

Tests for Principal Eigenvalues and Eigenvectors

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We establish central limit theorems for principal eigenvalues and eigenvectors in the divergent spiked covariance models, and develop three two-sample tests for testing (1) the equality of principal eigenvalues, (2) the stability of eigenvalue proportions, and (3) the invariance of principal eigenvectors. One important application of our results is to understand structural breaks in large factor models. That is, when a structural break is suspected or detected, these tests provide unique insights into the source, determining whether the structural break stems from altered factor strength (eigenvalues), a shift in the factors' relative importance (eigenvalue proportions), or a fundamental factor reorientation (eigenvectors). We demonstrate the application by analyzing daily returns of S&P 500 stocks, revealing that major historical structural breaks, such as the 2008 financial crisis and the 2020 pandemic, were complex events characterized by simultaneous shifts in factor strength, proportional variance, and orientation.

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