Deep Portfolio

Kyounghun Bae
-Hanyang University-

Contents

- traditional portfolio selection
- deep portfolio four steps
  - autoencode, calibrate, validate, verify
- deep portfolio characteristics
- new paradigm based on deep portfolio

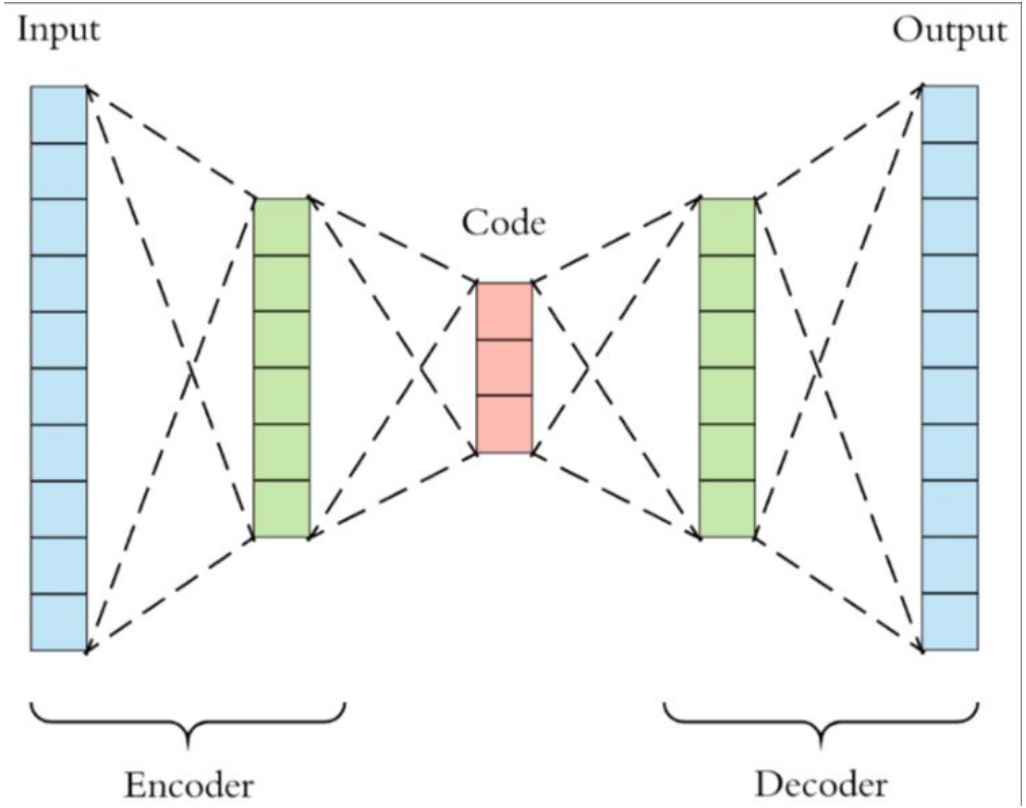
Traditional Portfolio Selection

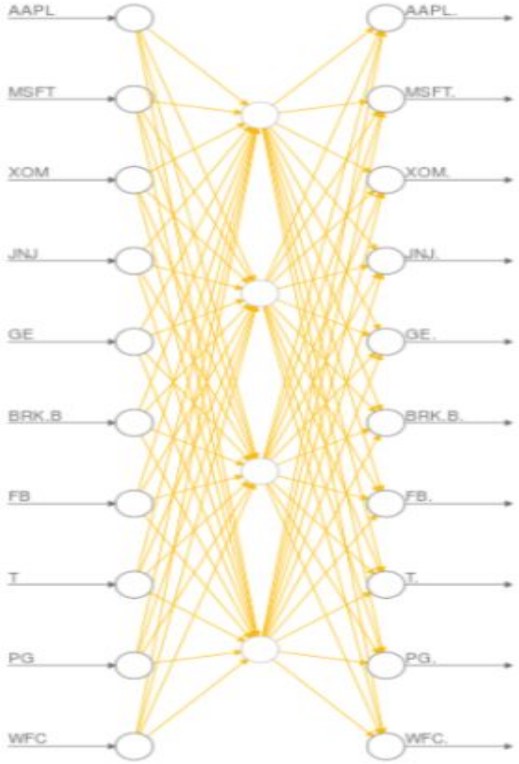
- Markowitz optimization
  - mean, variance and covariance
  - ignore higher moments, higher co-moments
  - ignore jump and large volatility
- multifactor model + alpha research
  - back-testing issue
  - static
  - AQR example

Deep Portfolios

- **4- Steps: auto-encode, calibrate, validate, and verify**
- in-sample fitting: find deep portfolio
  - **auto-encoding**: find the market-map
    - extract risk factors
    - auto-encoder
  - **calibrating**: find the portfolio-map
    - create a portfolio from X for the approximation of objective Y
    - Kolmogorov-Arnold theorem

Autoencoder: extract risk factors

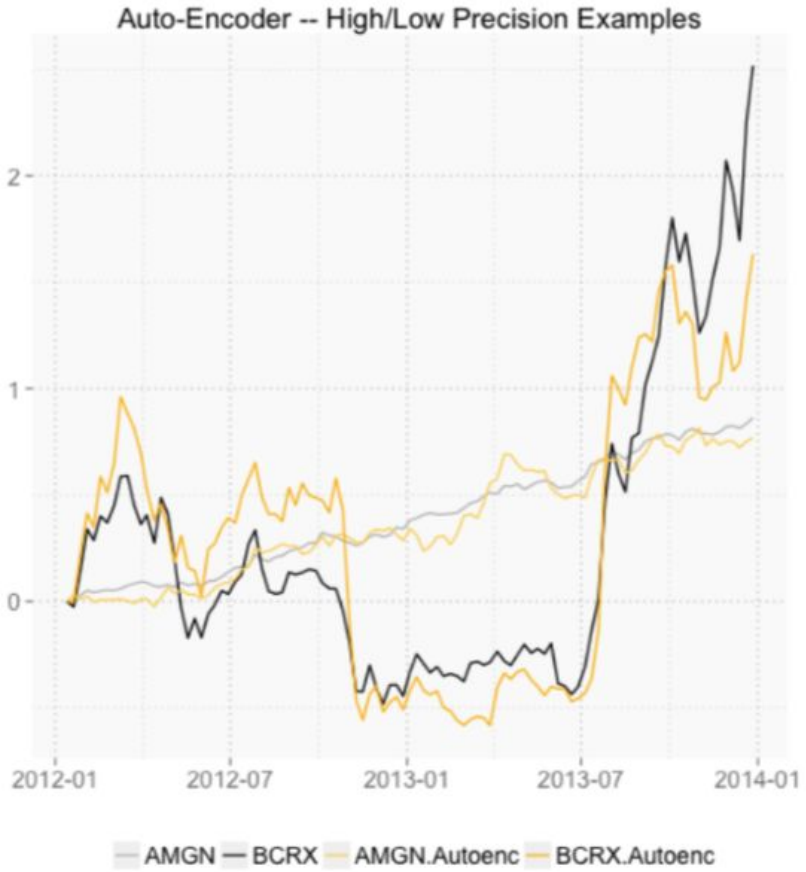


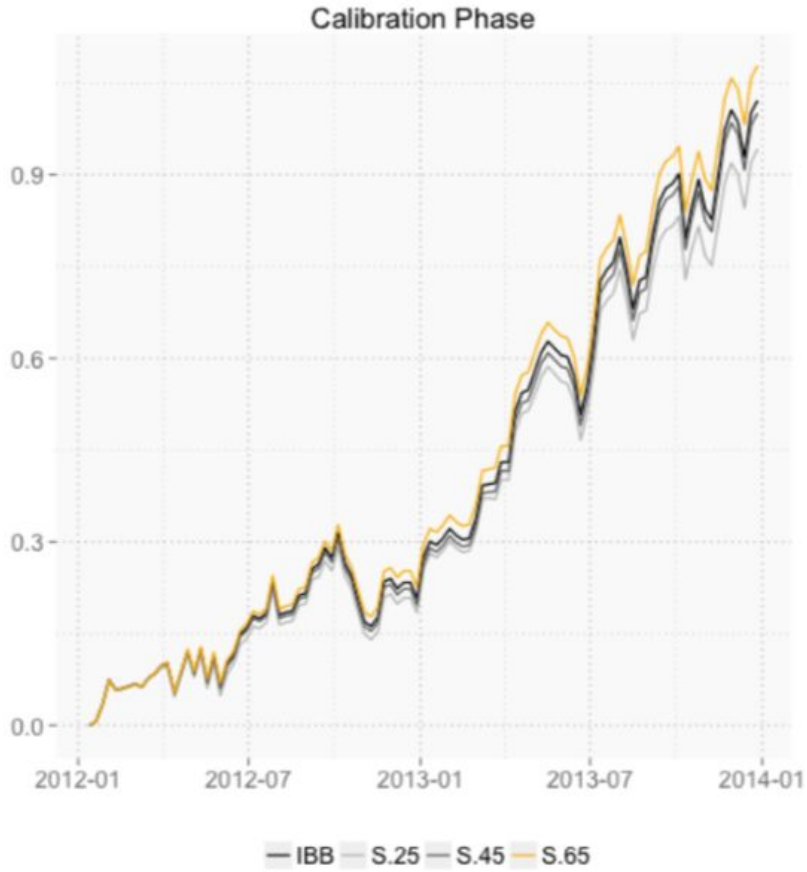


Deep Portfolios

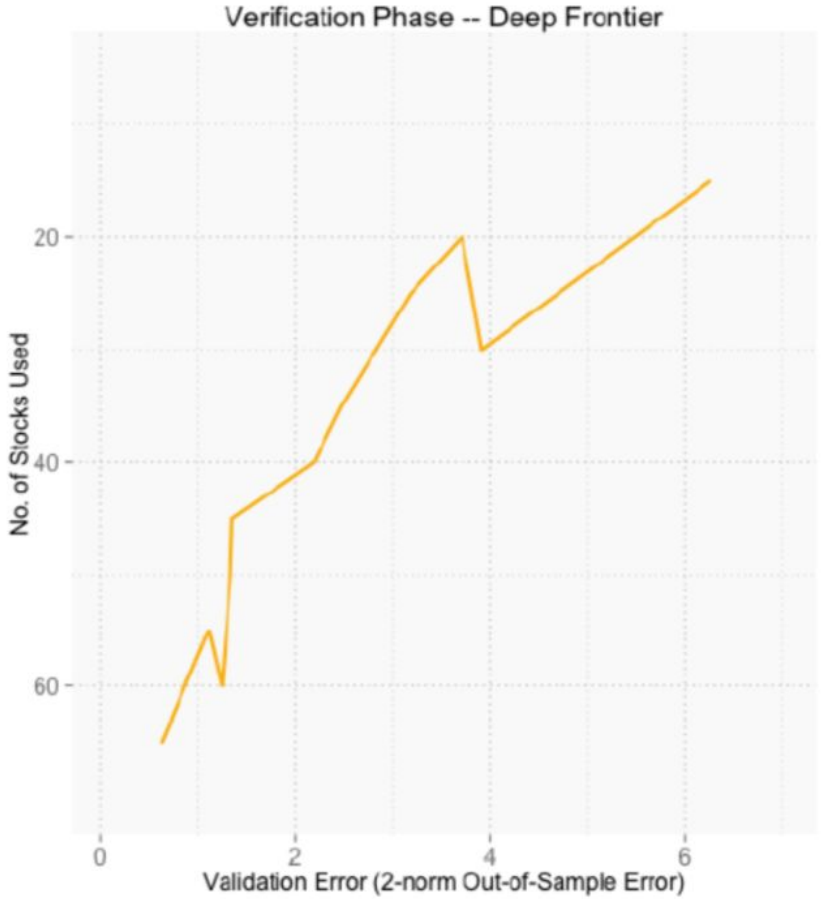
- out-of-sample test: test deep portfolio
  - **validating:** Find Lm and Lp to balance the trade-off between the two errors: e_m, and e_p
  - **verifying**
    - The verification step uses a cross validation approach to trace out an ex post deep portfolio efficient frontier.
- note: activation functions: tanh or rectified linear units (ReLU)

Heaton, Polson and Witte (2016): Figure 2





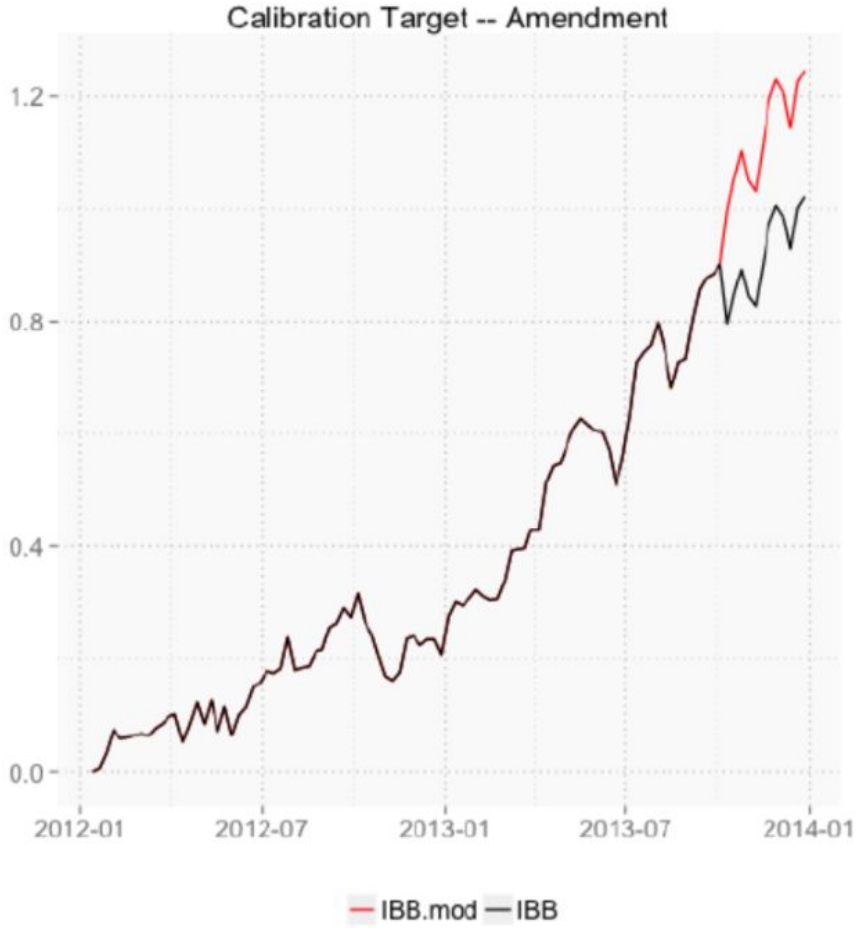
Heaton, Polson and Witte (2016): Figure 2

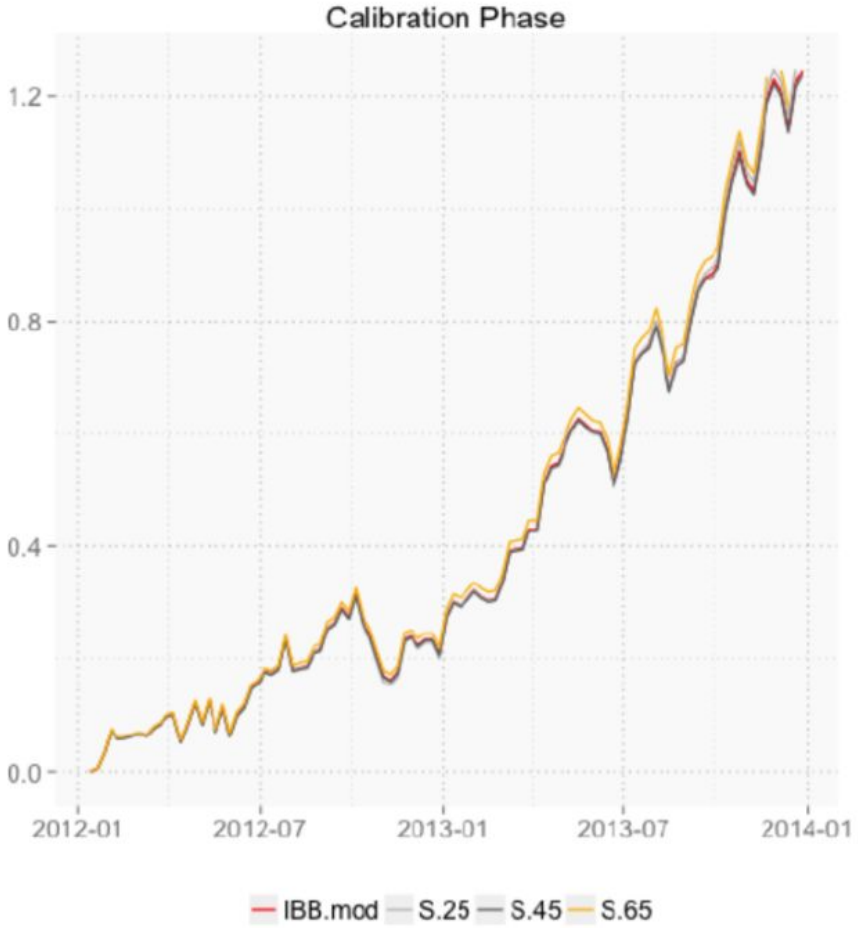


Bae and Kang (2018): Calibration (In-Sample)

Bae and Kang (2018): Validation (Out-Sample)

Heaton, Polson and Witte (2016): Figure 3





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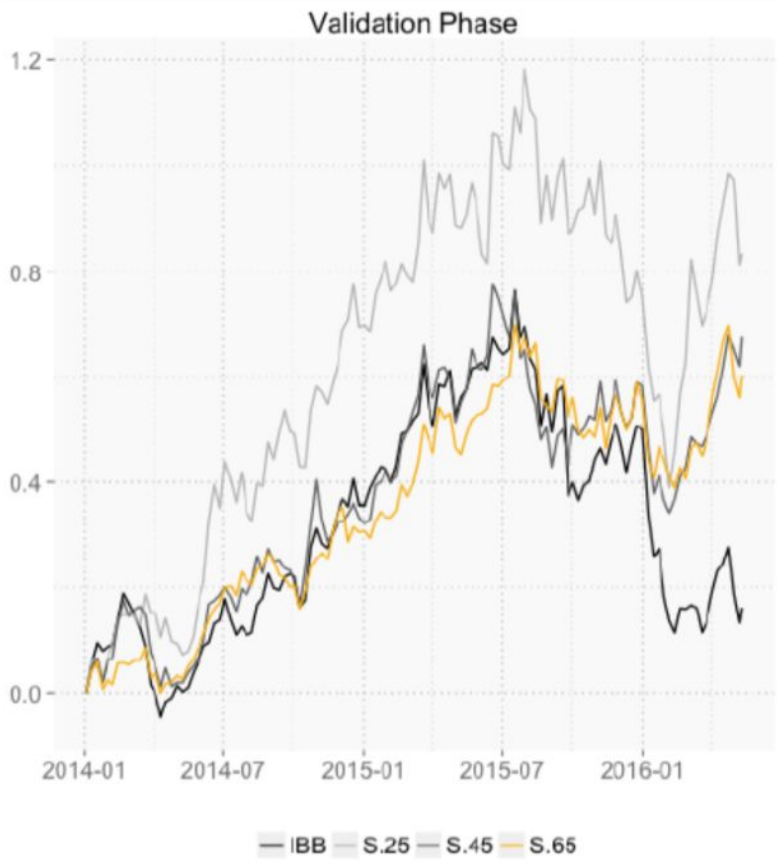
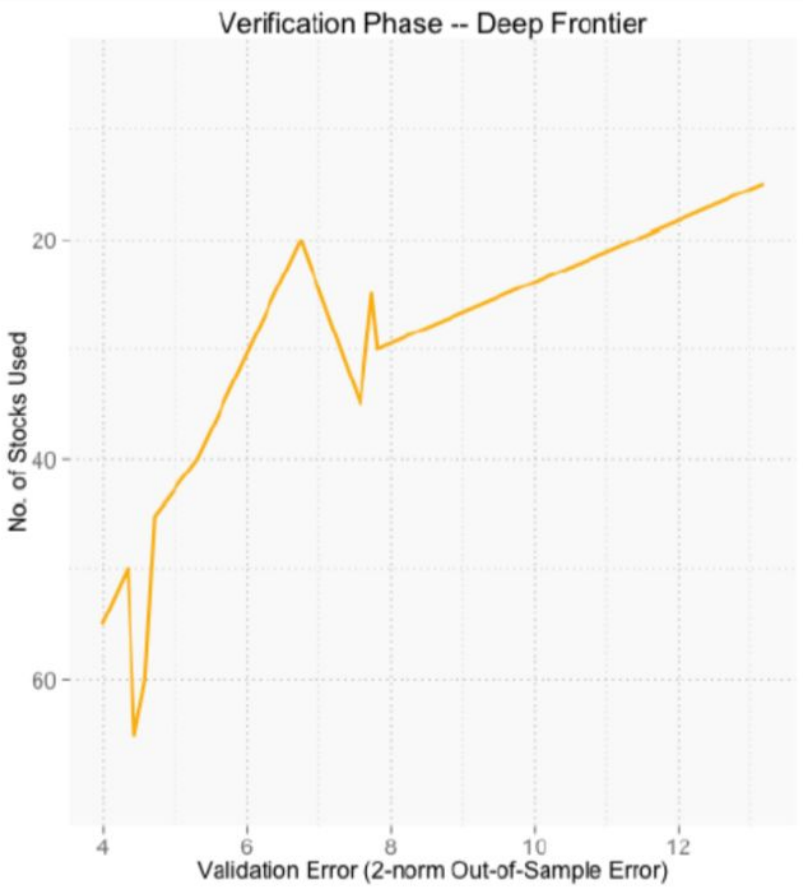
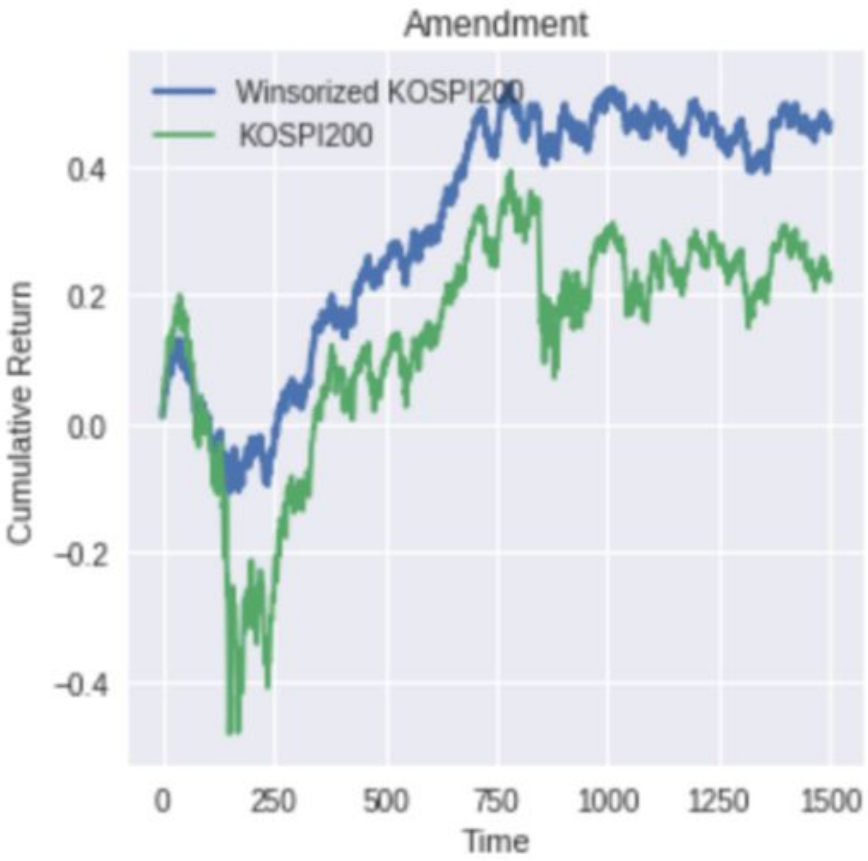
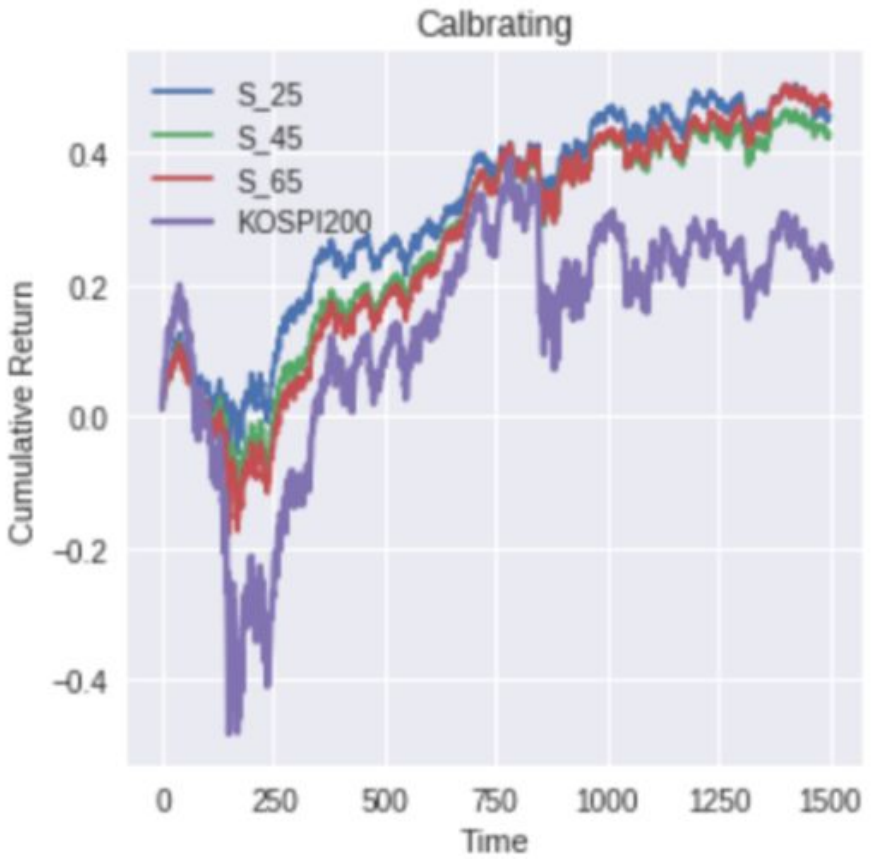


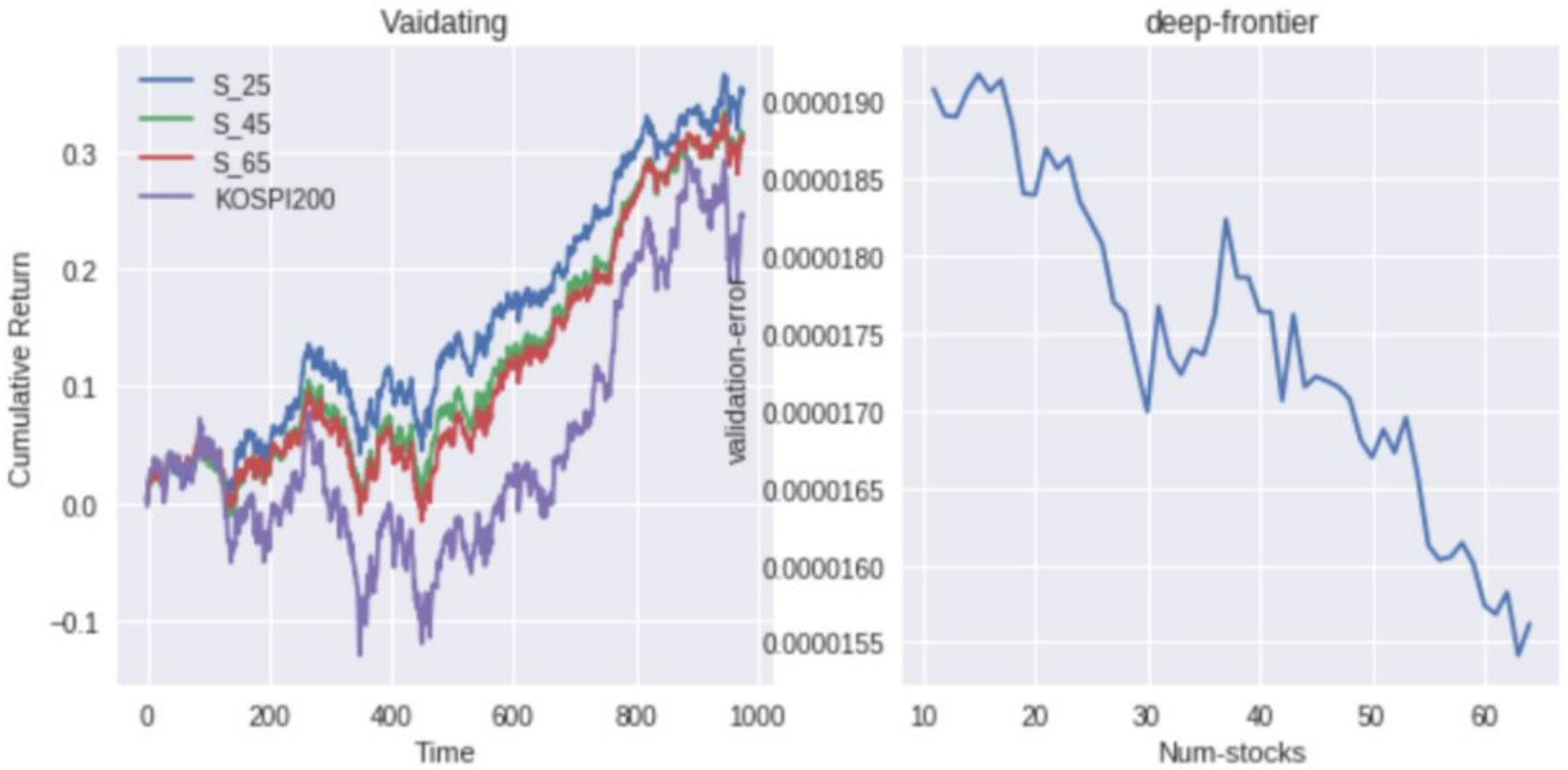


Bae and Kang (2018): Calibration (In-Sample)





Bae and Kang (2018): Validation and Verification (Out-Sample)



Deep Portfolio Characteristics

- reduce model dependence
- no model for variance-covariance matrices
- allow for non-linearities in a time-varying implied variance-covariance structure
- portfolio optimization and inefficiency detection become an almost entirely data driven (and therefore model free) tasks.

Deep Portfolio Characteristics

- avoid the specification of any statistical inputs such as expected returns or variance-covariance matrices.
- if we had allowed for richer non-linear structure in determining the market-cap, we could capture lower pricing errors whilst still providing good-out-of-sample portfolio efficiency. (need to include non-linear payoff from derivatives contracts)
- conditioning variable z: accounting variable or derivative price

New Paradigm based on Deep Portfolio

- feed alpha portfolios and risk managements tools to deep portfolios
- track benchmark (e.g. KOSPI 200, S&P 500)
- add alpha (1%, 2%, 3%, or etc)
  - let deep portfolios to detect the best active-alpha
- avoid large drawdowns
  - let deep portfolios to use the best risk managements tools

New Paradigm based on Deep Portfolio

- conditioning variables: financial data + textual data
  - options and futures open interests
  - all news articles
  - facebook
  - twitter
  - Blogs: seeking alpha, etc
  - analysts reports

New Paradigm based on Deep Portfolio

- tracking benchmark
- dynamic alpha generating
- dynamic risk managements