14_VAR

QuantFit Estimator Standard Operating Procedure

SOP: Vector Autoregression (VAR)

Multivariate time-series model with all variables endogenous

=> VAR treats every variable as endogenous; impulse responses and FEVD reveal system dynamics.

1. Purpose

VAR(p) regresses each of k variables on p lags of itself and all other variables. The reduced-form residuals are orthogonalised via Cholesky decomposition for structural interpretation. Impulse responses (IRF) trace shock propagation; forecast error variance decomposition (FEVD) attributes the share of forecast variance to each shock.

2. When to use this estimator

Multiple stationary variables with bidirectional causality.

Forecasting and structural analysis without imposing strict theoretical priors.

Identifying lead-lag relationships via Granger causality.

3. Required data structure

k stationary time series (apply unit-root tests first).

T sufficient for k2 x p parameter estimation (T ? k2 x p).

If variables are I(1) and cointegrated, switch to VECM.

4. Mathematical formulation

Reduced-form VAR(p):

Y_t = c + Sum_{i=1}^{p} A_i Y_{t-i} + u_t

Var(u_t) = Sum_u

Cholesky: Sum_u = L L’ => structural shocks epsilon_t = L^-1 u_t

IRF_h = J A^h J’ L, J = [I_k 0 ? 0] (companion-matrix form)

FEVD_h: share of forecast variance of variable i from shock j at horizon h.

5. Pre-estimation diagnostics

Stationarity per series.

Lag selection: minimise AIC / BIC / HQ over candidates.

Granger causality tests pre-IRF.

6. Estimation procedure

Build the design with p lags of each Y series.

Estimate each equation by OLS (efficient by GLS-equivalence).

Build companion matrix; verify spectral radius < 1 (stability).

Cholesky factorise Sum_u; compute IRF and FEVD over horizon H.

Bootstrap CIs for IRF (residual resampling).

Run Granger causality tests by F-statistic.

7. Output produced

8. Output interpretation

IRF: response of variable i to a one-standard-deviation shock in equation j over horizons.

FEVD at horizon h: percentage of variable i's forecast error variance attributable to shock j.

Granger causality $p < 0.05$ => X helps predict Y beyond Y's own past.

Spectral radius >= 1 => VAR is unstable; revisit lag order or use VECM.

9. Post-estimation diagnostics

Stability: spectral radius of companion matrix.

Residual autocorrelation: portmanteau (Ljung-Box) on residuals.

Normality: multivariate Jarque-Bera on residuals.

ARCH-LM for residual heteroskedasticity.

10. Common pitfalls

Cholesky ordering matters - reorder via theory; check robustness to alternative orderings.

Unit roots in any variable invalidate the reduced-form VAR - use VECM instead.

Too many lags overfit; AIC tends to over-pick relative to BIC.

11. Reporting checklist

Lag order with selection criterion.

Cholesky ordering and theoretical justification.

IRF panels with bootstrap CI.

FEVD panels with horizon table.

Granger causality matrix.

Stability diagnostic.

12. References

Sims, C. A. (1980). Macroeconomics and Reality. Econometrica.

Lütkepohl, H. (2005). New Introduction to Multiple Time Series Analysis.

Springer.

Field	Meaning
varIRF	[H+1][shock][response] orthogonalised IRFs
varIRFLower / varIRFUpper	Bootstrap CIs
varFEVD	[H+1][variable][shock] variance decomposition
companionSpectralRadius	Stability check (< 1)
grangerTests	Per-pair F-statistic p-values
variableOrder	Cholesky ordering used