International Journal of Production Economics 191 (2017) 267–277

Contents lists available at ScienceDirect

International Journal of Production Economics

journal homepage: www.elsevier.com/locate/ijpe

Free or calculated shipping: Impact of delivery cost on supply chains moving to online retailing

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ARTICLE INFO

Keywords:
Free shipping policy
Calculated shipping policy
Online retailing
Geographical pricing
Uniform pricing

ABSTRACT

Shipping policy is an important element in the operations strategy for retailers moving online. In this study, we provide a framework to respectively investigate the impact of shipping policies in the multi-retailer and exclusive-retailer supply chains. We first develop an oligopoly model of price competition under calculated shipping policy and a Cournot model of quantity competition under free shipping policy in the supply chain with multiple competitive retailers. Our main finding is that while online retailing may result in a lower price for customers and a higher supply quantity for the supplier, none of the retailers can benefit from online move under calculated shipping policy, and only retailers with relatively small local market size may be better off under the free shipping policy. Both the supplier and customers prefer free shipping policy. For the supply chain consisting of an exclusive retailer, we develop a geographical pricing model and a uniform pricing model. We find that shipping policies with or without charges make no difference under geographical pricing approach. Under uniform pricing approach, customers in regions with shipping costs lower than the weighted average shipping cost prefer calculated shipping policy, while those in regions with shipping costs higher than the weighted average shipping cost prefer free shipping policy.

1. Introduction

In recent years, with the development of the Internet related information technology and the growth of third party logistics providers (Tsay and Agrawal, 2004), a growing number of traditional retailers have found it attractive to move online and employ the new means provided by the Internet to serve customers. Consequently, many retailers with brick-and-mortar stores are now entering the online marketplace to increase convenience for their local customers and sell to online shoppers from distant regions. Examples of companies making such a transition and having built online channels include Best Buy, Wal-Mart, Barnes & Noble, Tesco, Metro, Costco Wholesale etc. (NRF, 2014; Bernstein et al., 2008).

With increasing numbers of brick-and-mortar stores entering the online marketplace, e-commerce sales have climbed remarkably steadily for years, with continuous further growth expected. According to Forrester's latest five-year e-commerce forecast, US online retail sales will grow to $480 billion by 2019, up from 298.26 billion US dollars in 2014. Online retail sales in Canada are predicted to reach $39.9 billion, or 9.1% of total sales, in 2019, up from $22.3 billion in 2014, or 6.1% of total sales (Wray, 2014). And China is expected to become the first market to reach $1 trillion in online retail sales in 2019 (Meena, 2016).

One of the most salient characteristics that differentiates online and offline shopping behavior is the low "transportation costs" required to visit an online store (Moe and Fader, 2004; Zhang et al., 2017; Xu et al., 2017). In the offline world, where the shopper incurs high "transportation costs" by taking the time and effort to visit stores located in other regions, it is more likely that he/she will choose to visit a local store. The low cost of visiting an online store site and the ease of acquiring online price information make the shopper more likely to search and compare the total prices before making a purchasing decision. Most consumers are sensitive to shipping charges, which are considered a main reason why online shoppers abandon their shopping carts. In a survey conducted by Kawamoto (2008), 72% of those surveyed responded that if an online retailer starts charging a shipping cost, they would turn to another one that offered free shipping. Meanwhile shipping costs are anticipated to significantly impact online retailers' profitability, particularly when they offer free deliveries.

Although it has become a general trend for a brick-and-mortar retailer to open an online outlet, some fundamental questions remain to be answered. It is unclear as to whether the retail move from offline to online would benefit all parties in the supply chains. The online channels would cannibalize sales from the existing stores. According to Forrester's forecast, e-retail sales accounted for 7.4 percent of all retail sales

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http://dx.doi.org/10.1016/j.ijpe.2017.06.022
Received 28 April 2016; Received in revised form 12 June 2017; Accepted 15 June 2017
Available online 20 June 2017

worldwide in 2015. This figure is expected to reach 12.8 percent in 2019. Thus, it is necessary to recognize the impact of retail move and the online shipping policy on the supply chains.

Furthermore, it is unclear how traditional retailers moving online should compete in terms of price. Most studies that compared price and service differences between online retailers have assumed that the delivery costs to customers are equal. Since shipping costs vary depending on the distance between the retailers' original location and the customers' destination location, it is necessary to recognize this critical factor.

In this paper, we attempt to fill this gap by explicitly modeling the strategic interaction between firms operating online retail business and showing how the retail online move and the shipping policy affect the related parties in the supply chain. In particular, we try to answer the following questions.

- How does competition among retailers operating online channels affect their pricing strategies? What is the resulting effect on the supplier and customers?
- Who can benefit when the retailers move online? What is the impact of shipping policy on the related supply chain parties?
- Does channel structure affect the results? What if the products are distributed by one exclusive online retailer?

We first consider a supply chain in which a supplier selling an identical product through its retailers located at different regions who are moving online. We model the price competition and Cournot competition among the retailers under the calculated shipping policy (i.e., the customers pay the shipping costs for products delivered from the retailers) and the free shipping policy (i.e., the retailers absorb the shipping costs), and study the retailers' optimal decisions on pricing and order quantity. To investigate the effect of channel structure, we consider a supply chain consisting a supplier and an exclusive retailer, and analyze the retailer's optimal decisions under both the geographical pricing approach and the uniform pricing approach.

The rest of the paper is organized as follows. In Section 2, we review the related literature. Section 3 describes the model. Section 4 derives the equilibrium results and compares the two shipping policies in the supply chain with multiple competitive retailers. Section 5 examines two different forms of pricing approach in the supply chain with an exclusive retailer. Finally, we draw our conclusions in Section 6. All proofs are provided in the Appendix.

2. Literature review

Our work is related to the research stream on shipping strategy. For online retailing operations, shipping policy is an important decision. There is a growing body of literature examining shipping policy. As Becerril-Arreola et al. (2013) discussed, a variety of shipping-related policies implemented by online retailers can be divided into three categories: unconditional free shipping policy (i.e., under which the retailer absorbs the shipping costs); contingent free shipping policy (i.e., under which a retailer pays for the shipping costs if the orders equal to or larger than a value or quantity threshold; and customers pays for the shipping costs. Lewis et al. (2006) investigate the impact of shipping charges on consumer purchasing behavior. They show that consumers are sensitive to shipping charges, and promotions such as free shipping and free shipping for orders that exceed some size threshold are effective in generating additional sales. In another research paper, Lewis (2006) reported that the contingent free shipping policy is the most effective policy in increasing the revenues of online retailers. Based on an analytical model and subsequent empirical analyses using data collected from the online retailers of digital cameras and video games, Yao and Zhang (2012) find that online retailers will increase base prices when they offer free shipping. The value-based or quantity-based free shipping policy is widely adopted by online retailers as a common marketing promotion. Huang and Cheng (2015) examine the two forms of threshold free shipping policy from the customers' perspective. Boone and Ganeshan (2013) investigate how to structure value-based free shipping strategies and design inventory policies to maximize profits. Based on an optimization model that encompasses costs of procurement, ordering and holding inventory, and shipping to customers, they provide suggestions for the retailer to optimally determine the threshold value and replenish the inventory simultaneously.

Becerril-Arreola et al. (2013) consider a two-stage decision process in which the retailer first makes optimal decisions on the profit margin and the contingent free shipping threshold, and then determines the optimal inventory value. They show that variations in a positive finite free-shipping threshold affect both the average value and the standard deviation of the order sizes. To tackle the shipping-fee dilemma, Jiang et al. (2013) develop nonlinear mixed-integer programming models to concurrently determine the optimal shipping-fee schedules and product selling prices for single and multiple product transactions. To explore the free shipping policy in the context of newsvendor setting, Kwon and Cheong (2014) extend the base model developed by Zhou et al. (2009) to consider inventory issues when the exact distribution function of demand is not available. They present the optimal policies for the extended model and conduct numerical experiments to analyze the impacts of minimum free shipping quantity and the fixed shipping fee on the performance of the extended model.

Another stream of literature related to our work studies competition between online retailers (Abhishek et al., 2015; Wu et al., 2015) and the interactions between online firms and traditional firms (Yao and Liu, 2005, Hsiao and Chen, 2014; Chen et al., 2012; Wang et al., 2016). To capture the complexity that are associated with online retail competition, Dou and Ghose (2006) propose a Catastrophe Theory model and analyze the competitive influence that one online retailer can exert on its rival competing in the same online industry. They identify conditions under which catastrophes can occur in the customer base of a less-established online retailer competing with its more established competitor. Huang et al. (2013) formulate a Stackelberg game to investigate the dynamics between price and lead time for an e-retailing system with two duopolistic suppliers and a retailer in a competitive environment. They suggest that when a supplier chooses a shorter lead time as the competitive strategy, the other supplier should choose a lower price for counteraction.

Forman et al. (2009) shows that the parameters in existing theoretical models of channel substitution such as offline transportation cost, online disutility cost, and the prices of online and offline retailers interact to determine consumer choice of channels. Mokhtarian (2004) analyzes the transportation and spatial impacts of online retailing and compares the advantages of brick-and-mortar stores and e-tailing. The author concludes that neither type uniformly dominates the other. Viswanathan (2005) develops a stylized spatial differentiation model to examine the impact of differences in network externalities and switching costs on competition between online, traditional, and hybrid firm. The results indicate that with network effects an increased market share does not translate into higher profits, and consumers rather than firms, benefit from increasing network externalities, with competitive effects outweighing the surplus-extraction abilities of firms. To study the effect of the browse-and-switch behavior on the brick-and-mortar retailer and the online retailer, Balakrishnan et al. (2014) analyze a stylized economic model that incorporates uncertainty in consumers' valuation of the product and captures the heterogeneity among consumers in their inclination to purchase online. They shows that the browse-and-switch behavior intensifies competition, reducing the profits for both firms. Bernstein et al. (2008) show that clicks-and-mortar arises as the equilibrium channel structure, which does not necessarily imply higher profits for the competing firms.

There is scant literature, however, addressing the impact of shipping policy on the entire supply chain. Our work contributes to the literature in two main aspects. First, our work is the first to provide a comprehensive comparison of the impact of calculated shipping policy and free