Available online at www.sciencedirect.com
ScienceDirect
Int. J. Production Economics 113 (2008) 193–204
international journal of production economics
www.elsevier.com/locate/ijpe

The role of forecasting on bullwhip effect for E-SCM applications

Erkan Bayraktar[a], S.C. Lenny Koh[b,*], A. Gunasekaran[c], Kazim Sari[d], Ekrem Tatoglu[e]

[a]Department of Industrial Engineering, Faculty of Engineering, Bahcesehir University, Besiktas, Istanbul 34349, Turkey
[b]Management School, University of Sheffield, 9 Mappin Street, Sheffield S1 4DT, UK
[c]Management Department, University of Massachusetts-Dartmouth, 285 Old Westport Road, North Dartmouth, MA 02747-2300, USA
[d]Department of International Logistics and Transportation, Beykent University, Sisli, Istanbul, Turkey
[e]Department of Business Administration, Faculty of Business Administration, Bahcesehir University, Besiktas, Istanbul 34349, Turkey

Received 14 April 2006; accepted 6 March 2007
Available online 24 July 2007

Abstract

The bullwhip effect represents the information distortion in customer demand between orders to supplier and sales to the buyer. Demand forecasting is one of the main causes of the bullwhip effect. The purpose of this study is to analyze the impact of exponential smoothing forecasts on the bullwhip effect for electronic supply chain management (E-SCM) applications. A simulation model is developed to experiment the different scenarios of selecting right parameters for the exponential smoothing forecasting technique. It is found that longer lead times and poor selection of forecasting model parameters lead to strong bullwhip effect in E-SCM. In contrast, increased seasonality helps to reduce the bullwhip effect. The most significant managerial implication of this study lies in the need to reduce lead times along the E-supply chain to mitigate the bullwhip effect. While high seasonality would reduce the forecast accuracy, it has a positive influence on the reduction of bullwhip effect. E-SCM managers are therefore strongly suggested to utilize exponential smoothing by selecting lower values for α and β and a mid-value for γ to keep the bullwhip ratio low, while at the same time to increase forecast accuracy.

Keywords: Bullwhip effect; Forecasting; Exponential smoothing; E-SCM

1. Introduction

Despite shorter product life cycles and tight product/service costs, the idea of "any product any time any place" has now become possible through advancements in communication and transportation technologies. The contemporary businesses faced with these challenges have been more effectively coping with uncertainties emerging in their supply chains. Uncertainty is generally defined as unknown future events that cannot be predicted quantitatively within useful limits, thus making the occurrence of uncertainty unpredictable (Cox and Blackstone, 1998). The sources of uncertainty lie in the process of matching demand

*Corresponding author. Tel.: +44 114 222 3395; fax: +44 114 222 3348.
E-mail address: S.C.L.Koh@Sheffield.ac.uk (S.C. Lenny Koh).

0925-5273/$ - see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijpe.2007.03.024

with supply. The following sources of uncertainty, which include delivery lead times, manufacturing yields, transportation times, machining times and operator performances (Simchi-Levi et al., 2003), all lead to supply uncertainty that has significant impact on chain performance. On the other hand, the difficulties in predicting customer needs and wants in a given period constitute the main source of demand uncertainty that a good forecast may cope with this uncertainty. In fact, the ultimate success lies in the ability to manage the demand uncertainty with the existent supply capabilities.

It has been emphatically pointed out that understanding and practising supply chain management (SCM) has become an essential prerequisite to be able to manage demand uncertainties and to growing profitably in the global competitive race (Power et al., 2001; Moberg et al., 2002). SCM includes a set of approaches and practices to reduce the uncertainty along the chain through enabling a better integration among suppliers, manufacturers, distributors and customers (Koh et al., 2007). It is "the efficient management of the end-to-end process, which starts with the design of the product or service and ends with the time when it has been sold, consumed, and finally, discarded by the consumer" (Swaminathan and Tayur, 2003, p. 1387). Apart from traditional SCM practices, there are several tools and techniques of electronic SCM (E-SCM) to diminish uncertainty in E-supply chains, which inter alia include information sharing, third-party logistics (3PL) providers, centralized planning, strategic alliances and E-commerce logistics (ECL). Of these tools, 3PL and ECL applications have been increasingly gaining popularity among contemporary businesses (Coyle et al., 1996; Lambert et al., 1999).

Given the imperatives of intense global competition, the buyers dominate the market and present their personalized and customized requirements. This makes the demand change rapidly and difficult to forecast (Ying and Dayong, 2005). By reducing uncertainty and improving efficiency to logistics management, 3PL could increase supply chain effectiveness through the following ways (Simchi-Levi et al., 2003; Maloni and Carter, 2006): (1) enabling the company to focus on its core competencies; (2) providing flexibility in adaptation to new technology, resource and workforce size; and (3) accessing to expertise of 3PL providers on the outsourced activity and their economies of scale. 3PL is a type of services of multiple distribution activities provided by an external party (assuming no ownership of inventory) to accomplish related functions that are not desired to be rendered and/or managed by the purchasing enterprise (Sink et al., 1996). In other words, 3PL refers to the outsourcing of transportation, warehousing and other logistics-related activities to a 3PL provider that were originally performed in-house. With the use of 3PL for all or part of an enterprise's logistics operations, significant reduction in logistics cost can be achieved while improving service quality.

ECL is defined as the "impact of the Internet on the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point-of-origin to the point-of-consumption in order to meet customers' requirements" (Giménez and Lourenço, 2004, p. 3). ECL is recognized as a subset of E-SCM that refers to "the impact that Internet has on the *integration* of key business processes from end user through original suppliers that provides products, services and information that *add value* for customers and *other stakeholders*" (Giménez and Lourenço, 2004). E-SCM enhances the revenue through direct sales to customers with 24/7 access from any location, personalization and customization of information, faster time to market, flexible pricing and efficient fund transfer; and reduces the cost through better coordination with information sharing, lower delivery cost and time, less product handling, lower facility and processing costs, reduced inventory cost with centralization, and postponement product differentiation (Chopra and Meindl, 2001). According to Swaminathan and Tayur (2003), the Internet has influenced SCM in three ways: (1) increased use of ERP and advanced planning and optimization solutions; (2) ability to access real-time information in order to make real-time decisions; and (3) integrate information and decision making across different functional units. As a result, it diminishes the uncertainty with the availability of more information.

Risk-pooling, mass customization and dynamic pricing are some of the SCM issues heavily influenced by E-business applications. Although Internet applications introduce new perspectives to traditional issues and enhance capabilities of SCM, many SCM-related issues are yet to be resolved. Among some of these are keeping buffer inventory or capacity for guaranteeing the certain service levels and classical trade-off between fix and