

## Accepted Manuscript

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PII: S0304-4076(17)30190-2

DOI: <https://doi.org/10.1016/j.jeconom.2017.05.020>

Reference: ECONOM 4427

To appear in: *Journal of Econometrics*

Received date: 8 October 2014

Revised date: 9 May 2017

Accepted date: 9 May 2017

Please cite this article as: Cho J.S., Phillips P.C.B., Pythagorean generalization of testing the equality of two symmetric positive definite matrices. *Journal of Econometrics* (2017), <https://doi.org/10.1016/j.jeconom.2017.05.020>

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# Pythagorean Generalization of Testing the Equality of Two Symmetric Positive Definite Matrices

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May 9, 2017

## Abstract

We provide a new test for equality of two symmetric positive-definite matrices that leads to a convenient mechanism for testing specification using the information matrix equality or the sandwich asymptotic covariance matrix of the GMM estimator. The test relies on a new characterization of equality between two  $k$  dimensional symmetric positive-definite matrices  $A$  and  $B$ : the traces of  $AB^{-1}$  and  $BA^{-1}$  are equal to  $k$  if and only if  $A = B$ . Using this simple criterion, we introduce a class of omnibus test statistics for equality and examine their null and local alternative approximations under some mild regularity conditions. A preferred test in the class with good omni-directional power is recommended for practical work. Monte Carlo experiments are conducted to explore performance characteristics under the null and local as well as fixed alternatives. The test is applicable in many settings, including GMM estimation, SVAR models and high dimensional variance matrix settings.

**Key Words:** Matrix equality; Trace; Determinant; Arithmetic mean; Geometric mean; Harmonic mean; Sandwich covariance matrix; Eigenvalues.

**Subject Classification:** C01, C12, C52

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