Online Appendix: Additional Results and Figures

The appendix is structured as follows. Section I discusses two generalized strategies and their performances. Section II provides additional figures on the empirical applications in Section 4, such as trading signals and trading performances of various strategies.

A.1 Two Generalized Strategies

In this section, I propose two generalized strategies (hereinafter Strategy D and Strategy E). I will first introduce how these two strategies work, and then discuss the computation of the optimal trading rules associated with these two strategies.

In Strategy A, I assume we will close the trade when the spread crosses the mean. I make this assumption for simplicity and it can be relaxed to construct generalized strategies with more flexible closing boundaries. For example, in Strategy D, I assume we close the trade when the spread crosses $(mean - \Delta)$ from above (or $(mean + \Delta)$ from below) for a parameter Δ, while keeping the threshold for opening a trade unchanged. See Tie et al. (2018) for an example of Strategy D. We can generalize Strategy C in a similar manner, and we call this generalization Strategy E. These two strategies are illustrated in Figures S1 and S2 for homoscedastic models.

To compute the optimal trading rule associated with these two strategies, I follow the simulation-based approach. More specifically, I represent $\Delta = \delta * U$ for a parameter δ, and search the optimal δ from $[-0.5, 1]$[1] for a grid size of 0.1. For every model specification and every realization of the process of the spread $\{x_t^{(m,n)}\}_{t=1}^T$, where m is for different models, and n is for different realizations of the spread in the simulation, I choose U_i from $[0.1, 2.5]$ and δ_j from $[-0.5, 1]$, where $i = 1, ..., 25$ and $j = 1, ..., 16$, and compute the resulting cumulative return and Sharpe ratio for Strategy D and Strategy E. For simplicity, I assume $L = -U$ in this section.

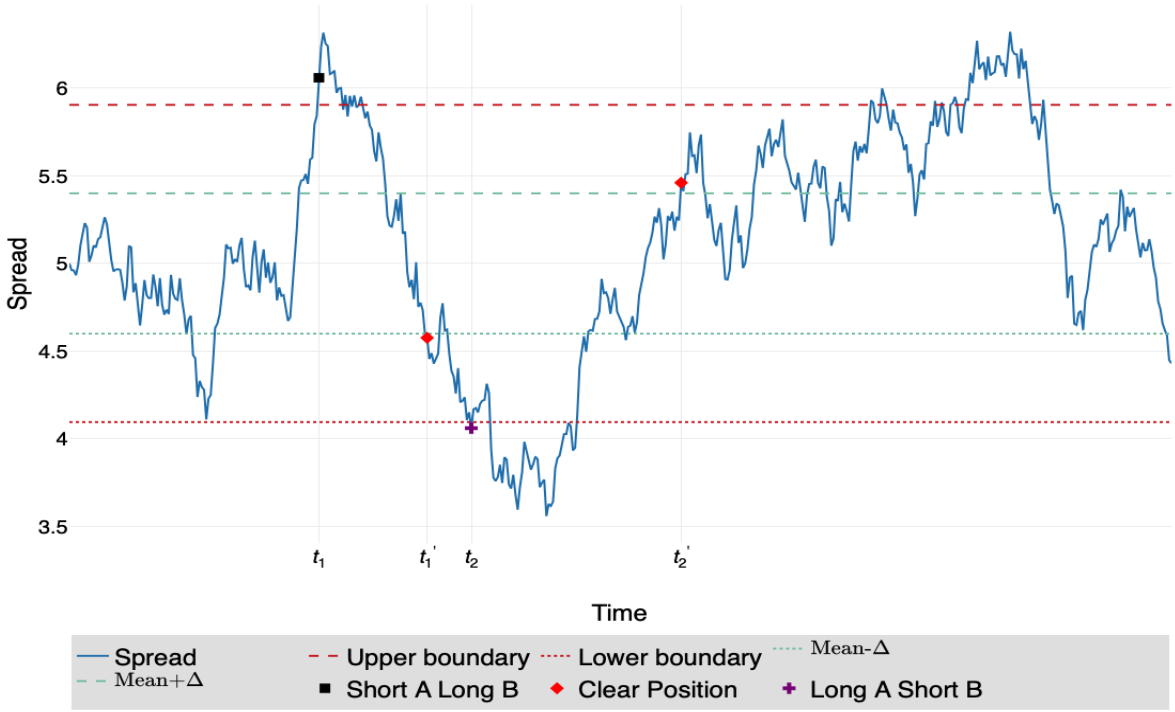
I use the following three specifications to compare the performance of Strategy D and Strategy E, and report the optimal threshold U^* and δ^*.

- Model A1: $x_{t+1} = 0.9590 * x_t + 0.0049 * \eta_t$, $\eta_t \sim N(0, 1)$
- Model A2: $x_{t+1} = 0.9590 * x_t + \sqrt{(0.00089 + 0.08 * x_t^2)} * \eta_t$, $\eta_t \sim N(0, 1)$
- Model A3: $x_{t+1} = 0.9 * x_t + 0.2590 * x_t^2 + \frac{0.0049}{\sqrt{3}} * \eta_t$, $\eta_t \sim$ t-distribution with 3 degrees of freedom

I follow the simulation size, trading length, transaction cost, and risk-free rate in Section 3.5. The optimal trading rules of Strategy D and Strategy E are given in Table S1. The expected

[1]It is easy to see that when $\delta = 0$, Strategy D (E) degenerates to Strategy A (C), and when $\delta = 1$ Strategy D degenerates to Strategy B. I assume $\delta \leq 1$ because when the spread crosses the upper boundary from below (or crosses the lower boundary from above), we will flip our position or close the trade, and not keep holding the previous portfolio.

Figure S1: Trading Strategy D



cumulative returns and Sharpe ratios as functions of various choices of U and δ are given in Figures S3-S5.

It is reasonable that we have better performance in Table S1 than Table 1 in terms of both return and Sharpe ratio since we have one more parameter (i.e., δ) in Strategy D and Strategy E. Also, notice that Strategy E shows optimal performances in most specifications when δ degenerates to 1, i.e., $\Delta = U$. In this case, we do not need any additional parameters to define Strategy E except U and L.

Figure S2: Trading Strategy E

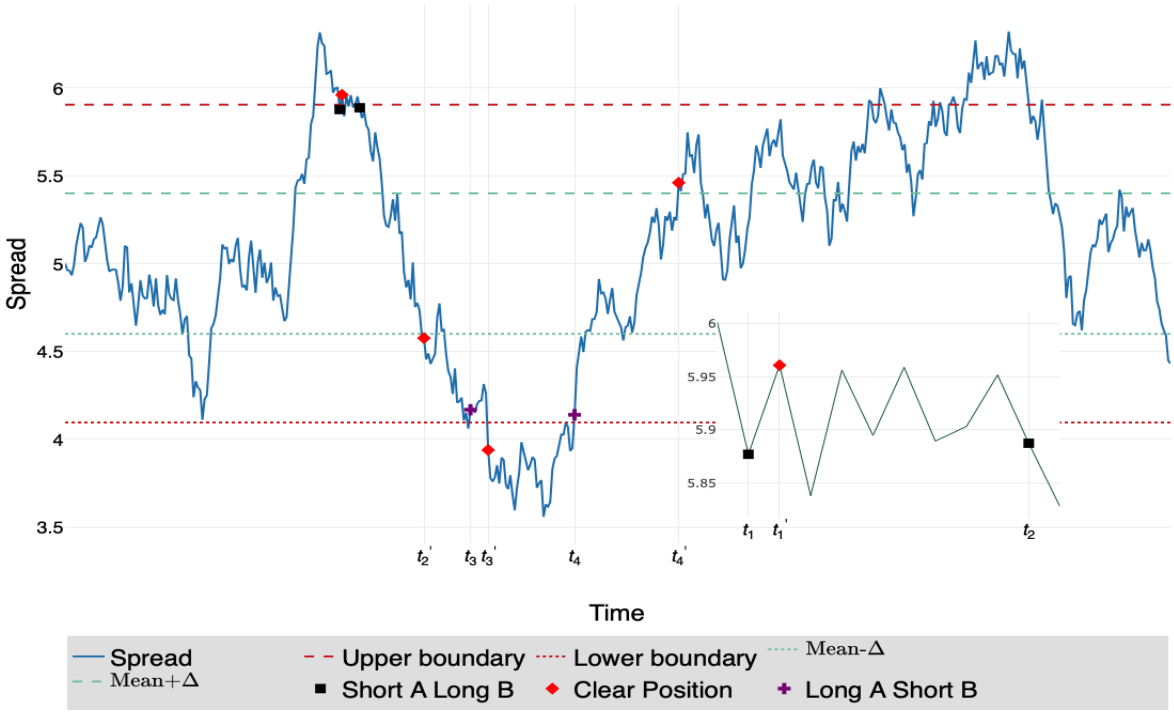


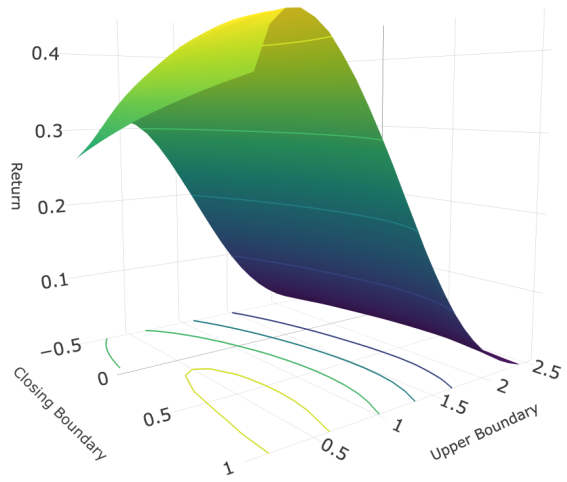
Table S1: Optimal Selection of Trading Rule for Cumulative Return and Sharpe Ratio

Model	Strategy	U^*	δ^*	CR	U^*	δ^*	SR
Model A1	D	0.4	0.8	0.4252	0.7	0.1	0.0885
	E	0.6	1	0.4234	0.4	0.9	0.1161
Model A2	D	0.2	0.6	4.0305	0.4	0	0.0751
	E	0.7	1	7.6958	0.2	1	0.2705
Model A3	D	0.6	0.8	0.5741	1.2	0	0.1293
	E	1	1	0.3733	1.1	0.5	0.1072

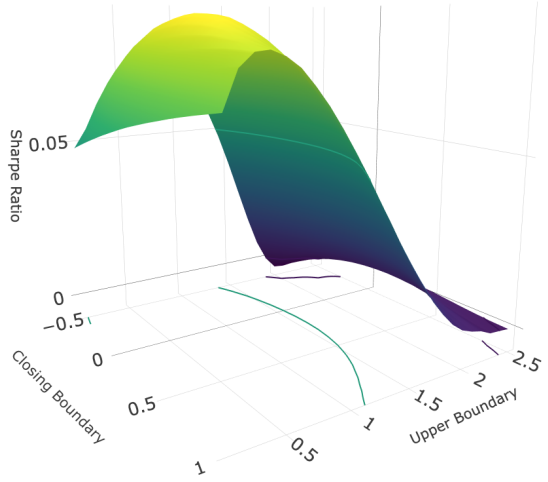
Note: The third and forth columns are the optimal choices of U and δ based on maximizing the cumulative return, and the fifth column is the resulting cumulative return. The sixth and seventh columns are the optimal choices of U and δ based on maximizing the Sharpe ratio, and the eighth column is the resulting Sharpe ratio. The cumulative return is displayed in decimal.

Figure S3: Performance of Strategy D and E, based on Model A1

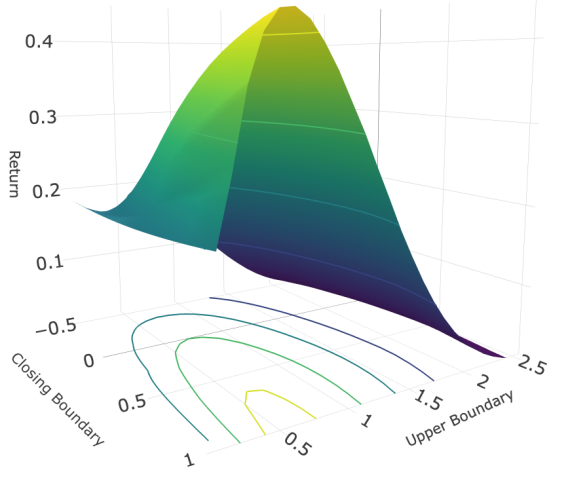
(a) Return of Strategy D, Model A1



(b) Sharpe Ratio of Strategy D, Model A1



(c) Return of Strategy E, Model A1



(d) Sharpe Ratio of Strategy E, Model A1

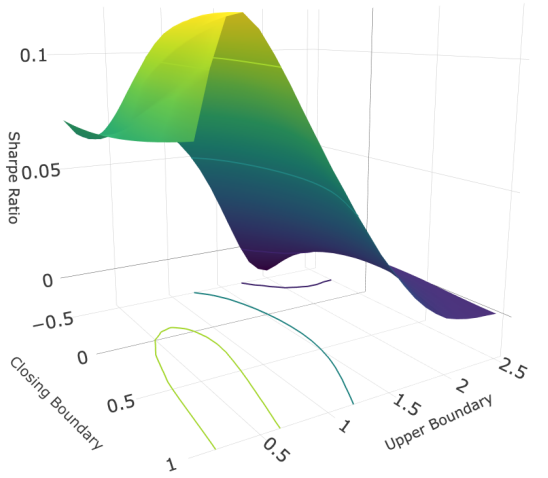
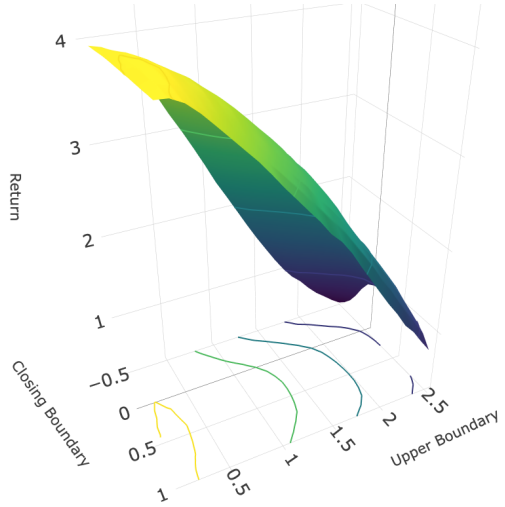
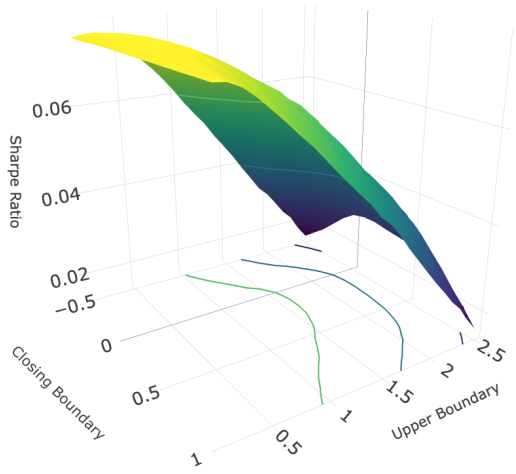


Figure S4: Performance of Strategy D and E, based on Model A2

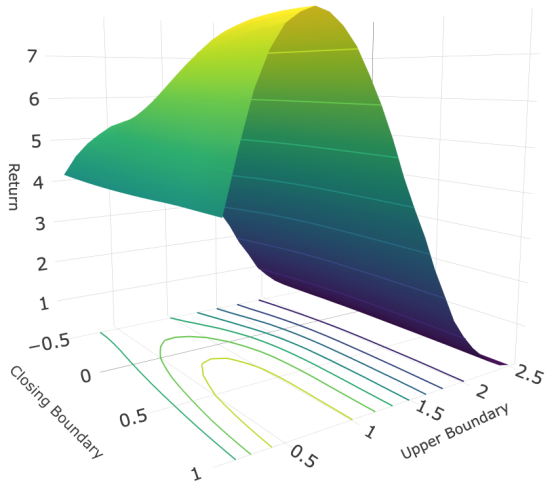
(a) Return of Strategy D, Model A2



(b) Sharpe Ratio of Strategy D, Model A2



(c) Return of Strategy E, Model A2



(d) Sharpe Ratio of Strategy E, Model A2

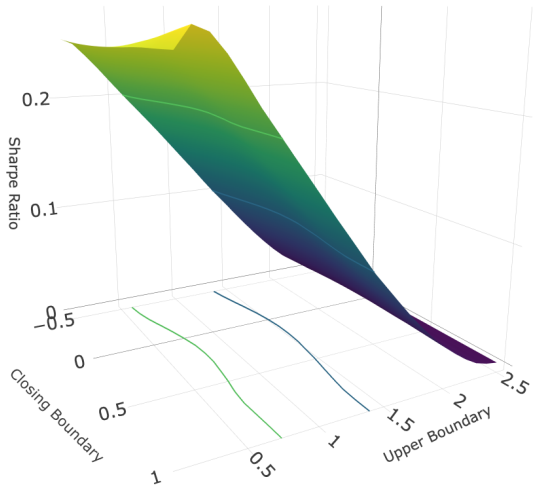
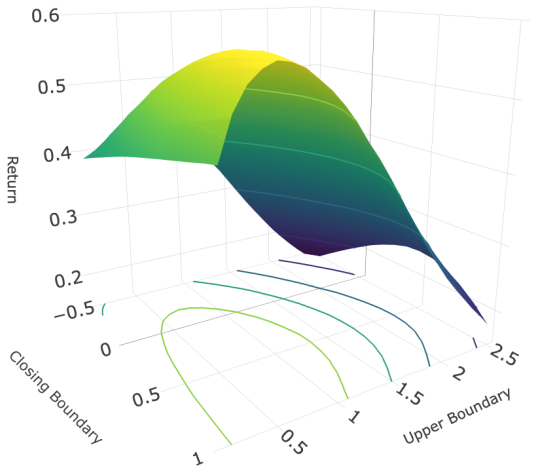
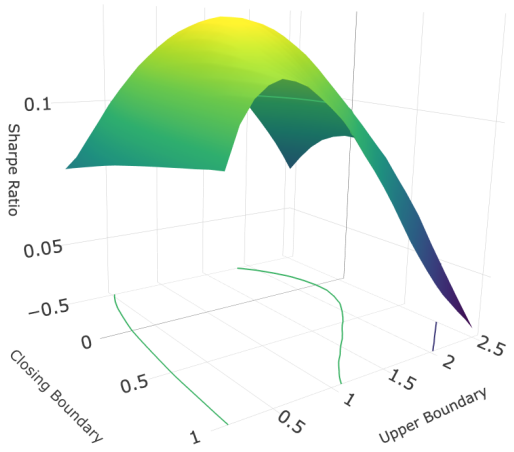


Figure S5: Performance of Strategy D and E, based on Model A3

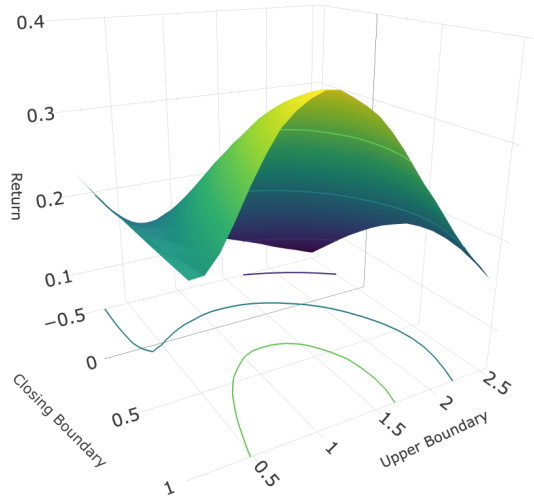
(a) Return of Strategy D, Model A3



(b) Sharpe Ratio of Strategy D, Model A3



(c) Return of Strategy E, Model A3



(d) Sharpe Ratio of Strategy E, Model A3

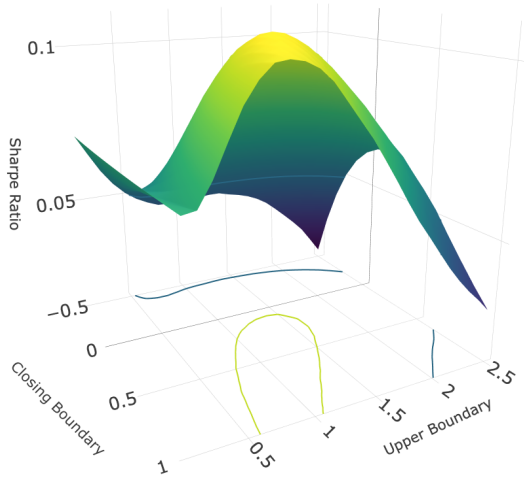
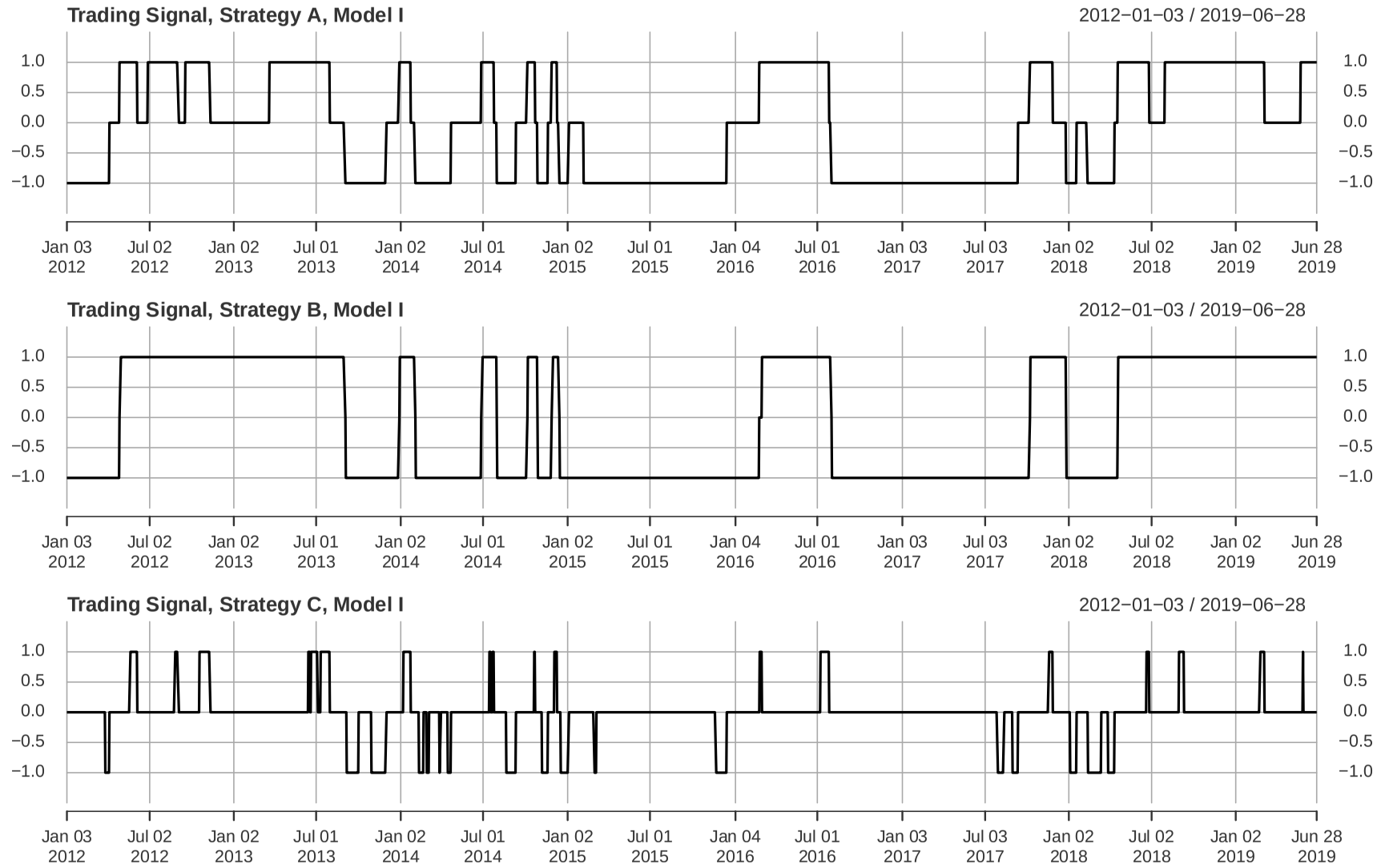
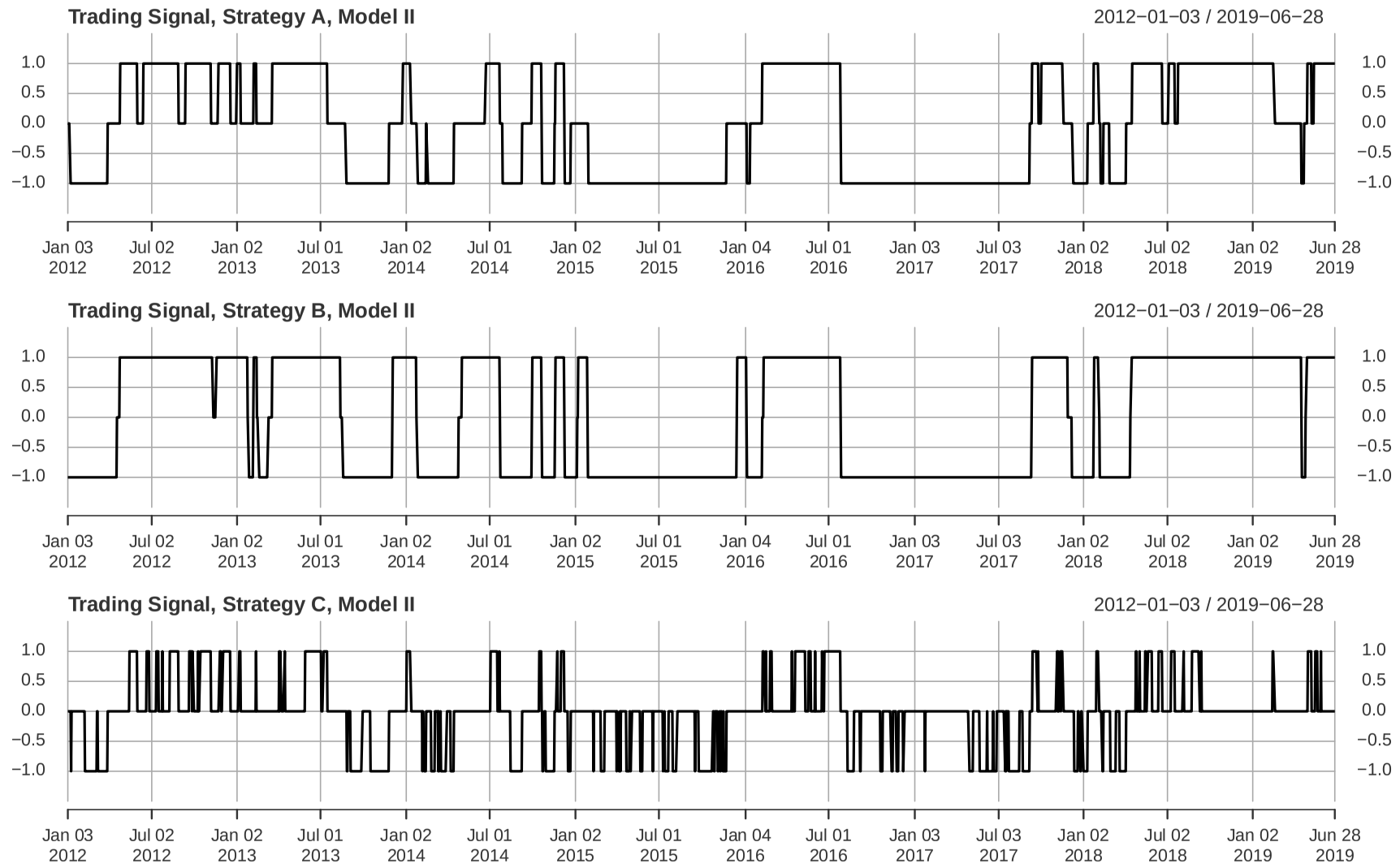


Figure S6: Trading signal of Strategy A, B and C on PEP vs. KO for Model I



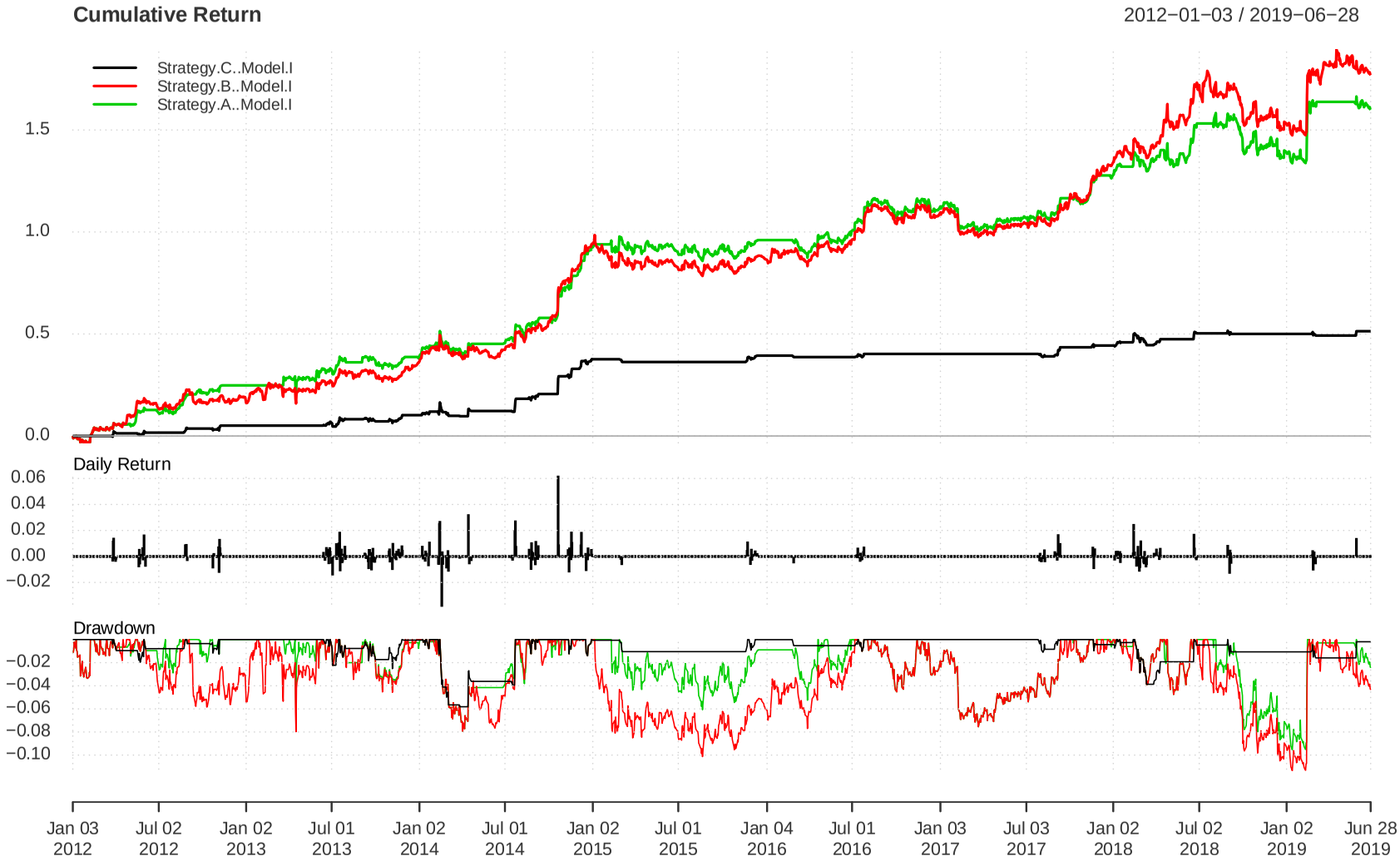
Note: When the trading signal is 1 we short PEP and long KO; when the trading signal is -1 we short KO and long PEP; when the trading signal is 0 we clear the position and hold no asset.

Figure S7: Trading signal of Strategy A, B and C on PEP vs. KO for Model II



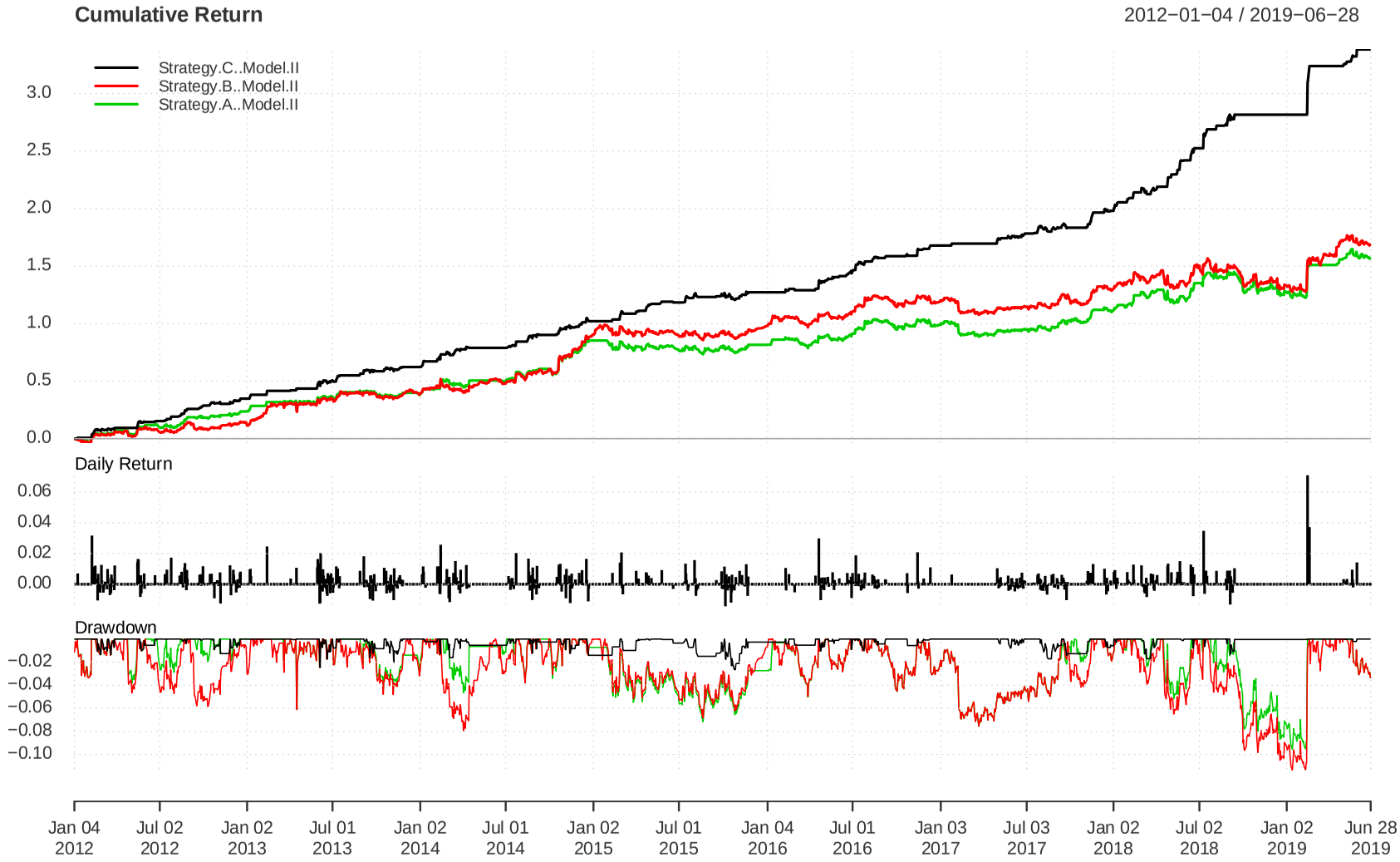
Note: When the trading signal is 1 we short PEP and long KO; when the trading signal is -1 we short KO and long PEP; when the trading signal is 0 we clear the position and hold no asset.

Figure S8: Trading Performance of Strategy A, B and C on PEP vs. KO for Model I



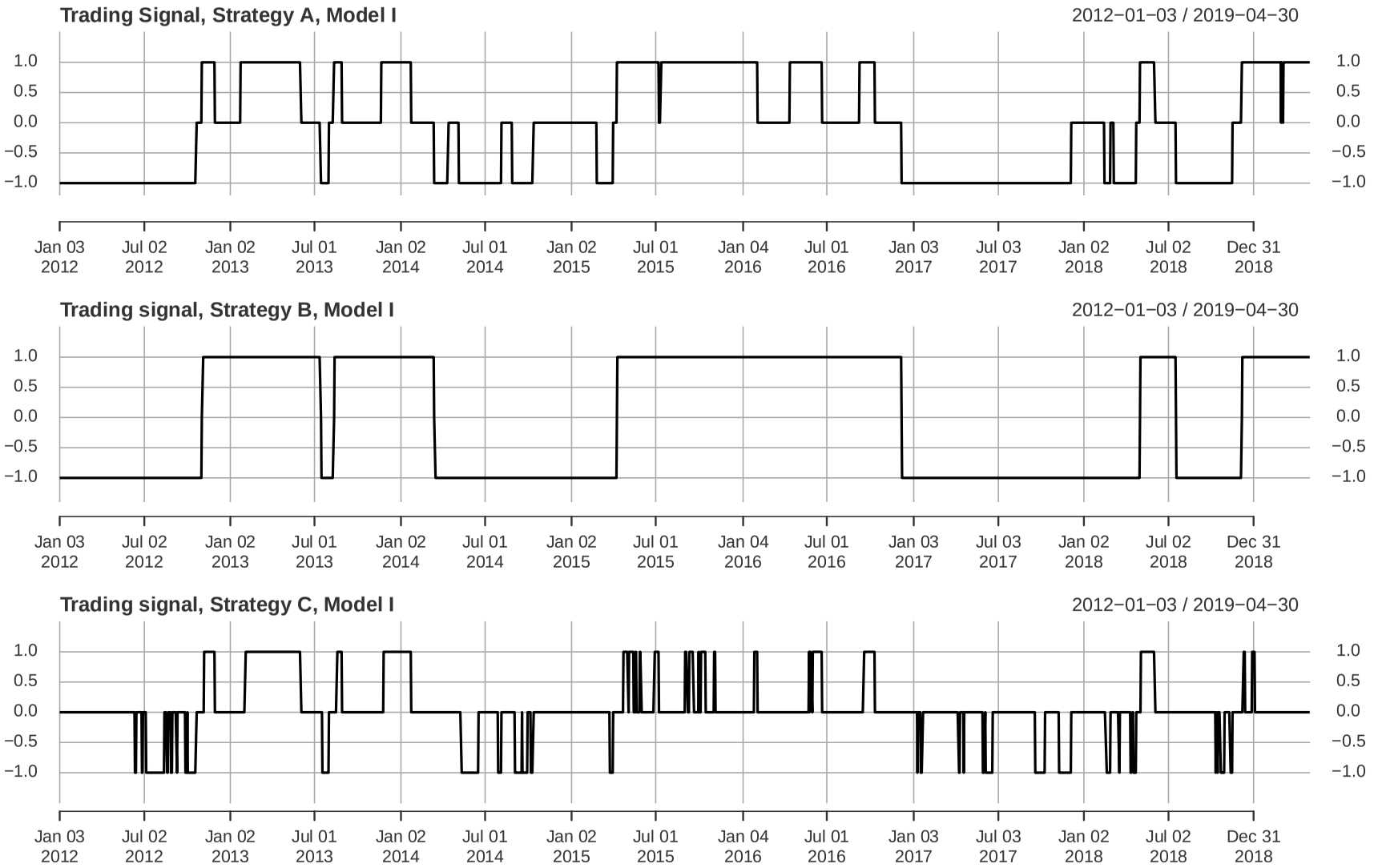
Note: Black curves are the results of Stragegy C; red curves are the results of Strategy B; green curves are the results of Strategy A. The Daily Return diagram is only for Strategy C

Figure S9: Trading Performance of Strategy A, B and C on PEP vs. KO for Model II



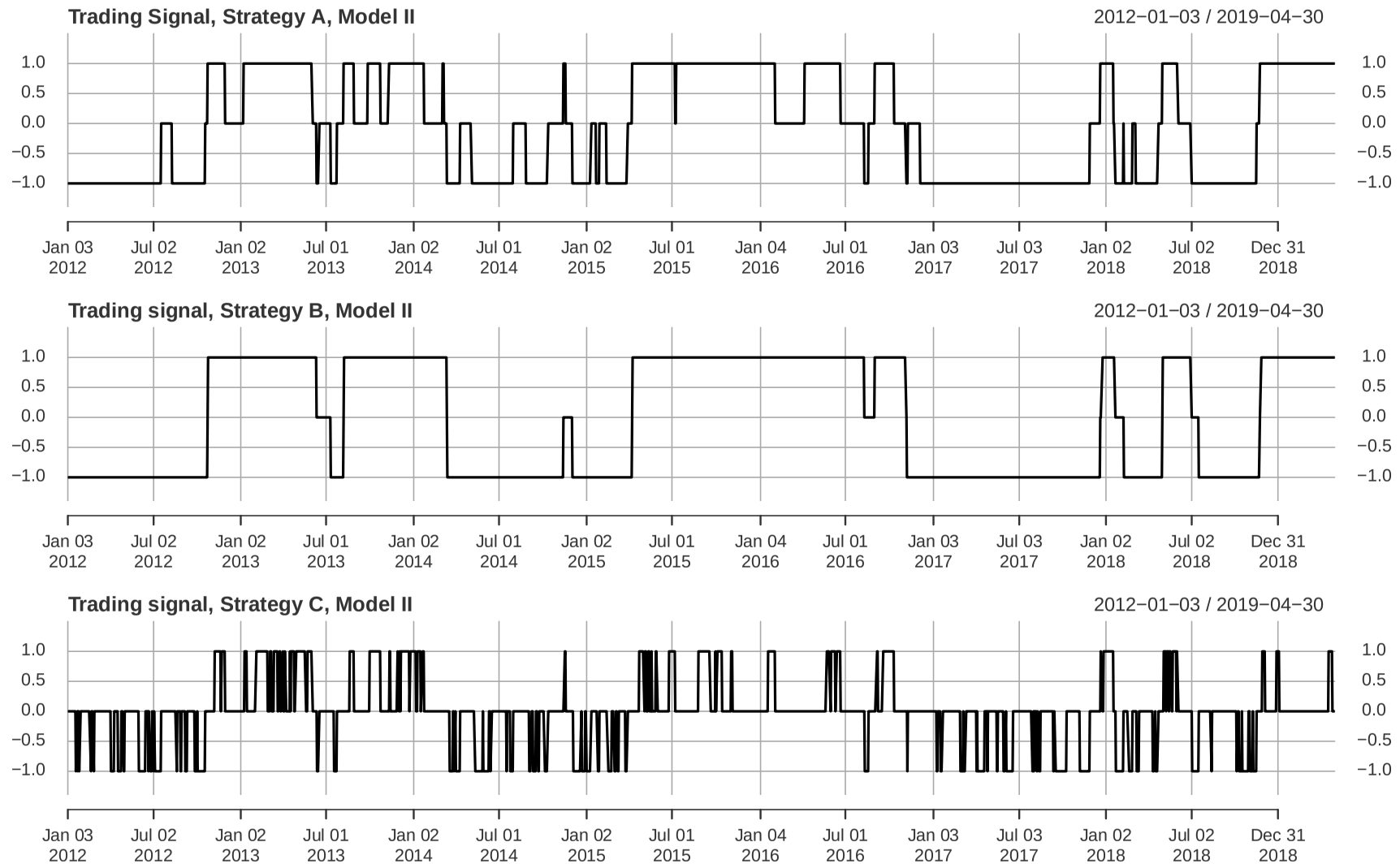
Note: Black curves are the results of Stragegy C; red curves are the results of Strategy B; green curves are the results of Strategy A. The Daily Return diagram is only for Strategy C

Figure S10: Trading signal of Strategy A, B and C on EWT vs. EWH for Model I



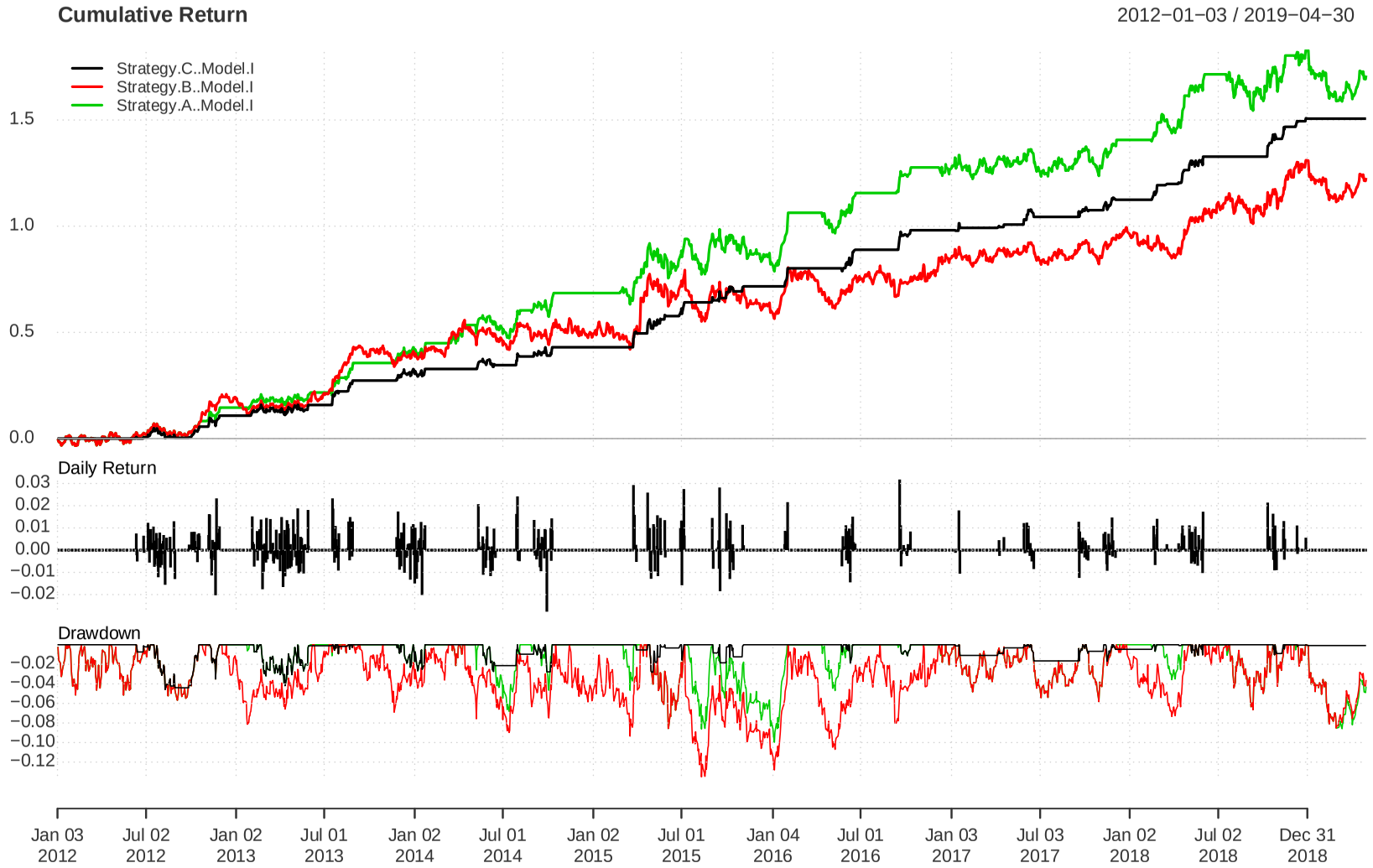
Note: When the trading signal is 1 we short EWT and long EWH;when the trading signal is -1 we short EWH and long EWT; when the trading signal is 0 we clear position and hold no asset.

Figure S11: Trading signal of Strategy A, B and C on EWT vs. EWH for Model II



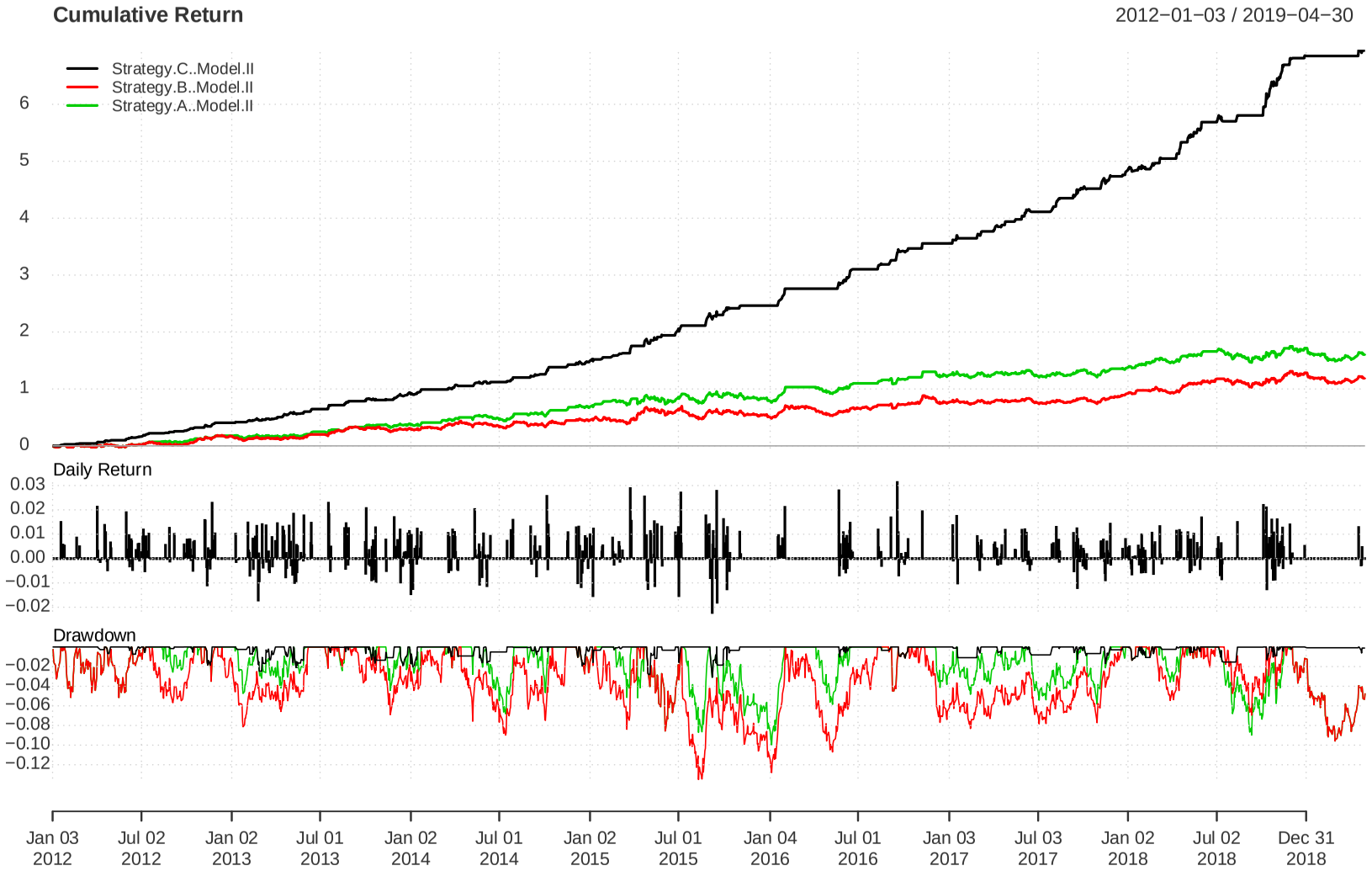
Note: When the trading signal is 1 we short EWT and long EWH;when the trading signal is -1 we short EWH and long EWT; when the trading signal is 0 we clear position and hold no asset.

Figure S12: Trading Performance of Strategy A, B and C on EWT vs. EWH for Model I



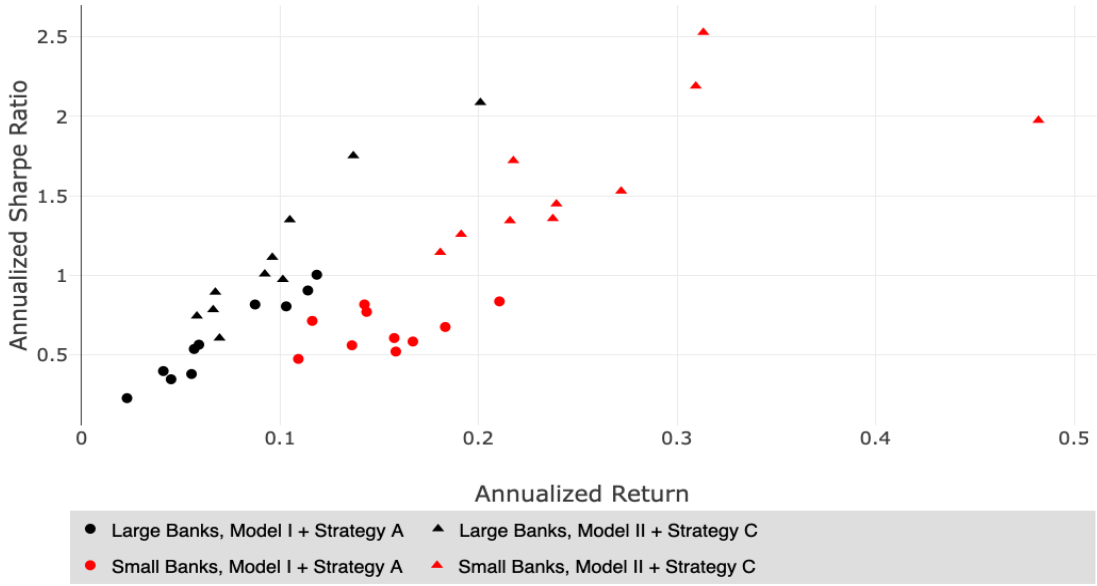
Note: Black curves are the results of Stragegy C; red curves are the results of Strategy B; green curves are the results of Strategy A. The Daily Return diagram is only for Strategy C

Figure S13: Trading Performance of Strategy A, B and C on EWT vs. EWH for Model II



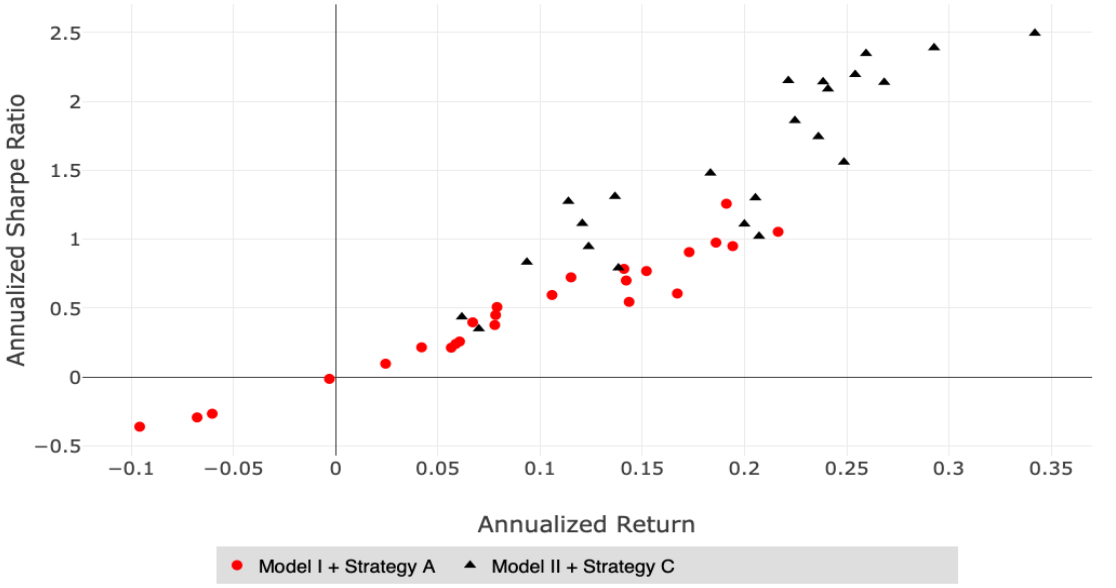
Note: Black curves are the results of Stragegy C; red curves are the results of Strategy B; green curves are the results of Strategy A. The Daily Return diagram is only for Strategy C

Figure S14: Annualized Return and Sharpe Ratio of Pairs Trading on Pairs of Large Banks and Pairs of Small Banks



Note: Black circles are the performances of Model I + Strategy A on pairs of large banks, red circles are the performances of Model I + Strategy A on pairs of small banks, black triangles are the performances of Model II + Strategy C on pairs of large banks, and red triangles are the performances of Model II + Strategy C on pairs of small banks.

Figure S15: Annualized Return and Sharpe Ratio of Pairs Trading on Pairs Between Large Banks and Small Banks



Note: Red circles are the performances of Model I + Strategy A on pairs between large banks and small banks: one from the group of large banks and the other one from the group of small banks; the black triangles are the performances of Model II + Strategy C on those pairs.