FE-630 Project

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Agenda

Financial Engineering - 630 (Portfolio Theory and Applications)

1. Overview
2. Data Collection
3. Fama-French three-Factor Model
4. Results

Overview (Strategy I & II)

Overview

Which optimization strategy produces the best weights?

- Σ , ϱ come from the Fama-French 3 factor model
- $\Sigma\beta$ come from the CAPM

The optimization model is being re-applied during a rolling window.

- Short-Term (ST) = 40 days
- Mid-Term (MT) = 90 days
- Long-Term (LT) = 180 days

$$TEV(\omega) = \sqrt{\omega^T \Sigma \omega - 2\omega^T cov(r, r_{SPY}) + \sigma^2_{SPY}}$$

(Strategy I)

$$\begin{cases} \max\limits_{\omega \in \mathbb{R}^n} \rho^T \omega - \lambda\sqrt{\omega^T \Sigma \omega} \\ -0.5 \leq \sum\limits_{i=1}^{n} \beta_i^m \omega_i \leq 0.5 \\ \sum\limits_{i=1}^{n} \omega_i = 1, \ -2 \leq \omega_i \leq 2, \end{cases}$$

(Strategy II)

$$\begin{cases} \max\limits_{\omega \in \mathbb{R}^n} \dfrac{\rho^T \omega}{TEV(\omega)} - \lambda\sqrt{\omega^T \Sigma \omega} \\ -1 \leq \sum\limits_{i=1}^{n} \beta_i^m \omega_i \leq 2 \\ \sum\limits_{i=1}^{n} \omega_i = 1, \ -2 \leq \omega_i \leq 2, \end{cases}$$

Data Collection

Collected ETF data from (Yahoo Finance)

- CurrencyShares Euro Trust (FXE)
- iShares MSCI Japan Index (EWJ)
- SPDR GOLD Trust (GLD)
- Powershares NASDAQ-100 Trust (QQQ)
- SPDR S&P 500 (SPY)
- iShares Lehman Short Treasury Bond (SHV)
- PowerShares DB Agriculture Fund (DBA)
- United States Oil Fund LP (USO)
- SPDR S&P Biotech (XBI)
- iShares S&P Latin America 40 Index (ILF)
- iShares MSCI Pacific ex-Japan Index Fund (EPP)
- SPDR DJ Euro Stoxx 50 (FEZ)

Fama French 3- Factor Data

- Date Range March 2007 - October 2022
- 3,945 daily closing prices

```
def gather_etf_data():
  import yfinance as yf

  ticker_list = ['FXE','EWJ','GLD','QQQ','SPY','SHV',
                 'DBA','USO','XBI','ILF','EPP','FEZ']
  etf_returns = yf.download(ticker_list,'2007-3-1')['Adj Close']
  return etf_returns
```

Fama French

$$E[r_j] = r_f + \beta_1(E[r_m] - r_f) + \beta_2 SMB + \beta_3 HML$$

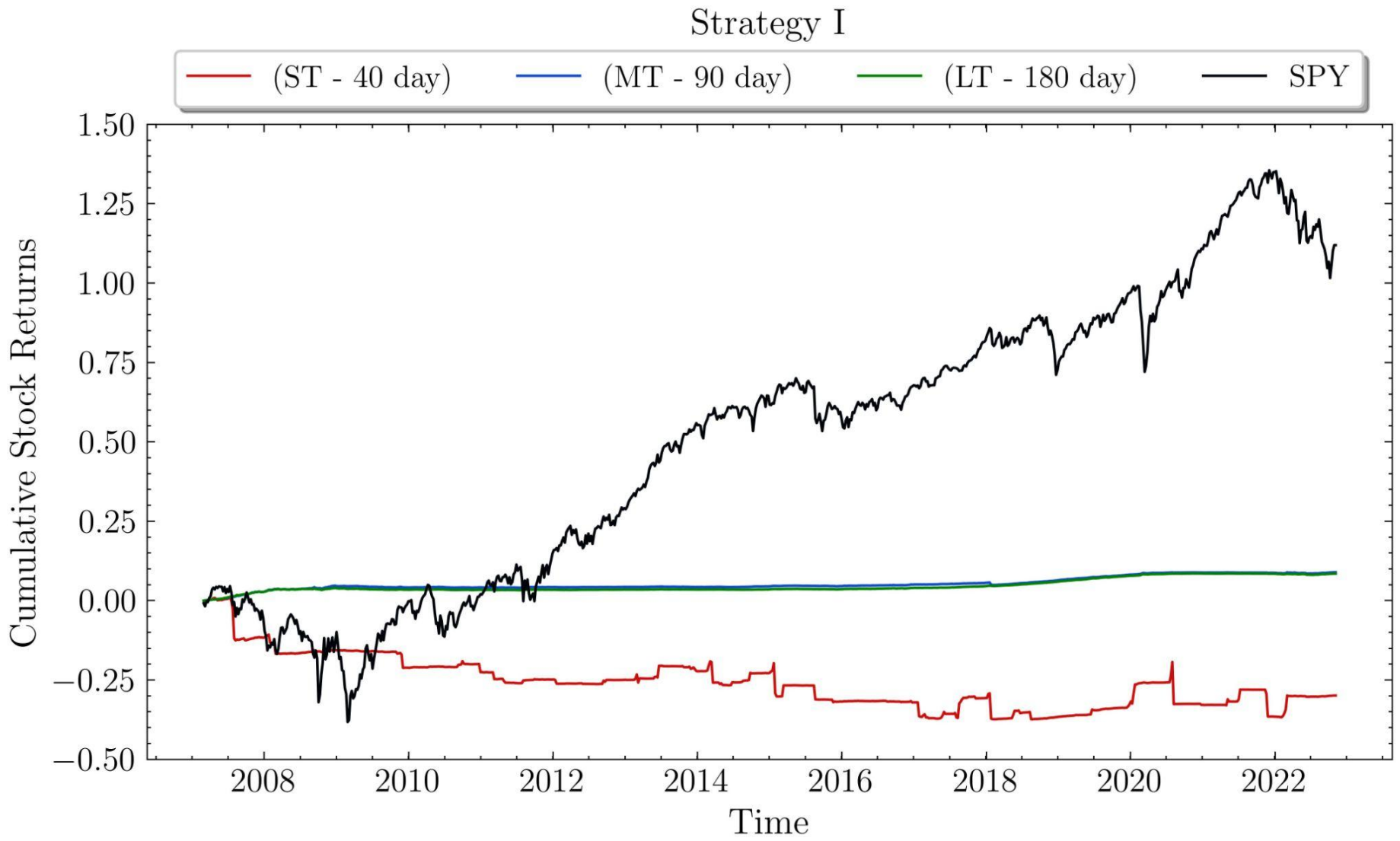
Date	Mkt-RF	SMB	HML	RF
20221025	1.78	1.35	-1.52	0.011
20221026	-0.66	0.42	0.89	0.011
20221027	-0.54	0.32	1.06	0.011
20221028	2.33	-0.04	-0.34	0.011
20221031	-0.67	0.39	0.75	0.011

Date Range: 7/1/1926 - 10/31/2022

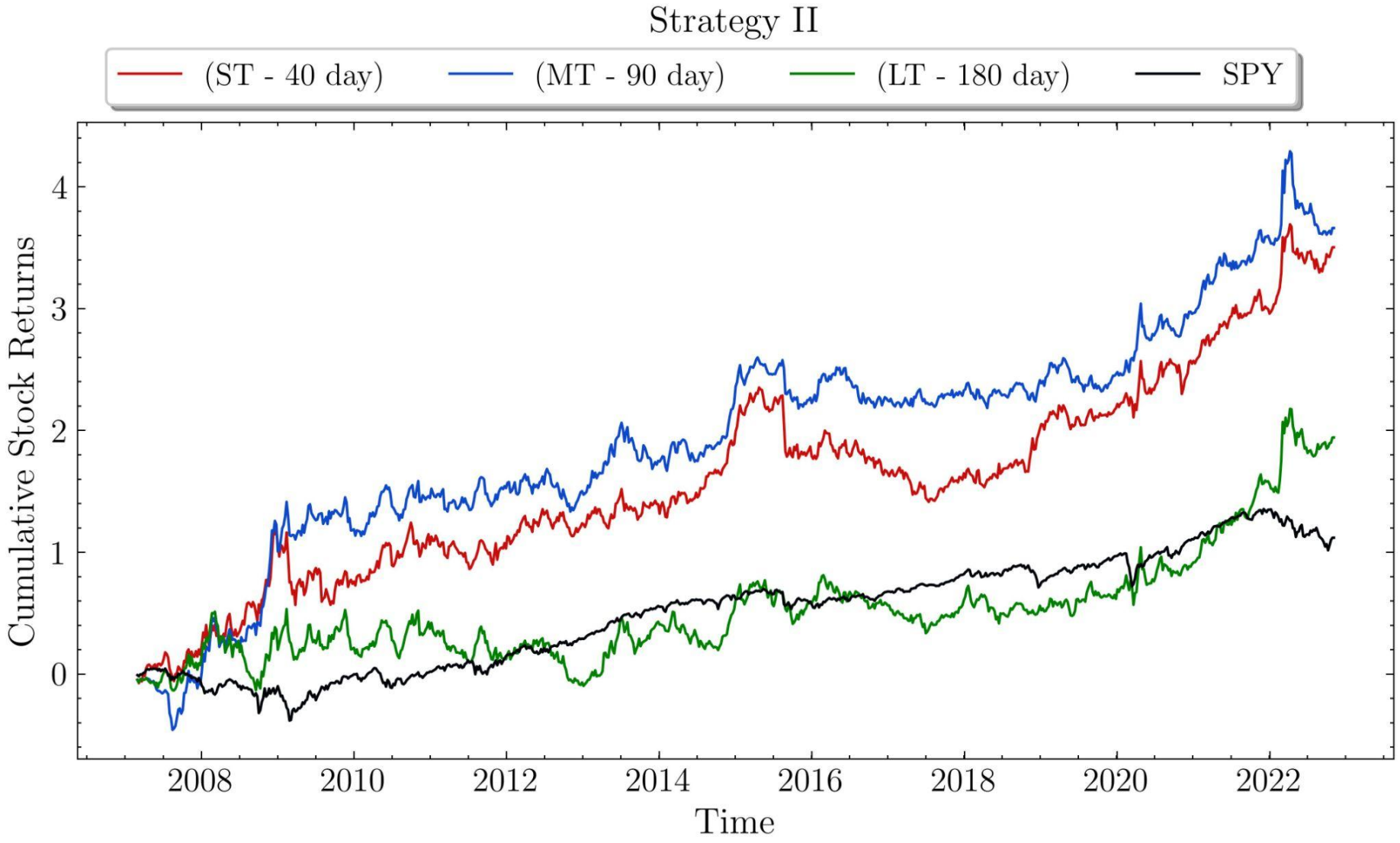
- Rm-Rf, the excess return on the market
- SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios
- HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios

Data Source: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

(λ = .7)

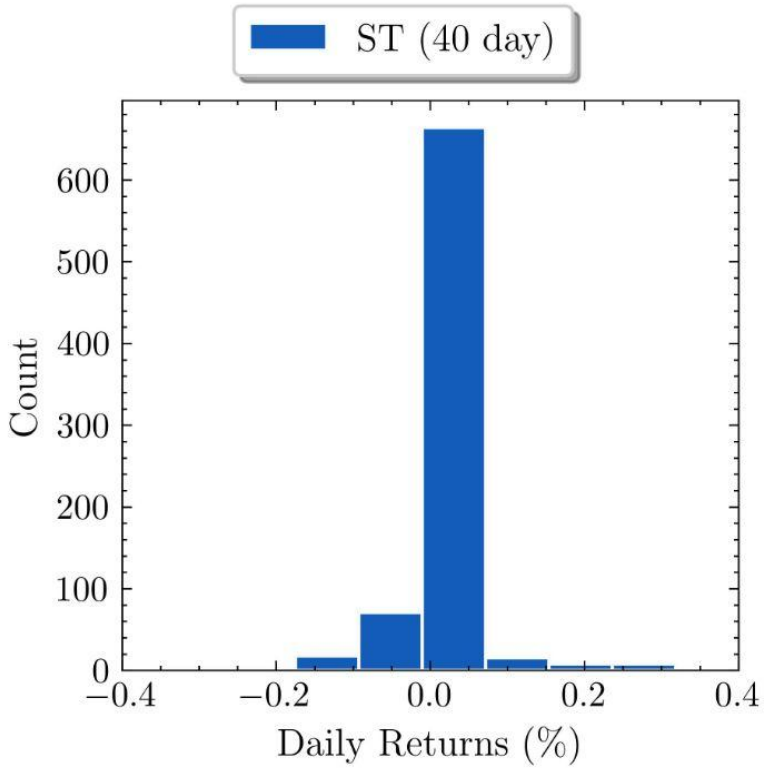

Strategy I
(ST - 40 day)
(MT - 90 day)
(LT - 180 day)
SPY
Cumulative Stock Returns
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
2008
2010
2012
2014
2016
2018
2020
2022
Time

(λ = .7)

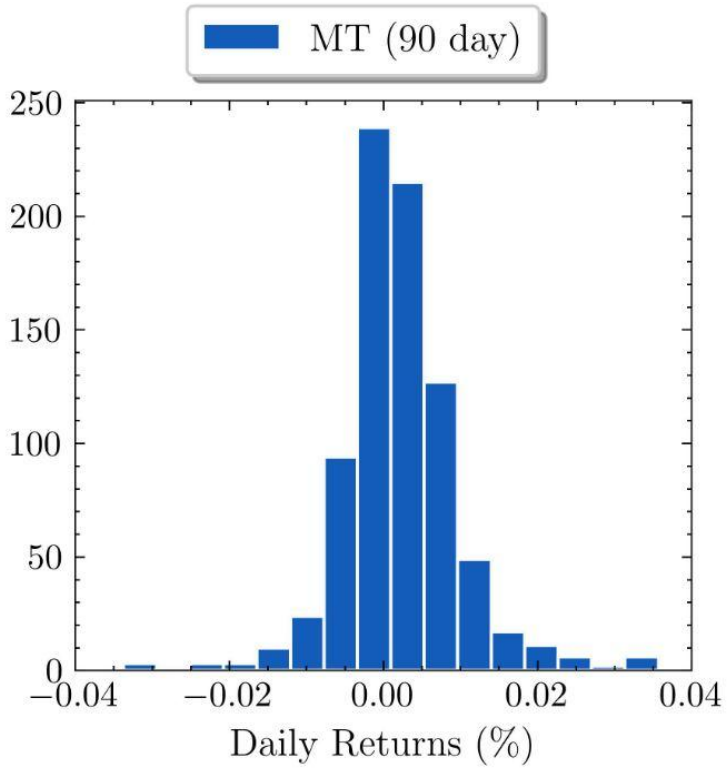

Strategy II
(ST - 40 day)
(MT - 90 day)
(LT - 180 day)
SPY
Cumulative Stock Returns
0
1
2
3
4
2008
2010
2012
2014
2016
2018
2020
2022
Time

Strategy I (λ = .7)

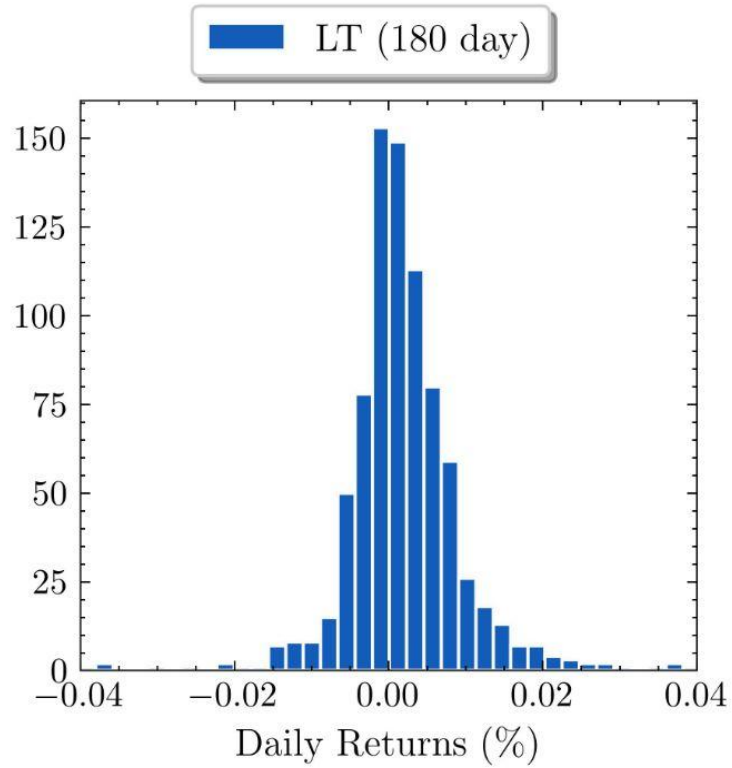
Histogram



Mean	-0.008
Standard Deviation	0.2
Skewness	-6.8
Kurtosis	77.9



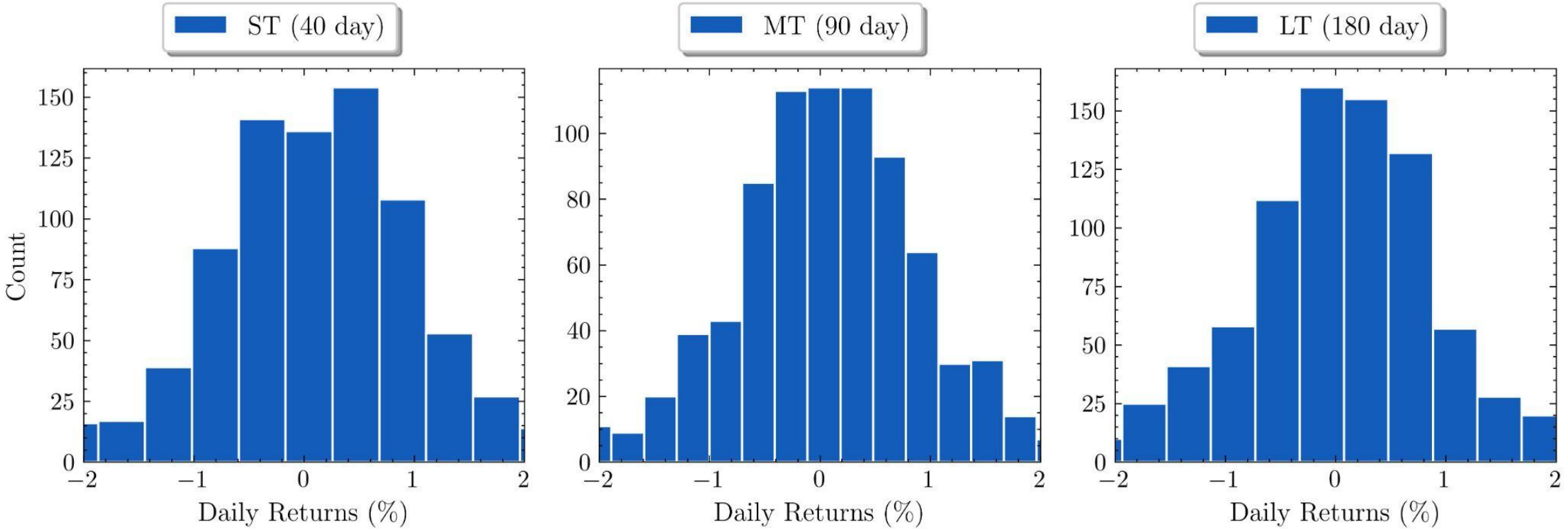
Mean	0.002
Standard Deviation	0.01
Skewness	-2.59
Kurtosis	49.71



Mean	0.002
Standard Deviation	0.008
Skewness	0.93
Kurtosis	9.3

Strategy II (λ = .7)

Histogram



Mean	.06
Standard Deviation	1.1
Skewness	-0.67
Kurtosis	3.8

Mean	0.07
Standard Deviation	1.0
Skewness	-0.11
Kurtosis	6.2

Mean	0.02
Standard Deviation	0.95
Skewness	-0.24
Kurtosis	2.9

Strategy I & II

INDEX	RESULTS_90_DAY_I	RESULTS_90_DAY_II
MEAN_RETURN	0.002176	0.066970
SHARPE_RATIO	0.215968	0.063362
SKEWNESS	-2.589913	-0.111833
KURTOSIS	49.715804	6.207317
MIN_RETURN	-0.137951	-5.745942
VOLATILITY_(ANNUAL)	0.072639	7.621707
VaR_(95)	-0.014394	-1.671543
EMP_VaR	-0.008213	-1.505323
EMP_cVaR	-0.018728	-2.479549

Main Research Question:
Which trading strategy produces the best results?

Results
The boxes in **blue** represent the statistics with the best outcome.

The results show strategy II has a higher daily return, but higher volatility.

An investor with higher risk-tolerance will find strategy II more beneficial.

Note
The values in the table are based upon the daily return (%)

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THANK YOU

Stevens Institute of Technology
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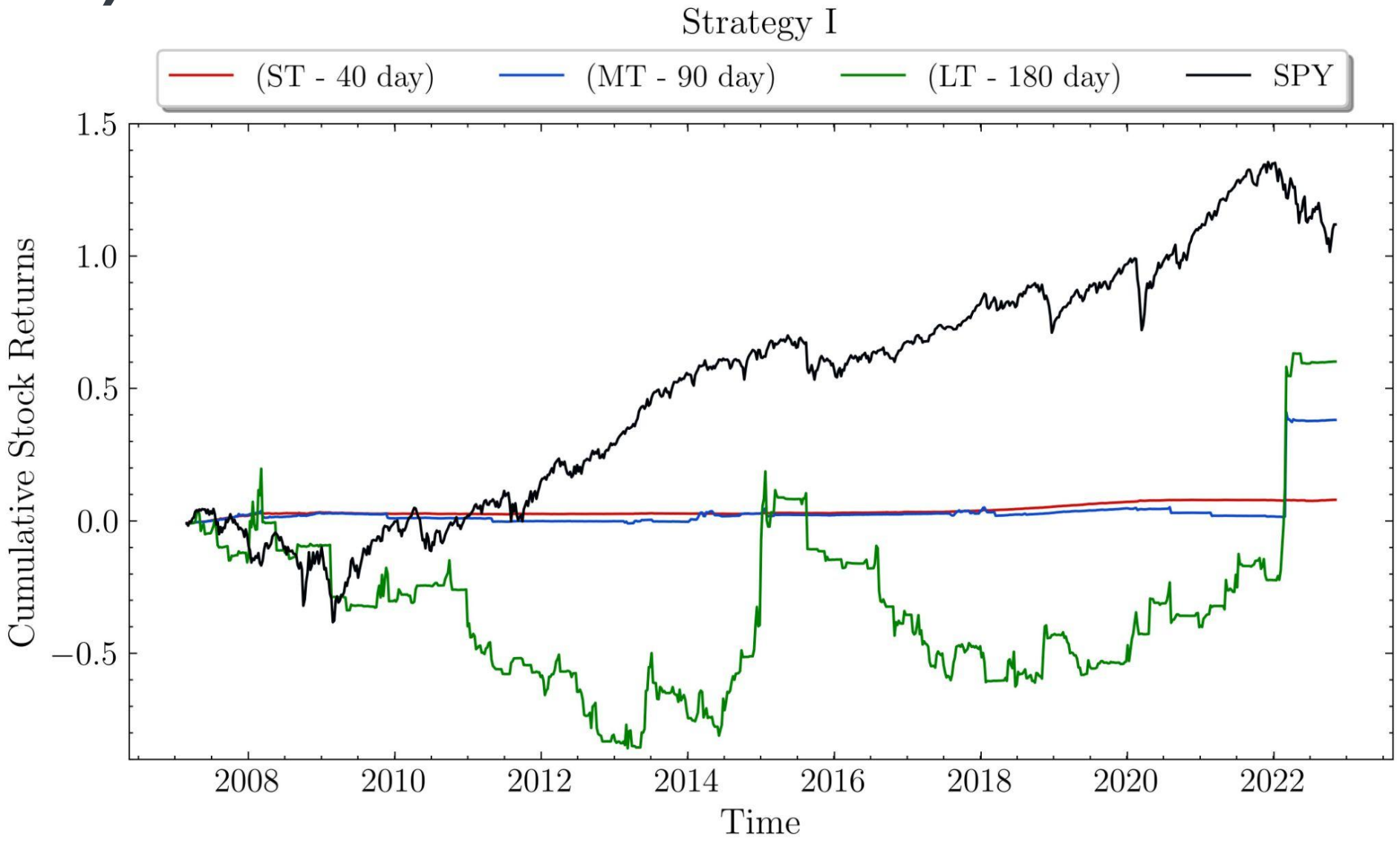
Appendix - Strategy I (λ = .7)

INDEX	RESULTS_40_DAY	RESULTS_90_DAY	RESULTS_180_DAY
MEAN_RETURN	-0.008107	0.002176	0.002072
SHARPE_RATIO	-0.040204	0.215968	0.260195
SKEWNESS	-6.783120	-2.589913	0.928839
KURTOSIS	77.957127	49.715804	9.276048
MIN_RETURN	-2.805527	-0.137951	-0.040227
VOLATILITY_(ANNUAL)	1.454145	0.072639	0.057427
VaR_(95)	-0.339798	-0.014394	-0.011027
EMP_VaR	-0.078777	-0.008213	-0.007298
EMP_cVaR	-0.519536	-0.018728	-0.014502

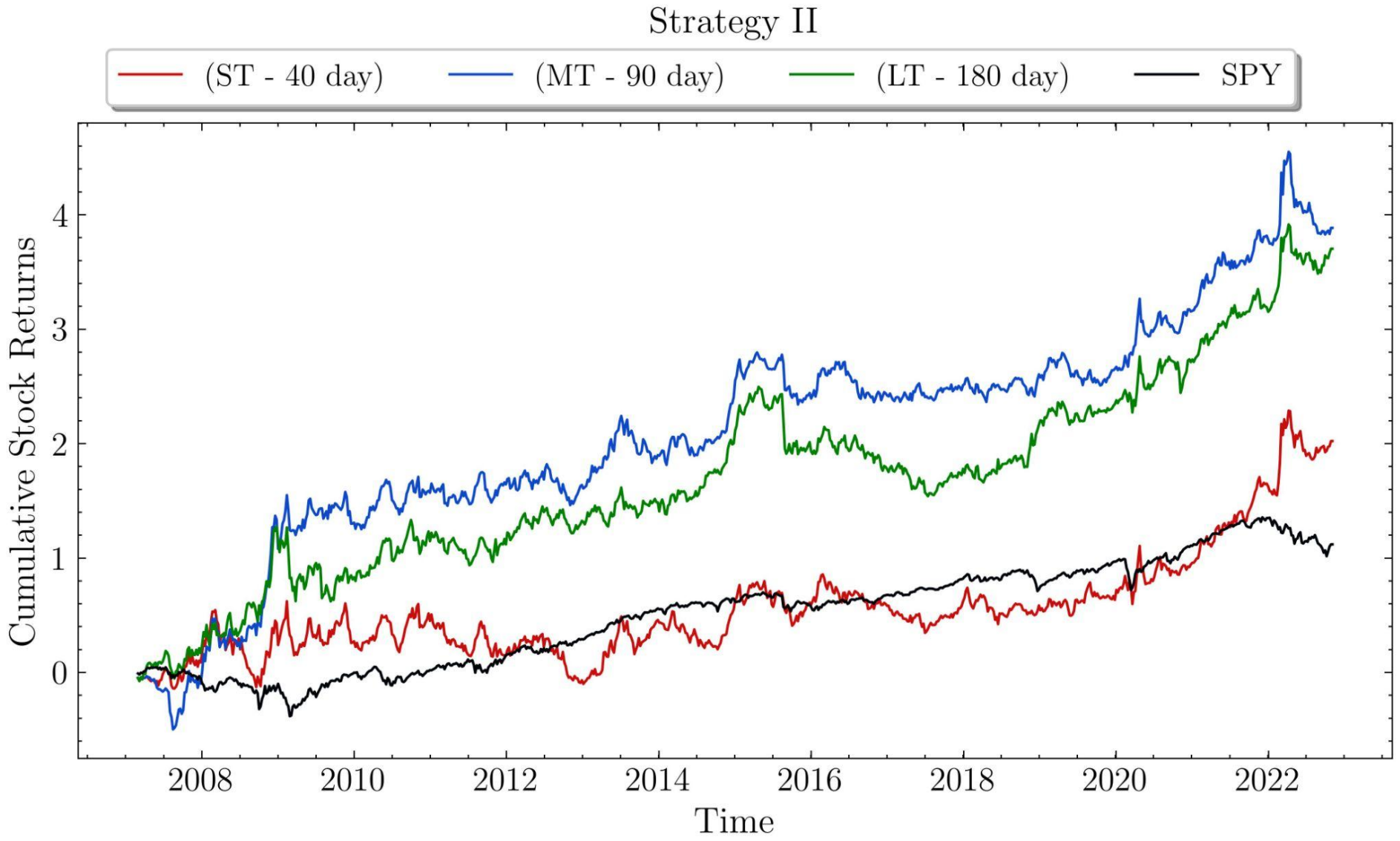
Appendix - Strategy II (λ = .7)

INDEX	RESULTS_40_DAY	RESULTS_90_DAY	RESULTS_180_DAY
MEAN_RETURN	0.063174	0.066970	0.029028
SHARPE_RATIO	0.059666	0.063362	0.030255
SKEWNESS	-0.665888	-0.111833	-0.243084
KURTOSIS	3.752661	6.207317	2.913228
MIN_RETURN	-5.265824	-5.745942	-4.351673
VOLATILITY_(ANNUAL)	7.635113	7.621707	6.918645
VaR_(95)	-1.678397	-1.671543	-1.549116
EMP_VaR	-1.642997	-1.505323	-1.590313
EMP_cVaR	-2.609752	-2.479549	-2.256706

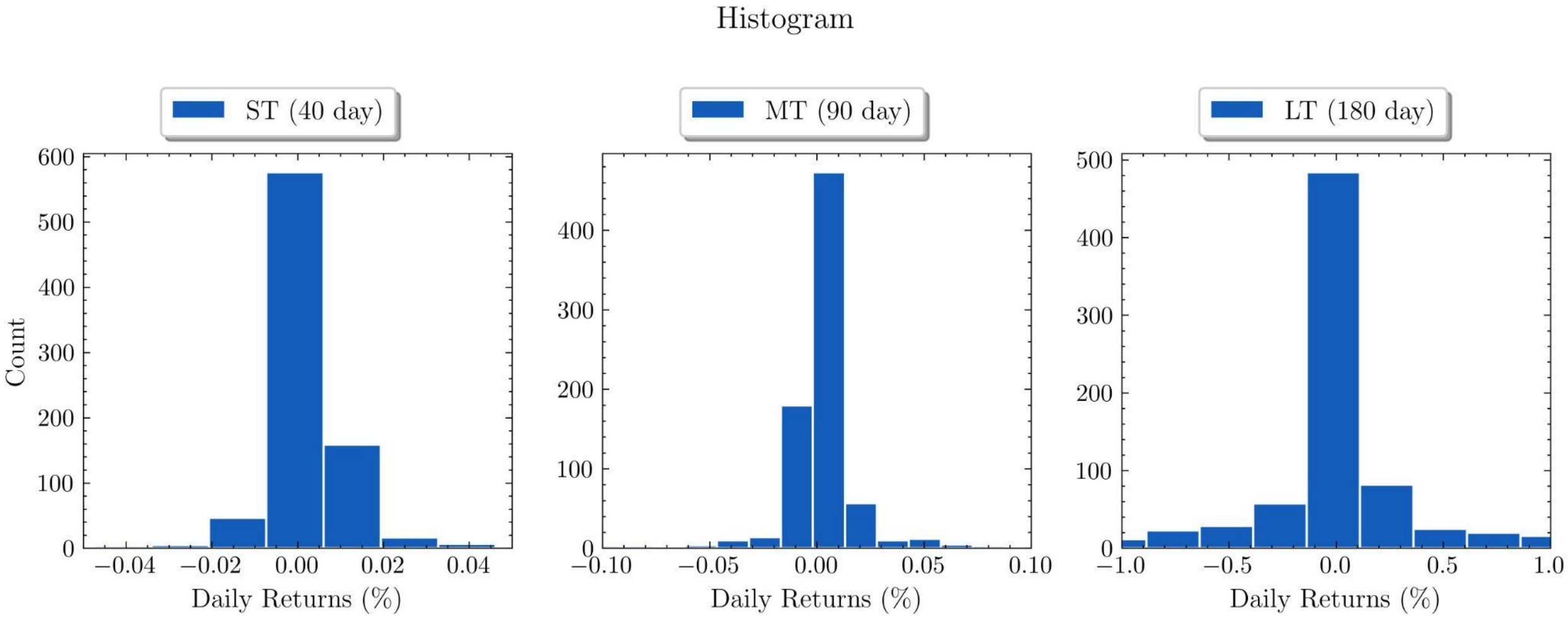
(λ = .5)


Strategy I
(ST - 40 day)
(MT - 90 day)
(LT - 180 day)
SPY
Cumulative Stock Returns
1.5
1.0
0.5
0.0
−0.5
2008
2010
2012
2014
2016
2018
2020
2022
Time

(λ = .5)


Strategy II
(ST - 40 day)
(MT - 90 day)
(LT - 180 day)
SPY
Cumulative Stock Returns
0
1
2
3
4
2008
2010
2012
2014
2016
2018
2020
2022
Time

(λ = .5)

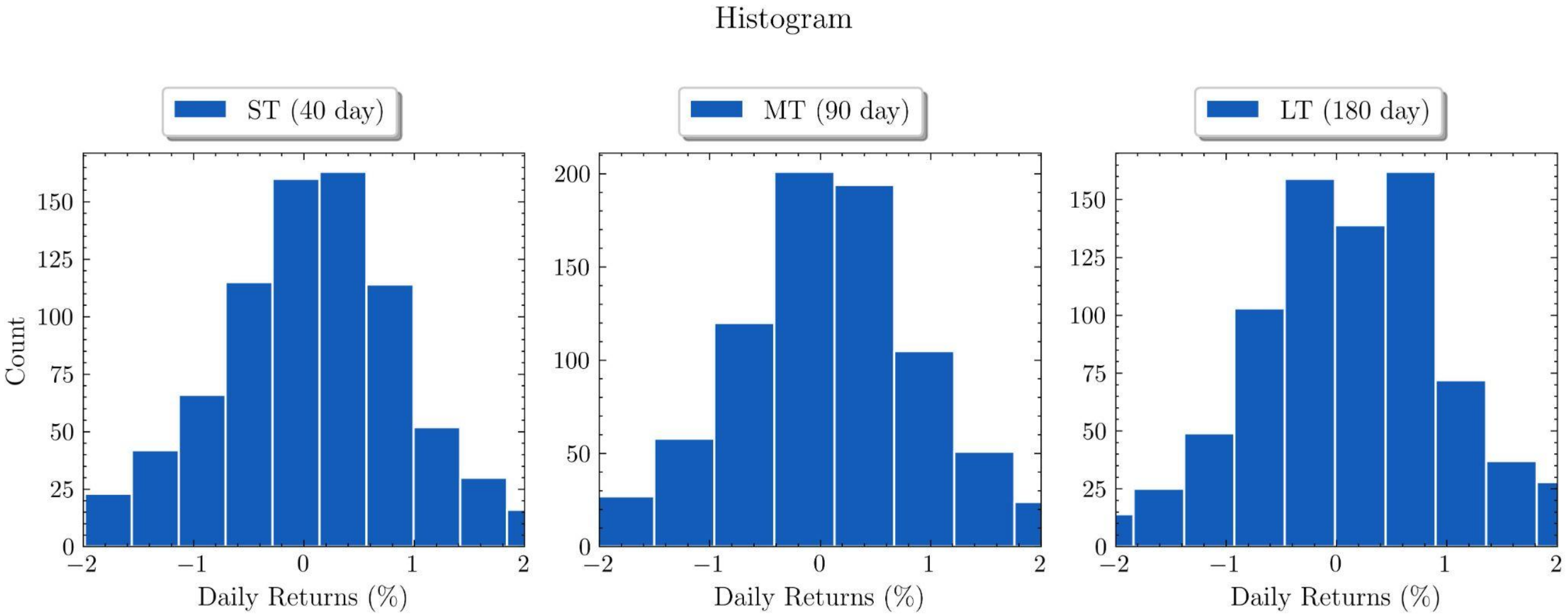


Mean	0.002
Standard Deviation	0.01

Mean	0.008
Standard Deviation	0.25

Mean	0.003
Standard Deviation	0.75

(λ = .5)



Mean	0.02
Standard Deviation	1.03

Mean	0.07
Standard Deviation	1.1

Mean	0.07
Standard Deviation	1.1

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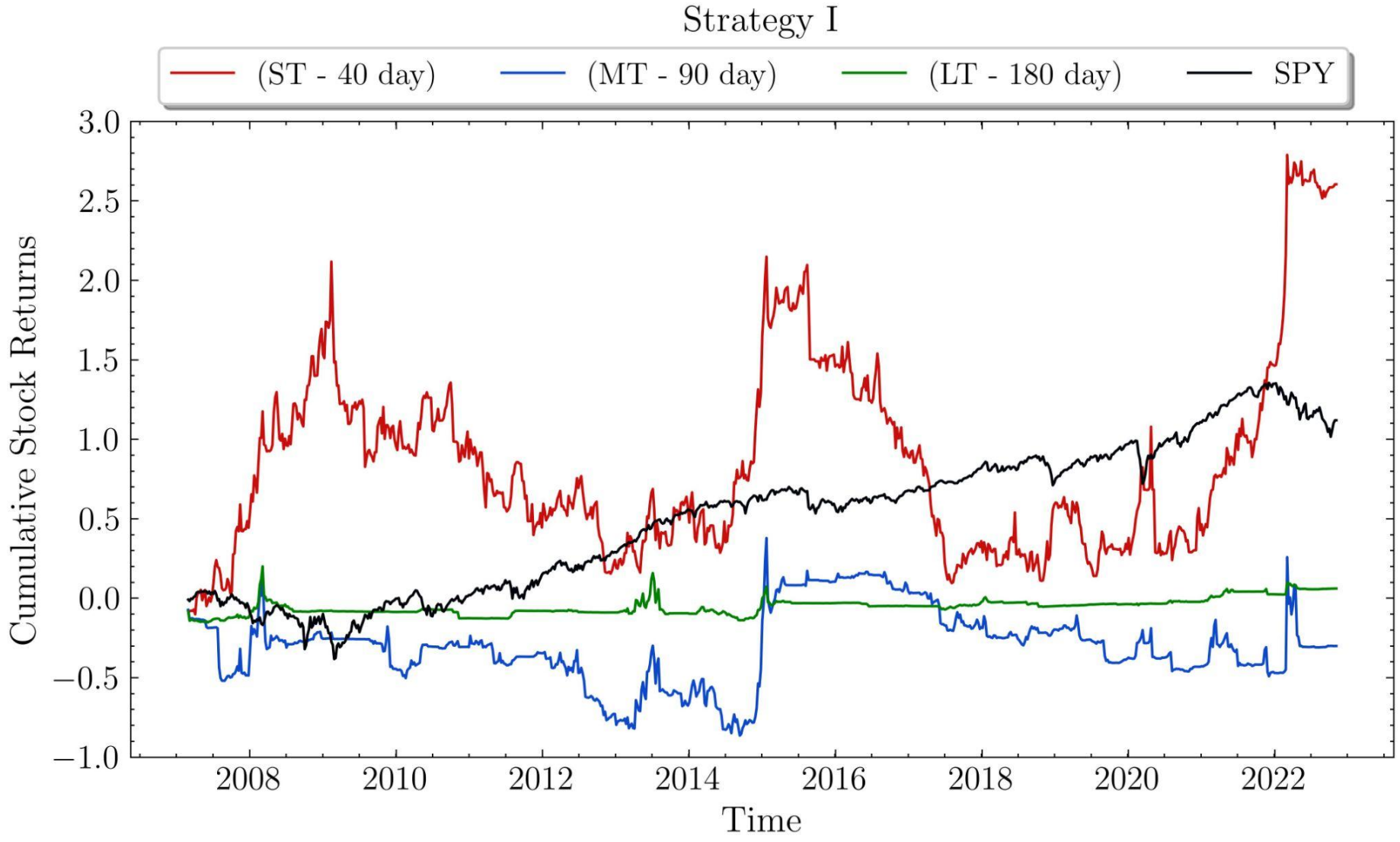
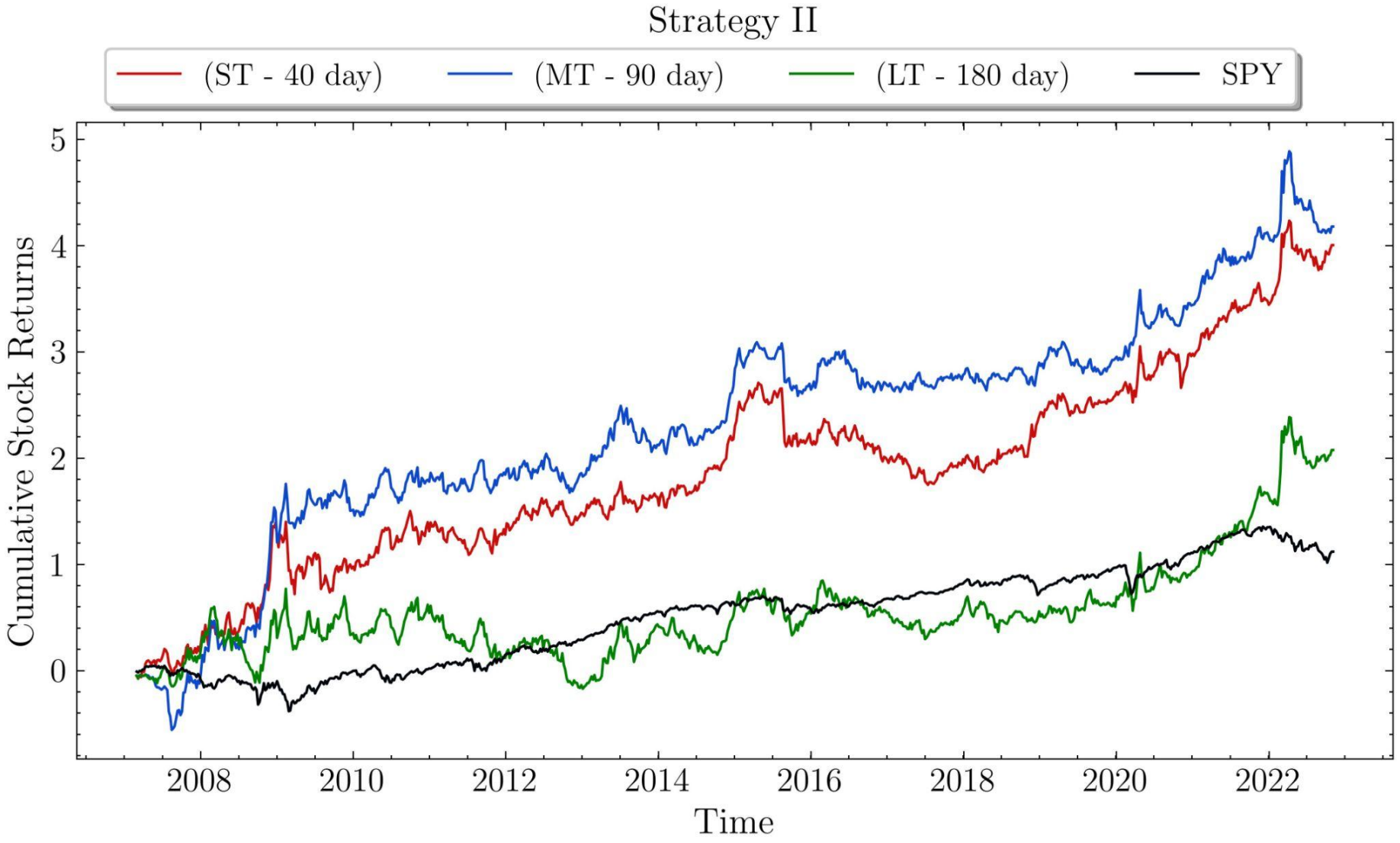
The last two slides represent $\lambda = .3$

Appendix (λ = .3)



Appendix (λ = .3)



Final Thoughts

- Is there a better way to visualize data from the summary table?
- Each variable has its own range. For example, mean return is generally small, and close to zero.
- Kurtosis however, might be more significant, ranging from 0 to 3.

The challenge

Each variable will need a unique y-axis. Otherwise, it will be challenging to interpret a bar graph. This is because plotting Kurtosis will make the bars for mean return so small it will be impossible to see!

INDEX	RESULTS_90_DAY_I	RESULTS_90_DAY_II
MEAN_RETURN	0.002176	0.066970
SHARPE_RATIO	0.215968	0.063362
SKEWNESS	-2.589913	-0.111833
KURTOSIS	49.715804	6.207317

Sample Plot