



Trade credit model with customer balking and asymmetric market information

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ABSTRACT

Customer balking exists in many industries, and would significantly impact the supply chain management. We consider trade credit, customer balking behavior and market information asymmetry and information sharing in a two-level supply chain. Stackelberg equilibriums are derived in each scenario, respectively. The wholesale price and order quantity at equilibrium decrease (increase) in balking threshold (balking probability) when the production cost is not relatively low. The retailer benefits from the manufacturer's pessimism with information asymmetry, while the optimism with information sharing. However, information asymmetry always harms the manufacturer. We design an information-dependent-credit-limited contract to enforce the retailer to share information.

1. Introduction

Trade credit is widely used in both developed and developing countries due to its easy access, role in taxes reduction and transaction costs (Burkart and Ellingsen, 2004; Fisman and Love, 2003; Sheen and Tsao, 2007; Jacobson and Schedvin, 2015). For example, Walmart uses four times more trade credit than short-term external financing (Breza and Liberman, 2013). Trade credit is an important source of external finance for both large firms (for example, Wal-Mart, Procter & Gamble) and those with limited working capital, such as start-ups and small- and medium-sized enterprises (SMEs). Therefore, trade credit has garnered considerable attention from the managers and scholars. One important direction is to model and explore the role and effect of trade credit on the operational decisions and performance of supply chain (Yang and Birge, 2017; Kouvelis and Zhao, 2012). This paper further focuses on the optimal pricing and ordering strategies of supply chain under trade credit by considering customer balking and information asymmetry and explores how they impact the optimal decisions and performance. Our model and results apply to the firms under trade credit with limited liability in practice.

Customer balking (or inventory balking) is a common phenomenon in retail industry, especially fashion seasonal or perishable products (Pasternack, 1989; Liao et al., 2011; Choi et al., in press). For example, customer who arrives in the fruit shop reduces his buying intention when the fruit inventory is small, since he believes that the remained fruit is less-qualified or defective. Sometimes, this phenomenon also exists even though in industries with durable products due to the customers' belief. For example, when the observed quantities of the product are small, the customer in queue may leave since he believes that the remaining stock is not enough to satisfy the demand. That is, when it's his turn, the product may sell out. Under this setting, the balking behavior has a

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negative effect on the actual demand, and the corresponding profit and inventory strategy change (Lee and Jung, 2014). Moreover, in fashion industry or supermarkets, retailers are usually allowed to pay the procurement cost later (i.e., trade credit). For example, Yang and Birge (2017) report that in their survey, 448 clothing & clothing accessories stores, and 445 food & beverage stores use trade credit extended by their suppliers to finance their inventories. Therefore, it is necessary to explore the problems in presence of trade credit and customer balking. We propose a two-level supply chain model to further explore the joint effect of the trade credit with limited liability and customer balking on the optimal wholesale pricing and ordering strategies and the supply chain performance. More importantly, the interaction of trade credit and customer balking is explored. Our model and results show that incorporating customer balking, the Stackelberg problem is piecewise, depending on the balking parameters.

In addition to customer balking, another interesting problem in practice (for example fashion industry) is information asymmetry with uncertainty (Lau and Lau, 2001). In this paper, we assume the retailer has full knowledge of the market information, while the manufacturer only estimates the market information by himself (Hsieh et al., 2008; Alan and Gaur, 2012; Cheong and Song, 2013). Therefore, the manufacturer may over-estimate or under-estimate (Scenario I). Under such setting, the decision of this Stackelberg leader impacts the retailer's decision in turn. Further, we explore the case in which the retailer shares the true information and her corresponding ordering strategy with the manufacturer (Scenario II) and show the value of information sharing. Such setting captures the effect of the manufacturer's sentiment on the equilibrium and agents' profits. Note that, in a classical two-level supply chain without trade credit, the decision of the manufacturer under Scenario II remains the same as that with symmetric information. Differently, in this study, we show the manufacturer's decision depends on his belief.

This paper incorporates customer balking and demand information asymmetry into the trade credit model, examines their effects on the decisions and performances and derives some new managerial insights. To address these questions, we propose a two-echelon supply chain consisting of one manufacturer and one capital-constrained retailer in single-period game. Specifically, we mainly focus on the following problems: (i) The Stackelberg equilibrium of order quantity and wholesale price with information asymmetry and information sharing under trade credit. (ii) The impact of customer balking and information asymmetry on the optimal decisions and performance. (iii) The conditions and contract to coordinate the supply chain. (iv) The condition where the retailer prefers to share information with the manufacturer. The contract to enforce the retailer to share true information.

Our work contributes to the literature in four ways. First, we derive the Stackelberg equilibrium of the two-level supply chain under trade credit contract and customer balking with information asymmetry and information sharing. The existence of customer balking results in two cases, i.e., high bankruptcy risk and low bankruptcy risk. Our result shows that customer balking has a significant impact on the equilibrium. Second, our results show that customer balking harms the manufacturer, while it enhances the retailer's performance which is counterintuitive. The retailer transfers the negative effect of customer balking to her upstream. The customer balking results in a lower order quantity, which results in a lower supply efficiency. Third, our results show that the effect of information asymmetry on the retailer's profit is two-fold, that is, the retailer benefits from the manufacturer's pessimism under Scenario I, while the optimism under Scenario II. However, the information asymmetry always harms the manufacturer. Forth, more importantly, we design an information dependent trade credit rationing contract to enforce the retailer to share information with the manufacturer. Specifically, the manufacturer offers a contract with the term of limited credit which depends on his belief on market demand information. Under such contract, the retailer would share the true information to get higher profit.

The remainder of the paper is organized as follows. The relevant work is reviewed in Section 2. Section 3 proposes the basic model and assumptions. Stackelberg equilibrium with trade credit and customer balking with different information setting is derived, respectively in Section 4. Section 5 gives managerial insights through computational study. Section 6 concludes this work. Proofs are collected in Appendix A.

2. Literature review

Our work is closely related to customer balking, trade credit and information asymmetry. Since problem with information asymmetry with uncertainty has been well reviewed (see, e.g., Hsieh et al., 2008), we only mainly review the former two streams.

The first stream examines the inventory problem considering customer balking. The seminal work, Pasternack (1989) models the balking problem in newsvendor framework. Lee and Jung (2014) investigate how the existence of customer balking impact the retailer's performance measures, such as expected sales, expected leftover inventory, and expected profit. Other related works considering customer balking focus on the newsvendor problem with distribution-free (Moon and Choi, 1995; Liao et al., 2011). Moon and Choi (1995) firstly relax the distribution assumption when considering balking, and derive the optimal order quantity. Liao et al. (2011) extend the model by considering lost sales penalty. Feng et al. (2014) propose a buy-back contract to coordinate the supply chain with customer balking. The above works merely focus on the problems within a newsvendor framework. However, few literatures examine the problem in a framework of supply chain and investigate the effect of balking on the manufacturer's wholesale price decision, the retailer's order quantity decision and supply chain performance. To bridge this gap, we propose a two-level supply chain model and analyze its impact of both optimal wholesale price and inventory decisions.

The second stream of work examine the role of trade credit with capital constraint in supply chain. The interface of operations and finance originates from Xu and Birge (2004), and Buzacott and Zhang (2004), which point out the necessity to incorporate budget constraint into operations management. Zhou and Groenevelt (2007) explore the open account financing (trade credit) with credit line limit and derive the equilibrium. Kouvelis and Zhao (2011) propose three types of bankruptcy-induced cost, and further analyze their effects on the optimal choices. Chen and Wang (2012) find that trade credit could partly coordinate the supply chain, which is confirmed by Kouvelis and Zhao (2012). Kouvelis and Zhao (2012) derive the optimal trade credit contract structure for the first time. They show that the optimal priced trade credit is cheaper than bank credit. As a complement, Jing et al. (2012) firstly analytically

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