S&P 500 emini Future Trading Strategy

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Summary of Strategy

Short-Term Rates Trend Strategy, Step by Step:

1. For each futures contract, forecast the next day's volatility using a GARCH(1,1) with past three years' daily return.

2. Compare the forecast to the trailing three years' fitted GARCH volatility; if the forecast is above the median, use High Vol Regime; otherwise, use Low Vol Regime.

3. Compare the current contract price to the moving average price that corresponds to the current volatility regime (Low, use 66 days; High, use 252 days).

4. If the contract price is above the moving average price, the strategy generates a "Long" signal—buy the contract (or hold if already long) at the close on the next business day. If the contract is below the moving average price, the strategy generates a "Short" signal—sell the contract (or hold if already short).

5. Repeat process for each of the four contracts in each region, equally weighting the four contracts and weighting the regions proportionally to open interest.

Notes:

1. Volatility will be calculated based on S&P 500 index.

2. The strategy compares the median of forecast volatility last three year with the forecast volatility tomorrow to decide whether the volatility regime is high ow low
   - if volatility regime is low, it will go long (buy) if price of STIR > moving average price of MA1 days and short if price of STIR < moving average price of MA1 days
   - if volatility regime is high, it will go long (buy) if price of STIR > moving average price of MA2 days and short if price of STIR < moving average price of MA2 days
3. The transaction cost is modelled by using the Bid-Ask price for S&P e-mini future contracts. Details are as follows:
   - When there is a buy signal, I buy the contract with ask price and when there is a sell signal, I sell the contract with bid price.
   - In addition, I also add the commission fee into the transaction cost.

Main functions

➢ sp500_future_analyzing:

```
sp500_future_analyzing(data = data, MA1=5, MA2=210, initial_equity1 = 1000000, commission_fee1 = 0.002):
'''
This function is to calculate the return of a portfolio of many S&P 500 emini future constracts with a trading strategy
    based of volatility regime and moving average price of MA1 days (for low volatility regime) and MA2 days (for high volatilit

Input
-----
    Price: a data frame with a Time column and Price column of S&P 500 emini future constract and volatility regime column
    MA1: moving average price using in low volatility regime
    MA2: moving average price using in high volatility regime
    initial_equity1: initial equity for each contract
    commission_fee1: commission_fee for each transaction

Output
------
    summary_port: a dataframe with 9 columns including 'Start date','Finish Date','MA1','MA2','annualized_return',
                                                        'annualized_sd','annualized_Sharpe','max_draw_down','winning_percentage'
'''
```

Main functions

- **get_portfolio_return:**

```
get_portfolio_return(data = data, MA1=5, MA2=210, initial_equity1 = 1000000, commission_fee1 = 0.002):
'''

This function is to calculate the return of a portfolio of many S&P 500 emini future constracts with a trading strategy
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    MA1: moving average price using in low volatility regime
    MA2: moving average price using in high volatility regime
    initial_equity1: initial equity for each contract
    commission_fee1: commission_fee for each transaction

Output
------
    port_ret1: return of portfolio
'''
individual_ret =[]
```
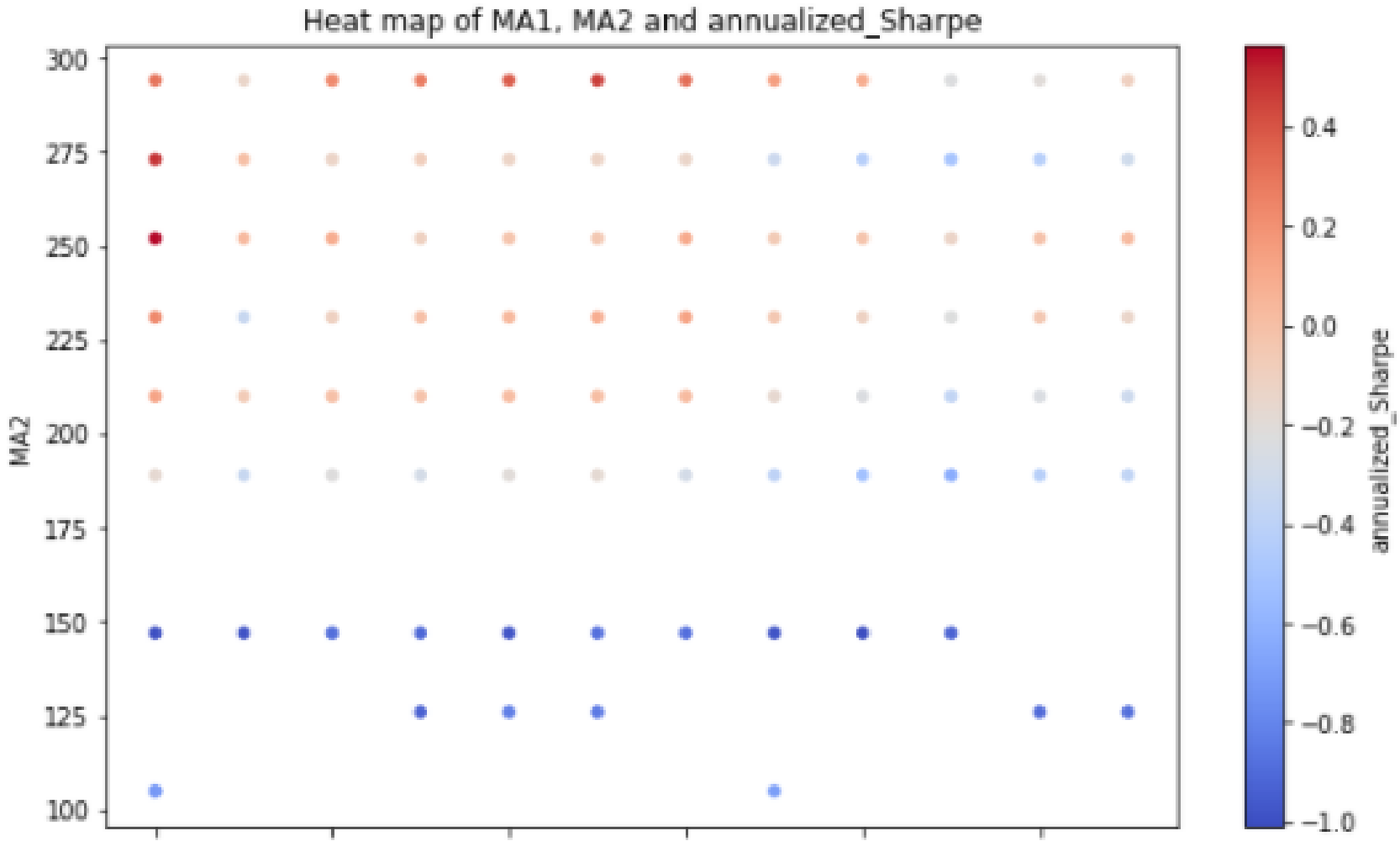

1. run grid-search with changes of MA1 (fast-moving window) and MA2 (slow-moving window) to see how these parameters affect the Sharpe ratio

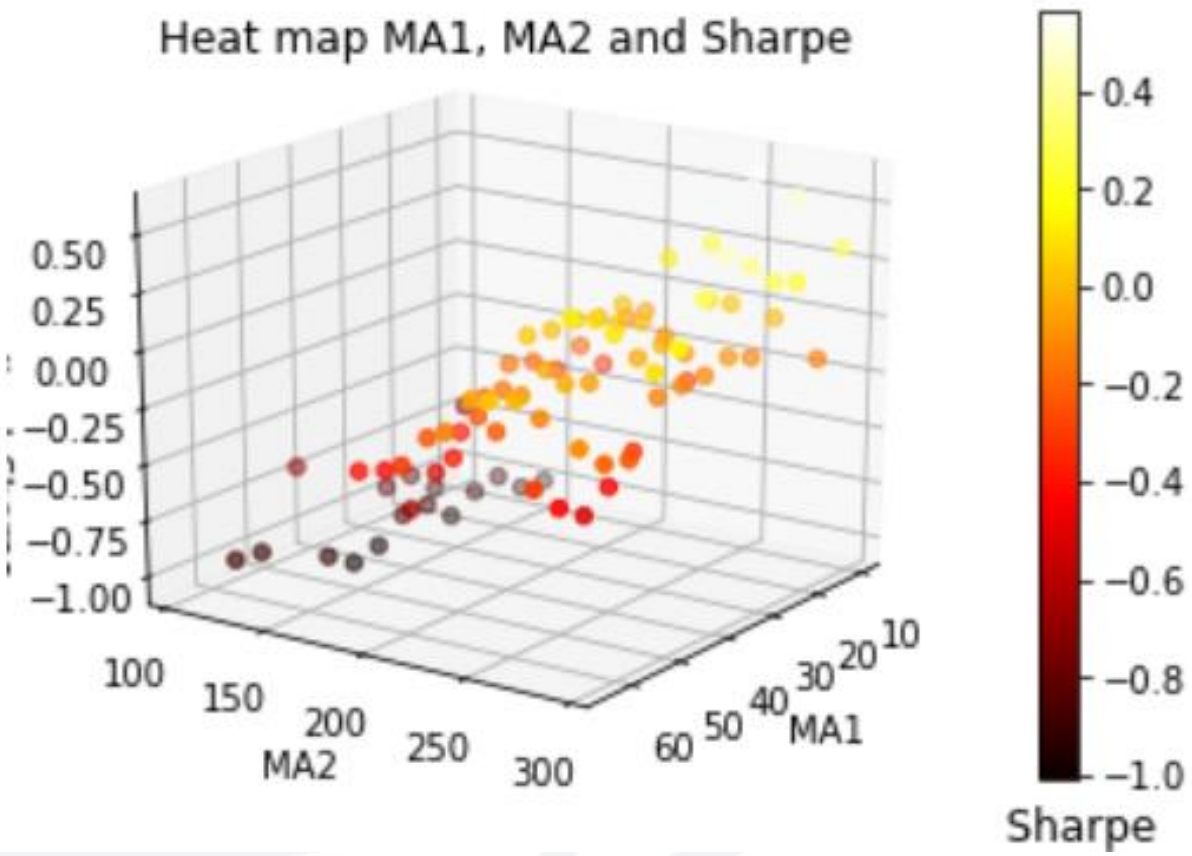
```
summary.sort_values('annualized_Sharpe', ascending = False)
```

	Start	Finish	MA1	MA2	annualized_return	annualized_sd	annualized_Sharpe	max_draw_down	winning_percentage
0	2009-09-11	2019-12-11	10	252	0.144032	0.254663	0.565579	0.416330	0.027734
0	2009-10-12	2019-12-11	10	273	0.136067	0.273701	0.497138	0.279517	0.025328
0	2009-11-10	2019-12-11	35	294	0.118940	0.252271	0.471479	0.315676	0.026094
0	2009-11-10	2019-12-11	30	294	0.095664	0.249387	0.383598	0.356379	0.026094
0	2009-11-10	2019-12-11	40	294	0.083961	0.256240	0.327665	0.380123	0.022256
...	...	...	...	...	...	...	...	...	...
0	2009-04-17	2019-12-11	60	147	NaN	0.645414	NaN	1.000158	0.019087
0	2009-05-18	2019-12-11	60	168	NaN	0.757131	NaN	1.934011	0.017372
0	2009-02-18	2019-12-11	65	105	NaN	1.331893	NaN	1.000002	0.016206
0	2009-04-17	2019-12-11	65	147	NaN	0.670319	NaN	1.000203	0.018713
0	2009-05-18	2019-12-11	65	168	NaN	0.750850	NaN	1.925471	0.017749

1. run grid-search with changes of MA1 (fast-moving window) and MA2 (slow-moving window) to see how these parameters affect the Sharpe ratio

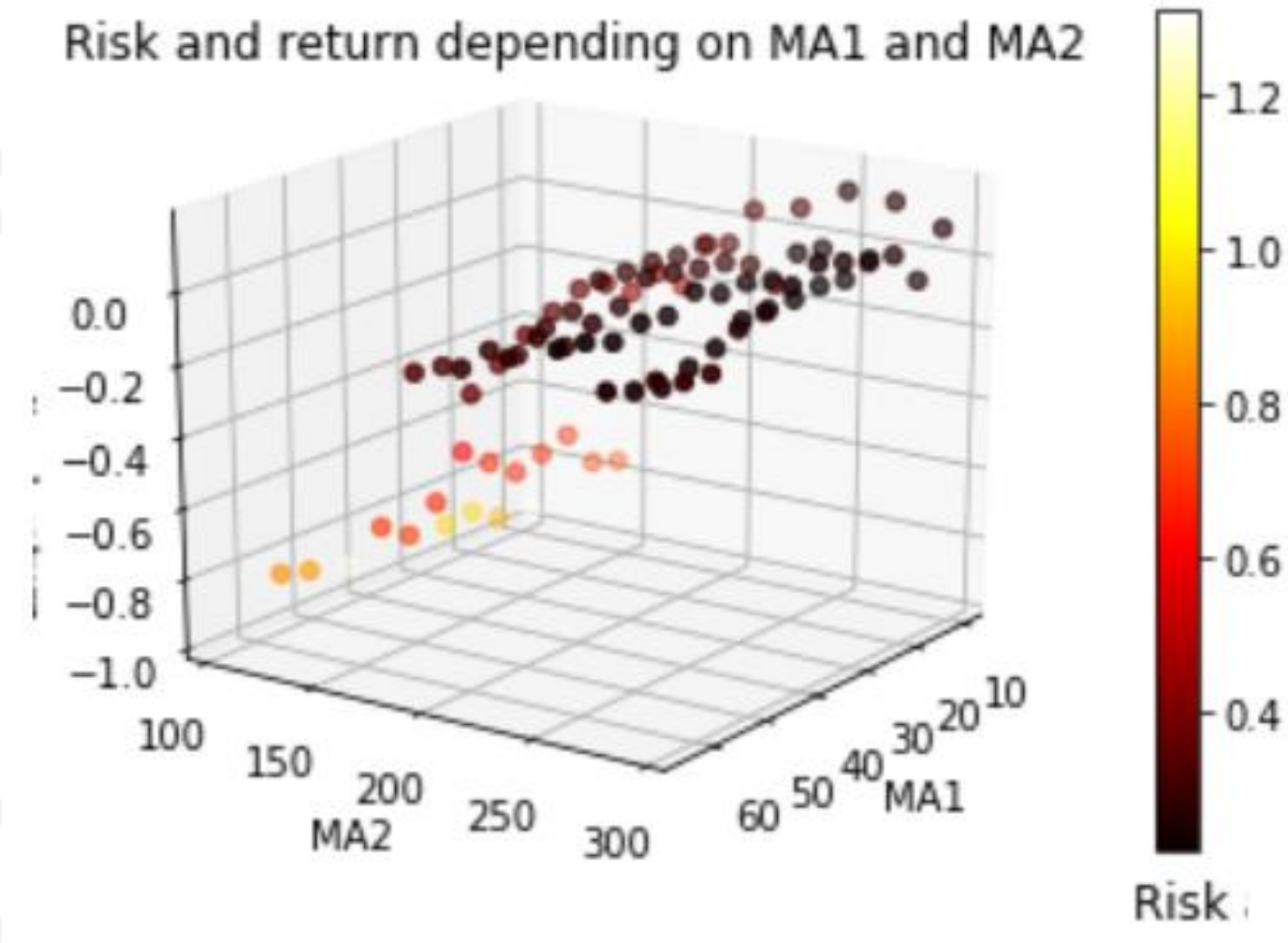


For easier to imagination, I created a 3d heat map

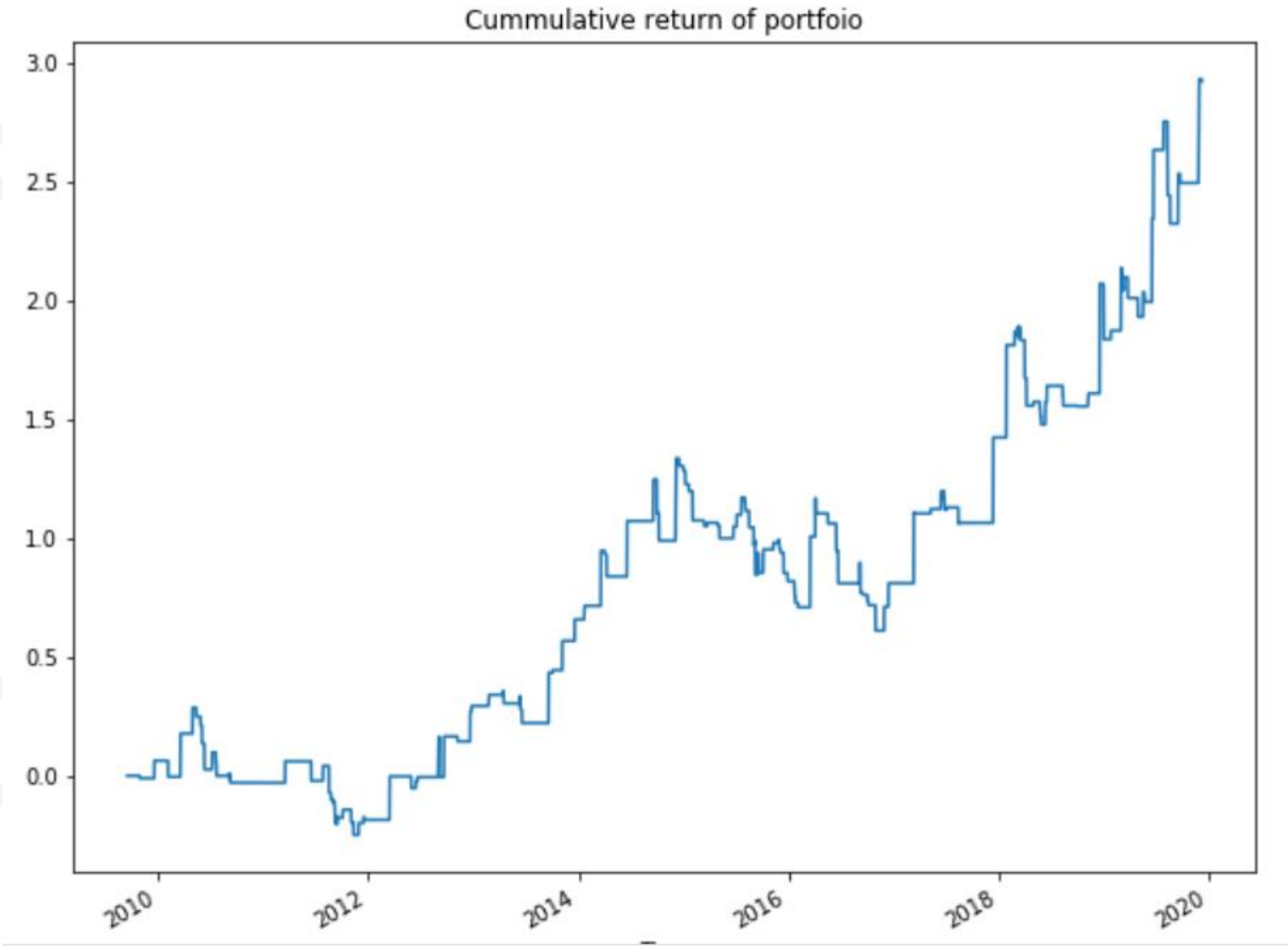


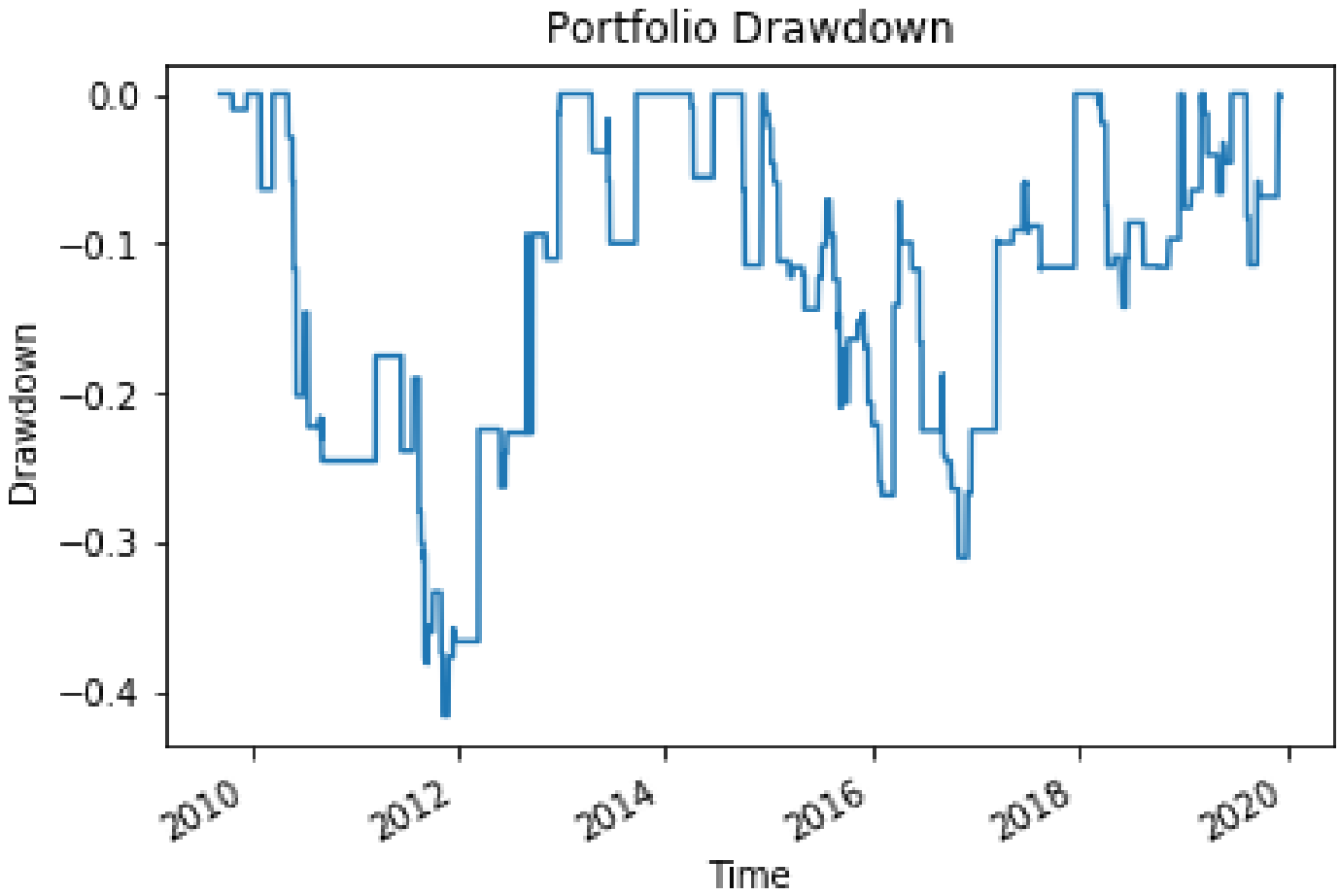
It can be seen that MA1 = 5 days and MA2 moves in a range from 200 - 300 days tends to produce highest Sharpe ratio

2. How changes in MA1 and MA2 affect risk and return profile?



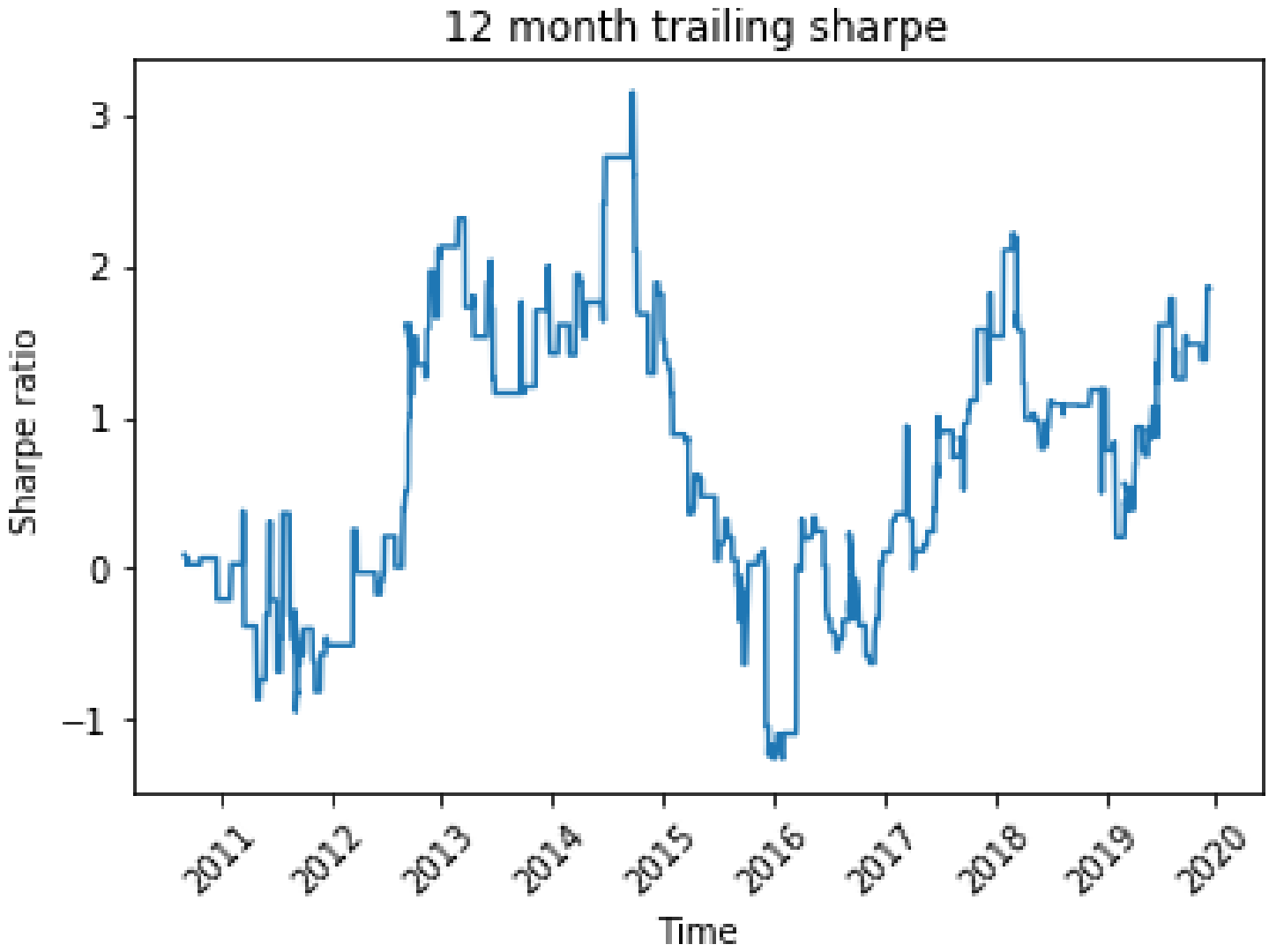
3. Analyse the performance of max Sharpe case (MA1 = 10, MA2 = 252, Sharpe = 0.56)




Portfolio Drawdown
Drawdown
0.0
−0.1
−0.2
−0.3
−0.4
2010
2012
2014
2016
2018
2020
Time

Performance Summary in years:

	Year	Annualize_return	Annualize_volatility	Annualize_sharpe	MaxDrawdown
0	2009	0.219752	0.136759	1.606855	NaN
1	2010	-0.087801	0.269921	-0.325285	0.245721
2	2011	-0.163455	0.261814	-0.624317	0.292011
3	2012	0.603147	0.312354	1.930971	0.049694
4	2013	0.282557	0.218975	1.290363	0.099840
5	2014	0.399546	0.289733	1. run grid-search with change...	4873
6	2015	-0.212352	0.160407	-1.323833	0.203402
7	2016	-0.004651	0.264983	-0.017551	0.256936
8	2017	0.343559	0.246524	1.393614	0.062849
9	2018	0.270700	0.260584	1.038822	0.142350
10	2019	0.294662	0.261500	1.126813	0.114413


12 month trailing sharpe
Sharpe ratio
3
2
1
0
−1
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Time