A Network Topology Approach to Diagnose the Shift of Covariance Structure

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Abstract. Understanding the shift of covariance matrices in any process is not an easy task. From the literatures, the most popular and widely used test for covariance shift is Jennrich's test and Box's M test. It is important to note that Box and also Jennrich have constructed their own test by involving sample covariance matrix determinant or, equivalently, generalized variance (GV) as multivariate variability measure. However, GV has serious limitations as a multivariate variability measure. Those limitations of GV motivate us to use a proposed test based on an alternative measure of multivariate variability called vector variance (VV). However, if after hypothesis testing the hypothesis of stable process covariance is rejected, then the next problem is to find the cause of that situation. In this paper, network topology approach will be used to understand the shift. A case study will be discussed and presented to illustrate the advantage of this approach.

INTRODUCTION

The shift of the covariance structure can be determined by testing the stability of covariance structure. The importance of covariance structure stability has been shown in many areas. For example, in financial market [1-3], real estate industry [4], service industry [5, 6], manufacturing industry [7, 8], software industry [9, 10], health care industry [11] and even supply chain management [12].

To test the stability of covariance structure, we use a test proposed by Yusoff and Djauhari [13]. In this study, if the null hypothesis about the stability of covariance structure is rejected, we use the network analysis approach to find out the root causes of that rejection. For that purpose, covariance matrix will be considered as representing a network. To filter the information in that network, we use minimum spanning tree (MST) issued from Kruskal's algorithm. Then, we construct the network topology of all variables. Its interpretation will be delivered by using centrality measures such as degree centrality and betweenness centrality.