Research Article

Omni channel Supply Chain Optimization and Mode Selection Based on Smart New Retail

Simin Zhang and Qi Li

1 Zhuhai City Polytechnic, Zhuhai 510225, China
2 Zhongkai University of Agriculture and Engineering, Guangzhou 519090, China

Correspondence should be addressed to Qi Li; liqimails@qq.com

Received 18 May 2022; Revised 26 July 2022; Accepted 4 August 2022; Published 29 August 2022

Copyright © 2022 Simin Zhang and Qi Li. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Smart new retail mode has rapidly become the hot shopping mode. In order to develop vigorously in the new retail environment, it is urgent for merchants to set up supply chain network reasonably. This paper constructs a supply chain newsvendor model consisting of 1 wholesaler and N retailers. Analyse how channel conversion rate, negotiation ability of supply chain members, number of retailers, and other factors affect the balance among supply chain members when offline demand, online demand, and cross-channel demand exist simultaneously. Combined with the case data of two fast fashion brands, this paper compares and analyses the profit changes of decentralized supply chain and centralized supply chain under the influence of multiple factors. The study shows that there is no absolute optimal supply chain model and the choice of supply chain model will change with the change of influencing factors. However, no matter in which supply chain mode, improving channel conversion rate and controlling the number of retailers are beneficial. In addition, in decentralized supply chain, balance can be achieved among supply chain members so as to achieve Pareto optimality. Wholesalers should take the initiative to promote the transformation of demand among channels, and should not be too strong in member negotiations. This paper analyses the basic characteristics of the supply chain network under the new retail, and establishes the network optimization strategy that is easy to implement, which can help enterprises to carry out the supply network layout more effectively under the smart new retail mode.

1. Introduction

With the development of information technology and the promotion of global economic integration, smart new retail mode has rapidly developed into the current popular shopping way. This new business model has strong vitality and radiation ability. It produces resonance and butterfly effect in the upstream and downstream of the complex industrial community, forming a multidimensional network system in which each subject is interdependent, each industry is interwoven and linked, and each department is cooperating with each other. To thrive in the new retail environment, more and more merchants are entering the online marketplace. The fast fashion industry is also moving stores online. In the past, people bought clothes mainly by shopping and trying on clothes. Stores of fast fashion brands such as Uniqlo, UR, H&M, and ZARA were often found in large shopping malls in cities. Now, these brands are launching an online model that allows customers to buy the clothes they want without leaving home.

Different from other categories, fast fashion is an industry with high requirements for fitting and experience. Compared with online, offline scenes have certain advantages and can also be attached with social functions. Therefore, most brands adopt the mode of simultaneous development of online and offline channels. With the development of omnichannel mode, online and offline gradually transform from independence and conflict to mutual promotion and integration, and the supporting supply chain network is bound to undergo fundamental changes. The problem for merchants is no longer just whether to pursue omnichannel strategy, but how to set up supply chain...
network effectively. As the logistics foundation of new retail, supply chain network needs to be able to efficiently integrate logistics resource elements, share logistics information and technology, and strengthen transportation function, so as to effectively meet the new retail logistics agility, flexibility, low cost, high efficiency of the comprehensive demand.

Compared with the traditional supply chain network, the new retail supply chain network is more complex, more difficult to optimize, and higher risk. Without the ability to optimize inventory and distribution, merchants will face the risk of inventory shortages, high emergency cover fees, and reduced profits. In the new retail model, how to determine the supply chain strategy and how to choose and optimize the supply chain model? This paper analyzes the interactions between manufacturers and retailers in omnichannel retail scenarios in order to understand the impact of omnichannel retail transformation on the supply chain. Specifically, we construct newsvendor models under two supply chain modes, respectively, analyze the influence of cross-channel conversion rate and negotiation ability of supply chain members on inventory and profit of supply chain, and study the optimization and mode selection of omnichannel supply chain under new retail based on this.

The results show that both supply chain models have optimal solutions. When wholesalers have strong negotiation ability and high channel conversion rate, centralized supply chain should be selected; otherwise, decentralized supply chain should be selected. The results also show that no matter which supply chain model is chosen, increasing channel conversion rate, and controlling the number of retailers are beneficial to improving the total profit of supply chain. By analyzing the situation of fast fashion clothing industry, the feasibility of this model in practice is verified. This paper theoretically reveals some basic characteristics of the optimization of new retail network and establishes network optimization strategies that are easy to implement, so as to help enterprises carry out supply network layout more effectively and seize the initiative in the development of new retail.

2. Literature Review

The new retail model of online and offline integration presents characteristics such as synergy, integration, networking, digitalization, and intelligence, which bring unprecedented challenges to the operation and management of new retail enterprises [1]. At present, some scholars study the new retail supply chain from the perspective of operation management of cocreation. Traditional retail takes enterprises as the center to conduct supply chain research. Basu and Bhaskaran [2] analyzed and concluded that integrating the participation cost and special demand of consumers in the upstream link of the supply chain has an important impact on enterprise strategy from the perspective of customers' participation in product design and production. Lacoste [3] discussed the role of sustainability in the process of value creation by connecting the supplier and customer networks through case analysis, and concluded that suppliers can promote the sustainable development of the supply chain through direct communication and interaction with consumers. Parker and Van Alstyne [4] analyzed the impact of technological innovations such as innovation, openness, and intellectual property protection duration on supply chain operations in platform-featured markets and their complementary application ecosystems. This study considers the interaction between a certain link in the supply chain and consumers. The new retail model not only needs to encourage consumers to participate in cocreation but also needs to consider the supply chain operation from the omnichannel multidimensional level.

Some scholars have studied supply chain optimization from the perspective of coordination between channels. Cao et al. [5] believe that the introduction of online channels is bound to have an impact on the existing supply chain equilibrium. Liu et al. [6] studied the dual-channel structure of cost information sharing. In the Bertrand competition model, retailers choose cost information sharing and manufacturers choose channel sharing on the basis of equilibrium. Feng and Shanthikumar [7] believe that collaborative optimization of resources of all subjects in the supply chain is the basic guarantee for smooth operation, and each subject should be encouraged to pay active attention to demand management and manufacturing in supply chain management. Yan et al. [8] designed different mechanisms to coordinate channel relations considering the strategic impact of product durability and channel structure on dual-channel supply chain. Xie et al. [9] realized the coordination of dual-channel supply chain through the revenue-cost-sharing mechanism. He et al. [10] construct a dual-channel closed-loop supply chain model of the influence of government incentive policies on consumers. It is found that when the level of government financial support is low, the amount of subsidy is crucial for manufacturers to choose channel structure, and manufacturers are more inclined to sell new products directly to consumers. Shi et al. [11] realize the coordination of dual-channel supply chain through wholesale and direct sales contracts. Most of the above researches are about the coordination of dual-channel supply chain. As the main development direction of new retail, omnichannel needs further exploration and research.

Some scholars have studied from the perspective of the supply chain coordination. Swami and Shah [12] believe that coordination can bring higher efficiency and higher prices. Ryan et al. [13] believe that in dual-channel mode, the coordination between manufacturers and retailers can make customers more satisfied. There are studies from a return policy perspective. Iravani et al. [14] believe that the role of service in controlling market competition has exceeded that of price. Saha et al. [15] studied the three-layer dual-channel supply chain, made a comparative analysis of the influence of different channel structures and cooperation on the supply chain, and designed a coordination mechanism of direct downward discount to coordinate the supply chain. He et al. [16] studied a single-retailer–single-vendor dual-channel supply chain model, in which the vendor sells deteriorating products through its direct online channel and the indirect retail channel. The results suggest that decentralization of the supply chain not only erodes the two firms' profit but also incurs higher wastes comparing to that under centralization.
Some are studied from the perspective of supply networks. Hubner et al. [17] believe that a new distribution network should be constructed to complete the process of goods delivery and recovery under multiple channels. Khayyat et al. [18] use information system to promote agile distribution process to realize the supply chain coordination mechanism. Feng et al. [19] discussed the problems of hinterland transportation planning caused by limited information sharing, lack of collaboration, and lack of COI, and designed a collaboration and decision-making mechanism for autonomous control by using multiagent technology and hybrid heuristic method. Chabot et al. [20] coordinated the supply chain from service level, cost, and environmental optimization. Guajardo et al. [21] studied alliance configuration, where any company can collaborate in multiple alliances to achieve collaborative transportation. Huang and Ardiansyah [22] studied the planning of last-mile delivery in a partially crowdsourced integration, which provides greater flexibility and requires less capital investment compared to traditional outsourcing. The current research on supply chain coordination is difficult to realize the distribution radiation capability of online and offline coordination between supply and demand. Therefore, when solving the complex logistics distribution problems under the new retail mode, it is necessary to scientifically estimate and rationally plan the crowdsourcing logistics quota, to improve the real-time, scientific, and reliable decision-making of logistics distribution.

Through the review and summary of the above relevant literature, two problems can be found. (1) Some of the existing literature on retail channels is about multichannel research, some is about cross-channel research, but the coexistence of the two omnichannel research is very few. (2) Most of the existing literature on supply chain model selection focuses on analyzing the influence of the interaction between manufacturers and retailers (such as price, trust, and coordination) on model selection, and few analyze the influence of external objective conditions (demand, number of individuals, demand conversion rate, etc.) on the selection. Based on this, this paper builds a newsupplier model of new retail under two supply chain modes, analyzes the influence of various factors on supply chain profits, and studies the optimization and mode selection of omnichannel supply chain under new retail. This paper first introduces the model construction. Then the optimal strategy of decentralized supply chain and centralized supply chain is analyzed, respectively. Finally, the choice of supply chain model is discussed.

3. Model and Analysis

We take the new retail model of fast fashion clothing industry as an example to study the problem. The fast fashion clothing industry is characterized by speed, design, and price. The main retail channels include: the traditional channels from wholesalers to retailer and then to customers, the online channel for purchasing and mailing items to customers, and cross-channel of online purchase and offline self-buy. To simplify the analysis, we assume that there is a wholesaler in the omnichannel supply chain of the new retail, whose online demand is $D$, $f_X(\cdot)$ represents the density function of the random variable $X$. $N$ retailers, with the corner script.

Each retailer will face two types of demand: one from the traditional channels and the other from cross-channel. The traditional channel demand $d_i$ is identically distributed and symmetrically correlated, which is the basis for the comparative analysis of the model. Cross-channel demand comes from customers who browse goods online but lack confidence in nonphysical purchases. Therefore, there is a certain correlation between such demand and online demand. We assume that there is a proportional relationship between the two, and call the ratio $\alpha$ as the cross-channel conversion rate, then the cross-channel demand is $\alpha D$.

The distribution of cross-demand among $N$ retailers can be divided into two cases. One is linear, that is, each retailer gets cross-channel demand of $\alpha D/n$. The other is proportional allocation, where each retailer gets cross-channel demand of $(q_i-d_i)/n$. To facilitate the analysis, a linear distribution is adopted in the subsequent analysis. For each retailer, the inventory it has is has a priority to meet the needs of traditional channels, the rest is used to meet the needs of cross-channels, and the unmet needs are lost.

There are two supply chain models to choose from under the new retail model (Figure 1). The first is the decentralized supply chain. In this mode, wholesalers and retailers are independent entities.

Wholesalers obtain commodities at cost price $C$, and quantity $Q$ of goods will become its own inventory to meet the demand of online channels. Online goods are sold for $r_M$. The transportation cost is $T_M$. Other goods are sold to the retailer at the wholesale price $w$. The retailer’s import cost is $t_M$. Inventory $q_i$ held by retailer $i$ is first used to meet traditional offline needs. The traditional channel is priced at $r_T$. After meeting the demand of traditional channels, the remaining goods are used to meet the cross-channel demand. For each unit of cross-channel demand satisfied, the retailer can obtain $w + \delta$ income from the wholesaler. That is to say, wholesalers will share the delta with retailers of profits earned through cross-channel sales. This is to compensate retailers for the shipping costs and the risk of providing wholesalers with “safety stock” for these items. The value of $\delta$ depends on the negotiating power between wholesaler and retailer. The second supply chain model is the centralized supply chain. In this mode, wholesalers and retailers in the supply chain are cooperated entities. In this supply chain, there is no profit distribution between wholesalers and retailers. Therefore, both wholesalers and retailers obtain goods at a cost price $C$, and retailers do not require revenue sharing from the supply chain after meeting cross-channel demand.

In general, due to the few links involved in online sales and relatively low cost, the price of online sales is generally lower than that of traditional channels. Therefore, we assume that $r_M < r_T$. Bulk shipping by retailers usually brings economies of scale, and the shipping cost is usually less than the shipping cost of a single piece purchased online, so
3.1. Decentralized Supply Chain. In a decentralized supply chain, the retailer’s revenue is split in two. The first is sales revenue from traditional channels. The sales volume of traditional channels is $E \min(q_i, d_i)$. The revenue per unit is $r_T$. The second comes from cross-channel sales. The remaining inventory after meeting the traditional demand is denoted as $(q_i - d_i)^+$. The cross-channel demand that this part of inventory can meet is $E \min[(q_i - d_i)^+, (\alpha D/n)]$, where the available income per unit of commodity is $W + \delta$, the expected profit function of retailer $i$ is

$$
\pi_i = -(w + t_M)q_i + r_T \text{Emin}(q_i, d_i) \\
+ (w + \delta) \text{Emin}\left[(q_i - d_i)^+, \frac{\alpha D}{n}\right].
$$

(1)

The sales revenue of wholesalers comes from three parts. The first part is the income from online sales channels. The second is the income from the wholesale of goods to retailers. The third is to gain revenue from cross-channel sales. The expected profit function of wholesalers is shown below. The third segment of revenue is closely related to cross-channel sales, which are mainly determined by the quantity of goods purchased by retailers as well as the quantity of traditional demand and cross-channel demand. For wholesalers, changing the distribution of cross-channel revenue will affect the purchase quantity of retailers, thus indirectly changing the revenue obtained in this channel.

$$
\Pi = -C \left( Q + \sum_i q_i \right) + w \sum_i q_i + (r_M - T_M) \text{Emin}[Q, D] \\
+ (r_M - w - \delta) \sum_i \text{Emin}(q_i - d_i)^+, \frac{\alpha D}{n}. 
$$

(2)

**Theorem 1.** The optimal subgame solution of this problem is a subgame function, and each equilibrium solution can be obtained by the following optimal conditions:

$$
r_T \text{Pr}\left(q_i^d < d_i\right) + (w + \delta) \text{Pr}\left(d_i < q_i^d < d_i + \frac{\alpha D}{n}\right) \\
= w + t_M, \quad \forall I,
$$

(3)

$$
\text{Pr}(D < Q^d) = \frac{r_M - T_M - C}{r_M - T_M}.
$$

(4)

**Proof of Theorem 1**

$$
\frac{\partial \pi_i}{\partial q_i} = -(w + t_M) + r_T \text{Pr}(q_i < d_i) \\
+ (w + \delta) \text{Pr}\left(d_i < q_i < d_i + \frac{\alpha D}{n}\right), \quad \forall i,
$$

(5)

Let $b_1 = \Pr(q_i < (\alpha D/n) + d_i)f_{d_i,q_i,(\alpha D/n)+d_i}(q_i)$,

$b_2 = \Pr(d_i < q_i)f_{(\alpha D/n)+d_i,q_i}(q_i)$.

We have $(\partial^2 \pi_i/\partial q_i^2) = r_Tf_{d_i}(q_i) + r_M(b_1 - b_2)$,

$(\partial^2 \pi_i/\partial q_i^2) = (r_M - T_M)f_{d_i}(Q)$. Because $f_{d_i}(q_i) > b_1, r_M > T_M$, easy to get $(\partial^2 \pi_i/\partial q_i^2) < 0, (\partial^2 \pi_i/\partial Q^2) < 0$. Therefore, we know that when $Q$ is constant, $\pi_i$ is a convex function of $q_i$, and the optimal solution satisfies the first-order condition. Similarly, when $q_i$ is constant, $\Pi$ is a convex function of $Q$, and the optimal solution satisfies the first-order condition. Hence the Theorem is proved.

**Theorem 2**

The definition: $q_0 = \left\{ q : \Pr(d_i < q_i) = \left( \frac{r_T - w - t_M}{r_T} \right) \right\}$,

$q_{\text{max}} = \left\{ q : \Pr\left(q_i > d_i + \left( \frac{\alpha D}{n} \right) \right) = \left( \frac{\delta - t_M}{\delta + w} \right) \right\}$.

If $q_{\text{max}} < q_0$, the only pure strategy equilibrium solution for retailers is $q_i^d = q_0$. At this point, retailers give up cross-channel sales and only do offline channels. We found this equilibrium when cross-channel sales hurt retailers’ profits. For example: (a) Marginal transportation costs are too high and (b) The marginal revenue across channels is too low. If $q_{\text{max}} > q_0$, the only pure policy equilibrium solution is $q_i^d = q_{\text{max}}$. At this time, retailers take into account both traditional channel and cross-channel sales.

**Proof of Theorem 2.** When $q_i^d < d_i$, $\Pr(q_i < d_i + (\alpha D/n)) = 1$, according to the first-order condition of formula (3), we get $\Pr(d_i < q_i) = (r_T - w - t_M)/r_T$. When $q_i^d \geq d_i$, $\Pr(q_i < d_i) = 0$. According to the first-order condition of formula (3), $\Pr(q_i > d_i + (\alpha D/n)) = (\delta - t_M)/\delta + w$ is obtained. Hence the Theorem is proved.
Theorem 3

(1) When the cross-channel conversion rate $\alpha$ value increases, the optimal inventory $q_f^*$ of retailers increases. Profits rose for both retailers and wholesalers.

(2) With the improvement of retailers’ negotiating power, the increase of $\delta$ value leads to the increase of retailers’ profit and the decrease of wholesalers’ profit.

Theorem 3(1) fits our common sense. When online channels generate more cross-channel demand, the total demand increases, thus stimulating retailers to increase inventory. Both retailers and wholesalers benefit from increased sales. At the same time, the increase in conversion rate increases wholesalers’ profits. Wholesalers are motivated to promote cross-channel sales mode when they are selling online. This behavior will also increase the total profit of the supply chain.

Theorem 3(2) is pretty straightforward. $\delta$ determines the distribution of profits for each unit of cross-channel sales. Both retailers and wholesalers want a larger share. From the supplier’s point of view, cross-channel sales increase profits without additional risk. It is willing to maintain this channel. Therefore, wholesalers will try their best to distribute the part of cross-channel profits to retailers to improve their enthusiasm to meet cross-channel demands.

Proof of Theorem 3. According to the implicit function derivative principle, formula (3) takes the implicit derivative of $\alpha$ to get 

$$
(\partial q_f^* / \partial \alpha) = (D(n)(\delta + w))b_2/r_{rt}f_d(q_i) + (\delta + w)b_1 > 0.
$$

And then the derivative of the retailer’s and wholesalers’ profit with respect to alpha is

$$
b(\partial \Pi_r / \partial \alpha) = (\delta + w)(D(n)Pr(q_i > d_i) + (aD/n)) + (aD/n)(\delta + w)f_d(q_i > d_i + (aD/n)) > 0, \quad (\partial \Pi_i / \partial \alpha) = (r_M - C - \delta)f_d(aD/(aD/n))(q_i > d_i + (aD/n)) > 0.
$$

Hence, Theorem 3(1) is proved.

The profit function of the retailer and wholesaler is derived with respect to $\delta$, $\partial \Pi_r / \partial \delta = E\min(q_i - d_i)^+$, $(aD/n) \geq 0$, $(\partial \Pi_i / \partial \delta) = -E\min(q_i - d_i)^+$, $(aD/n) \leq 0$ is obtained. Hence, Theorem 3(2) is proved.

3.2. Centralized Supply Chain. In a centralized supply chain, wholesalers and retailers operate as a whole, calculate costs and benefits uniformly. Therefore, there is no wholesale price $W$ and no profit distribution $\delta$ between retailers and wholesalers. Supply chain revenue is divided into three parts, which, respectively, come from traditional channels, online channels, and cross-channel sales revenue. The total profit function of the supply chain is

$$
\Pi_c = -CQ - (C + t_M) \sum_i p_i + (r_M - T_M)E\min(Q,D)
$$

+ $r_T \sum_i E\min[q_i, d_i] + r_M \sum_i E\min\left[\left(q_i - d_i\right)^+, \frac{aD}{n}\right].$

(7)

Theorem 4. The profit function of centralized supply chain $\Pi_c$ is the joint convex function of $(q_i, Q)$, And the optimal inventory $(q_f^*, Q_f^*)$ is unique and can be determined by the following expression:

$$
r_TPr(q_i^* < d_i) + r_MPr\left(d_i < q_f^* < d_i + \frac{aD}{n}\right) = c + t_M \forall i,
$$

(8)

$$
Pr(D < Q_f^*) = \frac{r_M - T_M - C}{r_M - T_M}.
$$

(9)

Proof of Theorem 4. Let $b_1 = Pr(q_i < d_i + D) + \alpha D$ and $b_2 = Pr\left(d_i < q_i < d_i + \frac{aD}{n}\right)$. We have $\partial \Pi_i / \partial q_i = -r_Tf_d(q_i) + r_M(b_1 - b_2)$, $\partial \Pi_i / \partial Qw = 0$, $\partial \Pi_i / \partial Q_i = -(r_M - T_M)f_D(Q)$, $(\partial^2 \Pi_i / \partial Qw^2 ) = 0$.

Hessian matrix is:

$$
H(q_i, Q_w) = \left[
\begin{array}{cc}
(\partial^2 \Pi_i / \partial q_i^2 ) & (\partial^2 \Pi_i / \partial q_i \partial Q)
\\
(\partial^2 \Pi_i / \partial Qw^2 ) & (\partial^2 \Pi_i / \partial Q_i^2 )
\end{array}\right]
$$

Because $f_d(q_i) > b_1, r_M T_M$, easy to get $|H_1(q_i, Q)| = (\partial^2 \Pi_i / \partial q_i^2 ) > 0, \quad |H_2(q_i, Q)| = (\partial^2 \Pi_i / \partial Qw^2 ) > 0, \quad |H_3(q_i, Q)| = (\partial^2 \Pi_i / \partial Q_i^2 ) > 0$. Hence, $H(q_i, Q)$ is a negative definite matrix and $\Pi_c$ is a joint concave function of $(q_i, Q)$. The only optimal solution $(q_f^*, Q_f^*)$ satisfies the first order condition. Hence the Theorem is proved.

Theorem 5. Define $q_b = \{q: Pr(d_i < q_i) = (r_T - c - t_M/r_T)\}$, $q_{max} = \{q: Pr(q_i > d_i + (aD/n)) = (r_M - c - t_M/r_M)\}$.

If $q_{max} < q_b$, the only pure strategy equilibrium solution of retailer inventory is $q_f^* = q_b$. At this point, the supply chain gives up cross-channel sales and only adopts offline channels. This equilibrium occurs when cross-channel sales undermine supply chain profits. For example, marginal transportation costs are too high or the marginal revenue from cross-channel sales is too low. If $q_{max} > q_b$, the pure strategy equilibrium solution of retailer inventory is $q_f^* = q_{max}$. At this point, the supply chain considers both traditional channels and cross-channel sales.

Proof of Theorem 5. When $q_f^* < d_i$, we get $Pr(d_i < q_i) = min[r_T - c - t_M/r_T, 1]$. When $q_f^* > d_i + (aD/n)$, we get $Pr(q_i > d_i + (aD/n)) = (r_T - c - t_M/r_T)$. Hence, $q_{max} = q_{max}$.

Theorem 6. When the cross-channel conversion rate $\alpha$ increases, the retailer’s optimal inventory $q_f^*(\alpha)$ increases and the total profit of the supply chain increases.

Similar to decentralized supply chains, when online channels generate more cross-channel demand, the total demand increases. This stimulates retailers to increase inventory and the supply chain benefits from increased sales. In addition, the improvement of conversion rate increases the profits of the supply chain, so the supply chain will further promote the cross-channel sales model. This will continue to increase the overall profit margin of the supply chain.
Proof of Theorem 6. The implicit derivative of $\alpha$ under formula (8) is $(\partial q/\partial \alpha) = (\partial q/r_M b_2) r_T f_d(q_i) + r_M b_1 > 0$. Hence the Theorem is proved. □

4. Comparative Analysis of Supply Chain Model

This part analyzes whether and when Pareto optimality exists under the decentralized supply chain mode and the choice of two supply chain modes under new retail. We analyze from the premise that wholesalers always prefer to exist across channels. Because of cross-channel existence, wholesalers can obtain additional "safety stock" without increasing costs. However, we are not sure about retailers’ channel preferences. From the perspective of channels, the existence of an omnichannel is reasonable, because it provides customers with more choices under various objective constraints (such as limitation of working ability, limitation of ability to meet demands).

In this part, we compare the profit of the two supply chain models through numerical experiments. The data sources are fast fashion brands $H$ and $U$. The data set is of two-year length and includes information on sales volume, cost, and profit. After data desensitization, the value is described as follows: $C = 3$, $w = 8$, $t_M = 0.2$, $T_M = 1$, $r_M = 18$, $r_T = 20$, $n = 10$, $\delta = 10$, $\alpha = 0.05$. Referring to Shao [23], we vary the different feasible combinations and find that the results are robust to the changes of parameters. And these numbers are reasonable and realistic. The retailer’s negotiating power $\delta$ is large enough to allow it to extract sufficient benefits from the risk pool. $T_M$ is less than $t_M$ indicating that there are economies of scale in bulk transportation by retailers compared to direct transportation by wholesalers. The demand is a Poisson distribution with a mean of $\lambda_D = 2000, \lambda_{di} = 100$. Cyclic optimization algorithm is adopted in this paper. Monte Carlo integral is used to estimate the probability of optimal conditions to ensure the convergence of results.

4.1. Pareto-Optimality Analysis of Decentralized Supply Chain

In the fast fashion clothing industry, decentralized supply chain is relatively common, so we first conduct pareto-optimal analysis of decentralized supply chain. We start with the analysis of the influence of retailers’ negotiating power $\delta$ on wholesalers and retailers’ profits. We keep the other parameters constant and take $\delta \in (0, 0.15)$ to draw the corresponding profit figure (Figure 2). As can be seen from the figure, when $\delta = 0$, retailer’s profit is the lowest and wholesaler’s profit is the highest. That is to say, when retailer has no negotiation ability at all, wholesaler occupies all cross-channel income. Correspondingly, with the increase of $\delta$, the negotiating power of retailers is gradually enhanced. The retailer’s profit from cross-channel revenue increases gradually, and so does its total profit. In contrast, wholesalers’ total profits are falling. In the figure, there is a crossover point of profits between wholesalers and retailers, indicating that there is a balance between them. From the analysis of profit data, we see that as the retailers’ share of profits from cross-channel sales increases, they are more willing to store goods for cross-channel sales. For wholesalers, on the one hand, they hope to get more profits from cross-channel sales; on the other hand, in order not to reduce the enthusiasm of retailers for cross-channel sales, they need to give enough profits to retailers. For the company, wholesalers and retailers should be guided to negotiate reasonably to achieve balance in the supply chain.

Next, we analyze the influence of cross-channel conversion rate $\alpha$ on supply chain. We keep the other parameters constant and take $\alpha \in (0.01, 0.3)$ to draw the corresponding profit figure (Figure 3). In this scenario, the proportion of cross-channel demand generated by online channels is increasing. As can be seen from the figure, with the increase of conversion rate, the profit of both wholesalers and retailers increases, and the profit of wholesalers increases faster than that of retailers. According to the data analysis, the increase of conversion rate increases the demand and thus increases the profit. Therefore, each participant in the supply chain should do more to improve the cross-channel conversion rate and gain more profits. Brands should make full use of brand influence, attract traffic, and improve cross-channel conversion rate.

Next, we analyze the influence of the number $n$ of retailers on the supply chain. Assume that total offline demand is fixed and evenly distributed among retailers. Keep other parameters unchanged and take $n \in (1, 50)$ to draw the corresponding supply chain profit, as shown in Figure 4. As can be seen from the figure, with the increase of the number of retailers, the profit of retailers first showed an obvious decrease and then became a steady decline. Wholesalers’ profits fluctuated. According to the data, when the number of retailers increases, the demand each retailer can obtain will decrease, which will obviously affect the profits it can obtain. Wholesalers are affected in two ways: as retailers increase, their revenue increases, but the cross-channel sharing revenue from retailers decreases. The total profit depends on which influence is dominant. From the perspective of the brands, increasing the number of retailers can expand the market share, but too many retailers will reduce the enthusiasm of participants, so it is very necessary to maintain an appropriate number.

4.2. Choice of Supply Chain Model

This section analyzes how to select supply chain mode in different situations and makes optimization analysis based on the cases of the two brands. Factors influencing the supply chain mode of the two fast fashion brands used in this section, such as retailers’ bargaining power, cross-channel conversion rate, and the number of retailers, are numerically measured and desensitized by the financial department of the brands. According to the data of the brands, brand $H$ is decentralized supply chain, adopts the sales strategy of high replenishment, and pays attention to the speed and cost of product renewal. Its negotiating power of retailers $\delta_H$ is 10, the cross-channel conversion rate $\alpha_H$ is 0.18, and the number of retailers $n_H$ is 44. Brand $U$ pays attention to quality and has a very strong control over the upstream of the supply chain. It adopts centralized supply chain. Its retailers’ negotiation power $\delta_U$
Figure 2: The profit changes of wholesaler and retailers under the change of $\delta$.

Figure 3: The profit changes of wholesaler and retailers under the change of $\alpha$.

Figure 4: The profit changes of wholesalers and retailers under the change of $n$. 
is 1, the cross-channel conversion rate $\alpha_U$ is 0.12, and the number of retailers $n_U$ is 32.

We start with the analysis of the influence of retailers’ negotiating power $\delta$ on supply chain model selection. Keep the other parameters constant and take $\delta \in (0, 15)$ to draw the corresponding profit figure (Figure 5). According to the data, $\delta$ has no impact on the profits of the centralized supply chain, which has been explained in the previous analysis. For decentralized supply chain, the total profit of supply chain increases with the increase of $\delta$. That is to say, with the increase of cross-channel revenue distributed by retailers, the profit cake of supply chain becomes larger, which is beneficial to both wholesalers and retailers. When the $\delta$ value is small, the total profit of the centralized supply chain is higher than that of the decentralized supply chain, so brands should choose the centralized supply chain. With the increase of $\delta$, the profit difference between decentralized supply chain and centralized supply chain gradually decreases. When $\delta = 8$ and 9, the difference is reduced to 0. Then with the increase of $\delta$, the decentralized supply chain is better than the centralized supply chain. According to the brands data, $\delta_H = 10$, brand $H$ is suitable for decentralized supply chain. $\delta_U = 1$, brand $U$ is suitable for centralized supply chain. Therefore, the supply chain mode currently selected by the two brands is appropriate. For brand $H$, if it can further improve the negotiating power of retailers, it will be very beneficial both from the perspective of increasing the total profit of the supply chain and reducing operational risks.

Next, we analyze the influence of cross-channel conversion rate $\alpha$ on supply chain model selection. Keep other parameters unchanged and take $\alpha \in (0.01, 0.3)$ to draw the supply chain profit graph (Figure 6). As can be seen from the figure, the total profit of both supply chain models increases as the conversion rate increases. This makes sense. Higher conversion rates increase the demand, which in turn increases profits. $\alpha_H = 0.18, \alpha_U = 0.12$. The supply chain model adopted by the two brands is basically suitable. In addition, the channel conversion rates of the two brands are in the middle position, there is still a large space for development. Therefore, both brands should actively improve the cross-channel conversion rate, such as through advertising, coupons, etc. In addition, we find that the influence of $\alpha$ on decentralized supply chain is greater than that of...
centralized supply chain. Only when the conversion rate is very small (less than 0.02), the total profit of the centralized supply chain is greater than that of the decentralized supply chain. In other cases, the profit of decentralized supply chain is greater than that of centralized supply chain, and the profit difference is getting bigger and bigger. In other words, brand $H$ can gain greater benefits in improving cross-channel conversion rate.

Next, we analyze the influence of the number of retailers $N$ on supply chain mode selection. Here, we assume that the total offline demand is a constant value, evenly distributed among retailers, and other parameters remain unchanged. The value of $n$ increases gradually from 1 to 50, that is to say, the number of retailers is gradually increased, and the corresponding profit value of the supply chain is drawn (Figure 7). It can be seen from the figure that for the centralized supply chain, as the number of retailers gradually increases, the profit of the supply chain gradually decreases. For the decentralized supply chain, although the profit sometimes increases and sometimes decreases with the increase of the number of retailers $N$, it also shows a downward trend in the long run. There is no absolute distinction between the two supply chain models. For both brands, $N_H = 44$, $N_U = 32$, the supply chain model adopted by the two brands is basically suitable. Both brands have a large number of retailers, so it is necessary to control the growth of the number of retailers while carrying out market expansion.

5. Conclusion

The omnichannel sales model of smart new retail is increasingly favored by customers. It is an inevitable development direction for enterprises to cater to customers’ preferences and carry out omnichannel sales. However, omnichannel sales are not a simple way to increase channels. The most important thing is to solve the logistics problems after increasing channels, including the arrangement of commodity inventory, the balance between wholesalers and retailers, and the choice of supply chain mode.

In this paper, the profit models of decentralized supply chain and centralized supply chain are established, and the optimal inventory of wholesalers and retailers is obtained under these two models, respectively. The influences of cross-channel conversion rate $\alpha$ and the negotiation power of supply chain members on the optimal solution are analyzed.

The results show that both supply chain models have optimal solutions. In the decentralized supply chain mode, with the increase of cross-channel conversion rate $\alpha$, the optimal inventory of retailers will be improved, and the profits of retailers and wholesalers will be improved at the same time. With the enhancement of the retailer’s bargaining power, the retailer’s profit increases, the wholesaler’s profit decreases, and the supply chain’s overall profit increases. In the centralized supply chain model, with the increase of cross-channel conversion rate $\alpha$, the retailer’s optimal inventory and the total profit of the supply chain will also be improved.

Combined with the numerical analysis method, this paper compares decentralized and centralized supply chain modes and analyzes how to select supply chain modes under different conditions. The results show that when wholesalers have strong negotiation ability and high channel conversion rate, a centralized supply chain should be selected; otherwise, a decentralized supply chain should be selected. The results also show that no matter which supply chain model is chosen, increasing the channel conversion rate and controlling the number of retailers are beneficial to improving the total profit of the supply chain.

Through the analysis of fast fashion clothing brand, the feasibility of this model in practice is verified. With the development of "new retail", online and offline will gradually transform from relative independence and conflict to mutual promotion and integration, and the supporting supply chain network will surely undergo fundamental changes. This paper is expected to reveal some basic characteristics of new retail network optimization in theory, and establish network optimization strategies that are easy to implement, to help
enterprises carry out supply network layout more effectively and seize the initiative in the development of new retail.

**Data Availability**

The data used to support the results of this study was provided under license from the enterprise and so cannot be made freely available. Requests for access to these data should be sent to "Si Min Zhang, lingberyl@163.com&qrdquo. The values of the notations used to support the findings of this study are included within the article.

**Conflicts of Interest**

The authors declare that there are no conflicts of interest regarding the publication of this paper.

**Acknowledgments**

This study was supported by Guangdong Province Ordinary Universities characteristic innovation project: Study on network Optimization of smart new retail Supply chain--An empirical study based on Guangdong and Macao smart new retail industry chain (2021WTSCX230) and Zhuhai Social Development Science and Technology Project: Research on the construction path of industry and education integration ecosystem of Zhuhai-Macao Cross-border e-commerce vocational education (ZH22036201210008PWC).

**References**


