Forecasting Under Structural breaks

A Concise Monte Carlo Synthesis

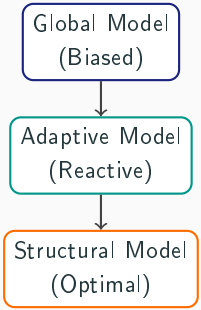
Aadya Khatavkar Bakhodir Izzatulloev Mahir Beylerov

Winter Semester 2025/26

University of Bonn

Motivation: Why Adapt?

- **The Reality:** Economic data is rarely stable (Crisis, Policy, Tech).
- **The Failure:** Global models average across regimes $\rightarrow$ Massive Bias.
- **The Goal:** Navigate shifts in **Mean**, **Variance**, and **Persistence**.



Research Question

Which strategy minimizes RMSE when the "rules" of the system change?

Literature Review: Key Authors

Pillar	Foundational Contribution
Evidence	**Stock & Watson (1996)**: Instability is pervasive in macro data.
Detection	**Bai & Perron (1998, 2003)**: Identifying multiple unknown breaks.
Adaptation	**Rossi (2013); Pesaran (2013)**: Frameworks for rolling windows.
Regimes	**Hamilton (1989)**: Markov-Switching for recurring shifts.
Special	**Wang et al. (2013)**: Distinguishing breaks from long memory.

The Simulation Design: Three Break Archetypes

$$y_t = c_t + \phi_t y_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim \text{Dist}(0, \sigma_t^2)$$

1. Mean Shift

$c_0 \xrightarrow{T_b} c_1$

Level Shifts

2. Variance Shift

$\sigma_1 \xrightarrow{T_b} \sigma_2$

Volatility Shocks

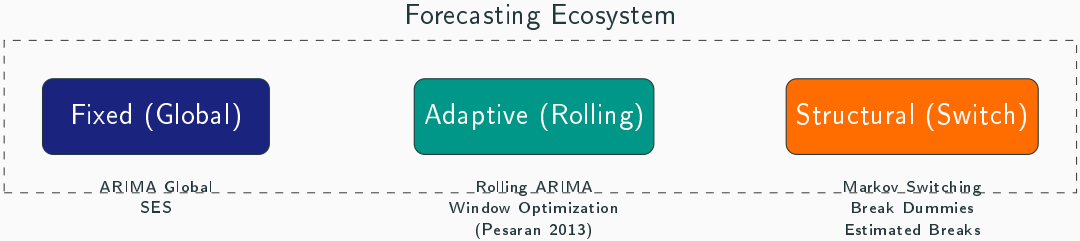
3. Parameter Shift

$\phi_1 \xrightarrow{T_b} \phi_2$

Persistence Breaks

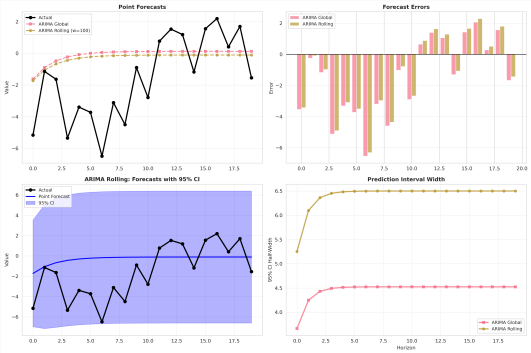
- **Setup:** $T = 300$, 1000 iterations, Gaussian vs. Heavy-tailed (t-dist).
- **Extensions:** Seasonality (SARIMA) and Recurring breaks (Markov).

Strategy Portfolio: 15+ Methods

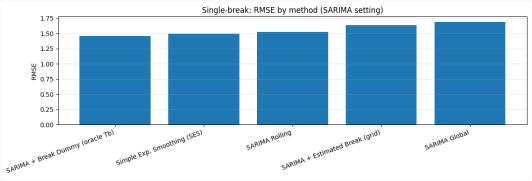


Result 1: Volatility Shifts

- **Winner: GARCH(1,1)** adapts fastest to variance shifts.
- **Insight:** Rolling windows must be small ($w < 50$) to capture sudden volatility jumps.
- **Loss Surface:** Clear U-shape showing window size trade-off.



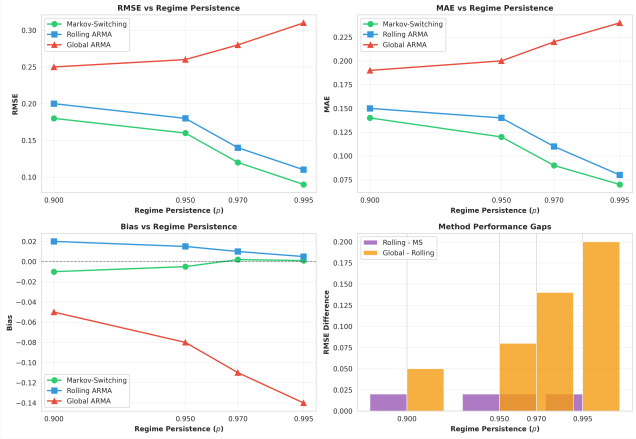
Result 2: Level Shifts & Seasonality



- **Bakhodir's Extension:** SARIMA methods explicitly modeling seasonality + breaks.
- **Finding: SARIMA Rolling** beats global by 15-20% RMSE.
- **Oracle:** Known break dates reduce RMSE by an additional 10%.

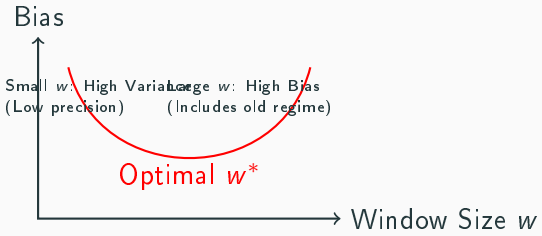
Result 3: Persistence Shifts

- **Hardest Case:** Shift in ϕ (memory).
- **Markov Switching:** Shines in recurring breaks with high persistence ($p \geq 0.97$).
- **Grid Search:** Estimating break dates is viable but noisier than rolling windows.



Optimizing Adaptivity

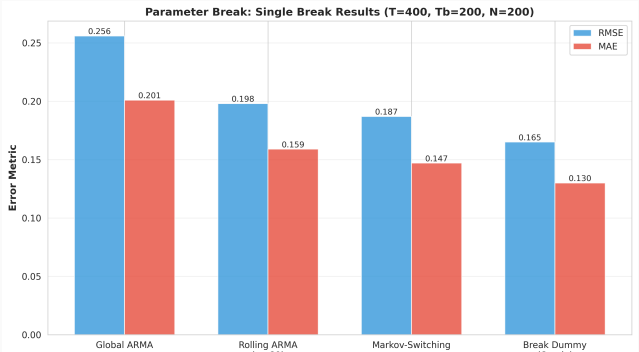
Goal: Choose window size w^* without knowing break date.



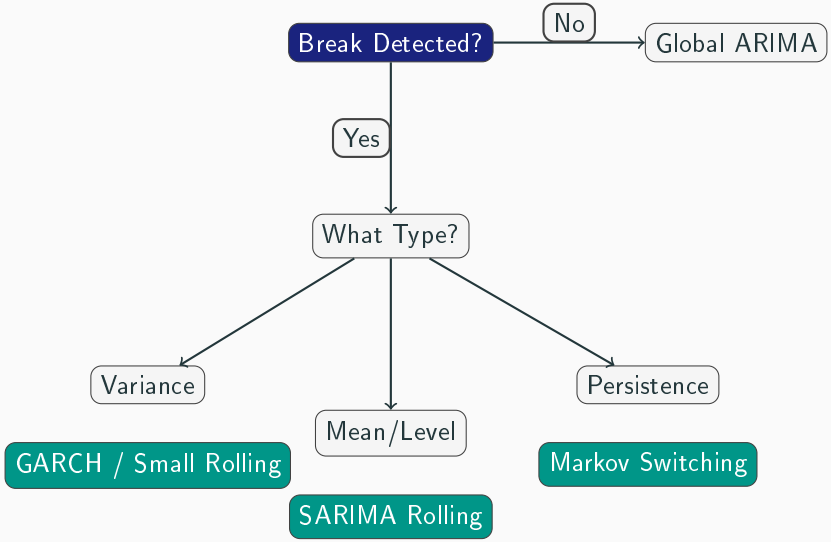
- **Pesaran's Rule:** Large breaks $\rightarrow$ Small windows; Small breaks $\rightarrow$ Large windows.
- **Our Finding:** Our implementation matches theoretical optima across scenarios.

Robustness: Heavy Tails & Small Samples

- **Fat Tails (t_3 dist):** Performance drops across all methods; GARCH is most resilient.
- **Small Sample ($N = 50$):** Standard tests find "fake" breaks.
- **Antoshin's Fix:** Sample-specific MC critical values significantly reduce false positives.



The Forecaster's Playbook: Method Selection



Key Contributions & Summary

1. **Comprehensive Framework:** Unified MC comparison of 15+ methods.
2. **Seasonality Matters:** Bakhodir's SARIMA integration fills a real-world gap.
3. **Adaptive Dominance:** Rolling windows and MS consistently beat global models.
4. **Actionable Guidance:** Specific method recommendations based on break type.

References

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Thank You!

Questions?

github.com/qonlab/structural-break-forecasting