06_FMOLS

QuantFit Estimator Standard Operating Procedure

SOP: Fully Modified OLS (FMOLS)

Phillips-Hansen cointegration estimator with semi-parametric corrections

=> Use FMOLS for cointegrated I(1) variables when you want a single long-run estimate.

1. Purpose

FMOLS corrects OLS on cointegrated variables for endogeneity and serial correlation in the long-run residuals. The result is a consistent and asymptotically unbiased estimate of the cointegrating vector with mixed-normal asymptotic distribution suitable for inference.

2. When to use this estimator

All variables are I(1) and confirmed cointegrated (Engle-Granger or Johansen).

Single cointegrating equation with one normalising variable.

Both time-series and panel data variants exist.

3. Required data structure

All Y and X variables I(1) per Stage 3 unit-root tests.

At least one cointegrating relationship confirmed at Stage 6.

Long-enough sample for kernel-based long-run variance estimation (T >= 50).

4. Mathematical formulation

Two semi-parametric corrections applied to the OLS regression in levels:

?_t* = Y_t - Omega?_yx Omega?_xx^-1 DeltaX_t (endogeneity correction)

beta?_FMOLS = (SumX_t X_t')^-1 (SumX_t Y_t* - T*gamma?) (autocorrelation correction)

Omega? = long-run variance from kernel (Bartlett / QS / Parzen)

5. Pre-estimation diagnostics

Confirm I(1) on every variable (Stage 3).

Confirm cointegration (Stage 6 - Engle-Granger / Johansen / Pedroni).

Choose kernel and bandwidth (Newey-West Bartlett or Andrews automatic).

6. Estimation procedure

Run OLS on the levels equation Y = Xbeta + u.

Estimate the long-run covariance matrix Omega? from residuals via kernel weighting.

Apply endogeneity correction: Y* = Y - Omega?_yx Omega?_xx^-1 DeltaX.

Apply autocorrelation correction term gamma?.

Compute beta?_FMOLS, mixed-normal SE, and t-statistics.

7. Output produced

8. Output interpretation

beta? is the long-run elasticity / multiplier between Y and X.

t-stats use mixed-normal critical values - same 1.96 cutoff applies.

Residuals must be I(0); rerun ADF on residuals for confirmation.

9. Post-estimation diagnostics

ADF/KPSS on residuals to confirm cointegration ex-post.

Recursive stability (CUSUM/CUSUMSQ) where T permits.

Compare to DOLS for robustness - coefficients should be similar.

10. Common pitfalls

Applying FMOLS to I(0) variables produces meaningless estimates - always check Stage 3.

Misspecified cointegration rank biases the long-run estimate.

Bandwidth too short under-estimates Omega?; too long inflates SE.

11. Reporting checklist

I(1) confirmation per variable.

Cointegration test result.

Kernel and bandwidth choice.

Coefficient table with mixed-normal SE.

Residual unit-root test on cointegrating residual.

12. References

Phillips, P. C. B., Hansen, B. E. (1990). Statistical Inference in Instrumental Variables Regression with I(1) Processes. Review of Economic Studies.

Pedroni, P. (2001). Fully Modified OLS for heterogeneous cointegrated panels. Advances in Econometrics.

Field | Meaning

coefficients | Cointegrating-vector coefficients

standardErrors | Mixed-normal SE valid for inference

metadata['kernel'] / bandwidth | Long-run variance settings

residuals / fitted | Cointegrating residuals (should be I(0))