attribute rating. The volatility of number of holdings was high with a 5-day rebalancing frequency given by large and frequent up-and-downs during the test period. Technical attribute 0 stood out from others for the largest average holdings and widest variation in number of holdings.

Average holdings	5 day	21 day	63 day	126 day	Average
Technical Attribute 0	539	535	535	542	538
Technical Attribute 1	193	195	192	192	193
Technical Attribute 2	237	240	239	236	238
Technical Attribute 3	275	279	280	276	277
Technical Attribute 4	211	214	212	209	211
Technical Attribute 5	231	234	233	227	231


Number of trades for technical attribute 0 with 5-day rebalancing frequency
technical attribute 0 with 5-day rebalancing frequency
Number of trades for technical attribute 1 with 5-day rebalancing frequency
technical attribute 1 with 5-day rebalancing frequency
Number of trades for technical attribute 2 with 5-day rebalancing frequency
technical attribute 2 with 5-day rebalancing frequency
Number of trades for technical attribute 3 with 5-day rebalancing frequency
technical attribute 3 with 5-day rebalancing frequency
Number of trades for technical attribute 4 with 5-day rebalancing frequency
technical attribute 4 with 5-day rebalancing frequency
Number of trades for technical attribute 5 with 5-day rebalancing frequency
technical attribute 5 with 5-day rebalancing frequency
Number of trades for technical attribute 0 with 21-day rebalancing frequency
technical attribute 0 with 21-day rebalancing frequency
Number of trades for technical attribute 1 with 21-day rebalancing frequency
technical attribute 1 with 21-day rebalancing frequency
Number of trades for technical attribute 2 with 21-day rebalancing frequency
technical attribute 2 with 21-day rebalancing frequency
Number of trades for technical attribute 3 with 21-day rebalancing frequency
technical attribute 3 with 21-day rebalancing frequency
Number of trades for technical attribute 4 with 21-day rebalancing frequency
technical attribute 4 with 21-day rebalancing frequency
Number of trades for technical attribute 5 with 21-day rebalancing frequency
technical attribute 5 with 21-day rebalancing frequency
Number of trades
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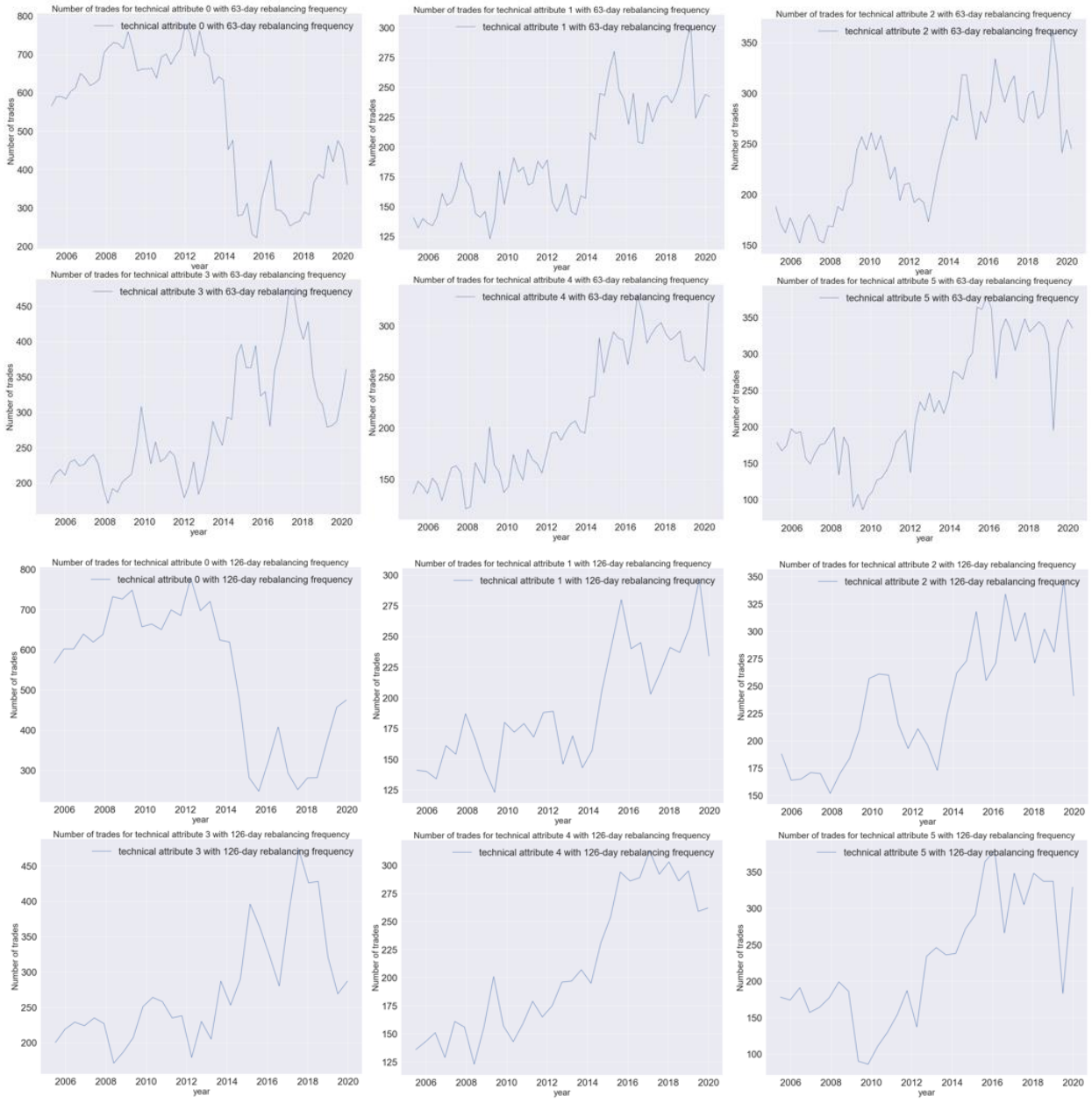


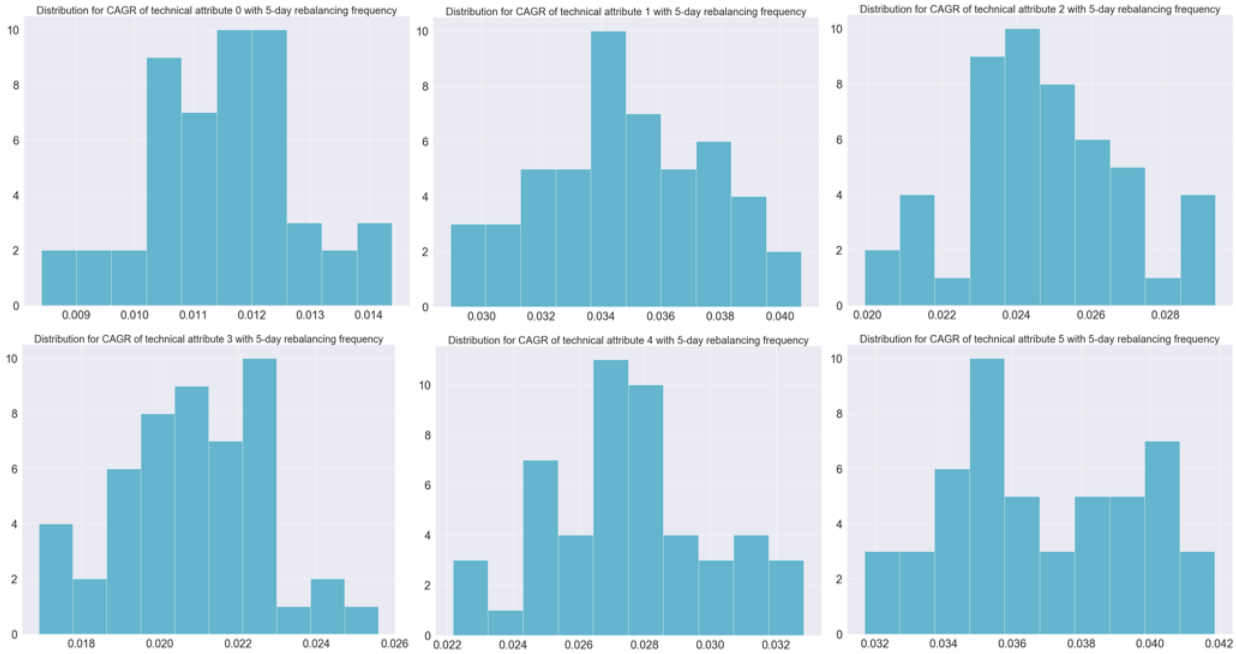
4.1.4 Random Portfolio Performance

To eliminate the effect of volatility of number of holdings and abnormal surge or plunge in stock prices on back-testing results, we constructed portfolios by randomly selecting 60 stocks for each technical attribute on the rebalancing day. We then simulated 50 times to see the distribution of CAGR for each portfolios.

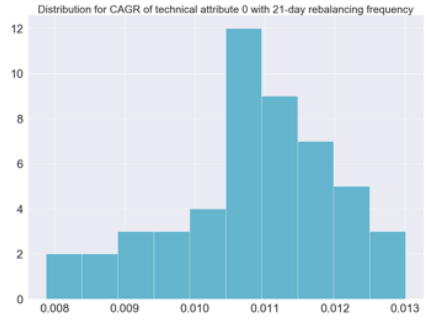
The following tables and histograms exhibit the simulation results of random portfolios. As expected, the average CAGR for technical attribute 5's portfolios is the highest and their CAGR lies within the highest range, irrespective of rebalancing frequency. This is exactly the opposite for technical attribute 0's portfolio. It is intriguing that portfolio constituted by buying all stocks with technical attribute 1 ranked the second in CAGR level, probably because stocks with this rating are more

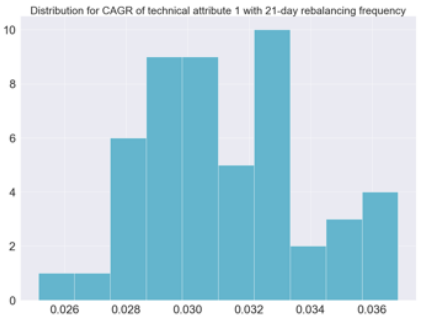
likely to rebound strongly after market falls and thus may reverse the overall cumulative return in this long test period.

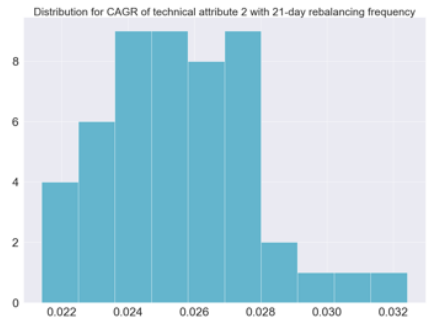
Technical Attribute	Simulated portfolio average CAGR 5 day	Simulated portfolio average CAGR 21 day	Simulated portfolio average CAGR 63 day	Simulated portfolio average CAGR 126 day	Average
Technical Attribute 0	0.0115	0.0108	0.0081	0.0129	0.0109
Technical Attribute 1	0.0348	0.0313	0.0320	0.0397	0.0345
Technical Attribute 2	0.0246	0.0255	0.0211	0.0288	0.0250
Technical Attribute 3	0.0208	0.0202	0.0195	0.0252	0.0214
Technical Attribute 4	0.0275	0.0293	0.0300	0.0375	0.0311
Technical Attribute 5	0.0369	0.0404	0.0396	0.0472	0.0410

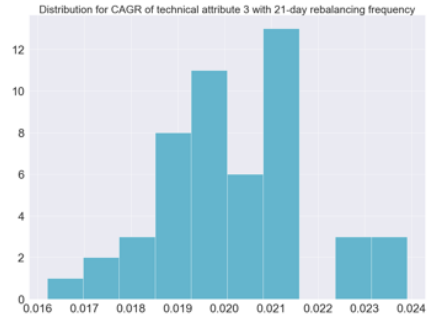


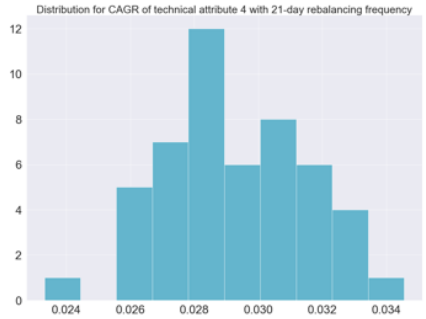
Technical Attribute	Simulated portfolio CAGR range 5 day
Technical Attribute 0	(0.0084, 0.0144)
Technical Attribute 1	(0.0290, 0.0407)
Technical Attribute 2	(0.0199, 0.0293)
Technical Attribute 3	(0.0169, 0.0256)
Technical Attribute 4	(0.0222, 0.0329)
Technical Attribute 5	(0.0317, 0.0419)

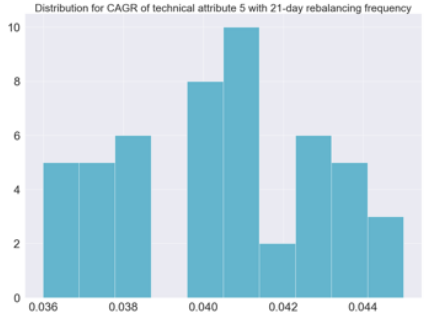




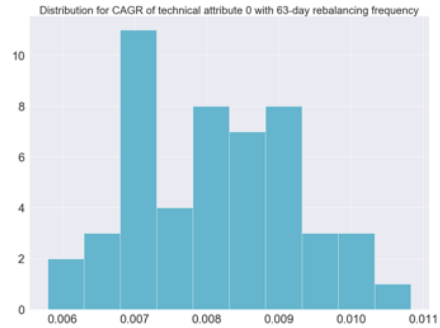


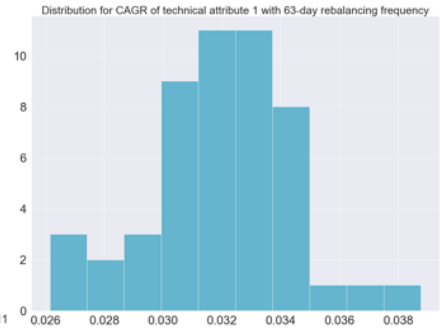


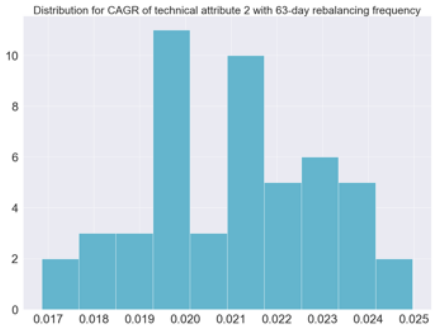


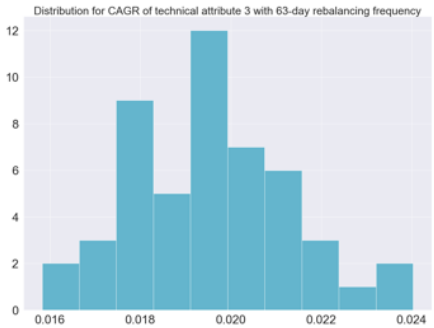


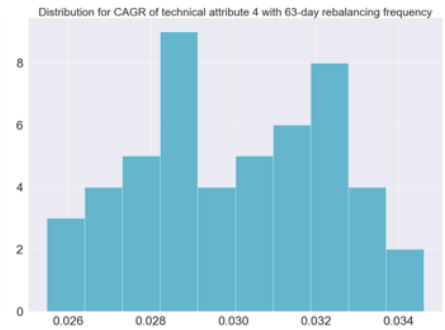
Technical Attribute	Simulated portfolio CAGR range 21 day
Technical Attribute 0	(0.0079, 0.0130)
Technical Attribute 1	(0.0251, 0.0368)
Technical Attribute 2	(0.0214, 0.0342)
Technical Attribute 3	(0.0162, 0.0239)
Technical Attribute 4	(0.0233, 0.0346)
Technical Attribute 5	(0.0360, 0.0450)

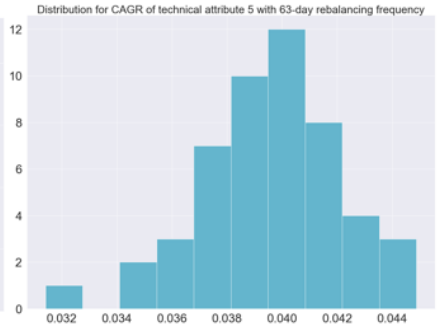




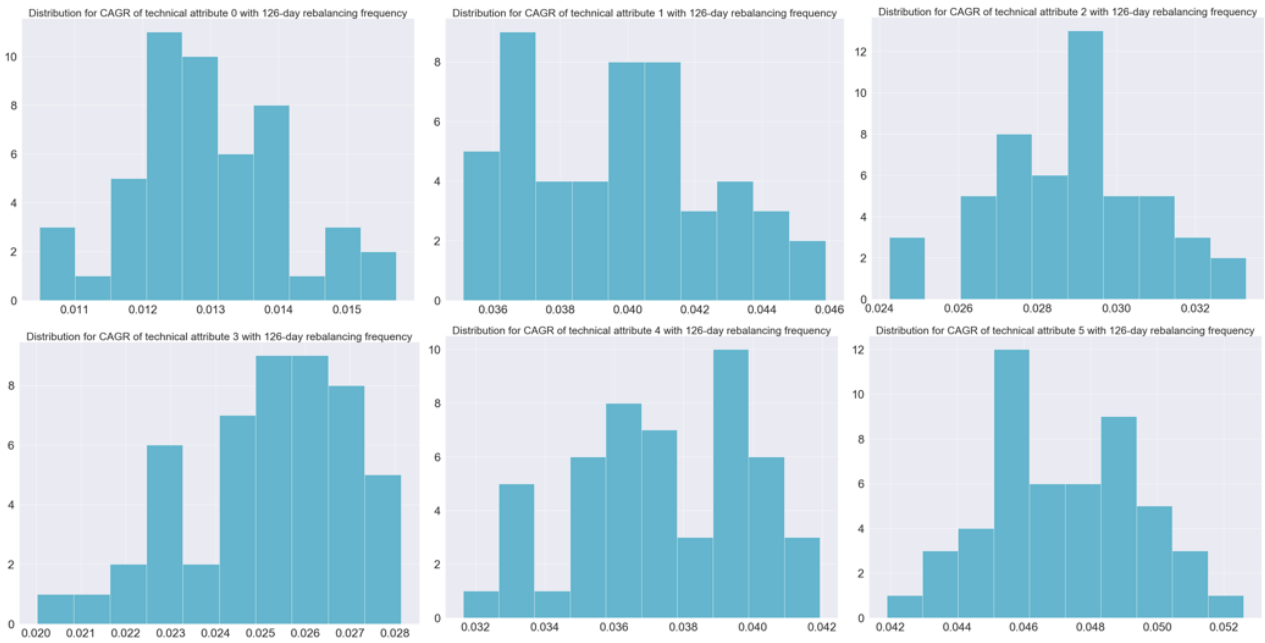








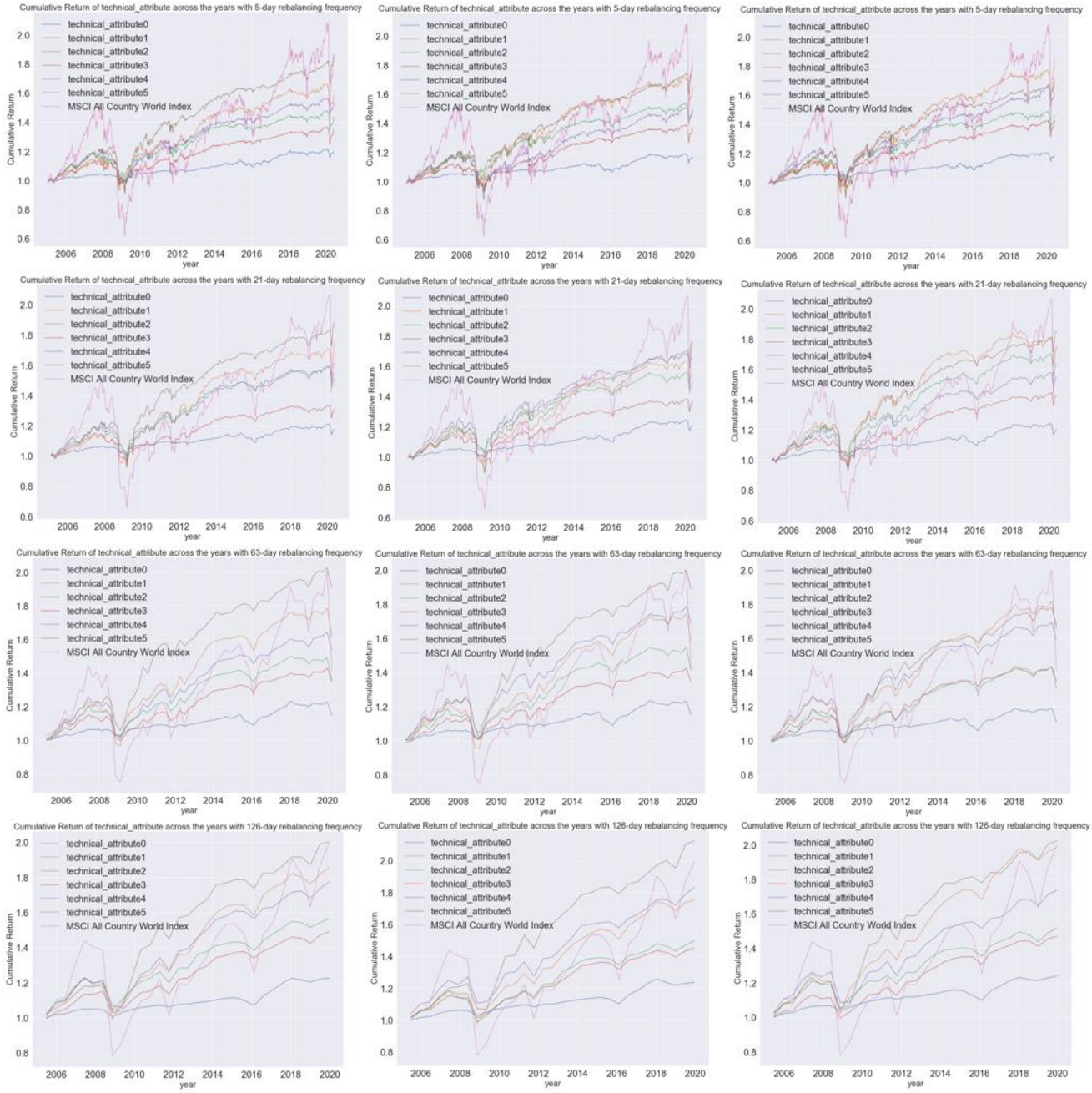
Technical Attribute	Simulated portfolio CAGR range 63 day
Technical Attribute 0	(0.0058, 0.0108)
Technical Attribute 1	(0.0261, 0.0386)
Technical Attribute 2	(0.0169, 0.0250)
Technical Attribute 3	(0.0158, 0.0240)
Technical Attribute 4	(0.0255,0.0346)
Technical Attribute 5	(0.0314, 0.0449)



Technical Attribute	Simulated portfolio CAGR range 126 day
Technical Attribute 0	(0.0105, 0.0157)
Technical Attribute 1	(0.0351, 0.0459)
Technical Attribute 2	(0.0242, 0.0333)
Technical Attribute 3	(0.0200, 0.0281)
Technical Attribute 4	(0.0316,0.0419)
Technical Attribute 5	(0.0419, 0.0526)

The below sets of graphs display typical samples of cumulative return curve for each portfolio. Now, a much more clear layered performance reveals how technical attribute rating determines portfolio returns. With a 126-day rebalancing frequency, the technical attribute rating can better exert its predictive power because taking the randomness of portfolio construction into consideration, the tendency that highest attribute portfolio can finally beat the market is the most stable. The performance of technical attribute 0's portfolio remained at the bottom and adjustment of rebalancing frequency didn't work for improvement of its performance. Interestingly, technical attribute 3's portfolio was constantly the second worst but the performance rank of technical attribute 1, 2 and 4 shifted at random as seen from every simulation. This may indicates that the predictive power

of these three technical attribute rating are weaker and more vulnerable to market noise. Technical attribute 1's portfolio sometimes even outperformed or almost performed the same as technical attribute 5's portfolio, particularly when some stocks which can perform extremely better than average after crisis were included into the portfolio and this allowed a steep growth of portfolio's return in the midst of recovery.



4.2 Momentum factors

Key takeaways:

- Monthly momentum performs best when the portfolio is rebalanced every 5 days, while daily momentum becomes the best when the portfolio isn't rebalanced so frequently.
- Monthly momentum strategy manages to mitigate downside risk given that maximum drawdown is the lower than the market level.
- The average of number of trades triggered by momentum factors is roughly at similar level, but the number of trades triggered by daily momentum is much more volatile than the number of trades triggered by monthly momentum.

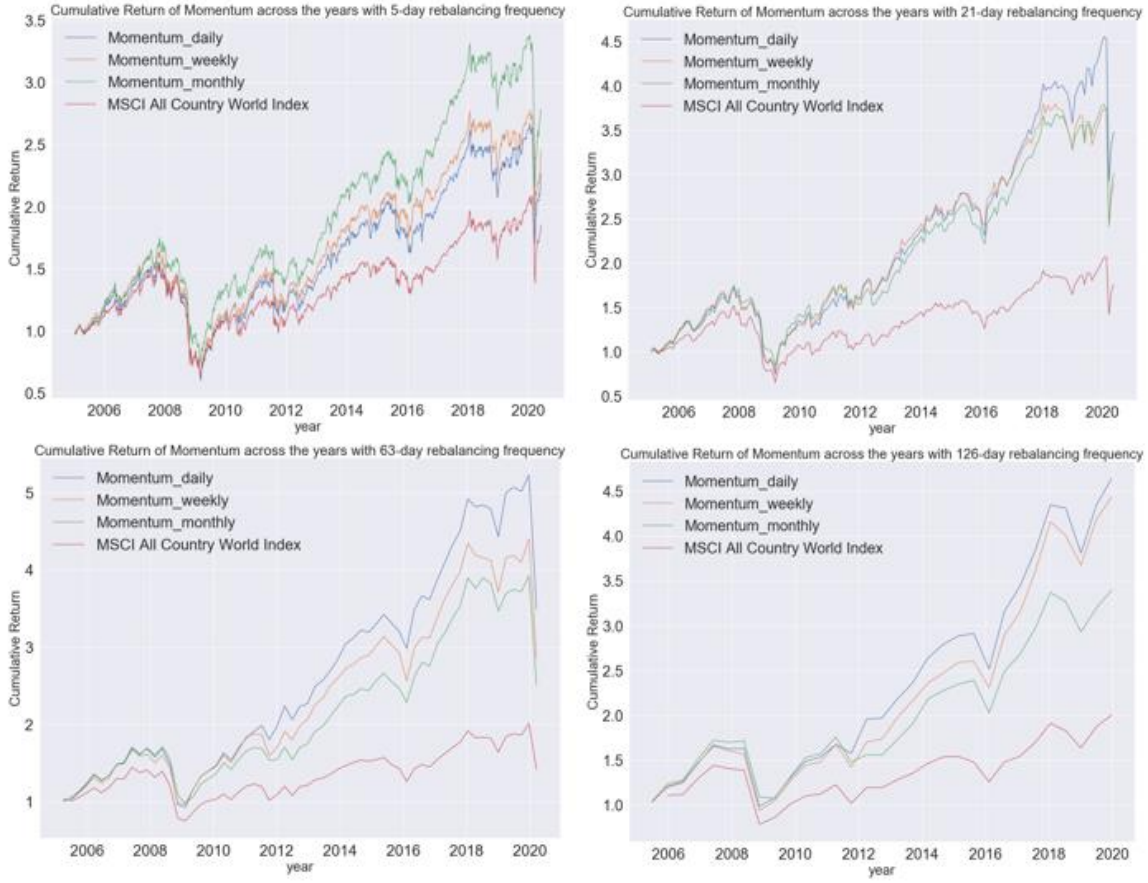
4.2.1 Back-testing result

To test the predictive power of momentum factors, we implemented a trading strategy that long every stock with the momentum factor whose value is 1 to see the cumulative return performance. We further measure the performance of the momentum factors by risk-based metrics.

The overall return performance of momentum factors moved together with the market conditions, suffering slump in price especially in the time of financial crisis and covid-19. The cumulative return of weekly momentum always lay in the middle. Monthly momentum performed the best when we rebalanced the portfolio every 5 days, while daily momentum took place of it when the rebalancing frequency is 21-day, 63-day and 126-day respectively.

Looking into the detailed yearly performance, the rank for portfolios' CAGR generated by these momentum factors seldom deviated from the overall result. The highest Sharpe ratio along with the lowest maximum drawdown of monthly momentum with 5-day rebalancing frequency indicated that its risk-adjusted performance was also good. The downside risk from daily momentum may be greater because its maximum drawdown was slightly higher than any other momentum factors.

Monthly momentum factor distinguished itself when the portfolio was rebalanced every 5 trading days by a greater chance of outperformance of the benchmark. Additionally, the change in number of holdings for daily momentum is the largest especially with a 5-day rebalancing frequency, so the trading strategy generated by daily momentum is more volatile.



CAGR 5 day	Daily Momentum	Weekly Momentum	Monthly Momentum	MSCI All Country World Index
2005	0.1663	0.2033	0.1978	0.1062
2006	0.1840	0.1905	0.1805	0.1762
2007	0.0376	0.0643	0.1788	0.0964
2008	-0.4283	-0.4684	-0.4088	-0.4379
2009	0.3424	0.4324	0.3402	0.3149
2010	0.1989	0.2091	0.1666	0.1042
2011	-0.1194	-0.1216	-0.1086	-0.0987
2012	0.1741	0.1961	0.1567	0.1313
2013	0.2754	0.2871	0.3193	0.2024
2014	0.0743	0.0563	0.0456	0.0210
2015	-0.0268	0.0107	-0.0195	-0.0426
2016	0.1396	0.1130	0.1457	0.0563
2017	0.2340	0.2256	0.2329	0.2111
2018	-0.1438	-0.1171	-0.0925	-0.1117
2019	0.2056	0.1805	0.1647	0.2404
2020	-0.1259	-0.0719	-0.1884	-0.0645

CAGR 21 day	Daily Momentum	Weekly Momentum	Monthly Momentum	MSCI All Country World Index
2005	0.1963	0.2138	0.1998	0.1004
2006	0.1889	0.2154	0.2022	0.1846
2007	0.0855	0.0842	0.1534	0.0693
2008	-0.4134	-0.3632	-0.3569	-0.4336
2009	0.3881	0.4382	0.3502	0.2950
2010	0.1328	0.2352	0.1573	0.0941
2011	-0.1449	-0.0692	-0.0801	-0.1125
2012	0.2096	0.2104	0.1408	0.1387
2013	0.2256	0.2691	0.2804	0.1732
2014	0.0606	0.0538	0.0499	0.0236
2015	-0.0455	-0.0063	-0.0356	-0.0553
2016	0.0611	0.1278	0.1636	0.0604
2017	0.2888	0.2385	0.2432	0.2078
2018	-0.1317	-0.1103	-0.0931	-0.1079
2019	0.2267	0.1337	0.1690	0.2311
2020	-0.0690	-0.1195	-0.1782	-0.1031

CAGR 63 day	Daily Momentum	Weekly Momentum	Monthly Momentum	MSCI All Country World Index
2005	0.2288	0.1930	0.2146	0.1004
2006	0.2228	0.2314	0.2227	0.1846
2007	0.0891	0.1023	0.1261	0.0693
2008	-0.3746	-0.3729	-0.3701	-0.4336
2009	0.4100	0.3681	0.3490	0.2950
2010	0.1824	0.2245	0.1514	0.0941
2011	-0.1382	-0.0311	-0.0853	-0.1125
2012	0.2227	0.2206	0.1540	0.1387
2013	0.2057	0.2551	0.2794	0.1732
2014	0.0580	0.0626	0.0437	0.0236
2015	0.0227	-0.0129	-0.0030	-0.0553
2016	0.0790	0.1113	0.1679	0.0604
2017	0.2768	0.2653	0.2372	0.2078
2018	-0.1169	-0.1078	-0.0712	-0.1079
2019	0.2025	0.1901	0.1768	0.2311
2020	-0.2583	-0.2875	-0.3091	-0.2127

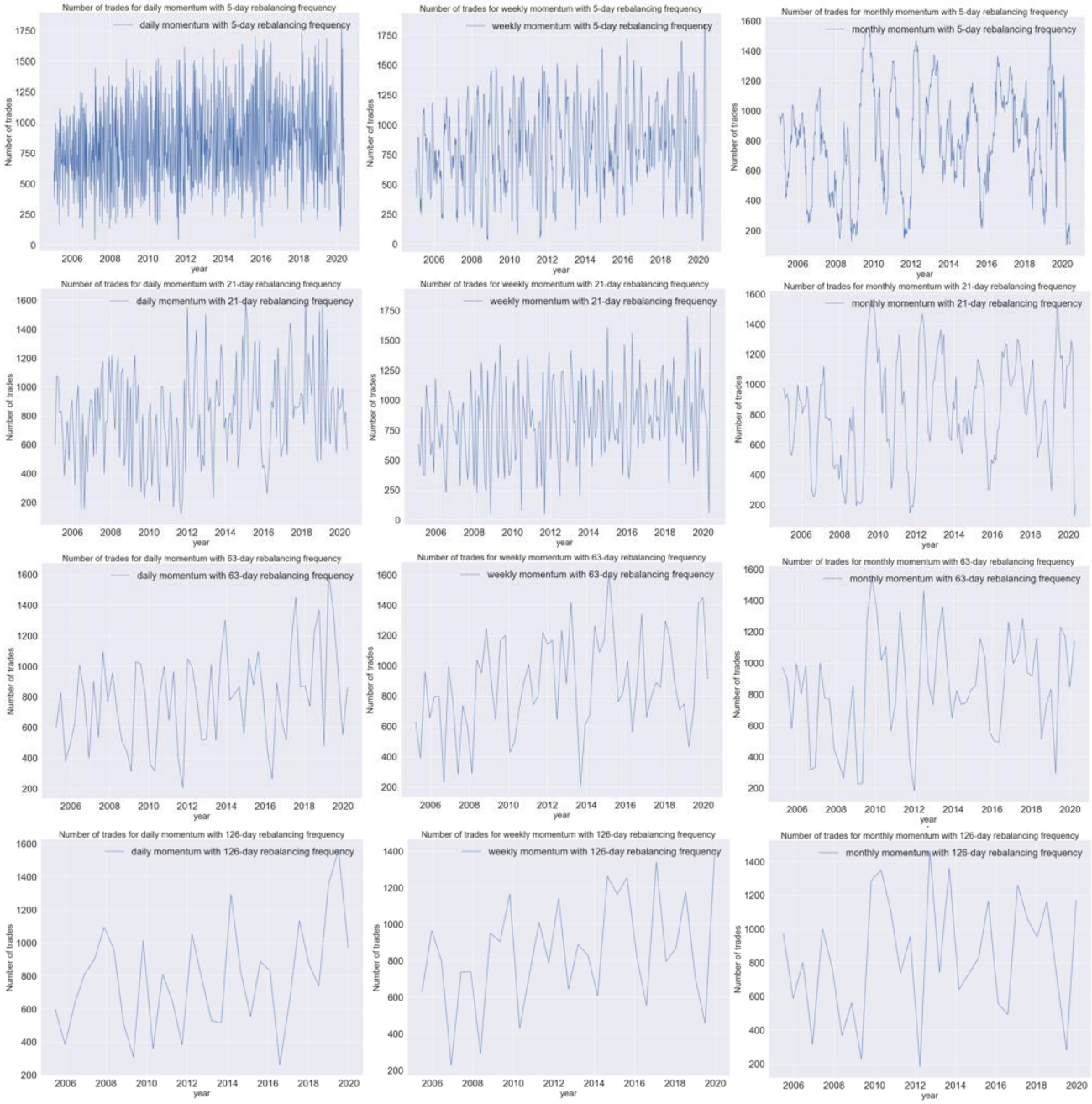
CAGR 126 day	Daily Momentum	Weekly Momentum	Monthly Momentum	MSCI All Country World Index
2005	0.1970	0.2073	0.2331	0.1004
2006	0.2321	0.2214	0.2255	0.1846
2007	0.1302	0.0797	0.1089	0.0693

2008	-0.3495	-0.3014	-0.3813	-0.4336
2009	0.4260	0.3756	0.2704	0.2950
2010	0.1876	0.2034	0.1843	0.0941
2011	-0.0823	-0.0830	-0.0343	-0.1125
2012	0.1527	0.1881	0.1800	0.1387
2013	0.2133	0.3148	0.2696	0.1732
2014	0.0705	0.0673	0.0363	0.0236
2015	-0.0011	-0.0018	0.0037	-0.0553
2016	-0.0250	0.0839	0.1683	0.0604
2017	0.2912	0.2640	0.2140	0.2078
2018	-0.0942	-0.0864	-0.0760	-0.1079
2019	0.2309	0.2186	0.1939	0.2311

Performance Metrics	Daily Momentum	Weekly Momentum	Monthly Momentum	MSCI All Country World Index
CAGR_5_day	0.0544	0.0598	0.0687	0.0395
Sharpe_ratio_5_day	0.4421	0.4967	0.5580	0.3529
SD_5_day	0.0261	0.0241	0.0237	0.0262
Max_drawdown_5_day	0.6136	0.6175	0.5744	0.5941
Success_ratio_5_day	0.5609	0.5771	0.5709	0.5585
CAGR_21_day	0.0843	0.0716	0.0742	0.0364
Sharpe_ratio_21_day	0.6108	0.5562	0.5784	0.3432
SD_21_day	0.0557	0.0530	0.0519	0.0524
Max_drawdown_21_day	0.5669	0.5513	0.5209	0.5694
Success_ratio_21_day	0.6492	0.6545	0.6492	0.6387
CAGR_63_day	0.0844	0.0702	0.0613	0.0223
Sharpe_ratio_63_day	0.6273	0.5445	0.5090	0.2627
SD_63_day	0.0954	0.0955	0.0902	0.0890
Max_drawdown_63_day	0.4553	0.4252	0.4288	0.4794
Success_ratio_63_day	0.6984	0.6825	0.6825	0.6508
CAGR_126_day	0.1046	0.1014	0.0825	0.0457
Sharpe_ratio_126_day	0.8002	0.7657	0.6621	0.4258
SD_126_day	0.1252	0.1284	0.1232	0.1246
Max_drawdown_126_day	0.4117	0.4336	0.3781	0.4566
Success_ratio_126_day	0.8065	0.7742	0.7419	0.6774

1-year outperformance	Daily Momentum	Weekly Momentum	Monthly Momentum
CAGR_yearly_5_day	0.69	0.63	0.81
CAGR_yearly_21_day	0.81	0.81	0.88
CAGR_yearly_63_day	0.75	0.88	0.88
CAGR_yearly_126_day	0.87	0.93	0.87

Average holdings	5 day	21 day	63 day	126 day	Average
Daily Momentum	823	801	789	781	799
Weekly Momentum	820	827	874	847	842
Monthly Momentum	809	827	838	833	827



4.3 Moving average indicators

Key takeaways:

- There are not many differences in terms of return and risk measures between the indicator combined 50-day MA with 150-day MA and the indicator combined 50-day MA with 200-day MA.
- The trading performance generated by moving average indicators can beat the benchmark majority of the time regardless of the market condition.
- 126-day rebalancing frequency is recommended because it can bring highest return with lowest risk.

4.3.1 Back-testing result

By applying the trading strategy that long every stock with positive moving average signal on each rebalancing day, we can test the return predictive power of moving average indicators.

Moving average indicator created by 50-day MA and 150-day MA more or less resembles the one created by 50-day MA and 200-day MA in cumulative return. As seen from the below charts, indicator produced by 50-day MA vs 150-day MA slightly outperforms 50-day MA vs 200-day MA in recent years when 126-day rebalancing frequency is set.

Moving average indicator is powerful because it can gain more than the benchmark in the bullish market but lose less or even make some profits in the bear market at most of the years during the test period. 126-day rebalancing frequency is suggested for trading not only because the highest CAGR, success ratio and outperformance ratio but because the lowest maximum drawdown.

Strategies generated by different setting of moving average indicators are similar to each other in volatility because of similar standard deviation of returns and fluctuation patterns of number of holdings.

CAGR 5 day	50 MA VS 150 MA	50 MA VS 200 MA	MSCI All Country World Index
2012	0.0460	0.0435	0.1313
2013	0.3492	0.3415	0.2024
2014	0.0627	0.0625	0.0210
2015	0.0375	0.0480	-0.0426
2016	0.1127	0.1070	0.0563
2017	0.2596	0.2595	0.2111
2018	-0.0931	-0.0942	-0.1117
2019	0.1890	0.2035	0.2404
2020	-0.1367	-0.1231	-0.0645

CAGR 21 day	50 MA VS 150 MA	50 MA VS 200 MA	MSCI All Country World Index
2012	0.0501	0.0469	0.1387
2013	0.3579	0.3551	0.1732
2014	0.0634	0.0665	0.0236
2015	0.0179	0.0294	-0.0553
2016	0.1217	0.1093	0.0604
2017	0.2595	0.2588	0.2078
2018	-0.1129	-0.1101	-0.1079
2019	0.1950	0.2129	0.2311
2020	-0.1359	-0.1238	-0.1031

CAGR 63 day	50 MA VS 150 MA	50 MA VS 200 MA	MSCI All Country World Index
2013	0.3637	0.3704	0.1732
2014	0.0588	0.0645	0.0236
2015	0.0197	0.0271	-0.0553
2016	0.1421	0.1300	0.0604
2017	0.2509	0.2532	0.2078
2018	-0.0889	-0.0893	-0.1079
2019	0.2004	0.2303	0.2311
2020	-0.2762	-0.2684	-0.2127

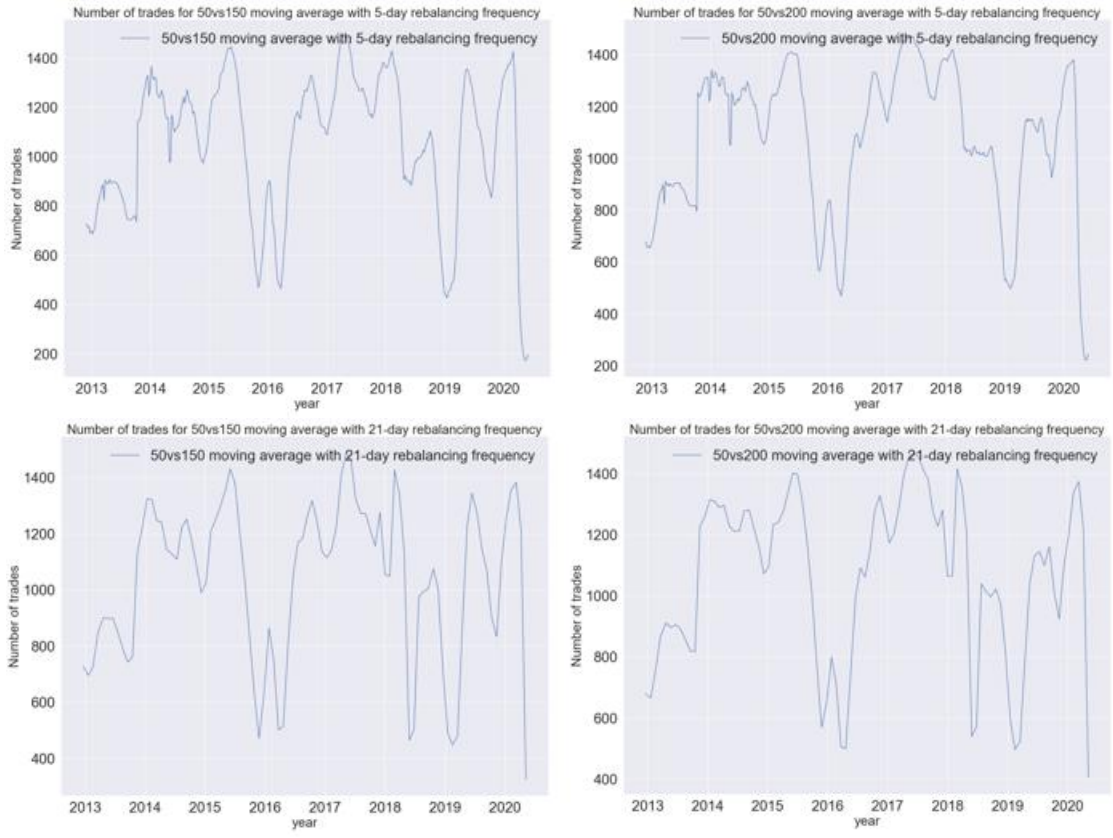
CAGR 126 day	50 MA VS 150 MA	50 MA VS 200 MA	MSCI All Country World Index
2013	0.3498	0.3525	0.1732
2014	0.0672	0.0722	0.0236
2015	0.0159	0.0269	-0.0553
2016	0.1268	0.1107	0.0604
2017	0.2359	0.2494	0.2078
2018	-0.0886	-0.0974	-0.1079
2019	0.2171	0.2256	0.2311

Performance Metrics	50 MA VS 150 MA	50 MA VS 200 MA	MSCI All Country World Index
CAGR_5_day	0.1002	0.1031	0.0395
Sharpe_ratio_5_day	0.8169	0.8398	0.3529
SD_5_day	0.0217	0.0216	0.0262
Max_drawdown_5_day	0.3816	0.3739	0.5941
Success_ratio_5_day	0.6256	0.6256	0.5585
CAGR_21_day	0.0858	0.0888	0.0364
Sharpe_ratio_21_day	0.7907	0.8251	0.3432
SD_21_day	0.0397	0.0391	0.0524
Max_drawdown_21_day	0.2613	0.2559	0.5694
Success_ratio_21_day	0.6522	0.6522	0.6387
CAGR_63_day	0.0995	0.1024	0.0223
SD_63_day	0.0629	0.0614	0.0890
Sharpe_ratio_63_day	0.9916	1.0399	0.2627
Max_drawdown_63_day	0.1537	0.1445	0.4794
Success_ratio_63_day	0.8667	0.8667	0.6508
CAGR_126_day	0.1134	0.1106	0.0457
Sharpe_ratio_126_day	1.3202	1.2900	0.4258
SD_126_day	0.0742	0.0741	0.1246

Max_drawdown_126_day	0.0838	0.0899	0.4566
Success_ratio_126_day	0.8000	0.8000	0.6774

1-year outperformance	**50 MA VS 150 MA**	**50 MA VS 200 MA**
CAGR_yearly_5_day	0.67	0.67
CAGR_yearly_21_day	0.56	0.56
CAGR_yearly_63_day	0.75	0.75
CAGR_yearly_126_day	0.86	0.86

Average holdings	**5 day**	**21 day**	**63 day**	**126 day**	**Average**
50 MA vs150 MA	1049	1041	1036	1040	1041
50 MA vs200 MA	1074	1064	1058	1061	1064



4.4 Weekly overbought & oversold indicator

Key takeaways:

- Both overall and monthly correlation of weekly overbought and oversold indicator with forward returns is significantly negative.
- In general, when it is overbought, it could lead to a downward price move. When it is oversold, it could lead to an upward price move.
- This indicator works the best with 5-day rebalancing frequency.

4.4.1 Correlation with forward returns

The information coefficient and information ratio are calculated by both Spearman correlation and linear correlation and the results are about the same. When we see the monthly results, we can observe the correlation dropped with the increase in time interval of forward return. Therefore, the correlation is the strongest in short term and decays as the time passes. The monthly risk premium of this indicator for short term is about 40 basis points accordingly, meaning that we can gain excess return by investing based on this factor.

1. Spearman correlation

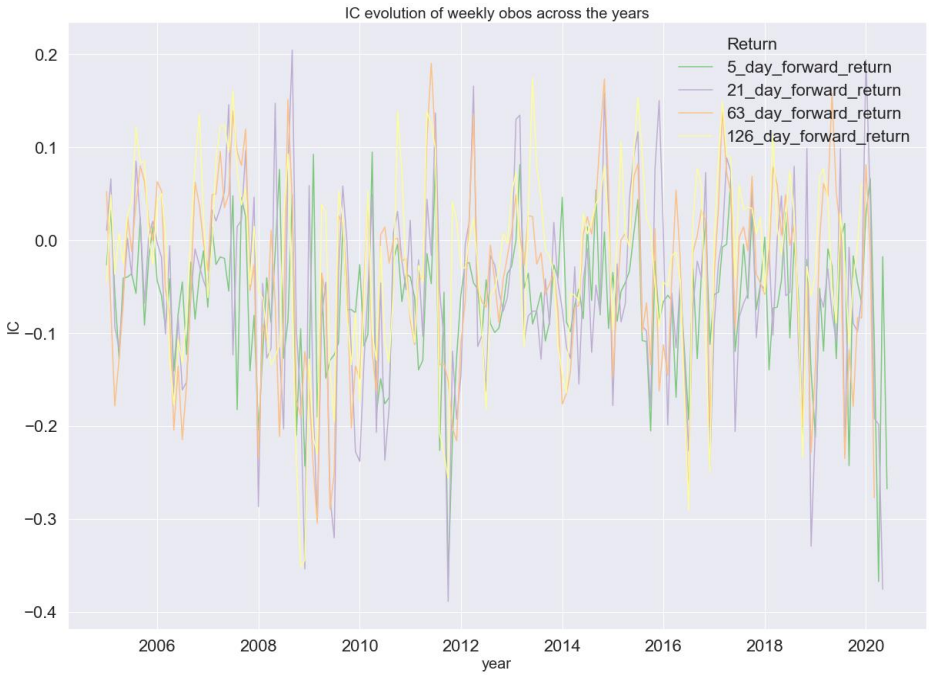
(1) Overall correlation

Return	Rank IC	P value
5_day_forward_return	-0.0203	0.00
21_day_forward_return	-0.0256	0.00
63_day_forward_return	-0.0188	0.00
126_day_forward_return	-0.0034	0.00

(2) Average of monthly correlation

Return	Rank IC	IR	P value
5_day_forward_return	-0.0683	-0.8769	0.03
21_day_forward_return	-0.0613	-0.5334	0.04
63_day_forward_return	-0.0448	-0.2468	0.04
126_day_forward_return	-0.0260	-0.4255	0.02

2. Linear correlation



(1) Overall correlation

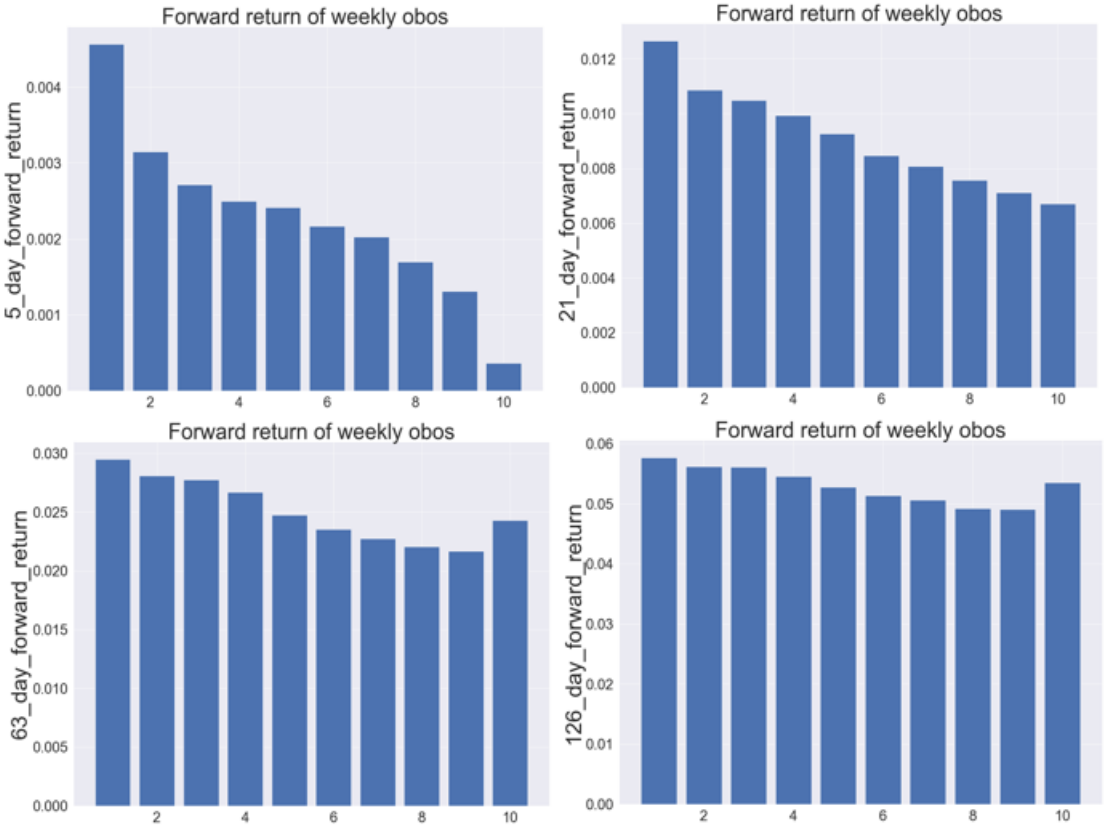
Return	Risk Premium	IC	P value
5_day_forward_return	-0.0748%	-0.0153	0.00
21_day_forward_return	-0.2118%	-0.0221	0.00
63_day_forward_return	-0.4416%	-0.0267	0.00
126_day_forward_return	-0.2343%	-0.0095	0.00

(2) Average of monthly correlation

Return	Risk Premium	IC	IR	P value
5_day_forward_return	-0.4284%	-0.0670	-0.8803	0.02
21_day_forward_return	-0.6954%	-0.0589	-0.5377	0.03
63_day_forward_return	-0.8100%	-0.0405	-0.4030	0.05
126_day_forward_return	-0.8075%	-0.0217	-0.2188	0.03

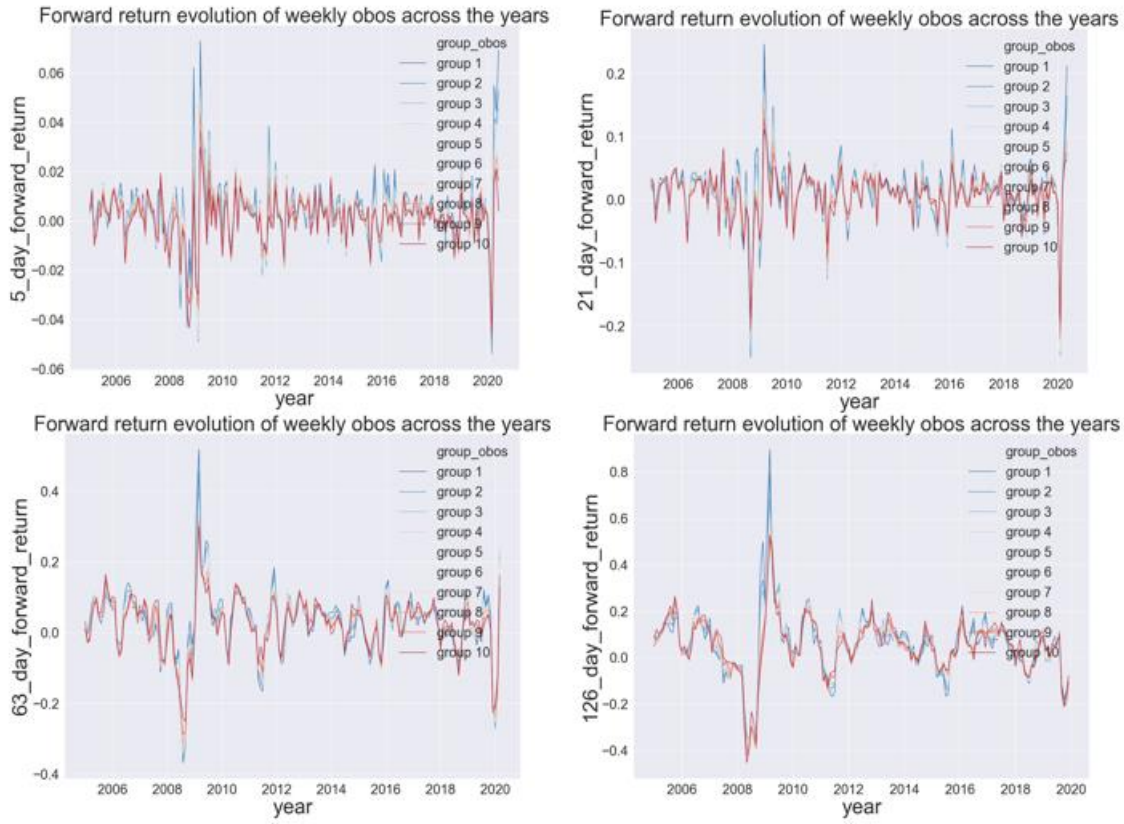
4.4.2 Decile Performance of average forward returns

We grouped the stocks by the values of this indicator to see the decile performance. The groups are created by percentiles updated on a particular day. The bar charts of average short-term forward return grouped by this indicator is exactly a ladder-like distribution, providing evidence that forward returns are negatively correlated with this indicator, but the shape of distribution turns to be obscure in the long-term. 5- day forward return in group 1 was over 10 times higher than in group 10, while the ratio fell sharply to under 2 times for 21-day forward return and further turned to nearly 1 for 126-day forward return. This further proofs that weekly overbought and oversold indicator is most effective in the short term.



Group	5_day Forward return	21_day Forward return	63_day Forward return	126_day Forward return
Group 1	0.0046	0.0127	0.0295	0.0577
Group 2	0.0032	0.0109	0.0281	0.0562
Group 3	0.0027	0.0105	0.0278	0.0562
Group 4	0.0025	0.0099	0.0267	0.0546
Group 5	0.0024	0.0093	0.0247	0.0528
Group 6	0.0022	0.0085	0.0235	0.0514
Group 7	0.0020	0.0081	0.0227	0.0506
Group 8	0.0017	0.0076	0.0220	0.0492
Group 9	0.0013	0.0071	0.0217	0.0491
Group 10	0.0004	0.0067	0.0243	0.0535

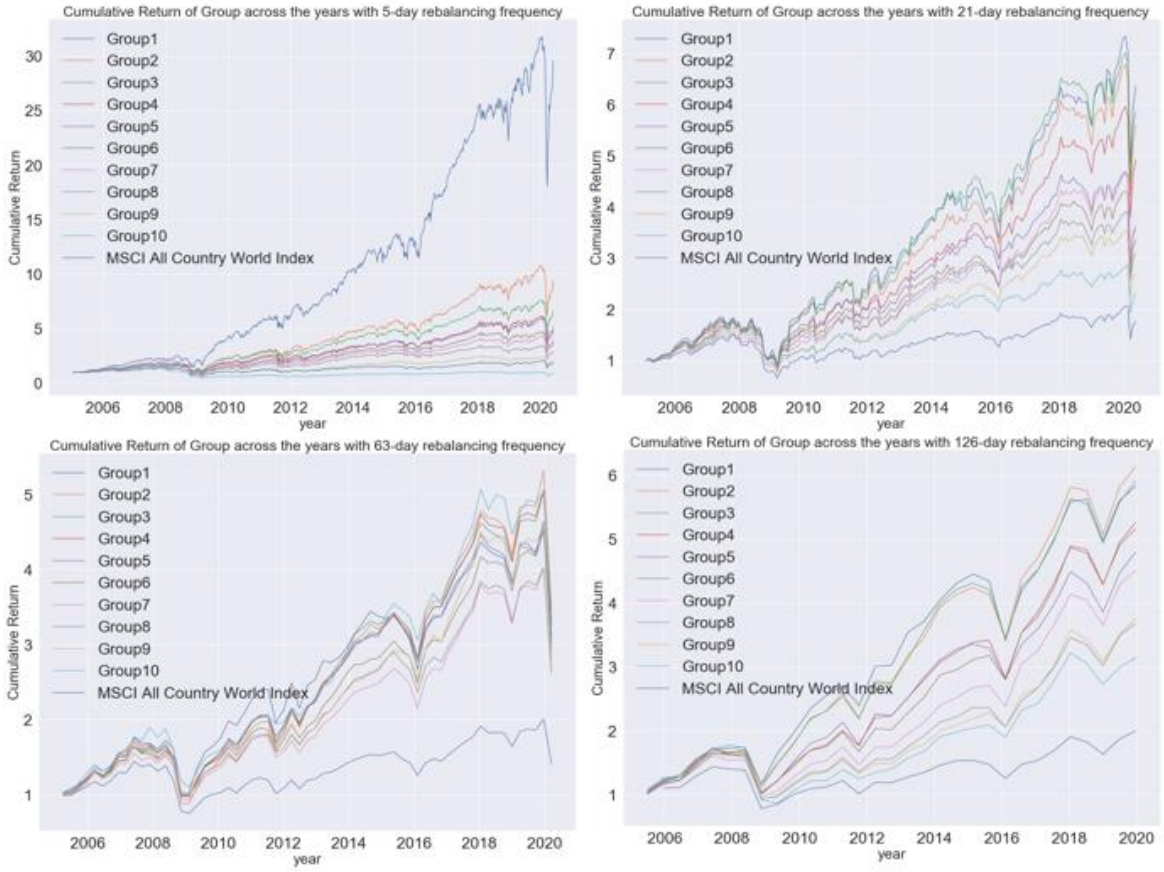
From the line charts below, the blue lines for low-value groups basically hovered above the red lines for high-value groups, representing that forward return from this indicator with negative value is usually larger than with positive value. There were several peak points in blue lines, showing that forward returns of stocks in groups for oversold status are much more volatile than those in groups for overbought status and that oversold stocks have propensity to significantly bounce back especially in the market gloom.



4.4.4 Back-testing result

We now constituted portfolio by investing every stock in each group. Based on the back-testing result with 5-day rebalancing frequency, stocks in the strongest overbought group can hardly benefit from the market growth and thus underperformed the benchmark during the test period. Stocks in the strongest oversold group drastically beat the market when we rebalance our portfolio every 5 days, but this group didn't always remain its first place when the rebalance period changes to longer term, probably due to the weaker correlation.

Investigating into the yearly performance, the above findings holds perfectly in the short term. Buying severely oversold stocks earns the most with the highest Shape ratio of 1.2 and an acceptable maximum drawdown which is lower than the market. However, long-term rebalancing frequency lowers the profits from oversold stocks and upgrades the volatility risk measured by standard deviation. Portfolios constructed by oversold stocks have advantage over the others by outperformance of the market.



CAGR 5 day	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	MSCI All Country World Index
2005	0.3302	0.1943	0.2169	0.1972	0.2611	0.2155	0.2309	0.2278	0.1775	0.1261	0.1062
2006	0.4679	0.2833	0.2806	0.2941	0.3074	0.2258	0.2165	0.1792	0.1081	0.0627	0.1762
2007	0.1355	0.1122	0.0962	0.0753	0.1423	0.1121	0.1501	0.1493	0.1365	0.0769	0.0964
2008	-0.1254	-0.3260	-0.3003	-0.3506	-0.3197	-0.3741	-0.3639	-0.4084	-0.4116	-0.4940	-0.4379
2009	0.8685	0.7258	0.6687	0.6094	0.4289	0.4693	0.4086	0.4381	0.2836	0.1055	0.3149
2010	0.3591	0.2734	0.2467	0.2903	0.2454	0.2392	0.1941	0.2039	0.1638	0.1084	0.1042
2011	0.0908	0.0149	-0.0442	-0.0472	-0.0853	0.0004	-0.0873	-0.0976	-0.1355	-0.1610	-0.0987
2012	0.2391	0.2550	0.2204	0.1690	0.2203	0.1500	0.2199	0.1997	0.1979	0.0856	0.1313
2013	0.3535	0.2517	0.2978	0.2803	0.2852	0.2917	0.3686	0.3056	0.2964	0.2538	0.2024
2014	0.0691	0.0352	0.0253	0.0837	0.0790	0.0835	0.0361	0.0910	0.1044	0.0441	0.0210
2015	0.1219	0.0451	-0.0038	-0.0095	-0.0076	-0.0126	0.0157	0.0254	0.0137	0.0370	-0.0426
2016	0.2779	0.2131	0.1485	0.1247	0.1179	0.1382	0.1093	0.0848	0.0697	0.0633	0.0563
2017	0.3580	0.3134	0.2532	0.2681	0.2568	0.2798	0.2442	0.2043	0.2228	0.1718	0.2111
2018	-0.0589	-0.0668	-0.1082	-0.0779	-0.0887	-0.1183	-0.1128	-0.1313	-0.1565	-0.1396	-0.1117
2019	0.3933	0.3360	0.2726	0.2301	0.2270	0.2253	0.2080	0.1850	0.1446	0.1067	0.2404
2020	-0.0057	-0.1014	-0.1364	-0.0363	-0.0566	-0.0844	-0.1377	-0.0878	-0.1101	-0.1107	-0.0645

CAGR 21 day	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	MSCI All Country World Index
2005	0.1880	0.1932	0.2075	0.2242	0.2518	0.1806	0.1558	0.2168	0.1991	0.2162	0.1004
2006	0.3742	0.2937	0.2413	0.2637	0.2526	0.2025	0.2056	0.1964	0.2229	0.1788	0.1846

2007	0.0316	0.0146	0.0508	0.0578	0.0827	0.0756	0.0978	0.1304	0.1405	0.1894	0.0693
2008	-0.2708	-0.3679	-0.3428	-0.3360	-0.3396	-0.4240	-0.3830	-0.3745	-0.3860	-0.3901	-0.4336
2009	0.6313	0.5388	0.6552	0.5259	0.4482	0.4678	0.4381	0.3580	0.2658	0.2502	0.2950
2010	0.2591	0.2330	0.2671	0.1986	0.2349	0.2119	0.2069	0.1826	0.1985	0.1530	0.0941
2011	-0.0679	-0.1050	-0.0575	-0.0630	-0.1039	-0.0938	-0.0573	-0.0716	-0.0719	-0.0591	-0.1125
2012	0.2854	0.2192	0.2406	0.2277	0.1908	0.1789	0.1638	0.1962	0.1586	0.1291	0.1387
2013	0.2351	0.2236	0.2938	0.2619	0.2835	0.2768	0.2715	0.2494	0.2690	0.2609	0.1732
2014	0.0589	0.0313	0.0639	0.0943	0.0521	0.0605	0.0604	0.0676	0.0740	0.0605	0.0236
2015	0.0345	0.0817	-0.0079	-0.0143	0.0052	-0.0163	-0.0265	-0.0084	0.0029	-0.0146	-0.0553
2016	0.2597	0.1607	0.1656	0.1367	0.1255	0.1089	0.1250	0.0947	0.0732	0.0818	0.0604
2017	0.2592	0.2596	0.3361	0.2644	0.2761	0.2841	0.2994	0.2241	0.2022	0.2220	0.2078
2018	-0.1439	-0.1178	-0.1353	-0.1579	-0.1489	-0.1448	-0.1070	-0.1143	-0.0884	-0.0876	-0.1079
2019	0.3846	0.3245	0.2762	0.2485	0.2510	0.1821	0.1836	0.1620	0.1411	0.1048	0.2311
2020	-0.0756	-0.1621	-0.1413	-0.1516	-0.1591	-0.1587	-0.1615	-0.1551	-0.1350	-0.1250	-0.1031

CAGR 63 day	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	MSCI All Country World Index
2005	0.2155	0.1925	0.1931	0.1970	0.2306	0.2075	0.1494	0.1788	0.1868	0.2969	0.1004
2006	0.3021	0.2727	0.2428	0.2475	0.2381	0.2043	0.2139	0.2091	0.2678	0.1883	0.1846
2007	0.0883	0.0400	0.0286	0.0507	0.0248	0.0669	0.0990	0.0988	0.1323	0.2528	0.0693
2008	-0.2956	-0.3256	-0.3427	-0.3470	-0.3518	-0.3959	-0.4154	-0.3946	-0.3966	-0.3991	-0.4336
2009	0.7552	0.5942	0.5967	0.4797	0.5081	0.3749	0.3888	0.3231	0.2363	0.2751	0.2950
2010	0.2078	0.2784	0.2302	0.1881	0.1885	0.2016	0.2016	0.2005	0.2248	0.2063	0.0941
2011	-0.1490	-0.1115	-0.0880	-0.0668	-0.0765	-0.0522	-0.0830	-0.0212	-0.0429	-0.0433	-0.1125
2012	0.2262	0.2833	0.2319	0.2442	0.1769	0.1826	0.1870	0.1410	0.1684	0.1469	0.1387
2013	0.2482	0.2796	0.2939	0.2776	0.2898	0.2976	0.2569	0.2484	0.2330	0.2159	0.1732
2014	0.0918	0.0584	0.1074	0.0542	0.0454	0.0610	0.0573	0.0475	0.0586	0.0560	0.0236
2015	-0.0483	-0.0322	-0.0184	0.0047	0.0146	-0.0191	0.0227	0.0595	0.0326	0.0365	-0.0553
2016	0.2491	0.1304	0.1447	0.1144	0.1723	0.1445	0.1546	0.1185	0.0653	0.0520	0.0604
2017	0.2903	0.2620	0.2624	0.2208	0.2397	0.2192	0.2340	0.2765	0.2353	0.2723	0.2078
2018	-0.0957	-0.0983	-0.0990	-0.0572	-0.1080	-0.1260	-0.0876	-0.1000	-0.0880	-0.1023	-0.1079
2019	0.2485	0.2241	0.2401	0.2429	0.1903	0.2011	0.2333	0.2426	0.1867	0.1659	0.2311
2020	-0.2938	-0.2889	-0.2947	-0.2591	-0.2814	-0.2657	-0.2798	-0.2713	-0.2726	-0.3051	-0.2127

CAGR 126 day	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	MSCI All Country World Index
2005	0.2324	0.2062	0.2434	0.1739	0.2161	0.1950	0.1593	0.1926	0.1863	0.2783	0.1004
2006	0.2582	0.2091	0.2833	0.2717	0.2738	0.1913	0.2473	0.1954	0.2464	0.1575	0.1846
2007	0.0863	0.0525	0.0996	0.0645	0.0601	0.1141	0.0854	0.0836	0.1012	0.1859	0.0693
2008	-0.3537	-0.3340	-0.3503	-0.3785	-0.3312	-0.3719	-0.3705	-0.3598	-0.3832	-0.3756	-0.4336
2009	0.8043	0.5993	0.6324	0.4697	0.4848	0.3585	0.3358	0.2919	0.2382	0.1961	0.2950
2010	0.2458	0.2916	0.2716	0.2126	0.2056	0.1940	0.1723	0.1724	0.2034	0.1676	0.0941
2011	-0.1697	-0.1231	-0.0684	-0.0675	-0.0686	-0.0738	-0.0969	-0.0061	-0.0597	-0.0446	-0.1125
2012	0.2662	0.2374	0.2263	0.2324	0.1613	0.1611	0.1952	0.1721	0.1759	0.1371	0.1387
2013	0.1985	0.2268	0.2656	0.2621	0.2861	0.2859	0.2926	0.2585	0.2733	0.3221	0.1732

2014	0.0714	0.0547	0.0765	0.0711	0.0688	0.0871	0.0560	0.0666	0.0311	0.0463	0.0236
2015	-0.0451	-0.0146	0.0145	-0.0151	-0.0055	-0.0119	0.0097	0.0593	0.0393	0.0053	-0.0553
2016	0.3287	0.2018	0.1746	0.1299	0.1531	0.1552	0.1270	0.1073	0.0273	-0.0126	0.0604
2017	0.3331	0.3244	0.2998	0.2513	0.2353	0.1831	0.2443	0.2311	0.1907	0.2364	0.2078
2018	-0.0982	-0.1112	-0.1008	-0.0678	-0.1031	-0.1173	-0.0755	-0.1018	-0.0474	-0.1016	-0.1079
2019	0.1965	0.2265	0.2345	0.2501	0.2177	0.2016	0.2231	0.2412	0.2024	0.1751	0.2311

Performance Metrics	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	MSCI All Country World Index
CAGR_5_day	0.2453	0.1562	0.1302	0.1122	0.1066	0.0928	0.0875	0.0719	0.0484	-0.0077	0.0395
Sharpe_ratio_5_day	1.2222	0.8879	0.7792	0.7107	0.6945	0.6416	0.6221	0.5529	0.4232	0.0414	0.3529
SD_5_day	0.0331	0.0313	0.0307	0.0296	0.0289	0.0276	0.0270	0.0255	0.0240	0.0225	0.0262
Max_drawdown_5_day	0.4370	0.4608	0.4533	0.4844	0.5480	0.5447	0.5564	0.5621	0.5845	0.6779	0.5941
Success_ratio_5_day	0.5995	0.5746	0.5721	0.5734	0.5721	0.5771	0.5771	0.5734	0.5659	0.5535	0.5585
CAGR_21_day	0.1274	0.1182	0.1215	0.1088	0.0859	0.0816	0.0875	0.0760	0.0666	0.0561	0.0364
Sharpe_ratio_21_day	0.7566	0.7365	0.7589	0.7149	0.6002	0.5930	0.6402	0.5881	0.5330	0.4896	0.3432
SD_21_day	0.0678	0.0622	0.0614	0.0591	0.0587	0.0562	0.0540	0.0520	0.0521	0.0478	0.0524
Max_drawdown_21_day	0.5068	0.4944	0.4877	0.5109	0.5198	0.4963	0.4898	0.4961	0.5344	0.5358	0.5694
Success_ratio_21_day	0.6440	0.6754	0.6440	0.6492	0.6440	0.6492	0.6649	0.6597	0.6702	0.6387	0.6387
CAGR_63_day	0.0762	0.0842	0.0797	0.0811	0.0738	0.0721	0.0653	0.0644	0.0693	0.0795	0.0223
Sharpe_ratio_63_day	0.5445	0.5947	0.5890	0.5907	0.5635	0.5546	0.5164	0.5226	0.5458	0.6200	0.2627
SD_63_day	0.1069	0.1042	0.0988	0.0999	0.0962	0.0958	0.0952	0.0914	0.0938	0.0898	0.0890
Max_drawdown_63_day	0.4341	0.4671	0.4038	0.4301	0.4430	0.4080	0.4006	0.3951	0.3969	0.4171	0.4794
Success_ratio_63_day	0.6508	0.6825	0.6825	0.7143	0.6667	0.6984	0.6825	0.6984	0.6825	0.6984	0.6508
CAGR_126_day	0.1210	0.1248	0.1221	0.1136	0.1069	0.1123	0.1026	0.0882	0.0897	0.0771	0.0457
Sharpe_ratio_126_day	0.8157	0.8421	0.8651	0.8056	0.7752	0.8328	0.7761	0.6872	0.6997	0.6089	0.4258
SD_126_day	0.1416	0.1406	0.1325	0.1361	0.1334	0.1273	0.1272	0.1287	0.1273	0.1331	0.1246
Max_drawdown_126_day	0.3335	0.3500	0.3208	0.4088	0.4113	0.3743	0.4037	0.4391	0.4244	0.5109	0.4566
Success_ratio_126_day	0.8387	0.7419	0.7419	0.7742	0.7742	0.7419	0.8065	0.7742	0.7742	0.7742	0.6774

1-year outperformance	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10
CAGR_yearly_5_day	1.00	0.94	0.88	0.88	0.94	0.81	0.81	0.75	0.63	0.38
CAGR_yearly_21_day	0.88	0.81	0.81	0.81	0.88	0.81	0.88	0.81	0.75	0.69
CAGR_yearly_63_day	0.88	0.81	0.88	0.88	0.75	0.75	0.94	0.94	0.81	0.75
CAGR_yearly_126_day	0.87	0.73	1.00	0.93	0.87	0.80	0.93	0.93	0.73	0.67

Future improvements

- Try to combine the technical factors to see their combined effect on predictive power.
- Implement more complicated trading strategies to see the back-testing result of the returns.