Chapter 9
Bullwhip Effect Performance of Supply Chains Under Statistical Process Control–Based Policy

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ABSTRACT

This chapter discusses the bullwhip effect performance of serial and divergent supply chains under statistical process control (SPC)-based and order-up-to (OUT) policies. The performance of the supply chains is evaluated in terms of order rate variance ratio and bullwhip slope under four realistic customer demand models such normal, normal with a sudden change in mean, normal with seasonality, and normal with seasonality and a sudden change in mean. The impact of sharing of customer demand among the other members of the supply chain and the introduction of order smoothing parameter on both policies are also studied. The results show that under non-stationary customer demand models the difference in the performance of serial and divergent supply chains is noticeable. The bullwhip slope under OUT policy is significantly differing from the bullwhip slope under the SPC-based policy. OUT policy with order smoothing performs better than the SPC-based policy with order smoothing. This finding provides proper guidelines for a supply chain manager to make a decision in a practical scenario.

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INTRODUCTION

Nowadays in the emerging global market, the competition is not between the companies but between the supply chains. Hence, the best performing supply chains may survive over a long period. In a supply chain, the increase in demand variability from downstream stage to upstream stage, namely bullwhip effect creates an adverse impact on the performance of the supply chain (Lee, Padmanabhan, & Whang, 1997). Previous studies confirmed that the bullwhip effect cannot be eliminated from a supply chain, but can be reduced or controlled (Chen, Drezner, Ryan, & Simchi-Levi, 2000). The common methods to mitigate the bullwhip effect in supply chain are: avoid multiple demand forecast updates; break order batches; stabilize prices; eliminate gaming in shortage; reduce lead time and adapt strategic partnerships (Lee, Padmanabhan, & Whang, 1997), implement appropriate co-ordination mechanism (Disney, Lambrecht, Towill, & Van de Velde, 2008), share information (Chen, Drezner, Ryan, & Simchi-Levi, 2000), select proper inventory policy (Gaalman, 2006; Pillai, Talari, & Elluri, 2013), use smoothened inventory policy (Dejonckheere, Disney, Lambrecht, & Towill, 2004; Kim & Springer, 2008), use better forecasting method (Wright & Yuan, 2008), and reduce variability in lead time (Boute, Disney, Lambrecht, & Van Houdt, 2007). Inventory policy has a vital role in a supply chain and is one of the contributory factors to the bullwhip effect in the supply chain. The selection of appropriate inventory policies is often quoted as the effective means of achieving better supply chain performance and alleviating overall supply chain cost. Hence, the challenging role of a company manager is to keep inventory cost as least as possible by choosing an appropriate inventory policy in consideration with inventory policies chosen by other members of the same supply chain. The industrially popular periodic review inventory policy is Order-Up-To (OUT) policy. The OUT policy and its variants cause bullwhip generation in a supply chain, where the order variance amplification is more under OUT policy than its variants (Dejonckheere, Disney, Lambrecht, & Towill, 2003; Dejonckheere, Disney, Lambrecht, & Towill, 2004). However, in the present competitive market, an inventory policy that adjusts with the market trend may perform better in terms of bullwhip effect (T C Pamulety & Pillai, 2011). Control charts used for process control uses current information to indicate the latest status of a process. The concept of control charts is used for developing a Statistical Process Control (SPC)-based inventory policy.

This chapter discusses the bullwhip effect performance comparison of serial and divergent supply chains under an SPC-based and OUT policies. For this purpose, the concepts of the SPC-based policy proposed by Costantino, Di Gravio, Shaban, & Tronci (2014a, 2014b, 2015a, 2015b) are adapted. The bullwhip effect measures used are the order rate variance ratio and the bullwhip slope. The analysis is carried