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Risk-averse procurement strategy under large-scale promotion online considering strategic customer

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ABSTRACT

Driven by large-scale promotion online, customers are becoming strategic in their purchasing behaviour, thus giving rise to pulsed demand. However, pulsed demand is dynamic and highly uncertain. It will not only undermine retailers' profit but will also increase their risks. Based on strategic customer behaviour and multiplicative demand, this paper proposes a pulsed demand model and establishes a procurement decision model within the expected utility framework from the perspective of a risk-averse retailer. A strategic customer ratio (SCR) is employed to denote the proportion of such customers in the entire customer population. We find that the optimal procurement strategy depends on a threshold - a retailer will procure only if the initial inventory level is below this threshold. When the SCR is price-independent, the procurement volume in the promotion period decreases in the selling price, and increases in the SCR in a previous period. When the SCR is price-dependent, the impact of the price in a previous period on the current procurement volume depends on the relationship of price elasticity between SCR and demand in that period. Our numerical study shows that the risk-averse procurement strategy can effectively mitigate risk without significant profit loss, and more so when the SCR becomes larger.

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1. Introduction

Electronic commerce (EC) has undergone dramatic developments in recent years. According to the market research data of e-marketer, global sales of EC amounts to 120 million US dollars in 2013, a year-on-year increase of 17%. To follow this trend, traditional firms are swarming to compete in the B2C market. For example, 80% of the top 500 online selling companies in the US are originally from the traditional firms. The traditional competition between retailers has now become competition between retailers and online sales platforms. Especially, large-scale promotion online manifested by China's Singles' Day (on 11th November) and the US's "Cyber Monday" highlights a crucial change in consumer behaviour in the world's largest economies.

This study aims at investigating a retailer's procurement strategy with the consideration of strategic shopping behaviour of customers during large-scale online sales and promotion. There are two main issues to address in this study. The first concerns a customer's strategy or timing for making a purchase when a large-scale promotion is looming - the customer would expect a

significant price discount during the promotion and hence postpone the purchase now. When this opportunity materialises, the customer would then make the purchase, perhaps in large quantity to take advantage of the discounted price. These phenomena are called strategic waiting and stockpiling in this paper. Secondly, although online channel sales will probably increase during the promotion, the arrival of customer orders in an overwhelming manner within a short space of time presents a major difficulty to the retailer. Such pulsed demand, while hikes when large-scale promotion online takes place, will fall steep when the promotion is off. According to Taobao, a C2C website of Alibaba, some fashions retailers would achieve 20% of their yearly sales total (in volume terms) on the Singles' Day alone.

Pulsed demand due to online sales is characterised by large volume, high uncertainty and its dynamic occurrence. Such a demand pattern presents a retailer major dilemma in developing its procurement strategies in balancing profit against risk. Apparently, the retailer will need to adjust the ordering quantity in view of rapidly changing customer demand. However, he also needs to be aware that inappropriate adjustment would give rise to lower profit as well as significant risks.

The demand of a product in the environment of online channel depends on its pricing, historical sales volume and consumers' comments, service level such as product availability and on-time

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delivery, among others. Among these, dynamic pricing is considered to be the most critical and endogenous as it has a profound impact on demand. Such an impact is complex and would persist with time. It is found in many researches such as Su and Zhang (2008), Yin, Aviv, Pazgal, and Tang (2009), and Mersereau and Zhang (2012) that dynamic pricing affects the buying behaviour of customers. Essentially, dynamic pricing would encourage strategic customers to postpone purchasing, especially in anticipation of a better bargain to come. This will cause the potential demand to accumulate - up to the point when the price is finally reduced. Moreover, we anticipate more and more customers within the online sales environment would acquire such strategic or intelligent purchasing behaviour over time.

However, we observe that most retailers in China have not sufficiently recognised the full implications of the strategic behaviour of customers and also the need to jointly consider their pricing and procurement approaches/strategies. A lack of understanding of these related issues will expose them to unfavourable situations. Without appropriately considering the possible strategic customer behaviour, a retailer might underestimate the price elasticity in relation to demand, thus resulting in the underestimation of demand during promotion due to under-pricing. This underestimation of demand would in turn lead to shortage of inventory, loss of sales and customer goodwill; and both revenue and profit will be undermined as a result. Furthermore, strategic customer behaviour is related to demand variability; and inadequate assessment of the customer behaviour will lead to higher procurement risks. To address possible demand hikes, this study proposes a new procurement strategy that jointly considers procurement, sales pricing and also strategic customer behaviour.

Unfortunately, since large-scale promotion online is a rather recent phenomenon, few, if any, study has been made to address such a dynamic research problem. Although the relevant issues of strategic customer behaviour and stockpiling have been studied, no suitable demand model has been made available. Therefore, no proper strategy has been devised to control procurement risk against the background of large-scale promotion online with pulsed demand. In addition, risk-neutral procurement strategies is inappropriate due to risks incurred under large-scale promotion online, where pulsed demand is dynamic and highly uncertain.

To practically better control retailer's procurement risk under large-scale promotion online, and theoretically complement the study of pulsed demand, this paper will first present a pulsed demand model based on strategic customer behaviour. Then, a procurement decision model from the perspective of a risk-averse retailer is established. By considering these two models concurrently, we propose a procurement strategy under pulsed demand. The proposed model is fully analysed under different scenarios. Also, the demand model is extended to consider both additive demand and stockpiling. Finally, numerical experiments are performed to explore the impact of strategic customer behaviour and discount.

2. Literature review

Procurement is a capital incentive function and hence the risks involved in it have been received enormous attention by both practitioners and academia. Representatively, the team of Nagali thoroughly analysed and managed procurement risk for Hewlett-Packard in 2007. They practically proved the effectiveness of their portfolio procurement strategy in controlling procurement risk (Nagali et al., 2008). Essentially, procurement risk can be categorised into three major types including demand, supply and price risk (He, Huang, & Yuan, 2015; Shi, Wu, Chu, Sculli, & Xu, 2011). Various strategies have been proposed in the literature to control

procurement risks. Based on the portfolio concept, Martínez-de-Albéniz and Simchi-Levi (2005) utilise the cost advantage and flexibility of different supply contracts while (Merzifonluoglu, 2015) uses a portfolio of forward contracts, option contracts and spot. In a similar vein, by considering the differences in cost and reliability of suppliers, diversification strategy could be devised to avoid some extreme supply risks such as disruption (Federguen & Yang, 2014; Li, Sethi, & Zhang, 2013; Yan, Ji, & Wang, 2012).

However, the above procurement strategies have assumed that decision makers are risk neutral. Such an assumption is inappropriate for retailers who are more concerned with protecting their bottom lines when making procurement decisions in face of complex and uncertain environments (Bisière, Décamps, & Lovo, 2014; Madadi, Kurz, Taaffe, Sharp, & Mason, 2014; Rieger, Wang, & Hens, 2015). Therefore, many researchers have chosen to model retailers as risk-averse for better capture of their cautious behaviour in making procurement decisions. For example, Shu, Wu, Ni, and Chu (2015) propose a risk-averse strategy to control supply and demand risks by introducing an increasing and concave utility function. Choi, Rusczyński, and Zhao (2011) study a multiproduct risk-averse newsvendor problem with law-invariant coherent measures of risk. They find that ordering quantities decrease against risk aversion when demands in different periods are independent of each other. Wang, Webster, and Suresh (2009) also explore the problem in the risk-averse newsvendor setting but within the expected utility theory framework. They show that a risk-averse newsvendor would order less when price increases beyond a threshold. However, these strategies were developed before the era of large-scale promotion online and hence further extensions are required to reflect the new developments in the retail industry.

Under large-scale promotion online, customers would change their purchasing behaviour significantly. Many researchers (Jerath, Netessine, & Veeraraghavan, 2010; Mersereau & Zhang, 2012; Su, 2007; Su & Zhang, 2008) have pointed out that dynamic pricing could train customers to become strategic in their purchasing behaviour. Such customers do not only decide whether to buy, but they also decide whether or not to wait for possible price discount. In some situations, customers might stockpile goods such as household items and staple foods when sales promotions take place for offsetting possible price increase in the future (Su, 2010a). In addition, when supply is limited, e.g. NBA tickets, speculators would appear and compete with genuine customers for the product. These speculators would help magnify the demand at the beginning of sales season (Su, 2010b). Consequently, customer behaviours make demand shift within a sales period in a highly dynamic manner. Therefore, any procurement strategy that ignores such dynamic behaviour of demand may result in undesirable managerial implications for online retailers. Despite the above good understanding has been given to pulsed demand, it is still necessary for retailers to jointly consider demand and customer behaviour when developing effective procurement policies. In the following sections, pulsed demand under large-scale promotion online based on strategic customer behaviour will first be modelled. This is followed by the proposal of a risk-averse procurement strategy.

3. Pulsed demand model

The main notations used to model pulsed demand and procurement decision are given below.

Decision variables
q Procurement volume

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