Simulation Plan – revised

1 Single-Level Simulation Design

Table 1: Factorial design (single level)

Factor	**Levels / Notes**
Skewness & Distribution	• Moderate skew-normal: `alpha = ±4` • Strong skew-normal: `alpha = ±9` • Extreme: $\chi^2(1)$ (mirrored for left skew)
Direction pattern	$\{++, --, +-\}$ for the two series (right/right, left/left, right/left)
Time points T	50 and 100
Gaussian copula ρ	0.30 and 0.50
VAR parameter sets	Sets A and B (Table 2)
Replications	100 per cell
Fitted models	1. Skew-normal marginals + Gaussian copula ("correct") 2. Normal marginals + Gaussian copula (misspecified)
Outcome metrics	Mean relative bias, 95 % coverage, mean posterior SD, **SD-Bias**, # divergences (for T=50, 100 also split by diverging vs. non-diverging chains)

Number of conditions. 3 (skew) × 3 (direction) × 2 T × 2 ρ × 2 VAR sets = 72 cells. With 100 replications: $72 \times 100 = 7{,}200$ simulated data sets.

2 VAR Parameter Sets and Rationale

All coefficients are empirically plausible: AR 0.25–0.55, cross-lag 0.05–0.15.

3 SD-Bias Definition

For replication $r = 1, \ldots, R$ with posterior mean $\hat{\theta}_r$ and posterior SD s_r,

$$\bar{\theta} = \frac{1}{R}\sum_{r=1}^{R}\hat{\theta}_r, \qquad \mathrm{SD}_{\mathrm{emp}} = \sqrt{\frac{1}{R-1}\sum_{r=1}^{R}(\hat{\theta}_r - \bar{\theta})^2},$$

Table 2: Lag-1 coefficient matrices kept in the final design

Set	Φ	Purpose / Empirical Motivation
A	$\begin{bmatrix} 0.40 & 0.10 \\ 0.10 & 0.40 \end{bmatrix}$	Symmetric positive spill-over; AR 0.40 is typical daily inertia, CL 0.10 a modest effect.
B	$\begin{bmatrix} 0.55 & 0.10 \\ 0.10 & 0.25 \end{bmatrix}$	Asymmetric stability: series 1 highly inert (e.g. negative affect), series 2 more volatile.

$$\overline{s} = \frac{1}{R}\sum_{r=1}^{R} s_r, \qquad \text{SD-Bias} = \overline{s} - \text{SD}_{\text{emp}}.$$

Positive SD-Bias ⇒ too-wide intervals (over-conservative); negative ⇒ too narrow (over-confidence).

4 Stand-alone Exponential-Tail Test

- Generate a long series ($T = 500$) with *Exponential(1)* innovations (heavy right tail, no skew parameter).
- Fit (i) Skew-Normal (ii) Shifted-Exponential likelihood while keeping the Gaussian copula.
- Compare posterior bias and divergent transitions; investigate why the non-shifted Exponential previously failed (zero-location constraint).

5 Multilevel Phase (unchanged core design)

6 Next Steps