Supply Chain Coordination through a Revenue-Sharing Contract with Two Kinds of Fuzzy Demand

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ABSTRACT

Revenue-sharing contract is used in many industries. However, it is hard to guarantee that the retailer report the sales truly to the supplier. In fact, the retailer has both incentive and opportunity to underreport the sales to reduce the sharing revenue to the supplier. What the supplier should do when meeting with the opportunistic retailer(s)? This paper studies a kind of opportunistic phenomenon in a supply chain in which a supplier sells to a retailer under a revenue-sharing contract. Two settings are discussed. The first one is that the retailer does not, or cannot underreport the sales to the supplier to share when the supplier design a strict auditing mechanism under which no lies allowed. The second one is that the retailer can underreport the sales to the supplier to share under another soft auditing mechanism. Due to the uncertainty of market demand, it is characterized by a fuzzy variable. Interestingly, we find that the supplier’s profit is higher in the second setting than the one in the first setting. We hope that the conclusion drawn in the paper can provide a new viewpoint to help the supplier to solve the problem when meeting with an opportunistic retailer in a supply chain under a revenue-sharing contract in uncertain environments.

KEYWORDS

Auditing Mechanism, Fuzzy Variable, Opportunistic Retailer, Revenue-Sharing Contract

INTRODUCTION

Research on supply chain management evolved rapidly in different journals of interest to academics and practitioners. Supply chains are generally complex with numerous activities (logistics, inventory, purchasing and procurement, production planning, intra-and inter-organizational relationships and performance measures) usually spread over multiple functions or organizations and sometimes over lengthy time horizons. Single firm cannot compete as an independent member. The product used by the end customer passes through a number of entities contributed in the value addition of the product before its consumption. Also, the practices like globalization, outsourcing and reduction in supply base have exacerbated the uncertainty and risk exposure as well as more prone to supply chain disruption.

More and more firms want to improve their performance by coordination across the entire supply chain. However, the firms involved in a supply chain sometimes may not belong to the same corporate entities. And then, they prefer to maximize their own profits rather than the profit of the entire supply chain. These decision behaviors based on the individual incentives can cause some inefficiencies. To improve the overall performance of supply chain, the members of supply chain may behave as a part of a unified system and coordinate with each other. Thus “coordination” comes into focus. Supply chain

DOI: 10.4018/IJISSCM.2017100101

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contracts are the tools to coordinate the supply chain. Therefore, there have been many researches on supply chain contracts in order to alleviate the incentive conflict and coordinate firms to improve supply chain performance, which includes the quantity flexibility contracts (Tsay & Lovejoy, 1999), backup agreements (Eppen & Iyer, 1997), buy back or return policies (Emmons & Gilbert, 1998), quantity discount contract (Weng, 1995), and revenue-sharing contracts (Cachon & Lariviere, 2005).

The revenue-sharing contract was first applied in video rental industry. Over recent years, many researchers have attempted to provide the foundations for the role of revenue-sharing contracts in aligning supply chain incentives by characterizing the optimal use of revenue-sharing contract. We will review the literature on revenue-sharing in the next section.

However, it is hard to guarantee that the retailer report the sales truly to the supplier. In fact, the retailer has both incentive and opportunity to underreport the sales to reduce the sharing revenue to the supplier. There are some evidences of opportunistic retailer in different industries where revenue-sharing contracts are used. In the video rental industry, it is reported that some lawsuits where studios sued firms such as Blockbuster and Hollywood Video for underreporting of revenues. In the food industry, Dunkin’ Donuts suspected underreporting of gross sales revenues by a franchisee and took the franchisee to court for breach of contract because the amount of raw materials bought from Dunkin’ Donuts was not consistent with the reported sales. Underreporting of sales is observed when goods are distributed digitally through revenue-sharing contracts, too.

Due to the dishonesty, is it necessary for the supplier to cooperation with the retailer or not? Among literatures about supply chain coordination by revenue-sharing contracts above, market demand is characterized as a determinate or stochastic variable. However, in real world, not only demand changes from one period to another but also high degree of fuzziness is involved in data set. Therefore, it is difficult to estimate its probability distribution due to the lack of historic data. Fuzzy set theory which was originally introduced by Zadeh (1965) provides a framework for handling this type of problem in fuzzy environments. From then on, many researchers such as Zimmermann (1976) and Yager (1977) apply the theory successfully to optimization problems. Recently, Liu (2006) lays a foundation for optimization theory in uncertain environments, in which numerous models are proposed to deal with the optimization problems. This paper characterizes market demand as a fuzzy variable and will talk about what the supplier do when it meets with an opportunistic retailer. And due to the uncertainty of demand, it is characterized a fuzzy variable.

The study is structured as follows. We review some preliminaries about fuzzy theory in section 2. In section 3, a supply chain with revenue-sharing contract is modeled. Auditing mechanism under which no lie allowed and Auditing mechanism under which lies are allowed are discussed separately in section 4 and section 5. And then we conclude in section 6.

LITERATURE REVIEW

Our work is related to three stream of research: the literature on revenue-sharing contract; the literature on untruthful information telling behavior and the literature on fuzzy theory. We will review the three parts below.

Under such a contract, a retailer pays a supplier a wholesale price for each unit purchased, plus a percentage of the revenue generated by the retailer that is determined by retailer’s purchase quantity and price. Most of researches on revenue-sharing contract are based on the paper by Cachon and Lariviere published on Management Science. We will review some of these papers in the order of time.

Giannoccaro and Pontrandolfo (2004) addressed the problem of supply chain coordination under the hypothesis of a decentralized control, which is associated with the existence of several different decision-makers at the diverse supply chain stages and proposed a revenue-sharing model aiming at coordinating a three-stage supply chain, which increases the whole supply chain system efficiency as well as the profit of all the supply chain members by tuning the revenue-sharing contract parameters. Gupta and Weerawat (2006) compared three different mechanisms that a manufacturer, whose
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