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Ordering and pricing model of retailers' preventive transshipment dominated by manufacturer with conditional return

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ABSTRACT

Retailers often fail to implement the transshipment policy due to lack of the trust or information asymmetry among them in the process of transshipment, especially in the case that return becomes a norm. Therefore, we develop a framework about the preventive transshipment which is dominated by the manufacturer between two independent retailers to cope with the mismatch between demand and inventory. In this research, a two-period ordering and pricing model about the preventive transshipment with conditional return is formulated. To simplify the implementation of preventive transshipment, a dominant preventive transshipment policy is recommended at the beginning of the second period. So, one retailer may adjust the inventory without considering the impact of the other retailer's inventory quantity and the transshipment strategy. To analyze the mutual effect between two retailers, the existence and uniqueness of the ordering Nash Equilibrium and the optimal pricing policy is identified and analyzed. Furthermore, we obtain the relationship between the ordering quantity and transshipment price. Finally, a numerical analysis is carried out to examine the sensitivity of the transshipment price, wholesale price, ordering quantity, profit of the retailer and manufacture to the return rate.

1. Introduction

The increasingly fierce business competition and customers' requests for higher product variety intensify the imbalance between the demand and supply. To cope with this problem, some retailers try to adopt the reactive transshipment policy to obtain so-called "risk-pooling" effect which can potentially lead to a higher service level at a lower cost (Kutanoglu, 2008). However, there are significant hurdles among retailers in implementing the transshipment programs successfully due to the problems like the information asymmetry, lack of trust, or incentive mechanism etc. In addition, retailers are also likely to be skeptical about the rewards of the participation.

Therefore, some leading enterprises try to participate in the transshipment program to facilitate the transshipment. They have not only established the information system but also provided corresponding incentive mechanism. For example, MM, a leading manufacturer, operates the well-known Parts and Service System (P&SS) which provides the service parts and launches the Dealers Parts Inventory Sharing (DPIS) program, encouraging dealers to share their excess inventories with other dealers. In order to encourage retailers to participate in DPIS, MM bears the transport cost caused by the transshipment (Zhao, 2003). In addition, when an emergency order arrives, stocked-out dealers are charged (by MM) 0–8% of the sale price as a penalty fee while the overstocked retailers are provided 10% of the sale price as a reward for their participation in DPIS (Zhao, 2003). The Coca-Cola Company has also established the information system for information sharing under the underlying assumption that supply chain partners are willing to share the data and inventory, so the sales volume will increase and customer satisfaction can be improved through inventory sharing (Dong, Xu, & Evers, 2012). A shared information technology system called Okumalink is developed for Okuma America Corporation to ensure that all Okuma machine tools and parts are in stock at any times, no matter in its warehouse in Gharlotte, North Garolina, or somewhere along the distribution channel (Narus & Anderson, 1996). The Hewlett-Packard Company has also launched an Internet-based exchange-TradingHubs.com to share the inventory data among supply chain partners. From July 1999 to April 2000, over $45 million of parts and products were traded through the transshipment (Lee & Whang, 2002).

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In fact, the transshipment between retailers not only benefits themselves, but also benefits the upstream manufacturer. On one hand, a retailer who transships in products can reduce the risk of stock-outs, while the other can lower the risk of the leftover inventory. On the other hand, the service level and customer satisfaction can be increased, contributing to the improvement of the reputation of manufacturers' products. Therefore, the manufacturer would like to stimulate inventory sharing, and gain advantage over the retailer to control the preventive transshipment. Meanwhile, this changes the structure of the transshipment, and thereby affects the profit alignment among supply chain members.

In this paper, we try to solve the questions of the optimal ordering and the preventive transshipment policy between two retailers, as well as the pricing policy of the manufacturer in a selling season which consists of two selling periods in which different industry has different the transshipment timing. For example, the selling season of a comic book is usually two to three weeks. In the middle of the season, i.e., after a week to ten days, Comicfans Culture allows retailers to balance the inventory among all wholesalers at a price equal to the wholesale price they paid for orders placed prior to the start of the selling season. That is to say, there is a week to ten days during period 1, a week to eleven days during period 2 (Li, Ryan, & Zeng, 2012). Our model is intended to examine the following questions:

(1) How to determine the optimal ordering policy in the first selling period and the preventive transshipment policy in the second selling period for the retailers?
(2) How to determine the optimal wholesale price and the transshipment price in the first selling period for the manufacturer?
(3) How does return rate influence the transshipment price, wholesale price, and ordering quantity?

In order to address aforementioned questions and gain managerial insights into pricing, ordering and the preventive transshipment policy, we need to establish a supply chain system consisting of a manufacturer and two independent retailers. We formulate a two-period ordering and pricing model about the retailers' preventive transshipment which is dominated by the manufacturer under the return constraint. In addition, a computational experiment will be provided further to investigate how the optimal price and ordering quantity are influenced by the return rate.

The remainder of this paper is organized as follows: The next section provides a brief literature review. The problem description and assumptions are presented in Section 3. Based on Section 3, the preventive transshipment model of two retailers is formulated and the corresponding preventive transshipment policy is obtained in Section 4. Taking the transshipment policy into consideration, we show the existence of Nash equilibrium for ordering of two retailers in Section 5. Next, the pricing policy of the manufacturer is investigated in Section 6. We present a numerical study in Section 7. Finally, we conclude our findings in Section 8.

2. Literature review

The intervention of the upstream manufacturer changes the transshipment policy of retailers, which affects the profit allocation among supply chain partners. In fact, the transshipment price plays an important role in determining whether supply chain partners benefit or suffer from the transshipment. So, the transshipment price acts as a tool to align the profits of supply chain partners. Considering the important role of the transshipment price in determining the benefits that each partner gets from the transshipment, three cases the transshipment is controlled by the retailers, a third party, or the manufacturer is presented. That is to say, the transshipment is controlled by the retailers, a third party, or the manufacturer (Shao, Krishnan, & McCormick, 2011).

When the retailer facilitates the transshipment, he makes a decision on the transshipment price to control the transshipment. On the contrast, the manufacturer is in a weak position, and stimulates indirectly the transshipment between retailers. There is a well-developed body of research on the retailer-dominated transshipment including the literature (Axsäter, Howard, Axsäter, Howard, & Marklund, 2013; Dong & Rudi 2004; Güllü, van Houtum, Sargut, & Erkip, 2005; Li, Sun, & Gao, 2013; Mak & Shen, 2014; Nasr, Salameh, & Moussawi-Haidar, 2012; Rudi, Kapur, & Pyke, 2001; Shao, Krishnan, & McCormick, 2013; Zhang, 2005). For example, Rudi et al. (2001) consider a system which is made up of a manufacturer and two retailers in a single-period setup. The transshipment price is determined in advance by a retailer who transships in products or one who transships out products. They show that there exists a Nash Equilibrium of the ordering quantity, but the joint profit is generally not maximized at this equilibrium. Based on Rudi et al. (2001), Güllü et al. (2005) study a setting in which two retailers can rebalance their orders from the manufacturer after partial demand information is observed and show that there exists a unique NE of the ordering quantity. Alternatively, Mak and Shen (2014) derive the optimal ordering and transshipment policy in which both demand and supply yields are random. Assuming a normal demand distribution, Dong and Rudi (2004) also show that a higher transshipment price can increase the inventory level, which makes the retailers be less sensitive to the wholesale price and thus the manufacturer benefit more from the transshipment. Zhang (2005) generalizes the results of Dong and Rudi to an arbitrary demand distribution. In addition, Shao et al. (2013) consider a manufacturer who distributes a product line through two competing downstream retailers, and obtain the optimal ordering and transshipment quantity. The paper further demonstrates that the transshipment may hurt the manufacturer when the retailers are in charge of the transshipment. Nasr et al. (2012) combine the transshipment and safety stocks in the presence of interruptions and conclude that it is optimal to allow for a transshipment of inventory from the safety stock of one location to the other only in some cases. Taking this path, Li et al. (2013) investigate the optimal ordering and transshipment in a two-period setup, and concludes that the linear transshipment price coordinates the transshipment between the retailers. In addition, Axsäter et al. (2013) derive a rule that how many units should be transshipped, depends on the complete state of the system. The above literatures demonstrate that the decision of the transshipment price, depending on the ability of the negotiation of two retailers. That is to say, the retailer who is in charge of the transshipment either transships in products or transships out products. The manufacturer exerts the influence over the transshipment by setting the wholesale price because she[1] is in a weak position.

However, in practice, retailers often fail to implement the transshipment policy due to the lack of trust between them in the process of transshipment. So, the third party tries to participate in the transshipment by establishing the corresponding coordination and incentive mechanism (Hanany, Tzur, & Levran, 2010; Huang, Gu, Ching, & Siu, 2014; Huang & Sošic, 2010; Lee & Whang, 2002; Yan & Zhao, 2011; Zhao & Bisi, 2009). For example, Yan and Zhao (2011) and Hanany et al. (2010) consider a horizontally decentralized system with non-cooperative retailers. However, both papers require an assumption about a neutral third

[1] We'll adopt the convention that the retailer who requests a transshipment is female and the requested retailer is male. In addition, we further specify that the upstream firm is female, and the downstream firm is male.