

TESTING HIGH-DIMENSIONAL WHITE NOISE BASED ON MODIFIED PORTMANTEAU TESTS

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Abstract: For high-dimensional time series, we propose a new test to detect white noise that is not necessarily assumed to be independent and identically distributed. The test can be viewed as a modified portmanteau test in high dimensions, and the critical value of the test statistic is approximated by a multiplier bootstrap method. We provide asymptotic properties of our test under the null hypothesis. The usefulness of our tests is demonstrated by simulations and one real example, particularly for detecting dense alternatives.

Key words and phrases: Bootstrap, high-dimensional time series, hypothesis testing, white noise.

1. Introduction

The high-dimensional time series model has received much attention due to its wide application in economics, finance, biology, environmental studies, etc. The large p /small N problem becomes common with the extensively available dataset due to advances in information technology. The white noise testing is one of the most fundamental statistical problems in time series analysis. For univariate time series, the Box and Pierce portmanteau test (Box and Pierce, 1970) and the Ljung and Box portmanteau test (Ljung and Box, 1978) are popular choices for testing white noise, and they are designed for testing whether the first L autocorrelations of a time series are zero. Under certain regularity conditions, the null distribution of their test statistic is χ_L^2 . For multivariate analysis, several extensions of the portmanteau test exist, such as the multivariate Box and Pierce portmanteau test in Chitturi (1974), Hosking portmanteau test in Hosking (1980), and Li and McLeod portmanteau test in Li and McLeod (1981). They checked whether the first L autocorrelation matrices are zero, and their null distributions are chi-square under some regularity conditions. Two reasons prevent the application of these methods in testing high-dimensional white noise. The first reason is that the chi-square asymptotic distribution is derived under the assumption that p is fixed, and the second reason is that portmanteau tests require data to be independent and identically distributed (i.i.d.) Data can easily

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