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Quick response and supply chain structure with strategic consumers[☆]



Daojian Yang^{*}, Ershi Qi, Yajiao Li

College of Management and Economics, Tianjin University, Tianjin 300072, China

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ABSTRACT

This work explores the impact of quick response on supply chain performance for various supply chain structures with strategic customer behavior. By investigating pricing and inventory decisions in decentralized supply chains under revenue-sharing contracts and in centralized supply chains, we study the performance of four various systems and compare the value of quick response in different supply chain structures. The results show that if the extra cost of quick response is relatively low, the value of quick response would be greater in centralized systems than in decentralized systems. On the other hand, if the extra cost is high, decentralized supply chains reap more incremental profits from adopting quick response. We also find that revenue-sharing contracts enable a decentralized supply chain to outperform a centralized supply chain, but only allow limited flexibility of allocating total profits between a manufacturer and a retailer.

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1. Introduction

As firms in the apparel industry and beyond pay increasing attention to quick response [1], they face essential decisions on the structures of their supply chains: *centralized supply chain or decentralized supply chain*? Different companies may choose different structures. For example, Zara is quite famous for constructing a highly integrated supply chain [2,3]. It makes much effort to shorten the supply chain, including striving to own and manage all the stores [4]. H&M, by contrast, keeps a long supply chain. Its products are totally manufactured by independent suppliers [5]. It sources a lot from distant areas like Asia, where the production cost is low [6]. Mango, an international fast fashion company having presence in more than 100 countries [7], also operates a decentralized supply chain. The majority of its shops are franchise outlets [8]. A natural question to ask is: which system is likely to reap more *incremental benefits* from adopting quick response? It is for sure that a well devised supply chain system would help to exploit quick response capabilities.

Quick response is an operational strategy designed to reduce lead times and improve supply flexibility [1,9]. It utilizes a range of technologies (such as enhanced information systems, and expedited logistics operations) to achieve its goal. In the middle 1980s, the first adoption of quick response took place in the apparel industry in the United States. Now quick response is successfully implemented in various industries. Zara, H&M, and Adidas are

among the companies that invest in building quick response capabilities [10]. The benefits of quick response are well acknowledged [1,11,12]. Retailers in supply chains with quick response are able to adjust their ordering quantity rapidly, according to the market demand information gathered. Quick response enables firms to avoid overproduction, ensure low inventory levels, and counteract strategic customer behavior [13]. Furthermore, it is known that the value of quick response for a retailer, which is measured in terms of profit increment, is greater with strategic consumers than without [9]. Nevertheless, there is little research investigating the impact of quick response on the performance of decentralized supply chains with strategic consumers. So we aim to bridge this gap in the literature and answer the question we raise above.

In this paper, we analyze the decisions made by different members in various supply chain structures, and then compare the value of quick response in centralized systems with that in decentralized systems. Building upon the newsvendor model with strategic customers proposed in [14], our model considers four types of supply chains, namely: (1) decentralized supply chain without quick response, (2) decentralized supply chain with quick response, (3) centralized supply chain, and (4) centralized supply chain with quick response. In the absence of quick response, Su and Zhang [14] study the performance of supply chains taking into account strategic customers. They find that a decentralized supply chain could outperform a centralized supply chain under an appropriate wholesale price contract. The decentralized systems in this paper are governed by revenue-sharing contracts instead of wholesale price contracts. Revenue-sharing contracts have been extensively studied and could be viewed as generalized versions of

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^{*} Corresponding author. Tel.: +86 13821138396.

E-mail address: yangdaojian@tju.edu.cn (D. Yang).

wholesale price contracts [15]. We would like to examine whether revenue-sharing contracts could help to achieve optimal supply chain performance. Our model begins with a decentralized supply chain, in which we analyze the retailer's decisions and the parameters in revenue-sharing contracts. Next we extend the model to incorporate quick response. To compare the value of quick response in alternative supply chain structures, we then introduce centralized systems, both with and without quick response. Further, we study the inventory decisions and the performance of the four supply chains, and then investigate the value of quick response both in centralized systems and in decentralized systems, analytically and numerically.

We now provide the main findings. First, we show that with strategic consumers, the value of quick response is higher in centralized supply chains than in decentralized supply chains, if the unit cost of products with quick response is close to the unit cost of ordinary products. This is a counterintuitive finding, because according to [9,14], one would expect that quick response would generate more value for decentralized systems. Thus, if a firm could vertically integrate its supply chain and make the best of quick response, thereby effectively reducing the additional cost of quick response, it would make more profits from implementing quick response, compared to a decentralized system. For instance, Zara is reported to have an extraordinary fast supply chain [2,3]. Chances are it does so well in quick response that its cost of an additional product after observing accurate demand would not be much higher than the unit cost of the initial inventory. However, if the extra cost of quick response is great, decentralized systems would reap more incremental profits.

Second, we find that revenue-sharing contracts are preferred over wholesale price contracts in decentralized supply chains with strategic customer behavior. This is because the revenue-sharing contract not only enables a decentralized system to outperform a centralized system, but also allows alternative allocations of profits between a manufacturer and a retailer. The wholesale price contract, by contrast, is known to only permit a particular division of the profits. Yet, the revenue-sharing contract imposes an upper bound on the retailer's share of the overall profits generated by the supply chain. In consequence, it fails to allow full flexibility of dividing profits. This is in contrast to the prevailing view that revenue-sharing contracts support arbitrary split of total profits between members within the supply chain. As the retailer's bargaining power grows, it may accept neither revenue-sharing contracts nor wholesale price contracts.

Third, limiting initial inventory often works well for discouraging strategic customer behavior, provided that the supply chain could convince consumers of its credibility. Quick response, as well as decentralization, would just serve as a means to persuade strategic customers that the supply chain would stick to its decision of low stocking level. We show that the equilibrium inventory is lower in a decentralized supply chain with quick response, compared to in a centralized supply chain with or without quick response. Low inventory levels reduce the possibility for the supply chain to salvage excess products, which increases strategic consumers' willingness to buy early. The supply chain could thus charge a higher retail price, contributing to the increment of profits.

The remainder of this paper is organized as follows. Section 2 reviews relevant literature. Section 3 introduces the model of a decentralized supply chain. Section 4 extends the model by studying a decentralized supply chain with quick response. Section 5 addresses the model of centralized supply chains. Section 6 compares the performance of various supply chains and investigates the value of quick response. Section 7 presents a numerical study. Section 8 provides discussion, extension and managerial implications. Section 9 offers concluding remarks.

2. Literature review

Our work is related to three streams of research: the literature on consumer behavior in operations management, the literature on quick response, and the literature on supply chain contracting.

Researchers have recognized the importance of investigating consumer behavior in operations management and built a variety of models [13,16]. Strategic customer behavior, well studied in economics [17] and marketing [18–20], is introduced into a supply chain setting by Su and Zhang [14], where the impacts of strategic customer behavior on system performance under various contracts are analyzed. Khouja, Park, and Zhou [21] consider a newsvendor problem, in which patient consumers could get free gift cards offered by retailers at the end of the season if the consumers choose to delay their purchase. Dasu and Tong [22] conclude that neither a posted pricing scheme nor a contingent pricing scheme is dominant when a monopolist sells short life cycle products over a finite time horizon to strategic consumers. Anily and Hassin [23] study a deterministic problem of pricing and replenishment, where strategic consumers take into account holding or shortage cost. Other examples include strategic customers anticipating future prices of products [24], determining which product variant to buy [25], making decisions concerning group buying [26], and considering search costs [27]. Besides strategic customer behavior, researchers also explore consumer learning behavior [28,29], consumer inertia behavior [30,31], bounded rationality [32], customer disappointment aversion [33], and hyperbolic discounting [34] in operations management.

Our model in this paper builds on the newsvendor model with strategic customer behavior developed by Su and Zhang [14], but our analysis is distinct in that we consider the order adjustment problem of quick response strategy in a supply chain setting with strategic customers. To the best of our knowledge, the influence of strategic customer behavior on the value of quick response in a decentralized system has not been addressed. Additionally, we obtain an unexpected finding that the value of quick response could be greater in centralized supply chains than in decentralized supply chains when the additional cost of quick response is low. Our work employs the revenue-sharing contract which is not studied in [14], and derives an interesting result: in the presence of strategic consumers, revenue-sharing contracts only allow limited flexibility of dividing overall profits, though they are favored over wholesale price contracts.

There exists an extensive literature exploring quick response in operations management [1,11,12,35]. These papers usually treat quick response as a vehicle to reduce lead times and mitigate demand uncertainty. Among them, a few recent studies [9,36,37] are most relevant to our work. They address the impact of strategic customer behavior on the value of quick response. Cachon and Swinney [9] find that quick response capability provides far more value to the retailer if strategic consumers are present than if all consumers are myopic. Our paper differs from the above works [9,36,37] in that (1) this paper considers not only the centralized supply chain with strategic consumers but also the decentralized supply chain composed of more than one firm, whereas they [9,36,37] investigate only the interaction between strategic customers and a single seller, (2) our work compares the performance of centralized supply chains with that of decentralized supply chains, and studies the value of quick response in various systems with strategic consumers, (3) this paper shows that the centralized system could harvest more incremental profits from implementing quick response, relative to the decentralized system, if the extra cost of quick response is relatively low, (4) our study suggests that firms may employ decentralized structure for their supply chains if they are unable to effectively reduce the additional cost of quick response, (5) we recommend that decentralized supply chains

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