The Bullwhip Effect: Applying Stochastic Models on Beer Distribution Game

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ABSTRACT

Supply chain management is a fledgling science which concerned with synchronization of both material flow and information flow by integrating companies for a common objective to meet the requirements of the end customer. Bullwhip effect is an important research topic of the supply chain management. The Bullwhip effect is precarious to both short and long run competitive advantage, the dependability sustainability advantage of the chain. This paper proposes to show the impact of the Bullwhip effect on the supply chain using experimentally simulated data from Beer distribution game. The game represents a simple supply chain which consists of factory, distributor, wholesaler and retailer. The paper used empirical models of ANOVA, spectral density estimation, ARMAX and Cochrane- Orcutt autoregression. The result of the study prevails that when we quantify the impact of the Bullwhip effect to different actors of the supply chain with respect of inventory holding cost and stock-out case it is found that different cost implications. When quantifying the impact of the Bullwhip effect to the whole supply chain it is found that at least one of the competitive advantages of the chain is lost. When generalizing it the all the actors in the supply chain will suffer from the Bullwhip effect. The overall evidence from statistical causality analysis suggest that without proper both intra-organizational and inter-organizational coordination of the companies across the supply chain it is difficult to have effective and efficient customer relationship management, customer demand management and inventory management.

Keywords: Beer Distribution Game, Bullwhip Effect, Organizational Coordination, Stochastic Models, Supply Chain Management

1. BACKGROUND

The term “supply chain management” introduced in the late 1980s and came into widespread use in the 1990s. Supply chains embrace the companies and the business activities needed to plan, source, produce, distribute, and use products or services. The Supply chain is the configuration of firms that convey products or services to market that contains of all phases involved in fulfilling a customer request (Ganeshan, et al., 1995).

Supply chain management includes activities such as marketing, finance, new product development and customer service and other interrelated issues. According to Christopher, (1998) in a wider interpretation of supply chain philosophy takes along a systems approach to

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understanding and managing the diverse activities required to organize the flow of products or services to best work for the final customer. In other words, the important but the challenging subject of the supply chain management comes it insights the whole chain as a single object.

The central philosophy of the supply chain management is the fact that the non-existence of the single company stands by itself as it is self-produced (from raw material), distributor, or retailer to the end customer. One of the indicators of effective supply chain management is the degree of synchronization of the companies in the chain and its ability to be flexible according to the pattern of the end customer. The behaviour and demand pattern of the end customer is dynamic because of many observable realistic factors. For example, information technology created tremendous choices with respect of quality, price and time for the end customers which of course make every business activity to become stochastic. Therefore, designing supply chain management under condition of known and foreseeable demand for the end customer turn out to be so hazardous to achieve its goals (Sakun, et al., 2011).

A supply chain management strategy commonly is held as thorough presentation of the conceptions and techniques of planning, and operation across the chain. According the DuPont analysis the task of supply chain management is intensified amount while simultaneously reducing both inventory and operating expense. Furthermore, the formulation of supply chain management is assigning the coordination and the control of production, location, inventory, transportation and information. Therefore, supply chain management entreaties more rigorous and deep analysis of the system under conditions of uncertainty (Chopra, et al., 2001).

The main motivation of this paper is the uncertainty of the end customer demand. The theory of supply chain management suggests that a successful flow of material has to be supported by the flow of appropriate, on time, reliable, consistent information. Proper information flow across the supply chain has need of the coordination of the companies in the supply chain. However, knowledgeably or unintentionally the companies in the supply chain have shown negative ideology towards coordination. In literature we can find the concept about the Bullwhip effect which is one of the effects of the lack of coordination across the supply chain. A very small change in the pattern of demand from the end customer can amplify unnecessary accumulation of inventories in the upstream of the supply chain. So, this paper tried to show how the Bullwhip effect attack the supply chain using ANOVA, Spectrum density estimation, Autoregressive-Moving average with exogenous input and the Cochrane-Orcutt autoregression models.

2. LITERATURE REVIEW

2.1. Traditional Management

Management has been applied since the inauguration of civilization and community living. Whenever people have worked structured in groups there has been management (Barnard, 1938). Traditionally management is defined as business and organizational activities is the act of harmonizing the efforts of people to undertake preferred goals and objectives using available resources efficiently and effectively (March, et al., 1958). Management encompasses scheduling, consolidating, staffing, leading or directing, and supervising an organization (a group of one or more people or entities) or effort for the purpose of achieving the company’s objective.

There are scholars who viewed management as a process by which managers craft, direct, sustain and operate a purposive organization through structured, coordinated, accommodating human labours. The word Process illustrates the dynamic nature of management, which are actions over a fluctuating span of time (Koontz, 1961). This philosophical concept is a key to understand and apply the contingency...
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