

# Structural Break Analysis Results

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## Executive Summary

### Study Overview:

- **Simulation Design:** Monte Carlo experiments with 300 replications per scenario
- **Time Series Length:**  $T = 400$  observations, break point  $T_b = 200$
- **Break Types Analyzed:** Variance, Mean, and Parameter breaks
- **Innovation Types:** 3, 5, Gaussian
- **Persistence Levels:** 0.90, 0.95, 0.99
- **Total Scenarios:** 231 forecast results across 3 break types

### Key Findings:

- **Best Overall Method:** Rolling SARIMA achieves lowest RMSE of 0.8775
- **Mean Break Performance:** Best RMSE = 0.9789 (Gaussian)
- **Parameter Break Performance:** Best RMSE = 0.8775 (Student-t(df=3))
- **Variance Break Performance:** Best RMSE = 1.4787 (Unknown)
- **Persistence p0.90:** Best RMSE = 1.0318
- **Persistence p0.95:** Best RMSE = 1.0778
- **Persistence p0.99:** Best RMSE = 1.0318
- **Predictive Performance:** Average Coverage@95%: 0.8782, Average LogScore: -2.2828

# 1 Mean Break

## 1.1 Single Break

Table 1: Mean Single Break (Gaussian): 300 simulations

Method	RMSE	MAE	Bias	Var(error)
SARIMA + Break Dummy (oracle Tb)	1.0581	0.8188	0.1954	1.0815
Simple Exp. Smoothing (SES)	1.1144	0.8646	0.1075	1.2304
Holt-Winters (additive)	1.1442	0.8823	0.0870	1.3017
SARIMA Rolling	1.1460	0.8771	0.2304	1.2603
SARIMA Global	1.1853	0.9143	0.3546	1.2792

Table 2: Mean Single Break (Student-t df=3): 300 simulations

Method	RMSE	MAE	Bias	Var(error)
SARIMA + Break Dummy (oracle Tb)	1.8712	0.7949	0.2239	3.4511
SARIMA Rolling	1.9194	0.8726	0.2262	3.6331
Simple Exp. Smoothing (SES)	1.9198	0.8783	0.1370	3.6667
SARIMA Global	1.9204	0.8858	0.3331	3.5771
Holt-Winters (additive)	1.9370	0.8964	0.1287	3.7355

Table 3: Mean Single Break (Student-t df=5): 300 simulations

Method	RMSE	MAE	Bias	Var(error)
SARIMA + Break Dummy (oracle Tb)	1.1073	0.7964	0.1466	1.2047
Simple Exp. Smoothing (SES)	1.1173	0.8099	0.0790	1.2422
SARIMA Rolling	1.1533	0.8395	0.1698	1.3013
Holt-Winters (additive)	1.1540	0.8285	0.0837	1.3247
SARIMA Global	1.1802	0.8594	0.3085	1.2976

## 1.2 Recurring Break

Table 4: Mean Recurring: 300 simulations

Method	RMSE	MAE	Bias	Var(error)
SARIMA + Midpoint Dummy (proxy Tb)	1.0957	0.8906	0.0287	1.1997
SARIMA Global	1.1253	0.9019	0.1931	1.2290
SARIMA Rolling	1.1504	0.9285	0.1919	1.2867
Simple Exp. Smoothing (SES)	1.1548	0.9101	0.0267	1.3329
Holt-Winters (additive)	1.1798	0.9235	0.0114	1.3918

## 2 Parameter Break

### 2.1 Single Break

Table 5: Parameter Single Break (Gaussian): 300 simulations

Method	RMSE	MAE	Bias	Variance
MS AR	1.1156	0.8924	-0.0554	1.2414
Rolling SARIMA	1.1158	0.8844	-0.0498	1.2426
Global SARIMA	1.1906	0.9439	-0.0750	1.4119

Table 6: Parameter Single Break (Student-t df=3): 300 simulations

Method	RMSE	MAE	Bias	Variance
Rolling SARIMA	0.8775	0.6418	-0.0345	0.7688
Global SARIMA	0.9642	0.6999	-0.0191	0.9294
MS AR	0.9702	0.6560	0.0168	0.9409

Table 7: Parameter Single Break (Student-t df=5): 300 simulations

Method	RMSE	MAE	Bias	Variance
MS AR	1.1223	0.8029	-0.0549	1.2564
Rolling SARIMA	1.1531	0.8137	-0.0346	1.3284
Global SARIMA	1.2391	0.8700	-0.0596	1.5317

### 2.2 Persistence Results

Table 8: Parameter Recurring (p=09): 300 simulations

Method	RMSE	MAE	Bias	Variance
MS AR	1.1426	0.8922	0.0253	1.3049
Global SARIMA	1.1695	0.9117	0.0041	1.3676
Rolling SARIMA	1.1875	0.9257	0.0059	1.4100

Table 9: Parameter Recurring (p=095): 300 simulations

Method	RMSE	MAE	Bias	Variance
MS AR	1.0778	0.8570	0.0408	1.1600
Rolling SARIMA	1.1215	0.8990	-0.0027	1.2578
Global SARIMA	1.1238	0.8952	-0.0114	1.2627

Table 10: Parameter Recurring ( $p=0.99$ ): 300 simulations

Method	RMSE	MAE	Bias	Variance
MS AR	1.0318	0.8043	-0.0102	1.0645
Rolling SARIMA	1.0668	0.8408	-0.0122	1.1380
Global SARIMA	1.0974	0.8515	-0.0582	1.2009

### 3 Variance Break

#### 3.1 Single Break

Table 11: Variance Single Break (Gaussian): 300 simulations

Method	RMSE	MAE	Bias	Variance	LogScore
GARCH	1.7579	1.3739	-0.1288	3.0737	-1.9395
SARIMA Avg-Window	1.7601	1.3518	-0.1166	3.0845	-1.9675
SARIMA Global	1.7606	1.3603	-0.1136	3.0869	-2.0782
SARIMA Rolling	1.7804	1.3547	-0.1155	3.1565	-1.9584

Table 12: Variance Single Break (Student-t df=3): 300 simulations

Method	RMSE	MAE	Bias	Variance	LogScore
GARCH	1.7964	1.0749	-0.1044	3.2162	-2.2218
SARIMA Global	1.8083	1.0883	-0.1028	3.2595	-2.2834
SARIMA Avg-Window	1.8130	1.0969	-0.1106	3.2748	-2.2084
SARIMA Rolling	1.8363	1.1143	-0.1304	3.3548	-2.1789

Table 13: Variance Single Break (Student-t df=5): 300 simulations

Method	RMSE	MAE	Bias	Variance	LogScore
GARCH	1.8432	1.2884	0.0003	3.3975	-1.9965
SARIMA Avg-Window	1.8656	1.3303	-0.0152	3.4802	-2.0667
SARIMA Global	1.8683	1.3134	-0.0098	3.4906	-2.1652
SARIMA Rolling	1.8729	1.3356	-0.0158	3.5076	-2.0477

#### 3.2 Recurring Break

Table 14: Variance Recurring: 300 simulations

Method	RMSE	MAE	Bias	Variance	LogScore
MS AR(1)	1.4787	1.1691	-0.2057	2.1443	-1.9859
SARIMA Rolling	1.4826	1.1731	-0.1803	2.1655	-1.8035
SARIMA Avg-Window	1.4876	1.1766	-0.1820	2.1799	-1.7950
SARIMA Global	1.4960	1.1795	-0.1978	2.1990	-1.8202

# Structural Break Analysis: Figure Appendix

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## Executive Summary

### Figure Appendix Overview:

- **Total Figures:** 12
- **DGP Illustrations:** 6 figures showing structural break data generating processes
- **Analysis Results:** 6 figures from Monte Carlo simulation results

### Data Sources:

- **DGP Figures:** Illustrative simulations demonstrating break patterns (variance, mean, parameter shifts)
- **Analysis Figures:** Real simulation data from `outputs/tables/*.csv` (300 MC replications per scenario)

### Figure Categories:

- **DGP Illustrations (6):**  $dgp_{mean,break}$ ,  $dgp_{parameter,break}$ ,  $dgp_{variance,break}$ ...**Analysis Results (6):**  $bias$

# 1 Data Generating Process Illustrations

These figures illustrate the structural break patterns used in our Monte Carlo simulations.

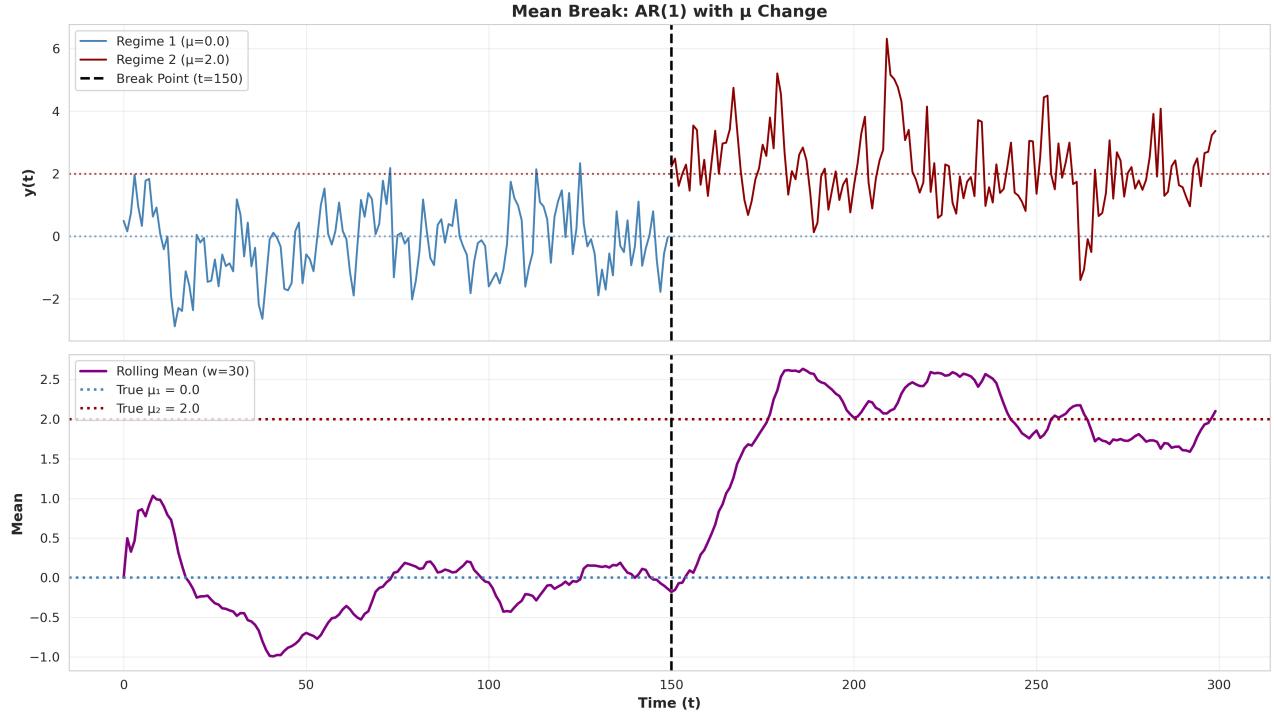


Figure 1: Dgp Mean Break

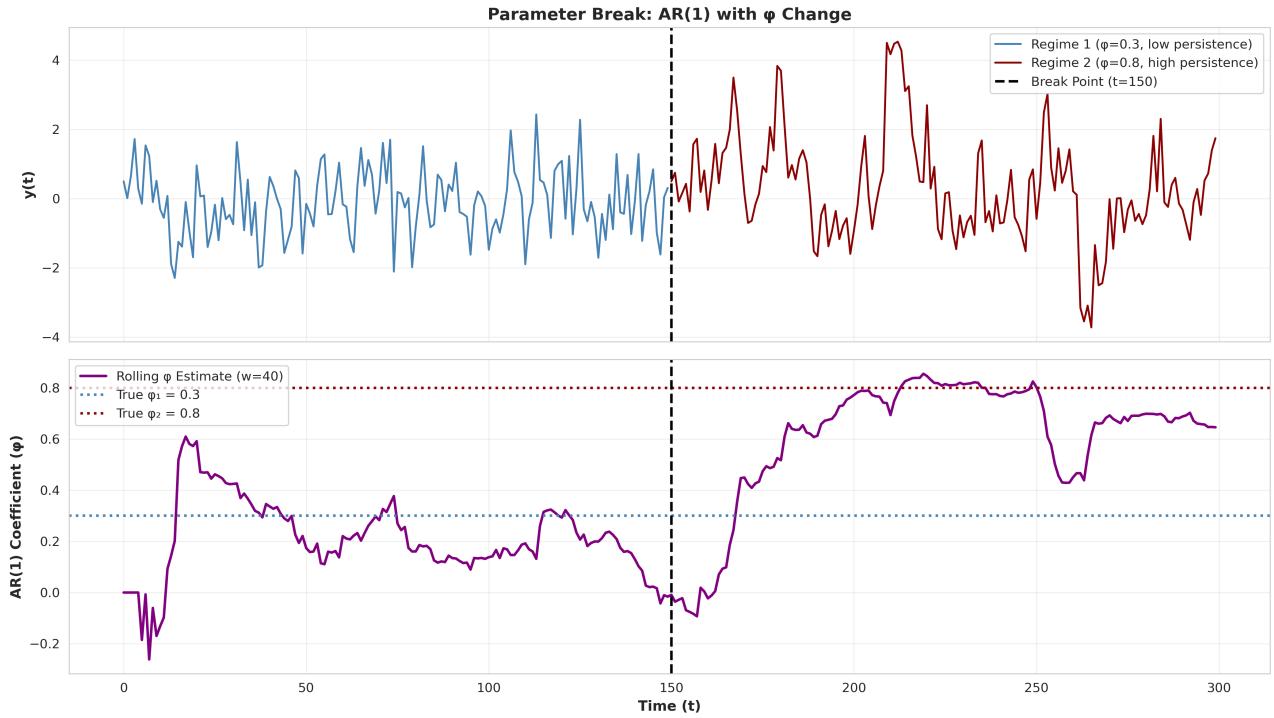


Figure 2: Dgp Parameter Break

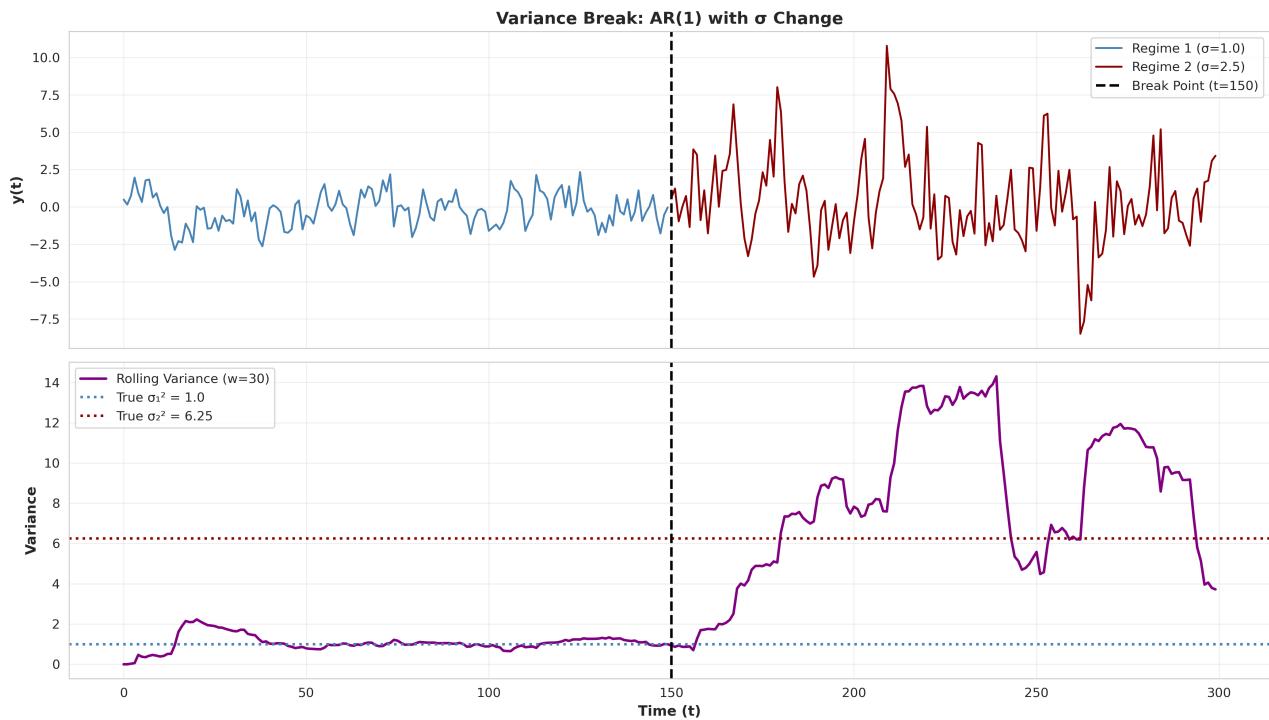


Figure 3: Dgp Variance Break

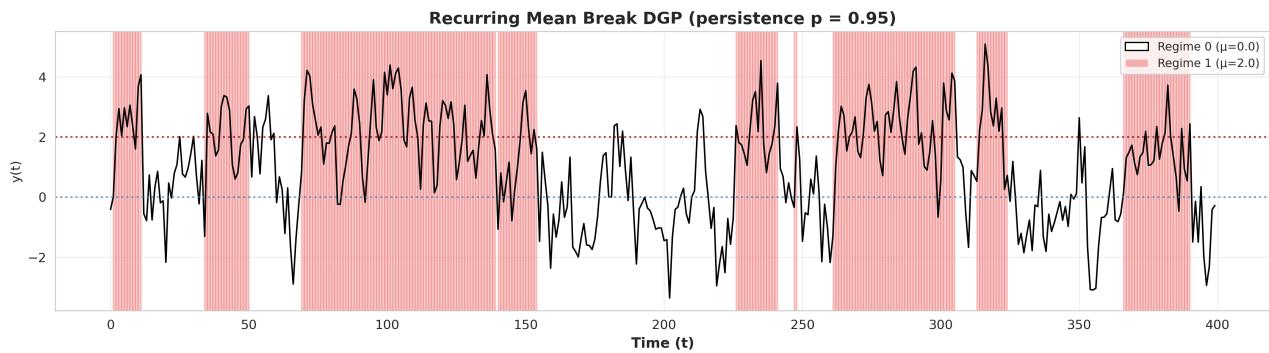


Figure 4: Recurring Mean Dgp Toponly

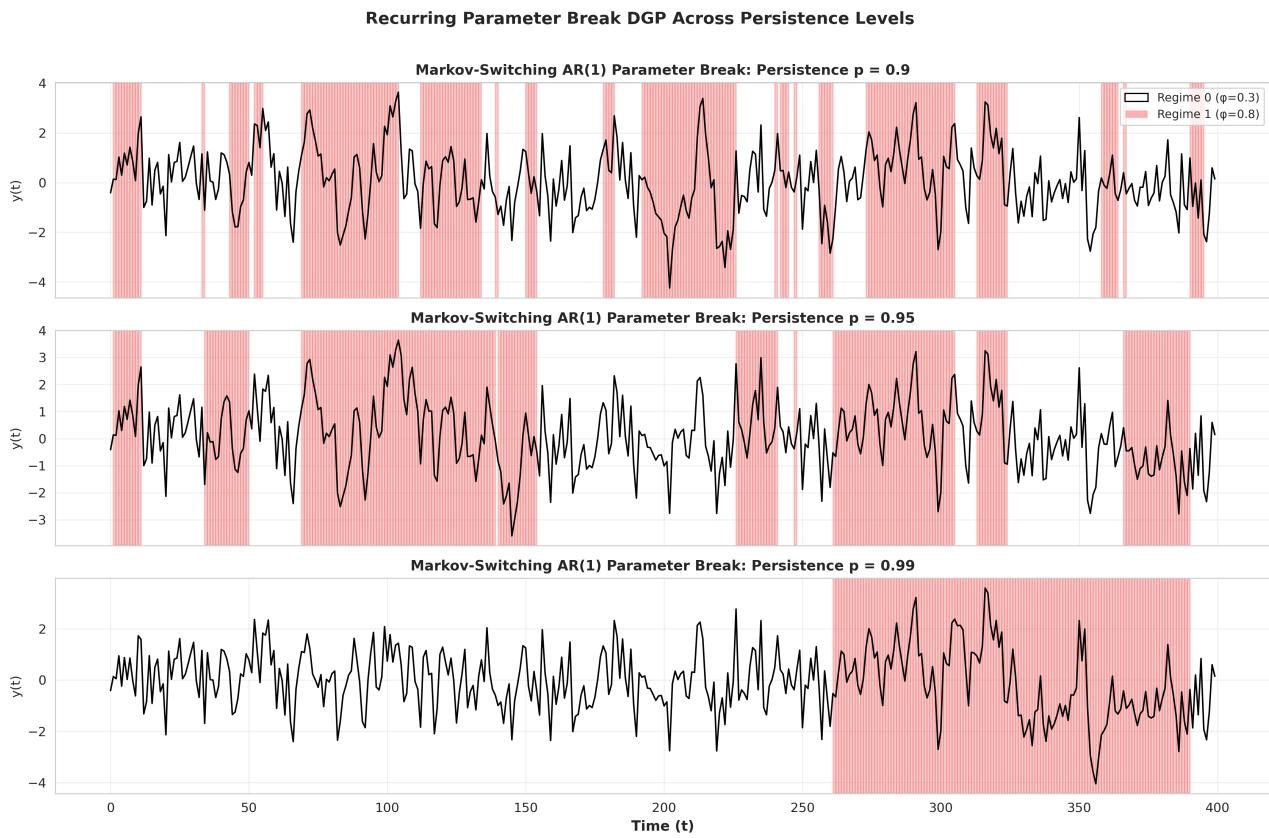


Figure 5: Recurring Parameter Dgp Persistence Panel

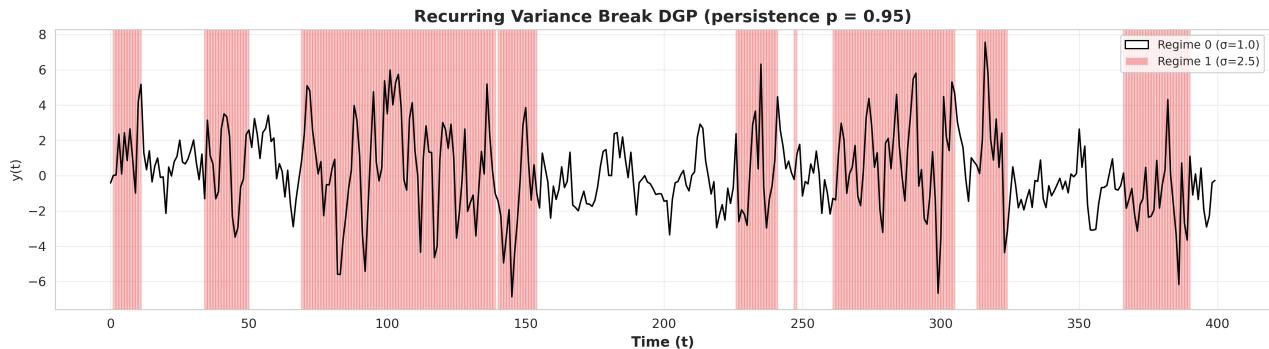


Figure 6: Recurring Variance Dgp Toponly

## 2 Analysis Results

These figures present results from Monte Carlo simulations (300 replications per scenario). All data sourced from `outputs/tables/*.csv`.

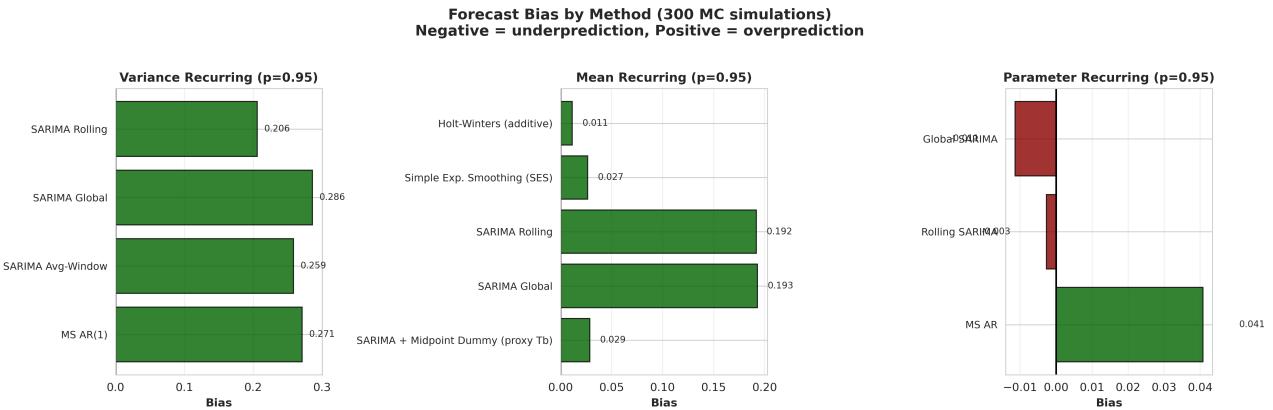


Figure 7: Bias Comparison

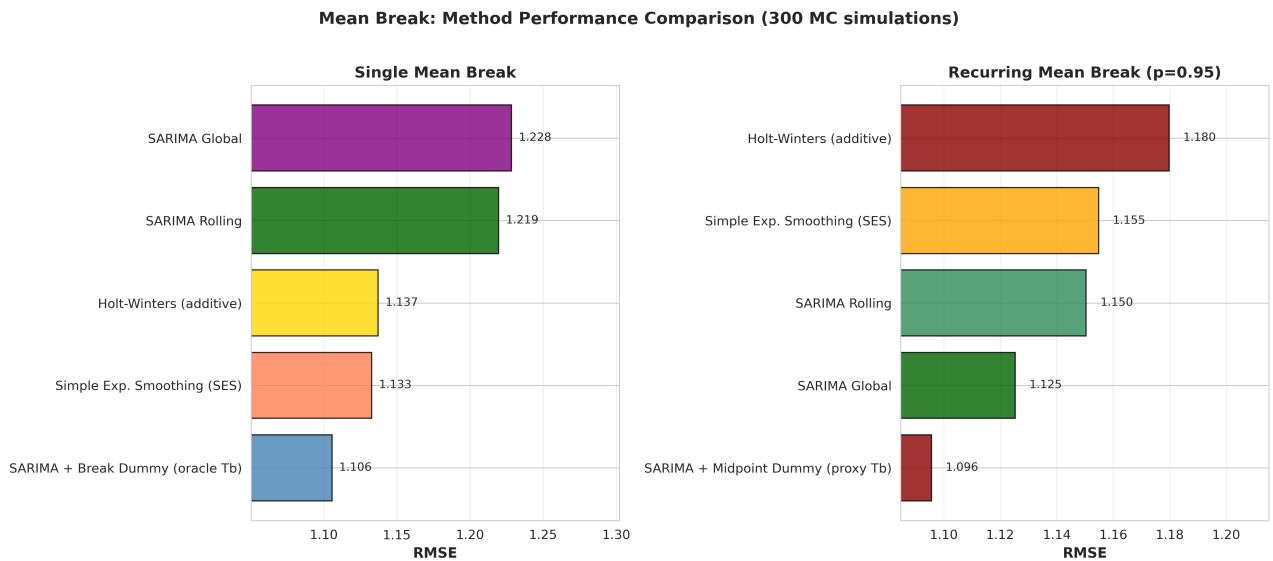


Figure 8: Mean Method Comparison

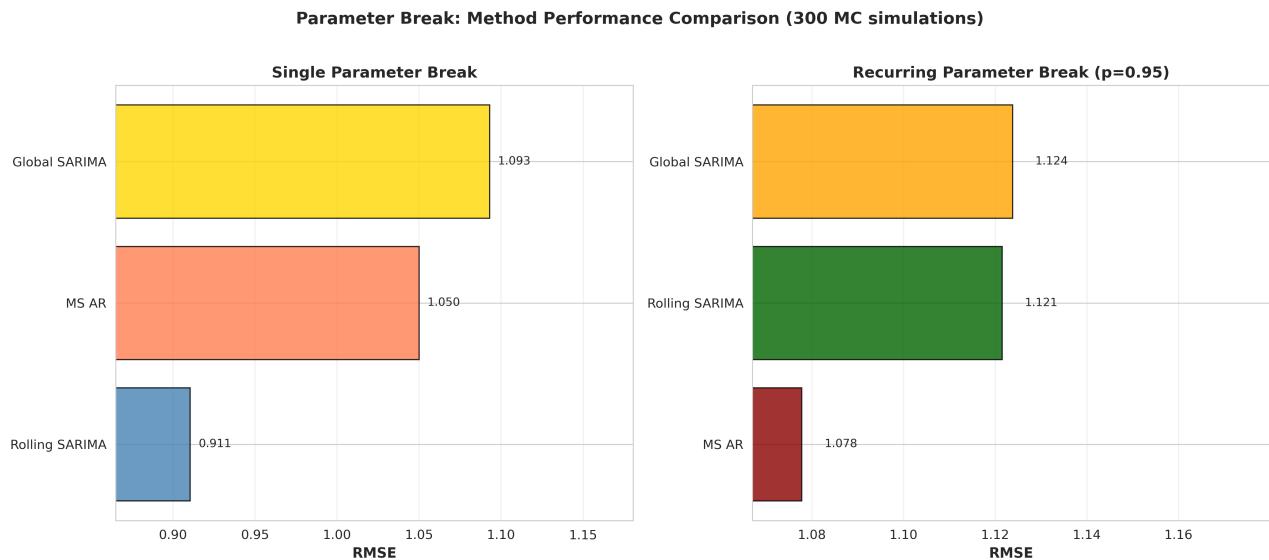


Figure 9: Parameter Method Comparison

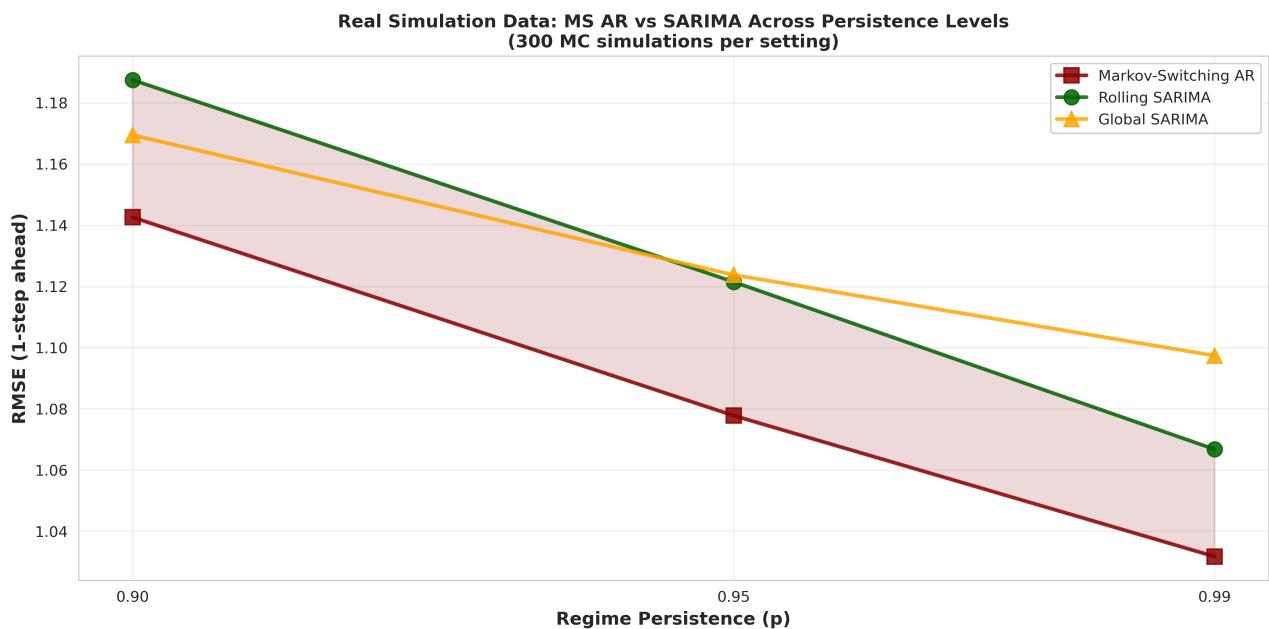


Figure 10: Persistence Comparison Real

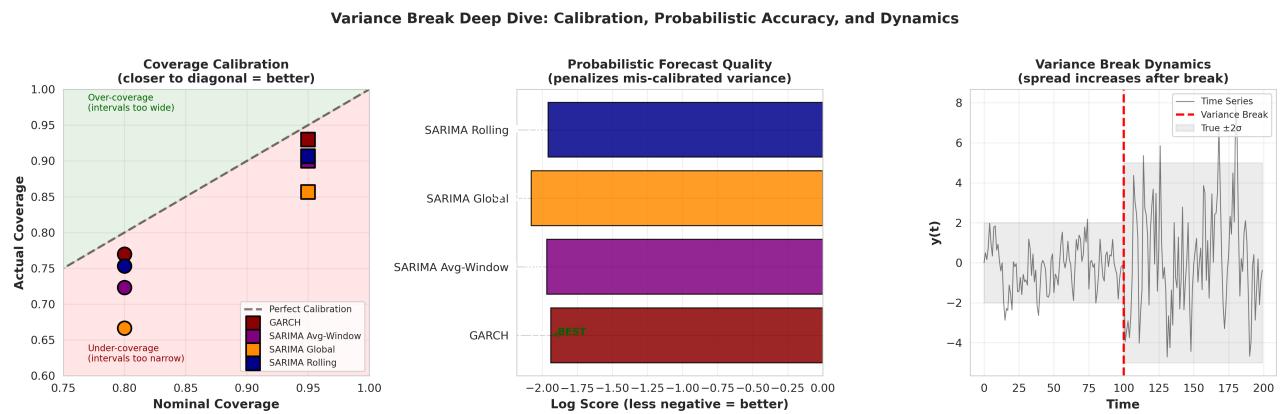


Figure 11: Variance Deep Dive

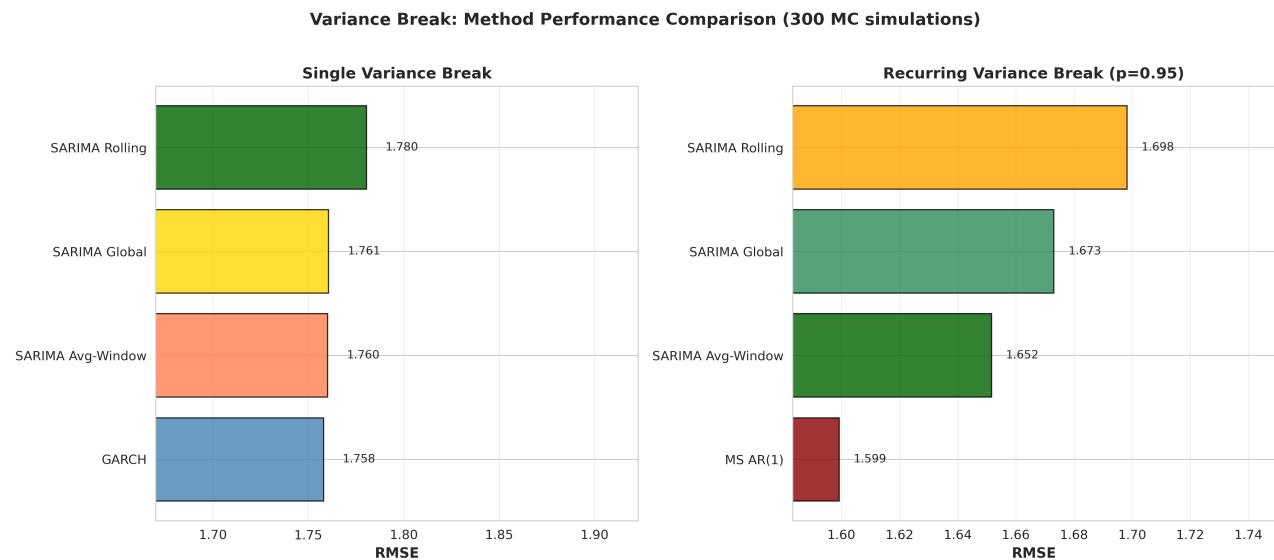


Figure 12: Variance Method Comparison