Week 1 - Summer 2021

Cheng Lu

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Last Meeting Summary

- Thorough experiment results
- Portfolio stats: volatility and turn over
- Expand literature review
- Expand experiment to lager dataset

Experiment Goal

Table 1: Sharpe ratio on DOW 30 from 1996 to 2017

Naive Shrinkage		
Strategy	TBN	Identity
shrink 0 pct	0.444084	0.444084
shrink 50 pct	0.349595	0.507769
shrink 100 pct	-0.430668	0.573233
Ledoit &Wolf		
linear shrinkage	NA	0.471745
non-linear	NA	0.449374
Minimum Spanning Tree		
MST stock	-0.056445	-
MST TBN	0.667070	-
Reinforcement Learning		
DQN	0.122987	0.506485
REINFORCE	-0.490042	0.503571

Problem

- Available shrinkage packages only allow shrinking to few targets, like factor model. They doesn't allow shrinking to other target, like TBN.
- Ledoit provides estimator(see Appendix) for shrink intensity but it's not complete.
- It depends on the choice of shrinkage target and requires a case-by-case analysis.
- Our results(next page) doesn't show a reasonable performance. Values are too small.

Shrink to TBN

	alpha TBN x10^5	alpha MST x10^5	alpha identity
1996	0.213	-0.033	0.133
1997	0.364	-0.033	0.090
1998	0.581	-0.045	0.088
1999	0.363	-0.059	0.102
2000	0.978	-0.093	0.160
2001	0.446	-0.054	0.064
2002	0.272	-0.049	0.041
2003	0.086	-0.020	0.040
2004	0.060	-0.018	0.122
2005	0.044	-0.015	0.074
2006	0.041	-0.017	0.096
2007	0.043	-0.016	0.051
2008	1.306	-0.033	0.051
2009	0.305	-0.031	0.035
2010	0.054	-0.010	0.034
2011	0.144	-0.013	0.031
2012	0.045	-0.012	0.057
2013	0.031	-0.014	0.092
2014	0.026	-0.012	0.067
2015	0.036	-0.013	0.036
2016	0.034	-0.014	0.068

Table 2: Shrinkage intensity of different targets

[1] [2] [3]

[1] First two columns' values are multiplied by 10^5

[2] Third column are computed using sklearn as benchmark

[3] First two columns' values calculated by our program using Ledoit's estimator

Next

- Double check estimator ρ_T formula
- Double check codes
- Potential solution: use the diagonal item of TBN to simplify the problem
- continue with remaining tasks

Appendix

$$\gamma_T^* = \frac{1}{T}\frac{\pi_T - \rho_T}{\nu_T} + O\left(\frac{1}{T^2}\right)$$

$$\pi_T = \sum_{i=1}^{N}\sum_{j=1}^{N} A\,\mathrm{sy}\,\mathrm{Var}\left(\sqrt{T}s_{ij}^T\right)$$

$$\rho_T = \sum_{i=1}^{N}\sum_{j=1}^{N} \mathrm{AsyCov}\left(\sqrt{T}f_{ij}^T, \sqrt{T}s_{ij}^T\right)$$

$$\nu_T = \sum_{i=1}^{N}\sum_{j=1}^{N} \left(\phi_{ij}^T - \sigma_{ij}^T\right)^2$$

Appendix

$$\tilde{\gamma}_T^* := \frac{1}{T}\frac{\hat{\pi}_T - \hat{\rho}_T}{\hat{\nu}_T}$$

$$\hat{\pi}_T := \sum_{i=1}^{N}\sum_{j=1}^{N}\hat{\pi}_{ij}^T \quad \text{with} \quad \hat{\pi}_{ij}^T := \frac{1}{T}\sum_{t=1}^{T}\left[x_{ti}^T x_{tj}^T - s_{ij}^T\right]^2$$

$$\hat{\nu}_T := \sum_{i=1}^{N}\sum_{j=1}^{N}\left(f_{ij}^T - s_{ij}^T\right)^2$$

$$\hat{\rho}_T := \sum_{i=1}^{N}\sum_{j=1}^{N}\hat{\rho}_{ij}^T \quad \text{with} \quad \hat{\rho}_{ij}^T := \frac{1}{T}\sum_{t=1}^{T}\left[x_{ti}^T x_{tj}^T - s_{ij}^T\right]\left[f_{ij} - E[f_{ij}]\right]$$

Ledoit doesn't provide estimator ρ_T, because it depends on shrink target.