Predictive Stability

Monte Carlo Simulation of Predictive Stability under Structural Breaks

Mahir Baylarov
Bakhodir Izzatullaev
Aadya

University of Bonn

January 2026

Introduction: Predictive Instability

- Forecasting models are typically derived under assumptions of parameter stability
- Many economic time series exhibit structural instability over time
- Structural breaks invalidate maintained model assumptions and may induce forecast breakdown
- Strong in-sample performance may fail to translate into out-of-sample accuracy
- This phenomenon has been documented in empirical forecasting studies (Stock & Watson, 1996; Clements & Hendry, 1998)

Structural Breaks and Forecasting Performance

- Forecasting models estimated under stability implicitly average across regimes
- Structural change can induce forecast bias and forecast breakdown
- Strong in-sample performance may fail out-of-sample under instability
- Forecast evaluation itself becomes more difficult when breaks are present

$$\hat{y}_{t+h|t} = \mathbb{E}_t(y_{t+h} \mid \theta), \qquad \theta \text{ assumed constant}$$

Instability in forecasting relationships documented by Stock & Watson (1996)

Forecast Breakdown and Evaluation

- Structural breaks invalidate forecasts based on historical averages
- Forecast breakdown reflects model failure rather than purely stochastic noise
- Out-of-sample tests may have low power in the presence of instability

$$\mathrm{MSFE}_{t+h} = \mathbb{E}\left[(y_{t+h} - \hat{y}_{t+h|t})^2\right] \quad \uparrow \text{ after a break}$$

Forecast breakdowns: Clements & Hendry (1998)

Low power of forecast tests: Clark & McCracken (2001, 2012)

Monte Carlo Simulation under Structural Breaks

- Monte Carlo simulation provides a controlled framework for forecast evaluation
- The data-generating process can be specified explicitly
- Timing, magnitude, and frequency of structural breaks can be varied systematically
- Forecast errors can be evaluated relative to known true values

$$\text{Loss}_h = \mathbb{E}\left[\left(y_{t+h} - \hat{y}_{t+h|t}\right)^2\right]$$

Models as approximations rather than a fixed truth: Hansen (2005)

Data-Generating Process and Forecast Evaluation

- The data are generated from an AR(1) process
- A single deterministic structural break occurs in the autoregressive parameter
- One-step-ahead forecasts are generated recursively and evaluated before and after the break

$$y_t = \phi_t y_{t-1} + \varepsilon_t, \qquad \phi_t = \begin{cases} \phi_1, & t \leq T_b \\ \phi_2, & t > T_b \end{cases}$$

$$e_{t+1} = y_{t+1} - \hat{y}_{t+1|t}$$

Baseline calibration: $\phi_1 = 0.2$, $\phi_2 = 0.9$, $T_b = 200$

Evaluation metrics: RMSE, MAE, and forecast bias