

```
In [1]: from PortfolioOptimizer import *
C:\ProgramData\Anaconda3\lib\site-packages\pandas_datareader\compat\_init__.py:7: FutureWarning: pandas.util.testing is deprecated. Use the functions in the public API at pandas.testing instead.
from pandas.util.testing import assert_frame_equal
```

引入資料

初始化

```
In [2]: start_date = '2010-01-01'
end_date = '2019-12-31'
```

```
code_list=[
    '0050.TW',
    '3008.TW',
    '2330.TW',
    '1216.TW',
    '1301.TW',
    '2002.TW',
    'MSFT',
    'AAPL',
]
```

```
In [3]: df = Portfolio.get_price_table(code_list, start=start_date, end=end_date)
```

```
Finding 0050.TW
Finding 3008.TW
Finding 2330.TW
Finding 1216.TW
Finding 1301.TW
Finding 2002.TW
Finding MSFT
Finding AAPL
```

建立Portfolio物件

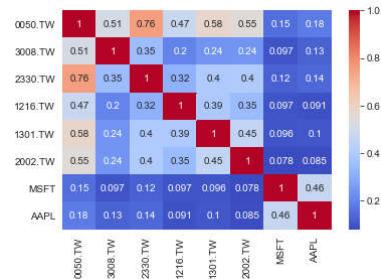
```
In [4]: port=Portfolio(df)
```

相關性分析

```
In [5]: port.price_corr_map()
```



```
In [6]: port.return_corr_map()
```



Equal-Weight 投組分析

```
In [7]: port.Summary()
Period
From 2010-01-04 to 2019-12-30, 3647 days.
Weights of Portfolio:
```

0050.TW	12.50%
3008.TW	12.50%
2330.TW	12.50%
1216.TW	12.50%
1301.TW	12.50%
2002.TW	12.50%
MSFT	12.50%
AAPL	12.50%

```
Technical Indicator:
Average Return : 0.160
Average Standard Deviation : 0.147
Sharpe Ratio : 0.748
Sortino Ratio : 1.027
Maximum Drop Down : 0.197
```

```
In [8]: port.Return_Plot()
```

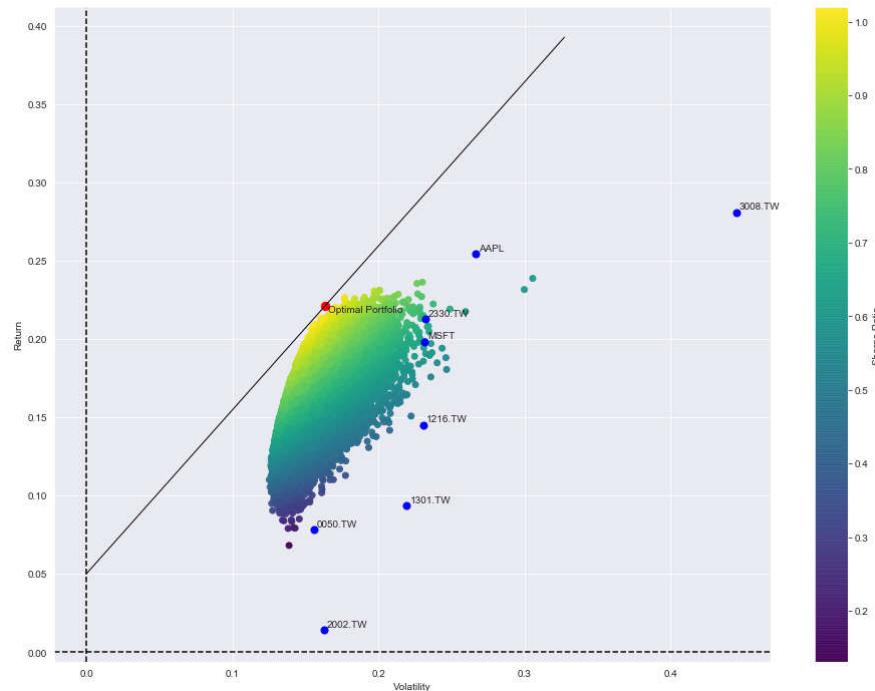
Return & MDD



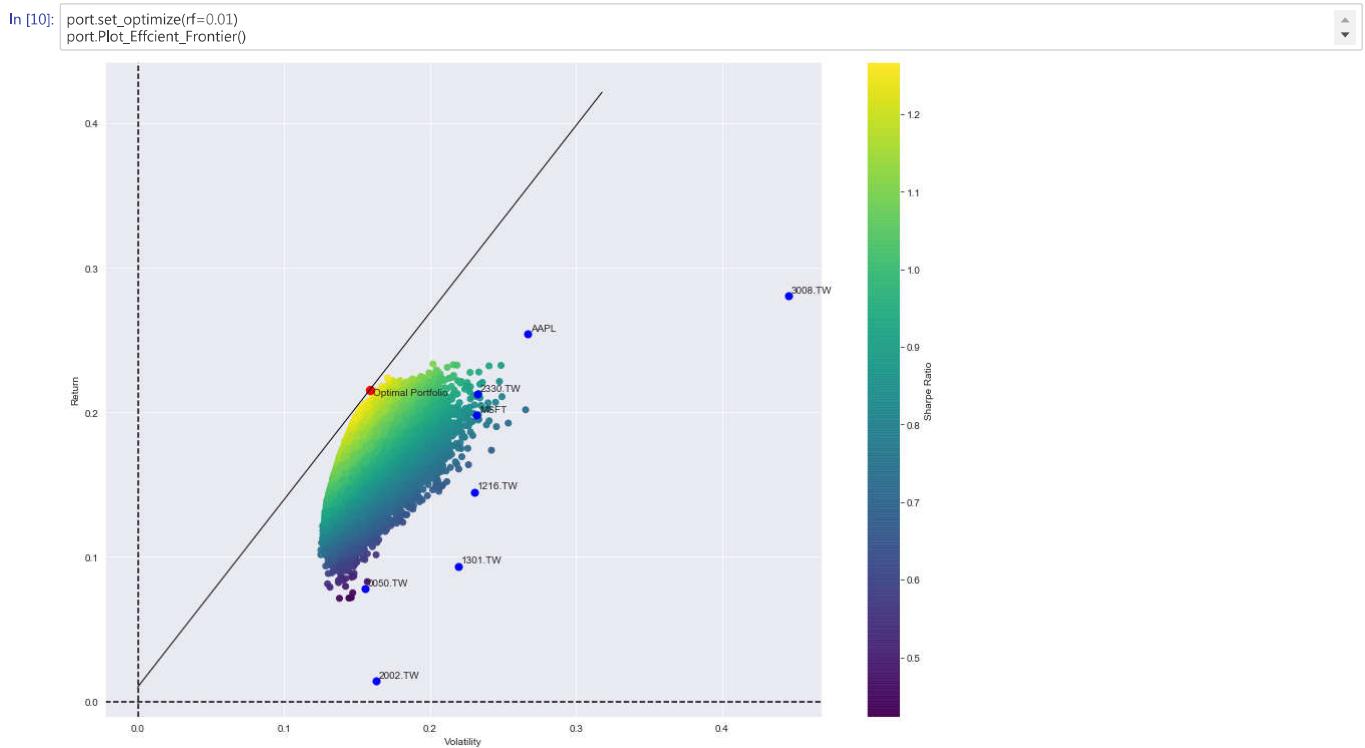
效率前緣

```
In [9]: port.set_optimize()
port.optimize_set()
port.Plot_Efficient_Frontier()
```

Begin : 2010-01-04 00:00:00
End : 2019-12-30 00:00:00
Rf : 0.05



可透過修改rf得到不同的切點投組



權重最佳化求解

Sharpe Ratio

In [11]:

```
port.Get_Best_Portfolio()
```

Out[11]:

```
(1.2955087656897764,
 [0.0,
  0.06632579349232069,
  0.3027936593563748,
  0.13912617859708545,
  0.0,
  1.3082280301757855e-16,
  0.22160345135388962,
  0.2701509172003294])
```

In [12]:

```
port.set_weights(port.Get_Best_Portfolio()[1])
```

In [13]:

```
port.Summary()
```

Period
From 2010-01-04 to 2019-12-30, 3647 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	6.63%
2330.TW	30.28%
1216.TW	13.91%
1301.TW	0.00%
2002.TW	0.00%
MSFT	22.16%
AAPL	27.02%

Technical Indicator:

Average Return :	0.216
Average Standard Deviation :	0.159
Sharpe Ratio :	1.044
Sotino Ratio :	1.429
Maximum Drop Down :	0.231

In [14]: port.Return_Plot()

Return & MDD



MDD

In [15]: port.set_weights(port.Get_Best_Portfolio(method='mdd')[1])
port.Summary()

Period
From 2010-01-04 to 2019-12-30, 3647 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	28.46%
1301.TW	1.58%
2002.TW	50.54%
MSFT	19.42%
AAPL	0.00%

Technical Indicator:

Average Return :	0.088
Average Standard Deviation :	0.136
Sharpe Ratio :	0.282
Sotino Ratio :	0.395
Maximum Drop Down :	0.163

In [16]: port.Return_Plot()

Return & MDD



Vol

In [17]: port.set_weights(port.Get_Best_Portfolio(method='std')[1])
port.Summary()

Period
From 2010-01-04 to 2019-12-30, 3647 days.

Weights of Portfolio:

0050.TW	30.15%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	7.58%
1301.TW	1.91%
2002.TW	33.82%
MSFT	18.02%
AAPL	8.51%

Technical Indicator:

Average Return :	0.098
Average Standard Deviation :	0.124
Sharpe Ratio :	0.391
Sotino Ratio :	0.538
Maximum Drop Down :	0.200



Hedge(作業的Alpha策略)

In [19]: `port.set_weights(port.Get_Best_Portfolio(hedge=True)[1])
port.Summary()`

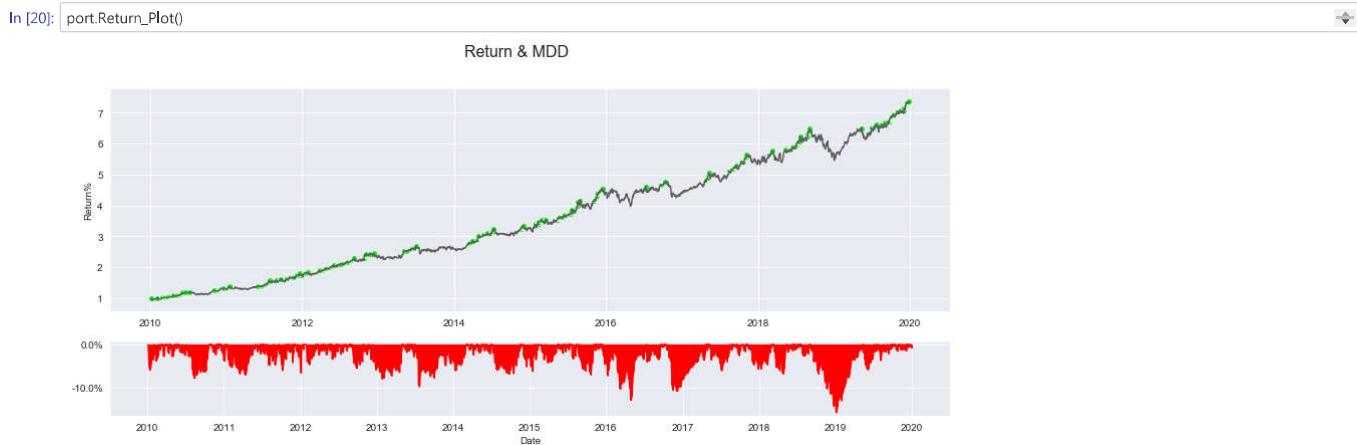
Period
From 2010-01-04 to 2019-12-30, 3647 days.

Weights of Portfolio:

0050.TW	-100.00%
3008.TW	15.41%
2330.TW	63.32%
1216.TW	21.81%
1301.TW	11.47%
2002.TW	-44.06%
MSFT	11.02%
AAPL	21.03%

Technical Indicator:

Average Return :	0.211
Average Standard Deviation :	0.148
Sharpe Ratio :	1.091
Sofino Ratio :	1.531
Maximum Drop Down :	0.157



蒙地卡羅

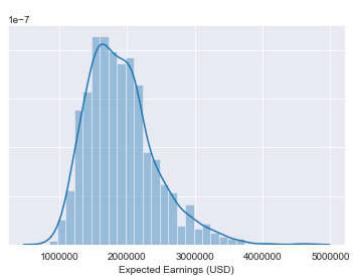
In [21]: `# port.Get_Monte_Carlo_Forecast(capital=1, path=1000, period=3, yearly=None)
port.Get_Monte_Carlo_Forecast()`

Minimum :	67.182%
5 Percentile :	122.582%
25 Percentile :	154.134%
Median :	184.768%
Mean :	190.197%
75 Percentile :	216.416%
Maximum :	452.750%

<Figure size 1152x576 with 0 Axes>

```
In [22]: port.Get_Monte_Carlo_Forecast(capital=1000000)
```

```
Minimum : 844454.286
5 Percentile : 1232967.939
25 Percentile : 1539178.192
Median : 1841977.276
Mean : 1912082.018
75 Percentile : 2169131.742
Maximum : 4617108.847
```



```
<Figure size 1152x576 with 0 Axes>
```

滾動回測

透過前一期的報酬以及波動，形成最佳化權重後，投資下一期

Positive

In [23]:

```
port.set_optimize()
port.Rolling_test(show=True)
```

Period
From 2010-12-31 to 2011-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	19.98%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	51.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	29.03%

Technical Indicator:

Average Return :	-0.044
Average Standard Deviation :	0.256
Sharpe Ratio :	-0.368
Sotino Ratio :	-0.507
Maximum Drop Down :	0.297

Period
From 2011-12-31 to 2012-12-31, 366 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	15.63%
1216.TW	10.01%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	74.36%

Technical Indicator:

Average Return :	0.265
Average Standard Deviation :	0.229
Sharpe Ratio :	0.939
Sotino Ratio :	1.406
Maximum Drop Down :	0.190

Period
From 2012-12-31 to 2013-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	13.61%
2330.TW	23.42%
1216.TW	39.84%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	23.14%

Technical Indicator:

Average Return :	0.164
Average Standard Deviation :	0.166
Sharpe Ratio :	0.684
Sotino Ratio :	0.956
Maximum Drop Down :	0.082

Period
From 2013-12-31 to 2014-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	30.27%
2330.TW	0.00%
1216.TW	8.59%
1301.TW	0.00%
2002.TW	0.00%
MSFT	61.14%
AAPL	0.00%

Technical Indicator:

Average Return :	0.372
Average Standard Deviation :	0.186
Sharpe Ratio :	1.732
Sotino Ratio :	2.423
Maximum Drop Down :	0.090

Period
From 2014-12-31 to 2015-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	19.25%
2330.TW	27.92%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	20.85%
AAPL	31.98%

Technical Indicator:

Average Return :	0.035
Average Standard Deviation :	0.204
Sharpe Ratio :	-0.073
Sotino Ratio :	-0.100
Maximum Drop Down :	0.188

Period
From 2015-12-31 to 2016-12-31, 366 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	52.32%
1301.TW	0.00%
2002.TW	0.00%
MSFT	47.68%
AAPL	0.00%

Technical Indicator:

Average Return :	0.070
Average Standard Deviation :	0.161
Sharpe Ratio :	0.122
Sotino Ratio :	0.170
Maximum Drop Down :	0.085

Period

From 2016-12-31 to 2017-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	15.15%
2330.TW	13.48%
1216.TW	0.00%
1301.TW	21.31%
2002.TW	37.09%
MSFT	12.97%
AAPL	0.00%

Technical Indicator:

Average Return :	0.147
Average Standard Deviation :	0.102
Sharpe Ratio :	0.950
Sotino Ratio :	1.354
Maximum Drop Down :	0.062

Period

From 2017-12-31 to 2018-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	23.73%
1216.TW	14.10%
1301.TW	7.58%
2002.TW	0.00%
MSFT	33.27%
AAPL	21.33%

Technical Indicator:

Average Return :	0.078
Average Standard Deviation :	0.190
Sharpe Ratio :	0.146
Sotino Ratio :	0.194
Maximum Drop Down :	0.209

Period

From 2018-12-31 to 2019-12-30, 364 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	42.26%
1301.TW	0.00%
2002.TW	0.00%
MSFT	57.74%
AAPL	0.00%

Technical Indicator:

Average Return :	0.337
Average Standard Deviation :	0.140
Sharpe Ratio :	2.044
Sotino Ratio :	2.910
Maximum Drop Down :	0.055

Out[23]: 2010-12-31 0.000283

2011-01-03 0.006083

2011-01-04 0.002903

2011-01-05 -0.005094

2011-01-06 -0.001285

...

2019-12-23 0.004538

2019-12-24 -0.001806

2019-12-26 0.004714

2019-12-27 0.001054

2019-12-30 -0.004998

Length: 2133, dtype: float64

```
In [24]: port.Backtest_Summary()
```

Period
From 2010-12-31 to 2019-12-30, 3286 days.

Latest Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	42.26%
1301.TW	0.00%
2002.TW	0.00%
MSFT	57.74%
AAPL	0.00%

Technical Indicator:

Average Return :	0.159
Average Standard Deviation :	0.187
Sharpe Ratio :	0.584
Sotino Ratio :	0.811
Maximum Drop Down :	0.297

```
In [25]: port.Return_Plot(backtest=True)
```

Return & MDD



使用累積資訊 (每一期計算最佳權重的資料都從頭開始計算)

In [26]:

```
port.set_optimize()
port.Rolling_test(show=True, cul_info=True)
```

Period
From 2010-12-31 to 2011-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	19.98%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	51.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	29.03%

Technical Indicator:

Average Return :	-0.044
Average Standard Deviation :	0.256
Sharpe Ratio :	-0.368
Sotino Ratio :	-0.507
Maximum Drop Down :	0.297

Period
From 2011-12-31 to 2012-12-31, 366 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.05%
2330.TW	7.33%
1216.TW	13.33%
1301.TW	12.13%
2002.TW	0.00%
MSFT	0.00%
AAPL	67.15%

Technical Indicator:

Average Return :	0.235
Average Standard Deviation :	0.211
Sharpe Ratio :	0.876
Sotino Ratio :	1.325
Maximum Drop Down :	0.193

Period
From 2012-12-31 to 2013-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	5.12%
2330.TW	21.49%
1216.TW	26.25%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	47.14%

Technical Indicator:

Average Return :	0.137
Average Standard Deviation :	0.181
Sharpe Ratio :	0.484
Sotino Ratio :	0.660
Maximum Drop Down :	0.136

Period
From 2013-12-31 to 2014-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	15.51%
2330.TW	16.15%
1216.TW	26.53%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	41.80%

Technical Indicator:

Average Return :	0.316
Average Standard Deviation :	0.154
Sharpe Ratio :	1.734
Sotino Ratio :	2.333
Maximum Drop Down :	0.079

Period
From 2014-12-31 to 2015-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	21.56%
2330.TW	26.26%
1216.TW	8.72%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	43.46%

Technical Indicator:

Average Return :	-0.000
Average Standard Deviation :	0.210
Sharpe Ratio :	-0.239
Sotino Ratio :	-0.327
Maximum Drop Down :	0.188

Period
From 2015-12-31 to 2016-12-31, 366 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	19.17%
2330.TW	22.44%
1216.TW	16.73%
1301.TW	0.00%
2002.TW	0.00%
MSFT	1.99%
AAPL	39.67%

Technical Indicator:

Average Return :	0.223
Average Standard Deviation :	0.171
Sharpe Ratio :	1.009
Sotino Ratio :	1.429
Maximum Drop Down :	0.101

Period

From 2016-12-31 to 2017-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	22.10%
2330.TW	30.39%
1216.TW	7.33%
1301.TW	0.00%
2002.TW	0.00%
MSFT	4.51%
AAPL	35.67%

Technical Indicator:

Average Return :	0.290
Average Standard Deviation :	0.132
Sharpe Ratio :	1.817
Sotino Ratio :	2.581
Maximum Drop Down :	0.120

Period

From 2017-12-31 to 2018-12-31, 365 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	13.72%
2330.TW	29.80%
1216.TW	11.02%
1301.TW	0.00%
2002.TW	0.00%
MSFT	11.47%
AAPL	33.99%

Technical Indicator:

Average Return :	-0.011
Average Standard Deviation :	0.215
Sharpe Ratio :	-0.285
Sotino Ratio :	-0.386
Maximum Drop Down :	0.246

Period

From 2018-12-31 to 2019-12-30, 364 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	9.74%
2330.TW	28.51%
1216.TW	15.62%
1301.TW	0.00%
2002.TW	0.00%
MSFT	18.28%
AAPL	27.86%

Technical Indicator:

Average Return :	0.487
Average Standard Deviation :	0.151
Sharpe Ratio :	3.284
Sotino Ratio :	3.930
Maximum Drop Down :	0.100

Out[26]: 2010-12-31 0.000283

2011-01-03 0.006083

2011-01-04 0.002903

2011-01-05 -0.005094

2011-01-06 -0.001285

...

2019-12-23 0.007337

2019-12-24 -0.002109

2019-12-26 0.009212

2019-12-27 0.005555

2019-12-30 -0.003488

Length: 2133, dtype: float64

```
In [27]: port.Backtest_Summary()
Period
From 2010-12-31 to 2019-12-30, 3286 days.
-----
Latest Weights of Portfolio:
-----
```

0050.TW	0.00%
3008.TW	9.74%
2330.TW	28.51%
1216.TW	15.62%
1301.TW	0.00%
2002.TW	0.00%
MSFT	18.28%
AAPL	27.86%

```
-----
Technical Indicator:
-----
Average Return : 0.182
Average Standard Deviation : 0.191
Sharpe Ratio : 0.691
Sotino Ratio : 0.952
Maximum Drop Down : 0.297
```



Neutral

```
In [29]: port.set_optimize()
port.Rolling_test(hedge=True)
```

```
Out[29]: 2010-12-31 -0.018523
2011-01-03 0.002839
2011-01-04 0.010368
2011-01-05 0.011484
2011-01-06 -0.024774
...
2019-12-23 -0.000411
2019-12-24 -0.007307
2019-12-26 -0.012000
2019-12-27 0.004847
2019-12-30 -0.017976
Length: 2133, dtype: float64
```

```
In [30]: port.Backtest_Summary()
Period
From 2010-12-31 to 2019-12-30, 3286 days.
-----
Latest Weights of Portfolio:
-----
```

0050.TW	-100.00%
3008.TW	-11.77%
2330.TW	47.43%
1216.TW	47.45%
1301.TW	40.05%
2002.TW	-34.75%
MSFT	77.99%
AAPL	-66.40%

```
-----
Technical Indicator:
-----
Average Return : 0.112
Average Standard Deviation : 0.313
Sharpe Ratio : 0.198
Sotino Ratio : 0.279
Maximum Drop Down : 0.444
```

```
In [31]: port.Return_Plot(backtest=True)
```

Return & MDD



累積資料

```
In [32]: port.set_optimize()  
port.Rolling_test(hedge=True, cul_info=True)  
port.Backtest_Summary()
```

Period
From 2010-12-31 to 2019-12-30, 3286 days.

Latest Weights of Portfolio:

0050.TW	-100.00%
3008.TW	22.80%
2330.TW	79.55%
1216.TW	36.11%
1301.TW	16.42%
2002.TW	-97.22%
MSFT	13.28%
AAPL	29.06%

Technical Indicator:

Average Return :	0.198
Average Standard Deviation :	0.250
Sharpe Ratio :	0.590
Sotino Ratio :	0.823
Maximum Drop Down :	0.318

```
In [33]: port.Return_Plot(backtest=True)
```

Return & MDD



改變換倉頻率

3個月

```
In [34]: port.set_optimize()  
port.Rolling_test(show=True, freq='3m')
```

Period
From 2010-01-31 to 2010-04-30, 89 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	100.00%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	0.00%

Technical Indicator:

Average Return :	0.993
Average Standard Deviation :	0.287
Sharpe Ratio :	3.286
Sotino Ratio :	4.863
Maximum Drop Down :	0.060

Period
From 2010-04-30 to 2010-07-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	29.72%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	5.83%
2002.TW	0.00%
MSFT	14.91%
AAPL	49.55%

Technical Indicator:

Average Return :	0.012
Average Standard Deviation :	0.256
Sharpe Ratio :	-0.150
Sotino Ratio :	-0.223
Maximum Drop Down :	0.100

Period
From 2010-07-31 to 2010-10-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	39.26%
2330.TW	0.00%
1216.TW	60.75%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	0.00%

Technical Indicator:

Average Return :	0.421
Average Standard Deviation :	0.247
Sharpe Ratio :	1.503
Sotino Ratio :	2.343
Maximum Drop Down :	0.064

Period
From 2010-10-31 to 2011-01-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	14.46%
1301.TW	56.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	29.55%

Technical Indicator:

Average Return :	0.414
Average Standard Deviation :	0.143
Sharpe Ratio :	2.543
Sotino Ratio :	3.373
Maximum Drop Down :	0.054

Period
From 2011-01-31 to 2011-04-30, 89 days.

Weights of Portfolio:

0050.TW	16.04%
3008.TW	10.84%
2330.TW	27.10%
1216.TW	0.00%
1301.TW	8.21%
2002.TW	22.10%
MSFT	0.00%
AAPL	15.71%

Technical Indicator:

Average Return :	0.143
Average Standard Deviation :	0.149
Sharpe Ratio :	0.626
Sotino Ratio :	0.884
Maximum Drop Down :	0.060

Period
From 2011-04-30 to 2011-07-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	27.40%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	60.95%
2002.TW	4.50%
MSFT	0.00%
AAPL	7.15%

Technical Indicator:

Average Return :	0.073
Average Standard Deviation :	0.230
Sharpe Ratio :	0.102
Sotino Ratio :	0.153
Maximum Drop Down :	0.134

Period

From 2011-07-31 to 2011-10-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	6.15%
2330.TW	0.00%
1216.TW	49.02%
1301.TW	0.00%
2002.TW	0.00%
MSFT	18.11%
AAPL	26.72%

Technical Indicator:

Average Return :	-0.108
Average Standard Deviation :	0.309
Sharpe Ratio :	-0.511
Sotino Ratio :	-0.749
Maximum Drop Down :	0.124

Period

From 2011-10-31 to 2012-01-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	30.52%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	69.48%

Technical Indicator:

Average Return :	0.472
Average Standard Deviation :	0.212
Sharpe Ratio :	1.992
Sotino Ratio :	3.147
Maximum Drop Down :	0.085

Period

From 2012-01-31 to 2012-04-30, 90 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	16.66%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	20.07%
AAPL	63.27%

Technical Indicator:

Average Return :	0.815
Average Standard Deviation :	0.225
Sharpe Ratio :	3.407
Sotino Ratio :	5.466
Maximum Drop Down :	0.072

Period

From 2012-04-30 to 2012-07-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	34.51%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	33.50%
AAPL	32.00%

Technical Indicator:

Average Return :	-0.115
Average Standard Deviation :	0.202
Sharpe Ratio :	-0.816
Sotino Ratio :	-1.123
Maximum Drop Down :	0.091

Period

From 2012-07-31 to 2012-10-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	39.25%
2330.TW	0.00%
1216.TW	60.75%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	0.00%

Technical Indicator:

Average Return :	0.359
Average Standard Deviation :	0.169
Sharpe Ratio :	1.828
Sotino Ratio :	2.645
Maximum Drop Down :	0.037

Period

From 2012-10-31 to 2013-01-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.05%
2330.TW	57.28%
1216.TW	42.67%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	0.00%

Technical Indicator:

Average Return :	0.399
Average Standard Deviation :	0.149
Sharpe Ratio :	2.342
Sotino Ratio :	3.431
Maximum Drop Down :	0.040

Period

From 2013-01-31 to 2013-04-30, 89 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	12.79%
2330.TW	62.04%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	25.17%
MSFT	0.00%
AAPL	0.00%

Technical Indicator:

Average Return :	0.174
Average Standard Deviation :	0.181
Sharpe Ratio :	0.684
Sotino Ratio :	1.032
Maximum Drop Down :	0.093

Period

From 2013-04-30 to 2013-07-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	38.57%
1301.TW	0.00%
2002.TW	0.00%
MSFT	61.43%
AAPL	0.00%

Technical Indicator:

Average Return :	0.041
Average Standard Deviation :	0.218
Sharpe Ratio :	-0.040
Sotino Ratio :	-0.048
Maximum Drop Down :	0.100

Period

From 2013-07-31 to 2013-10-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	25.67%
2330.TW	0.00%
1216.TW	13.94%
1301.TW	36.21%
2002.TW	0.00%
MSFT	0.00%
AAPL	24.18%

Technical Indicator:

Average Return :	0.140
Average Standard Deviation :	0.181
Sharpe Ratio :	0.494
Sotino Ratio :	0.654
Maximum Drop Down :	0.044

Period

From 2013-10-31 to 2014-01-31, 92 days.

Weights of Portfolio:

0050.TW	17.78%
3008.TW	0.00%
2330.TW	12.91%

1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	30.84%
AAPL	38.47%

Technical Indicator:

Average Return :	0.086
Average Standard Deviation :	0.122
Sharpe Ratio :	0.296
Sotino Ratio :	0.446
Maximum Drop Down :	0.053

Period
From 2014-01-31 to 2014-04-30, 89 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	48.38%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	4.44%
AAPL	47.18%

Technical Indicator:

Average Return :	1.210
Average Standard Deviation :	0.270
Sharpe Ratio :	4.299
Sotino Ratio :	6.574
Maximum Drop Down :	0.037

Period
From 2014-04-30 to 2014-07-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	36.38%
2330.TW	29.89%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	33.73%
AAPL	0.00%

Technical Indicator:

Average Return :	0.393
Average Standard Deviation :	0.174
Sharpe Ratio :	1.973
Sotino Ratio :	2.624
Maximum Drop Down :	0.076

Period
From 2014-07-31 to 2014-10-31, 92 days.

Weights of Portfolio:

0050.TW	29.43%
3008.TW	3.90%
2330.TW	0.00%
1216.TW	20.28%
1301.TW	0.00%
2002.TW	4.61%
MSFT	25.53%
AAPL	16.26%

Technical Indicator:

Average Return :	0.103
Average Standard Deviation :	0.148
Sharpe Ratio :	0.361
Sotino Ratio :	0.486
Maximum Drop Down :	0.074

Period
From 2014-10-31 to 2015-01-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	6.15%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	31.13%
MSFT	22.88%
AAPL	39.85%

Technical Indicator:

Average Return :	0.094
Average Standard Deviation :	0.168
Sharpe Ratio :	0.264
Sotino Ratio :	0.360
Maximum Drop Down :	0.061

Period
From 2015-01-31 to 2015-04-30, 89 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	48.96%
2330.TW	1.50%
1216.TW	0.00%
1301.TW	28.28%
2002.TW	0.00%

MSFT	0.00%
AAPL	21.26%

Technical Indicator:

Average Return :	0.457
Average Standard Deviation :	0.198
Sharpe Ratio :	2.052
Sotino Ratio :	2.878
Maximum Drop Down :	0.053

Period

From 2015-04-30 to 2015-07-31, 92 days.

Weights of Portfolio:

0050.TW	14.31%
3008.TW	30.53%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	55.15%
AAPL	0.00%

Technical Indicator:

Average Return :	-0.109
Average Standard Deviation :	0.190
Sharpe Ratio :	-0.834
Sotino Ratio :	-1.127
Maximum Drop Down :	0.074

Period

From 2015-07-31 to 2015-10-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.76%
2330.TW	0.00%
1216.TW	99.24%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	0.00%

Technical Indicator:

Average Return :	0.209
Average Standard Deviation :	0.277
Sharpe Ratio :	0.572
Sotino Ratio :	0.818
Maximum Drop Down :	0.080

Period

From 2015-10-31 to 2016-01-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	39.57%
2002.TW	0.00%
MSFT	60.43%
AAPL	0.00%

Technical Indicator:

Average Return :	0.163
Average Standard Deviation :	0.194
Sharpe Ratio :	0.579
Sotino Ratio :	0.834
Maximum Drop Down :	0.071

Period

From 2016-01-31 to 2016-04-30, 90 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	48.19%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	51.81%
AAPL	0.00%

Technical Indicator:

Average Return :	-0.118
Average Standard Deviation :	0.185
Sharpe Ratio :	-0.911
Sotino Ratio :	-1.188
Maximum Drop Down :	0.086

Period

From 2016-04-30 to 2016-07-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	100.00%
MSFT	0.00%
AAPL	0.00%

Technical Indicator:

Average Return :	-0.020
Average Standard Deviation :	0.274
Sharpe Ratio :	-0.256
Sotino Ratio :	-0.353
Maximum Drop Down :	0.125

Period

From 2016-07-31 to 2016-10-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	27.18%
2330.TW	36.10%
1216.TW	3.32%
1301.TW	0.00%
2002.TW	0.00%
MSFT	26.03%
AAPL	7.37%

Technical Indicator:

Average Return :	0.334
Average Standard Deviation :	0.158
Sharpe Ratio :	1.805
Sotino Ratio :	2.702
Maximum Drop Down :	0.052

Period

From 2016-10-31 to 2017-01-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	7.84%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	38.91%
2002.TW	0.00%
MSFT	26.07%
AAPL	27.18%

Technical Indicator:

Average Return :	0.292
Average Standard Deviation :	0.105
Sharpe Ratio :	2.316
Sotino Ratio :	3.187
Maximum Drop Down :	0.037

Period

From 2017-01-31 to 2017-04-30, 89 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	13.49%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	0.29%
2002.TW	37.63%
MSFT	26.49%
AAPL	22.10%

Technical Indicator:

Average Return :	0.277
Average Standard Deviation :	0.102
Sharpe Ratio :	2.236
Sotino Ratio :	3.216
Maximum Drop Down :	0.036

Period

From 2017-04-30 to 2017-07-31, 92 days.

Weights of Portfolio:

0050.TW	32.78%
3008.TW	2.06%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	37.62%
AAPL	27.53%

Technical Indicator:

Average Return :	0.268
Average Standard Deviation :	0.114
Sharpe Ratio :	1.911
Sotino Ratio :	2.474
Maximum Drop Down :	0.038

Period

From 2017-07-31 to 2017-10-31, 92 days.

Weights of Portfolio:

0050.TW	29.77%
3008.TW	0.40%
2330.TW	29.03%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	22.47%
MSFT	18.32%
AAPL	0.00%

Technical Indicator:

Average Return : 0.295
Average Standard Deviation : 0.090
Sharpe Ratio : 2.714
Sotino Ratio : 4.279
Maximum Drop Down : 0.030

Period
From 2017-10-31 to 2018-01-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	37.52%
1216.TW	24.67%
1301.TW	0.00%
2002.TW	0.00%
MSFT	27.69%
AAPL	10.11%

Technical Indicator:

Average Return : 0.320
Average Standard Deviation : 0.112
Sharpe Ratio : 2.418
Sotino Ratio : 3.317
Maximum Drop Down : 0.031

Period
From 2018-01-31 to 2018-04-30, 89 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	28.72%
1301.TW	36.36%
2002.TW	0.00%
MSFT	34.92%
AAPL	0.00%

Technical Indicator:

Average Return : 0.089
Average Standard Deviation : 0.193
Sharpe Ratio : 0.204
Sotino Ratio : 0.306
Maximum Drop Down : 0.064

Period
From 2018-04-30 to 2018-07-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	96.92%
1301.TW	0.00%
2002.TW	0.00%
MSFT	3.08%
AAPL	0.00%

Technical Indicator:

Average Return : 0.553
Average Standard Deviation : 0.209
Sharpe Ratio : 2.402
Sotino Ratio : 3.427
Maximum Drop Down : 0.044

Period
From 2018-07-31 to 2018-10-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	14.60%
2330.TW	4.32%
1216.TW	17.39%
1301.TW	6.82%
2002.TW	17.13%
MSFT	24.30%
AAPL	15.45%

Technical Indicator:

Average Return : -0.183
Average Standard Deviation : 0.213
Sharpe Ratio : -1.096
Sotino Ratio : -1.397
Maximum Drop Down : 0.110

Period
From 2018-10-31 to 2019-01-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	100.00%

Technical Indicator:

Average Return : -1.057
Average Standard Deviation : 0.476

Sharpe Ratio : -2.329
Sotino Ratio : -3.177
Maximum Drop Down : 0.358

Period
From 2019-01-31 to 2019-04-30, 89 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	11.56%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	86.33%
MSFT	2.10%
AAPL	0.00%

Technical Indicator:

Average Return :	0.055
Average Standard Deviation :	0.095
Sharpe Ratio :	0.058
Sotino Ratio :	0.084
Maximum Drop Down :	0.024

Period
From 2019-04-30 to 2019-07-31, 92 days.

Weights of Portfolio:

0050.TW	18.22%
3008.TW	5.17%
2330.TW	0.00%
1216.TW	0.00%
1301.TW	21.99%
2002.TW	0.00%
MSFT	37.47%
AAPL	17.15%

Technical Indicator:

Average Return :	0.046
Average Standard Deviation :	0.144
Sharpe Ratio :	-0.029
Sotino Ratio :	-0.040
Maximum Drop Down :	0.083

Period
From 2019-07-31 to 2019-10-31, 92 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	8.32%
1216.TW	68.08%
1301.TW	0.00%
2002.TW	0.00%
MSFT	18.03%
AAPL	5.57%

Technical Indicator:

Average Return :	0.024
Average Standard Deviation :	0.127
Sharpe Ratio :	-0.202
Sotino Ratio :	-0.312
Maximum Drop Down :	0.047

Period
From 2019-10-31 to 2019-12-30, 60 days.

Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.10%
2330.TW	67.83%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	32.07%

Technical Indicator:

Average Return :	0.855
Average Standard Deviation :	0.159
Sharpe Ratio :	5.056
Sotino Ratio :	7.632
Maximum Drop Down :	0.028

Out[34]: 2010-02-01 -0.023045
2010-02-02 0.013407
2010-02-03 0.030992
2010-02-04 0.009346
2010-02-05 -0.040338
...
2019-12-23 0.015389
2019-12-24 -0.003769
2019-12-26 0.008355
2019-12-27 0.009999
2019-12-30 -0.005169
Length: 2356, dtype: float64

```
In [35]: port.Backtest_Summary()
Period
From 2010-02-01 to 2019-12-30, 3619 days.
-----
Latest Weights of Portfolio:
```

0050.TW	0.00%
3008.TW	0.10%
2330.TW	67.83%
1216.TW	0.00%
1301.TW	0.00%
2002.TW	0.00%
MSFT	0.00%
AAPL	32.07%

Technical Indicator:

Average Return :	0.213
Average Standard Deviation :	0.205
Sharpe Ratio :	0.795
Sotino Ratio :	1.110
Maximum Drop Down :	0.405

```
In [36]: port.Return_Plot(backtest=True)
```

Return & MDD



3個月加上累積資料

```
In [37]: port.set_optimize()
port.Rolling_test(freq='3m', cul_info=True)
port.Backtest_Summary()
```

Period
From 2010-02-01 to 2019-12-30, 3619 days.

Latest Weights of Portfolio:

0050.TW	0.00%
3008.TW	8.50%
2330.TW	29.81%
1216.TW	12.22%
1301.TW	0.00%
2002.TW	0.00%
MSFT	20.51%
AAPL	28.97%

Technical Indicator:

Average Return :	0.212
Average Standard Deviation :	0.202
Sharpe Ratio :	0.804
Sotino Ratio :	1.116
Maximum Drop Down :	0.271

```
In [38]: port.Return_Plot(backtest=True)
```

Return & MDD



半年

```
In [39]: port.set_optimize()  
port.Rolling_test(freq='6m')  
port.Backtest_Summary()
```

Period
From 2010-02-01 to 2019-12-30, 3619 days.

Latest Weights of Portfolio:

0050.TW	0.00%
3008.TW	0.00%
2330.TW	16.10%
1216.TW	31.02%
1301.TW	0.00%
2002.TW	0.00%
MSFT	35.84%
AAPL	17.04%

Technical Indicator:

Average Return :	0.185
Average Standard Deviation :	0.203
Sharpe Ratio :	0.662
Sotino Ratio :	0.935
Maximum Drop Down :	0.274

```
In [40]: port.Return_Plot(backtest=True)
```

Return & MDD



半年加上累積資訊

```
In [41]: port.set_optimize()  
port.Rolling_test(freq='6m', cul_info=True)  
port.Backtest_Summary()
```

Period
From 2010-02-01 to 2019-12-30, 3619 days.

Latest Weights of Portfolio:

0050.TW	0.00%
3008.TW	9.10%
2330.TW	25.51%
1216.TW	16.12%
1301.TW	0.00%
2002.TW	0.00%
MSFT	22.48%
AAPL	26.78%

Technical Indicator:

Average Return :	0.223
Average Standard Deviation :	0.212
Sharpe Ratio :	0.814
Sotino Ratio :	1.137
Maximum Drop Down :	0.296

```
In [42]: port.Return_Plot(backtest=True)
```

Return & MDD



Hedge加上累積資料

```
In [43]: port.set_optimize()  
port.Rolling_test(freq='6m', cul_info=True, hedge=True)  
port.Backtest_Summary()
```

Period
From 2010-02-01 to 2019-12-30, 3619 days.

Latest Weights of Portfolio:

0050.TW	-100.00%
3008.TW	23.24%
2330.TW	78.91%
1216.TW	37.86%
1301.TW	10.66%
2002.TW	-100.00%
MSFT	19.01%
AAPL	30.31%

Technical Indicator:

Average Return :	0.270
Average Standard Deviation :	0.265
Sharpe Ratio :	0.830
Sotino Ratio :	1.160
Maximum Drop Down :	0.285

```
In [44]: port.Return_Plot(backtest=True)
```

Return & MDD



3個月Hedge加上累積資料

```
In [45]: port.set_optimize()  
port.Rolling_test(freq='3m', cul_info=True, hedge=True)  
port.Backtest_Summary()
```

Period
From 2010-02-01 to 2019-12-30, 3619 days.

Latest Weights of Portfolio:

0050.TW	-100.00%
3008.TW	22.67%
2330.TW	86.15%
1216.TW	33.86%
1301.TW	6.67%
2002.TW	-100.00%
MSFT	16.51%
AAPL	34.15%

Technical Indicator:

Average Return :	0.266
Average Standard Deviation :	0.261
Sharpe Ratio :	0.826
Sotino Ratio :	1.160
Maximum Drop Down :	0.293

```
In [46]: port.Return_Plot(backtest=True)
```

Return & MDD



發現與心得

1. 實際使用上，Markowitz模型需要比較長的資料來做基礎，所以累積資料的穩健度跟獲利性基本上扁打滾動資料
2. 從半年與三個月的Hedge來看，其實到後來做多與放空的比例都差不多，所以時間一長的話，模型權重趨於固定，因此對於市場突然的大波動反應不夠
3. 即使三個月換一次的Hedge還是太長了，實務上運用會有很多的衍生成本

檢討與改進

個人認為未來還可以朝以下方向改進：

1. 此模型只有透過純粹的價格資料，可以引入交易量、財報等資料做更宏觀的判斷
2. 由於Markowitz模型本身的限制，權重變動劇烈，實作困難，如果有適合的主觀矩陣生成方法，未來也可以考慮使用Black-Litterman Model來做改進
3. 在前期的選擇Stock Pool也很重要，未來也可以朝著這個地方的改良下手