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# Measure of bullwhip effect in supply chains with first-order bivariate vector autoregression time-series demand model

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## Abstract

With supply chains becoming increasingly global, the issue of bullwhip effect, a phenomenon attributable to demand fluctuation in the upstream section of the supply chains, has received greater attention from many researchers. However, most existing research studies on quantifying the bullwhip effect were conducted under the first-order autoregressive [AR(1)] incoming demand process or its variants as the fundamental demand process, thereby failing to account for the retailer demand dependency. This research work thus examined the bullwhip effect for the first-order bivariate vector autoregression [VAR(1)] demand process in a two-stage supply chain consisting of one supplier and two retailers. The impacts of the correlation parameters of the demand process, the correlation coefficient between the two error terms, and the variances of the error terms on the bullwhip effect were investigated. As such, the measure of the bullwhip effect was established using an analytical approach in which the minimum mean square error (MMSE) forecasting method and the base stock policy were applied to all members of the supply chain. Numerical experiments were then conducted to illustrate the behavior of the bullwhip effect with respect to various parameters of the demand processes to see in which situations the bullwhip effect would be absent. In addition, an evaluation of the inventory variance ratio was analyzed.

## Keywords

Supply chain; Bullwhip effect; Bivariate VAR(1) model; Base stock policy

## 1. Introduction

Supply chain management takes into consideration all tasks that could impact costs and customer requirements so as to maximize the overall value [1]. Besides, the management of supply chain becomes increasingly challenging as a result of fluctuating demand and complex interactions among various organizations in the supply chain [2].

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