

Determination of Reasonable Transfer Price of Clothing Supply Chain Channel Products

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Abstract

In the clothing supply chain consisting of manufacturers, wholesalers or distributors and retailers with upstream and downstream relationships, first of all, through proof, to maximize the profit of the clothing supply chain system, no matter how to choose the price of the channel products. Will not maximize the profits of the members of the supply chain. Then, from the perspective of profit distribution, according to the principle of "equal profit per unit product cost", the method of determining the price of channel products is proposed for both the known and unknown cost functions of each member of the clothing supply chain. The conclusions show that regardless of the cost function, the transfer price of the channel product can be determined. Under the condition that the total cost of the clothing supply chain is determined, the transfer price of the "i" member depends on the cost of the upstream distributor and gives. The corresponding calculation formula makes the profit distribution among the members of the apparel product channel fair and reasonable, which makes it possible to coordinate and re-create the clothing supply chain composed of various actors.

Keywords

Clothing supply chain; Channel products; Transfer price; Cost function.

1. Introduction

As one of the "clothing, food, housing and transportation", the clothing supply chain have gradually attracted the attention of scholars in recent years, but overall, this aspect of research is still in the early stage of exploration. As mentioned above, first, the practicality and particularity of enterprises in the industry need to be emphasized, and second, as the core of the coordination mechanism, the research on the price of their channel products is obviously lacking.

Based on the supply chain operation model of the apparel industry, the apparel supply chain is a combination of traditional clothing manufacturers, surface accessories suppliers, clothing distributors and retailers to quickly respond to customers' uncertain needs in order to maximize profits. The form of dynamic alliance generally includes three basic types: vertical integrated supply chain, procurement supply chain and third-party coordinated supply chain. The most common is the procurement supply chain. The clothing manufacturer is the core of the entire supply chain. It plays the role of a coordinator and drives the upstream and downstream of the supply chain. The clothing products are sold through wholesalers or dealers. Chain chains are long, and the determination of product channel prices has become a difficult problem in supply chain coordination.

In fact, the research on the bilateral decision-making mechanism for the participation of intermediate retail enterprises is usually the supply chain game between retailers and

upstream producers or suppliers. Because retailers often have the dominant position in the industrial chain and the existence of the “bullwhip effect” in the supply chain, The impact of retailer decision-making is transmitted and amplified upstream from the supply chain (Tien-hsiang Chang; Sucky) [1-2]. Therefore, the intermediate retailer's product channel supply chain decision-making mechanism is an important and far-reaching research topic. Due to the upstream transmission of information such as information, price, brand (such as literature [3]), services, etc., and decision makers always consider their own interests, regardless of the overall interests of the system[4], which makes the product channel The coordination of supply chain has become a hot issue in the research of supply chain management, and has produced rich research results.

The coordination mechanism for constraining supply chain member behavior requires comprehensive application cooperation, decision-making, incentive, self-discipline and other supply chain management mechanisms [5]. The main implementation method after the establishment of the coordination mechanism is the form of “contract”, which is the focus of most current literature research, and also the way in which members of the supply chain agree. Supply chain contract is mainly to design and adjust contract parameters (such as price, order quantity, etc.) to make supply chain members make decisions according to the goal of maximizing the interests of the entire supply chain, and to make reasonable profit distribution [6].

The price of channel products is an important issue in the coordination of supply chain. Its determination directly affects the distribution of interests among members of the supply chain, and its related research is getting hotter. Machlup & Taber and Morgan have studied bilateral monopoly. The price and output decisions of the channel products under the conditions, and the value range of the intermediate product price is obtained by changing the different market structure [7-8]. Dobbs also studied the decision of bilateral monopoly prices under uncertainty conditions [9]. In addition, many literatures study the price determination of intermediate products from the structure of the market. For example, Brickley et al conducted a question on the optimal transfer price of intermediate products for a company with two branches. Preliminary analysis [10], while Yeom Sungsoo and others studied the cost-based transfer pricing method from within the group[11]. It can be said that the current research in foreign countries uses more quantitative methods and analyzes them from different aspects or angles. There are still few domestic literatures on determining the transfer price of channel products, and there is a lack of involvement in a certain industry or field. For example, Du Yifei et al compared the dynamic game process of the upstream and downstream enterprises with the intermediate product price decision right and the static game process. The distribution of the square profit and the size of the equilibrium price [12]. Finally, the conclusion is drawn as to the range of the range in which the intermediate product price exists. Gu Zhen et al constructed a nonlinear model of intermediate product transfer price under the two pricing methods of intermediate product single pricing and differential pricing [13]. These documents analyze the price of intermediate products from different aspects, and give more reasonable price range, but lack reasonable judgment on price decision. Tang Xiaomei and Shao Yunfei respectively gave the determination method of the transfer price of the channel products under the condition that the cost function and the demand function are unknown, the output of each member is the same and a certain proportion, which has certain rationality [14-15]. Zhang Fuli gave an explanation of the applicable conditions of the conclusion and proposed a more appropriate price decision [16].

In general, these analyses are basically designed in combination with a certain structure or a certain condition. Most of them do not consider some practical problems that exist. For example, the cost function of intermediate products under each behavioral subject is known or unknown. There is no decision-making principle that a decision maker can recognize or accept, so that the

results can be used by the supply chain system. In addition, the optimal transfer price problem of intermediate products can be deepened and refined in different industries or different structural conditions, so that it has some obvious specific situations, and these problems need to be further analyzed.

In the clothing supply chain, due to the independence of the decision-making of each behavioral subject in the product channel, the corresponding cost function is often different in practice. Based on the above literature, this paper is based on the different situations of the cost function and follows. The unified decision-making principle recognized by independent decision-makers gives a relatively complete determination method for the price of the clothing supply chain channel products, so that the decision-making research on the transfer price is more in line with its actual situation.

2. Model Hypothesis

In general, in the apparel product supply chain, clothing retailers purchase products from apparel manufacturers for sale. This type of procurement apparel supply chain often goes through multiple dealers or sellers, and finally enters the consumer through retail. At present, this clothing market with both wholesale and retail functions is spread all over the country.

A clothing supply chain system is a simple secondary supply chain. A clothing manufacturer resells a number of wholesalers or sellers and sellers to form an upstream and downstream relationship of the supply chain of n members. Regarding the upstream and downstream sales, the following assumptions are made:

(1) Manufacturer 1 sells its own product P_1 to Vendor 2 at a price, Vendor 2 sells it to Vendor 3 at a price P_2 and so on. Finally, Vendor n sells the final product to the external market. The demand function of the final product is $p_n = f(Q_n)$;

(2) After the basic sales of each level of the seller, the purchase continues, there is no inventory, and the layers are resold, thus:

$$Q = Q_n = Q_{n-1} = \dots = Q_i = \dots = Q_1 \quad (i = 1, 2, \dots, n) \tag{1}$$

Among them, Q_i is the sales volume of each dealer, and Q_n is the market demand or output of the final product.

Set the production or sales cost of each member of the apparel supply chain to: $TC_i(Q_i) = TC_i(Q)$, the total cost of the supply chain system is $TTC_i(Q_i)$, thus:

$$TTC_i(Q_i) = TC_i(Q_i) + P_{i-1}Q_{i-1} = TC_i(Q) + P_{i-1}Q \tag{2}$$

The profit function of each member of the apparel supply chain is:

$$\Pi_1 = P_1Q_1 - TC_1(Q_1) = P_1Q - TC_1(Q)$$

$$\Pi_i = P_iQ_i - TTC_i(Q_i) = P_iQ_i - P_{i-1}Q_{i-1} - TC_i(Q_i) = (P_i - P_{i-1})Q - TC_i(Q) \quad i = 2, 3, \dots, n-1 \tag{3}$$

$$\Pi_n = P_nQ_n - TTC_n(Q_n) = P_nQ_n - P_{n-1}Q_{n-1} - TC_n(Q_n) = (f(Q) - P_{n-1})Q - TC_n(Q)$$

The profit of the clothing supply chain system is: $\Pi = f(Q)Q - \sum_{i=1}^n TC_i(Q)$

The sum of the profits of the manufacturer and the distributor is:

$$\begin{aligned} \sum_{i=1}^n \Pi_i &= \sum_{i=1}^n [(P_i - P_{i-1})Q - TC_i(Q)] = \sum_{i=1}^n (P_i - P_{i-1})Q - \sum_{i=1}^n TC_i(Q) \\ &= P_n Q - \sum_{i=1}^n TC_i(Q) = f(Q)Q - \sum_{i=1}^n TC_i(Q) = \Pi \end{aligned} \tag{4}$$

The above formula shows, $\Pi = \sum_{i=1}^n \Pi_i$. That is, the profit of the clothing supply chain is the sum of the profit of the manufacturer and the dealer. It has nothing to do with the product transfer price of the internal channel of the supply chain, and only relates to the final sales price of the product, and the transfer price of the channel product affects the profit of each seller. This is consistent with the conclusions in the paper [17].

The question now is whether there is such a channel product transfer price, which maximizes the profit of the clothing supply chain system, and at the same time maximizes the profits of garment manufacturers and dealers.

To illustrate the problem, we assume that there is only one seller, and according to the assumption, the actions of the clothing manufacturer 1 and the seller 2 are in order, and there is a benefit game between the two. Now consider such a dynamic game consisting of manufacturer 1 and seller 2: The manufacturer 1 first selects the price, $P_1 \geq 0$ and the seller 2 selects the price of the manufacturer 1 P_1 and then selects his own price, $P_2 \geq 0$ which is a complete information dynamic game. Depending on whether the price is related to the demand (yield or sales volume), the problem of determining the optimal price can be translated into the problem of determining the optimal yield.

In P_1 being given situation, the problem with vendor 2 is:

$$\max_{Q \geq 0} \Pi_2 = P_2 Q - P_1 Q - TC_2(Q)$$

The first-order condition for optimization is

$$P_2'Q + P_2 - P_1 - MC_2(Q) = 0 \tag{5}$$

That is, the response function is: $f'(Q)Q + f(Q) - MC_2(Q) = P_1$

The clothing manufacturer 1 predicts that the seller 2 will select the order quantity according to the above-mentioned reaction function, so the problem of the manufacturer 1 is:

$\max_{Q \geq 0} \Pi_1 = P_1 Q - TC_1(Q)$. The first-order condition for optimization is:

$$P_1'Q + P_1 - MC_1(Q) = 0 \tag{6}$$

Set the seller's profit maximization sales to $Q^\#$ so $Q^\#$ meet to $[P_1'Q + P_1 - MC_1(Q)]_{Q=Q^\#} = 0$.

Therefore, the sales profit of the seller 2 is also maximized $Q^\#$.

The problem of the clothing supply chain system channel product is: $\max_{Q \geq 0} \Pi = P_2 Q - TC_1(Q) - TC_2(Q)$. If the output of the secondary supply chain Q^* is maximized, the output Q^* is satisfied:

$$[P_2'Q + P_2 - MC_1(Q) - MC_2(Q)]_{Q=Q^*} = 0 \tag{7}$$

The profit of the clothing supply chain system is the sum of the profits of the manufacturer and the distributor, $\Pi_1(Q^\#) + \Pi_2(Q^\#) = \Pi(Q^\#)$.

The maximum output due to supply chain profit is Q^* . So:

$$\Pi(Q^\#) \leq \Pi(Q^*) \tag{8}$$

Adding two first-order conditions (5) and (6), you can get:

$$(P_1' + P_2')Q + P_2 - MC_1(Q) - MC_2(Q) = 0 \tag{9}$$

Obviously, Q^* satisfying equation (9). Take $Q = Q^*$ to the left end of equation (9) and consider (7), we have:

$$\begin{aligned} & [(P_1' + P_2')Q + P_2 - MC_1(Q) - MC_2(Q)]_{Q=Q^*} \\ &= [P_2'Q + P_2 - MC_1(Q) - MC_2(Q)]_{Q=Q^*} + (P_1'Q)_{Q=Q^*} = (P_1'Q_1)_{Q=Q^*} \end{aligned} \tag{10}$$

Because $f'(Q)Q + f(Q) - MC_2(Q) = P_1$. In fact, it is the demand function of the clothing manufacturer 1 product, so it can be assumed: $P_1' < 0$ so $(P_1'Q_1)_{Q=Q^*} < 0$.

Therefore, $Q = Q^*$ does not satisfy equation (9), $Q^\# \neq Q^*$. According to (8): $\Pi(Q^\#) < \Pi(Q^*)$. For the case of n-1 sellers, the same reason can be drawn: $\Pi(Q^\#) < \Pi(Q^*)$.

Conclusion 1: In the apparel product supply chain consisting of manufacturers and distributors, while maximizing the profitability of the supply chain system, the choice of the channel product price will not maximize the profits of the members of the supply chain.

Based on this conclusion, we can abandon the analysis method of pursuing the maximization of profit in the supply chain and its members by formulating the price of the channel product, and then to maximize the coordination of profits (such as profit distribution or rebate) through the clothing supply chain. Pursue the fairness and reasonableness of the profit distribution of members of the supply chain.

3. Determination of the Reasonable Transfer Price of Clothing Supply Chain Channel Products

The establishment of clothing supply chain channel product prices is an important means of coordination of the interests of supply chain members. In a product channel supply chain, there are often many middlemen. In order to pursue the rationality of profit distribution among members, it is very important to find a fair decision-making principle that is in line with reality.

This paper adopts the principle of “equal profit per unit product cost”, which can be accepted and recognized by all decision makers, reflecting the fair thinking of the overall clothing supply chain. Since the cost function of the members of the apparel supply chain is either known or unknown, we discuss these two cases based on the cost function of each member of the supply chain.

3.1. The Cost Function of Each Member of the Clothing Supply Chain is Unknown

Apparel supply chain system channel products are faced with the end market price proposed by the end dealer P_n (established) .To purchase a quantity of Q^* (established) clothing products, At this point, you need to first estimate the cost of each member of the supply chain $TC_i(Q^*)$. The profit function of manufacturer 1 and n-1 sellers can be expressed as:

$$\Pi_1 = P_1Q_1 - TC_1(Q_1) = P_1Q^* - TC_1(Q^*) \tag{11}$$

$$\Pi_i = P_iQ_i - P_{i-1}Q_{i-1} - TC_i(Q_i) = P_iQ^* - P_{i-1}Q^* - TC_i(Q^*) \quad (i = 1, 2, \dots, n)$$

The total profit of the clothing supply chain system is:

$$\Pi = P_nQ_n - \sum_{i=1}^n TC_i(Q_i) = P_nQ^* - \sum_{i=1}^n TC_i(Q^*) \tag{12}$$

Conclusion 2: Under the condition that the cost function of each member of the supply chain is unknown, the reasonable transfer price of each member channel of the apparel supply chain is:

$$\left\{ \begin{array}{l} P_1 = \frac{AC_1(Q^*)}{\sum_{i=1}^n AC_i(Q^*)} P_n = \frac{TC_1(Q^*)}{\sum_{i=1}^n TC_i(Q^*)} P_n = \frac{TC_1(Q^*)}{TC(Q^*)} P_n \\ P_2 = \frac{AC_1(Q^*) + AC_2(Q^*)}{\sum_{i=1}^n AC_i(Q^*)} P_n = \frac{TC_1(Q^*) + TC_2(Q^*)}{\sum_{i=1}^n TC_i(Q^*)} P_n = \frac{\sum_{i=1}^2 TC_i(Q^*)}{TC(Q^*)} P_n \\ \vdots \\ P_i = \frac{\sum_{k=1}^i AC_k(Q^*)}{\sum_{i=1}^n AC_i(Q^*)} P_n = \frac{\sum_{k=1}^i TC_k(Q^*)}{TC(Q^*)} P_n \\ \vdots \\ P_{n-1} = \frac{\sum_{i=1}^{n-1} AC_i(Q^*)}{\sum_{i=1}^n AC_i(Q^*)} P_n = \frac{\sum_{i=1}^{n-1} TC_i(Q^*)}{TC(Q^*)} P_n \\ P_n = \frac{\sum_{i=1}^n AC_i(Q^*)}{\sum_{i=1}^n AC_i(Q^*)} P_n = \frac{TC(Q^*)}{TC(Q^*)} P_n = P_n \end{array} \right.$$

The price increase of the products near the two vendors is $P_i - P_{i-1} = \frac{TC_i(Q^*)}{TC(Q^*)} P_n$

Proof: The reasonable principle for determining the transfer price of a channel product should be that the profit of the product cost of each member of the apparel supply chain is the same, namely:

$$\frac{\Pi_1}{TC_1(Q_1)} = \frac{\Pi_2}{TC_2(Q_2)} = \dots = \frac{\Pi_i}{TC_i(Q_i)} = \dots = \frac{\Pi_n}{TC_n(Q_n)} = \mu \tag{13}$$

Among them, μ is the unit cost profit.

Substituting (11) Π_i into (13) gives:

$$\frac{P_1 Q^*}{TC_1(Q^*)} = \frac{(P_2 - P_1) Q^*}{TC_2(Q^*)} = \dots = \frac{(P_i - P_{i-1}) Q^*}{TC_i(Q^*)} = \dots = \frac{(P_n - P_{n-1})}{TC_n(Q^*)} = \mu + 1 \tag{14}$$

Due to $\frac{TC_i(Q^*)}{Q^*} = AC_i(Q^*)$. For the average cost of each member, the formula (14) can be rewritten as:

$$P_i = P_{i-1} + (\mu + 1) AC_i(Q^*) \tag{15}$$

The formula (15) indicates that the transfer price of the i-th intermediate clothing product is equal to the price of the member product of the upstream member product plus the cost of the member product, μ and the bonus range is the unit cost profit of each member of the supply chain.

The following question is what kind of measure μ is, or what kind of characteristics it has.

According to the equivalence theorem, it can be obtained from (13):

$$\frac{\Pi_1}{TC_1(Q^*)} = \frac{\Pi_2}{TC_2(Q^*)} = \dots = \frac{\Pi_i}{TC_i(Q^*)} = \dots = \frac{\Pi_n}{TC_n(Q^*)} = \mu = \frac{\sum_{i=1}^n \Pi_i}{\sum_{i=1}^n TC_i(Q^*)} \tag{16}$$

The resulting gain range is:

$$\mu = \frac{\sum_{i=1}^n \Pi_i}{\sum_{i=1}^n TC_i(Q^*)} = \frac{\Pi}{TC(Q^*)} = \frac{P_n Q^* - TC(Q^*)}{TC(Q^*)} = \frac{P_n Q^*}{TC(Q^*)} - 1 \tag{17}$$

In the equation(17), $TC(Q^*) = \sum_{i=1}^n TC_i(Q^*)$ means the total cost of the apparel supply chain, if the cost of each member of the supply chain $TC_i(Q^*)$. It can be estimated realistically, and the total cost of the supply chain can be calculated. Since the final sales price P_n and the sales volume Q^* of the channel product are predetermined, the value of μ can be calculated according to the formula (17).

The price of the channel products of the downstream members of the apparel supply chain can be obtained by (15) and (17):

$$\left\{ \begin{array}{l} P_1 = (\mu + 1)AC_1(Q^*) \\ P_2 = P_1 + (\mu + 1)AC_2(Q^*) = (\mu + 1)[AC_1(Q^*) + AC_2(Q^*)] \\ \vdots \\ P_i = P_{i-1} + (\mu + 1)AC_i(Q^*) = (\mu + 1)\sum_{k=1}^i AC_k(Q^*) \\ \vdots \\ P_{n-1} = (\mu + 1)\sum_{i=1}^{n-1} AC_i(Q^*) \\ P_n = (\mu + 1)\sum_{i=1}^n AC_i(Q^*) \end{array} \right. \quad (18)$$

From the last formula in (18):

$$(\mu + 1) = \frac{P_n}{\sum_{i=1}^n AC_i(Q^*)} \quad (19)$$

Substituting (19) into (18), you can get the final transfer price of each member of the apparel supply chain, that is conclusion 2.

It can be seen from the conclusion 2 that the final transfer price of the clothing supply channel product intermediaries is related to the cost of each member. Under the condition that the total cost of the supply chain is determined, the transfer price of the i-th member depends on the cost of the upstream distributor.

3.2. The Known Cost Function of Each Member of the Clothing Supply Chain

At this time, it is assumed that the cost function of each member of the supply chain is a linear function, and the market demand function of the final apparel product is $P = f(Q)$. According to the above analysis, it is now necessary to determine the sales volume of the final product or the price of the final product. At this time, the price of each member of the apparel supply chain can be obtained according to the above conclusion.

The profit function of the clothing supply chain system is $\Pi = PQ - TC(Q) = f(Q)Q - \sum_{i=1}^n TC_i(Q)$

In order to pursue the maximum profit of the supply chain system, the extreme value of the formula is obtained. If the sales volume of the garment supply chain Q^* is maximized, then the supply chain profit maximization conditions are:

$$f(Q^*) + Q^* f'(Q^*) = \sum_{i=1}^n MC_i(Q^*) \quad (20)$$

According to the condition of (20), the sales volume Q^* when the profit of the clothing supply chain system is maximized can be obtained, and the market price of the final clothing product can also be obtained. The price of each member channel product can be determined based on the conclusion 2 of the principle that “the profit per unit product cost is the same” among the members of the clothing supply chain.

4. Conclusion and Prospects

This paper first proves that, while maximizing the profit of the clothing supply chain system, no matter how to choose the price of the channel product, the profit of the distributor members of the supply chain will be maximized, and the supply chain will be pursued from the perspective of profit distribution. The distribution of members' profits is fair and reasonable, and the distribution of supply chain profits is actually completed by the price of channel products. Therefore, the decision of the price of the channel product should ensure that all members of the apparel supply chain have the enthusiasm for production and sales, and strive to reduce their production costs, so that members of the supply chain can achieve a win-win situation through cooperation.

The supply chain of a clothing product includes the production and distribution process of the entire product, involving a large number of actors, such as fabric suppliers, manufacturers, intermediate wholesalers, intermediate distributors, retailers, etc., the relationship between them determines this the competitiveness of a product supply chain. In the downstream of the clothing supply chain, it is still common for dealers to be too long. How to coordinate the relationship between them has become an extremely important issue. What needs to be seen is that the internal relationship of the clothing supply chain is complex and there are many problems. It is difficult for manufacturers or retailers to form competitive advantages in the process of integrating the supply chain. The coordination and re-engineering of the downstream products of the supply chain channel is an unavoidable problem.

The core of the coordination of the clothing supply chain system is the handling of the interests of the dealers, rather than the order quantity of the buyers and sellers in the supply chain, but there is uncertainty in the various actors. In terms of the quantity ordered, the supplier has an optimal supply. If the buyer's order quantity based on its service demand exceeds the supplier's optimal supply quantity, the supplier's profit is a non-increasing function of the buyer's order quantity [18]. While the downstream supply chain of most apparel products emphasizes the problem of product transfer price between each other, we find that regardless of the cost function, the price of the channel product transfer can be determined. Under the condition that the total cost of the clothing supply chain is determined, the i -level the transfer price of a distributor member depends on the cost function of the upstream distributor company.

In practice, we can see that some large clothing retailers or distributors are rapidly emerging and are increasingly involved in the integration and re-engineering of product supply chains. The core idea of this retailer's supply chain reengineering lies in retailers. The establishment of strategic partnerships with upstream and downstream companies, especially between retailers and apparel suppliers. One thing that cannot be ignored is that in the clothing supply chain, the more the number of middle wholesalers, dealers, and retailers, the more difficult it is to coordinate, and the more problems it will bring. Therefore, the first consideration for the situation where the middlemen are too long to make the supply chain too long is how to make the chain of the clothing supply chain streamline, thus providing a basis for the reengineering of the supply chain.

With the rapid development of the economy, the structure type of the clothing supply chain will present a variety of styles, but no matter who the coordinator is, the determination of the product transfer price of the clothing supply chain channel is an important means of coordination of the interests of the supply chain members. In addition, other contract methods, such as quantity discounts, benefit sharing, etc., can be considered, and the influence of competition among members of the apparel supply chain on decision-making can be considered.

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