SELECTING THE SUPPLY CHAIN FINANCING MODE UNDER PRICE-SENSITIVE DEMAND: CONFIRMED WAREHOUSE FINANCING VS. TRADE CREDIT

Qiang Lin, Yang Xiao* and Jingju Zheng

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

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Abstract. In a product market with price-sensitive demand, we examine a supply chain consisting of one manufacturer and one capital-constrained retailer. The retailer may purchase by borrowing by securing confirmed warehouse financing (CWF) from a competitive bank or the manufacturers trade credit financing (TCF), provided that it is also to the latter’s benefit to extend TCF. We obtain the manufacturers optimal pricing decision in the two financing modes under the wholesale price contract that coordinates the supply chain given a wider range of wholesale prices in CWF. We find that CWF is more suitable for the customer segment for which the unit retail price is low and demand is stable, so the product can be monetized quickly; TCF is suitable for the customer segment for which the unit retail price is high and has a high price elasticity of demand and hence for long-term investment. The repurchase price is an important factor affecting the participants selection of CWF.

1. Introduction. Small and medium enterprises (SMEs) play an important role in promoting economic development, but due to their weak ability to bear risks, a lack of necessary collateral and banks hesitancy to issue them loans, SMEs face serious financing constraints. According to the Chinese Corporate Credit Risk Survey Report published by Coface in 2018, credit sales have become the most widely used method of payment. Continuing increases in overdue payment lead to increases in enterprises later stage risk, which exerts pressure on China’s economy. The proportion of companies surveyed with payments more than 120 days overdue increased from 19% in 2016 to 26% in 2017, while the proportion of those surveyed with payments more than 180 days overdue and representing more than 2% of their annual turnover increased from 35% in 2016 to 47% in 2017. This means that these enterprises are very likely to have serious cash flow problems. In addition, it was found that among the enterprises interviewed facing cash flow risk, the energy, construction and automotive industries accounted for the highest shares, followed by the pharmaceutical, paper and textile industries.
With the development of economic globalization, competition among companies has transformed into competition among supply chains. Financial constraints can affect not only SMEs but also the entire supply chain. Finding a new financing model is an urgent need. In practice, to address their lack of credit guarantees, Chinese SMEs commonly employ trade credit and confirmed warehouse financing.

Trade credit financing (TCF) can be regarded as a short-term business loan for a buyer's purchase of goods from a seller who finances the purchase by allowing the buyer to delay payment. It is one of the most commonly used methods in practice. Manufacturers often offer buyers a delayed payment period, known as the trade credit period, as a marketing policy to increase sales and reduce stock levels [8]. The basic form of trade credit is a net-term policy. In a net-term policy (e.g., net 40 days), the seller allows the buyer to delay payment until the net date [16]. Trade credit has been a critical source of working capital for many businesses, especially for start-ups and growing business [2]. Trade-credit sales represent nearly 18.5% of sales for large US firms [16].

Confirmed warehouse financing (CWF) was created by Ping An Bank (formerly Shenzhen Development Bank) and is one of the major forms of supply chain financing. Supply chain financing is an approach whereby two or more organizations in a supply chain, including external service providers, can create shared value by planning, implementing and controlling the flow of financial resources among the organizations involved [14]. CWF is an innovative method of channel financing. It has shown great benefit in freeing up cash flow for both vendors and their retailers [17]. CWF is a business in which a bank provides loans to a retailer according to a sales contract that stipulates the manufacturer's commitment to repurchase and the bank controls the retailer's right to take delivery of the goods. Fig. 1 depicts the operations of CWF. CWF has been adopted by many global top five hundred enterprises, such as between Ping An Bank with its customer Huawei Group and the Construction Bank with its customer FAW (First Automobile Workshop). For Ping An Bank alone, the revenues from CWF reached 900 billion RMB (approximately 138 billion dollars) in 2010. CWF is an innovative business model that was developed in recent years, and the theoretical research on CWF is relatively limited.

Figure 1. CITIC Banks CWF business process

TCF and CWF can not only alleviate SMEs lack of credit guarantees but also optimize the performance of the whole supply chain. They are tremendously beneficial for small- and medium-sized enterprises attempting to resolve their financing difficulties and promoting the development of enterprises. However, there is still
a lack of comparative analysis of these two financing models, and the only extant comparative study did not consider the impact of changes in the sales price of the product on demand. In practice, an enterprise faces random market demand, and market demand and commodity prices are closely related.

To explore the supply chain financing choice between TCF and CWF under price-sensitive demand, we examine a supply chain in which the retailer is capital constrained. This approach provides theoretical support for selecting between TCF and CWF as the optimal financing approach. Our paper also contributes to the operations and marketing literature on the supply chain, where the members are normally assumed to be endowed with sufficient capital.

Our basic model is embedded in the familiar single-period newsvendor framework, and the supply chain consists of a capital-constrained retailer and a core enterprise (a manufacturer). Market demand is stochastic and price sensitive, and its distribution is a common knowledge. In addition, commercial banks operate in a competitive credit market, and their decision objective is to maintain a balance between income and expenditure. The manufacturer will offer the retailer a deferred payment when the retailer is short of funds if doing so benefits the manufacturer. The retailer can also obtain a loan from a bank in a competitive credit market if the manufacturer is willing to provide the manufacturer with a credit guarantee. In other words, the manufacturer may choose to provide the retailer with TCF or CWF. At time zero, the manufacturer simultaneously announces a per-unit wholesale cash price, which is applicable at time zero if the retailer chooses to finance with CWF, and a postponed wholesale price, which is applicable at the end of the period if the retailer finances its purchase with TCF. The retailer will then choose one financing method and a corresponding order quantity. As the manufacturer is dominant in the supply chain, it can adjust the wholesale price to encourage the retailer to make a choice that is favorable for the manufacturer.

This study obtains several results. First, we derive the equilibrium decision of the retailer and the manufacturer under CWF and TCF, where the bank knows how to set the interest rate to ensure that it breaks even. Our second result concerns the choice of the wholesale price by the manufacturer. We identify measures of product retail price and price elasticity of demand. When the retail price is within a certain range, the manufacturer sets a postponed wholesale price that encourages the retailer to choose CWF. Otherwise, the manufacturer raises the wholesale cash price to make the retailer reluctant to borrow from banks. Furthermore, we find that, for the manufacturer, necessity goods with low demand elasticity are better suited to CWF than TCF. Moreover, we show that there exists a feasible region of the repurchase price under which both the manufacturer and the retailer benefit from CWF.

Based on the above results, it is clear that CWF is more suitable for retailers that sell commodities with a lower unit price and stable demand, such as paper, textiles, pharmaceuticals and so on. Customer demand for such products is relatively stable, and their high frequency of purchase means that retailers can quickly obtain substantial cash flows; TCF is suitable for retailers selling high-end products with higher unit prices, such as valuable jewelry, automobiles and so on. Customers buy such products less frequently, but the value of each transaction is larger, which is suitable for long-term investment.

The novel contributions of this paper can be summarized in three points. First, the paper describes application scenarios of two supply chain financing modes, CWF
and TCF, which serve as a reference for enterprises needing to select a financing mode. Second, the price elasticity of demand is introduced to describe the characteristics of market demand, which can better define market segments and help enterprises to quickly benchmark. Finally, this paper finds that the choice of financing mode is determined not only by product characteristics but also by the supply chain members pricing strategy and that the wholesale price range affects the Pareto region in the supply chain, which determines whether the members are willing to participate in financing.

The rest of this paper is organized as follows. Section 2 reviews the relevant literature. Section 3 establishes the basic model, including the models framework, notations, and assumptions. Sections 4 and 5 derive the equilibrium when the retailer finances via TCF and CWF, respectively. Section 6 compares TCF and CWF under wholesale price contracts. Section 7 presents a set of numerical experiments that we employ to highlight the main features and insights of our model. In Section 8, we provide concluding remarks and offer some direction for future work.

2. Literature review. In this section, we provide a review of the relevant research on TCF and CWF. This paper attempts to determine the reasons that enterprises apply these two modes and the difference between them.

There exists a vast literature on TCF, which is the main method of short-term external financing in America. Obviously, there are more specialized financial institutions that could provide financing, so why do industrial enterprises encourage the extension of payment financing? Some studies have offered an explanation for a manufacturers motivation for offering TCF. Schwartz [22] proposes the financing advantage theory, which holds that the seller has more advantages than traditional lenders when financing the buyer. Biais and Gollier [1] believe that the seller has the advantage because it is easier for him or her to acquire information on business and market demand, which reduces information asymmetry between the supply side and demand side. Smith [23] puts forth the viewpoint that under asymmetric information, trade credit may work as a screening mechanism for the seller, helping the seller assess the default risk of the buyer. Giannetti, Burkart and Ellingsen [12] analyze the reason that the manufacturer is willing to provide trade credit from the supply side. They note that mortgage liquidation, moral hazard, information superiority and imperfect competition are the main factors affecting manufacturers decision-making. Fabbri and Menichini [9] believe that the major manufacturers acting as liquidity providers are more likely to gain value from the default asset liquidation, thereby facilitating trade credit demand from buyers with credit constraints. Hill, Kelly and Lockhart [13] point out that trade credit is more advantageous to a company that holds a small market share because it has a stronger incentive to increase sales. Raddatz [21] finds that the increase in companies use of trade credit makes them more output dependent. It can be found that TCF can relieve the financial pressure of retailers to some extent, but there is no consensus on the circumstances under which enterprises are more willing to provide or use TCF.

CWF is an innovative business model developed in recent years, and its development was facilitated after Chinas property law promulgated the relevant provisions of chattel mortgage in 2007. Guo [10] studies the confirmation warehouse model in supply chain finance. The important design parameters of the contract are studied quantitatively, which provides participants with the optimal proposal in the early stage of the contract negotiation and risk control in the later stage of the contract.
Tan [24] focuses on confirmed warehouse financing and establishes a risk rating system. He finds that this risk rating system can be established based on the warehouse receipts pledge rate and used to reduce the credit risk faced by banks or other financing institutions. The CWF mode is a kind of financing that is provided by a bank in which the seller pledges to repurchase the unsalable stock. The existing literature does not address the question of when CWF should be applied.

It can be seen that TCF and CWF are two kinds of financing methods that are applied in practice, and CWF is a type of bank credit financing. Some manufacturers take into account the competition between trade credit and bank credit for retailers and set the cost of trade credit less than that of bank credit. Kouvelis and Zhao [15] compare trade credit and bank financing in a two-level supply chain and find that if the manufacturer provides the appropriate delay in payment contracts, the retailer will choose trade credit instead of bank financing and that trade credit improves the profits of manufacturers and the overall efficiency of the supply chain. Cai and Chen [3] find that competition in the financing market will affect retailers financing mode selection and that retailers prefer the one in which the financing market is more competitive. Lee and Rhee [16] also compare trade credit and bank financing in a two-level supply chain and point out that the manufacturer can fully coordinate the supply chain using trade credit with a markdown allowance. Du and Lu [7] study Chinese enterprises, analyze the relative importance of direct bank financing and trade credit, and find that the former is more important in enhancing corporate performance and promoting enterprise development. Gupta and Wang [11] offer a comparative analysis of the two types of financing from the perspective of the overall supply chain, analyze the effects of financing costs on manufacturers and retailers profits, and find that trade credit can improve the efficiency of the entire supply chain. In Giannetti, Burkart and Ellingsen [12] and Miwa and Ramseyer [19], many trade credits appear cheaper than bank credits. Marotta [18] conducts an empirical analysis for Italian manufacturing enterprises and finds that the financing cost of trade credit is only slightly higher than that of traditional financing. CWF and TCF can not only alleviate the SMEs lack of credit guarantees but can also optimize the performance of supply chains, solve the financing problems of SMEs, and substantially promote the development of enterprises. However, there is still a lack of comparative analysis of these two financing models; in different market segments, how should we choose between these two models? In addition, the literature does not consider the impact of changes in the market price of products on demand.

When we consider market segmentation, the price elasticity of demand is an important differentiating factor. The price elasticity of product demand determines the extent to which product demand is affected by price changes. The demand for a product is determined by the price of the product, the customer’s preferences and so on; thus, it is dynamic and uncertain. When demand is stochastic, there is a general mismatch between realized demand and the inventory stocked by the retailer. Wang [25] study the influence of a principal contract with revenue sharing on channel performance and note that the performance of the entire channel and that of the individual firm are strictly dependent on the price elasticity of demand and the cost sharing of the retailer. Cachon and Lariviére [4] mention that it is possible to implement a revenue sharing contract under price-sensitive demand, but they do not use an optimization model or identify the optimal policy choice of the participants. Chen and Teng [5] study the problem of supply chain coordination with
revenue-sharing contracts under price sensitivity and provide the formula for calculating the optimal decision-making behavior and the range of sharing coefficients. The above literature considers the impact of the price elasticity of demand on operational decision-making. However, the analysis is conducted under the premise that the supply chain is well funded and does not consider the impact of the financial constraints. In our model, all players act solely on the basis of the prior demand distribution, and demand depends on the selling price. In addition, the creditor not only shares the demand risk but also bears the default risk of the retailer. In this respect, the model in this paper is more realistic.

This paper describes the present situation of the financing difficulties faced by SMEs, puts forward possible solutions and mainly explores how enterprises make decisions regarding the choice between the TCF and CWF modes. Chen [6] is the most related study to our work and compares TCF and bank credit financing (BCF) with uncertain demand in a capital-constrained distribution channel. He considers TCF that has a lower cost than BCF and then sets the BCF cost as the upper bound of the TCF price. A notable difference between his formulation and ours is that in our model, we consider the market demand to be price sensitive. In addition, different from his model, we specifically study the CWF form of BCF, in which the manufacturer promises to repurchase unsalable products. Although the prior literature includes findings on TCF and CWF, these studies offer limited information about customer segmentation; they do not adopt the more realistic assumption of positive financing costs or comparatively study the two financing modes or do so only from the perspective of a capital-constrained manufacturer. This paper addresses these limitations.

In our model, we examine customer segmentation in a direct sales market in which customer demand is sensitive to price. Our findings can help enterprises quickly locate their targets and appropriate setting. In addition, we explicitly assume that the financing side will bear positive financing costs. For both TCF and CWF, smooth implementation requires the approval of the dominant company (the manufacturer in our model); thus, the manufacturer plays a leading role in the financing of SMEs. However, few scholars have studied whether providing the downstream retailer with TCF or CWF is better for the manufacturer. Thus, our model mainly focuses on the manufacturers optimal strategy for selecting the financing mode under specific conditions.

3. Model. We consider a single-period product market in which the manufacturer is controlled by a monopolist firm and the retailer is penniless. Thus, the supply chain consists of a manufacturer (referred to as he) and an entrepreneurial retailer (referred to as she). Demand in the market, D, is a function of the product selling price, p, that is D(p). There are mainly two forms of price-dependent demand function: additive and multiplicative. Petruzzi and Dada [20] point out that the main difference between the two forms is their different influence on demand uncertainty. We use the multiplicative form throughout the paper to establish the demand model. Let D(p) = Y(p)\(\epsilon\), where Y(p) = ap\(^{-b}\), a is a nonnegative constant, b denotes the price elasticity of demand, and when b > 1, demand is highly elastic. \(\epsilon\) is a random variable with function \(F(\epsilon)\). We assume that \(F(\epsilon)\) is absolutely continuous with density \(f(\epsilon) > 0\) on \((0, \infty)\) and is monotonically increasing in \(\epsilon\), \(F(0)=0, F(\epsilon) = 1 - F(\epsilon)\). The random variables hazard rate \(h(\epsilon) = \frac{f(\epsilon)}{1-F(\epsilon)}\) is increasing in \(\epsilon\), and \(H(\epsilon) = eh(\epsilon)\) is monotonically increasing in \(\epsilon\).
We assume that the retailer operates in a competitive market and that consumers hold the same reservation price for the product. Therefore, we set the retail price $p$ as an exogenous variable and treat it as a fixed variable that is known to all. The manufacturer has a constant marginal production cost $c$, $0 < c < w$. The retailer has no variable costs other than the wholesale price $w$. A salvage value is not considered in our model. To simplify the exposition, we also ignore any goodwill loss for either channel member due to stockout.

The retailer has no capital endowment and must rely on external sources to finance her operations. In particular, the retailer can borrow either via CWF or from the manufacturer if it is to the latter’s benefit to extend TCF. If the retailer is not able to repay the loan and the interest, she declares bankruptcy and will repay her entire realized revenue and default on the remaining portion of the loan. Therefore, the retailer has limited liability.

Following the convention in some finance and operations studies (e.g., Xu and Birge [26]; Kouvelis and Zhao [15]), we assume that the bank operates in a competitive market and that banks have access to unlimited funds at the risk-free interest rate $r_f$, which is normalized to zero without loss of generality, that is, $r_f = 0$ (e.g., Chen X [6]). All players in the model (i.e., the retailer, the manufacturer and the banks) are risk neutral and maximize their expected profits, except that the banks maintain a balance between income and expenditures because they operate in a competitive credit market.

We assume that the retailer will not simultaneously borrow from multiple banks and will choose only one of the financing modes. In the above setting, the manufacturer is clearly the Stackelberg leader, as the manufacturer is the focal company and plays the dominant role in the supply chain finance business. The sequence of events is shown in Fig. 2.

![Figure 2. Sequence of events](image)

At time zero, the manufacturer simultaneously announces two wholesale prices for the retailer to choose: 1) a per-unit wholesale cash price $w_C$, applicable at time zero if the retailer chooses to finance with CWF with an interest cost $r_C$, and 2) a postponed wholesale price $w_T$, applicable at the end of the period if the retailer finances its purchase with TCF. Then, the retailer must choose between CWF and TCF and decide the corresponding order quantity $q$, that is, $q_C$ under CWF or $q_T$ under TCF.

If the retailer adopts CWF, the competitive banks simultaneously announce the interest rate $r_C$. One of the banks helps her make a full payment for her purchase, and she repays the loan to the bank at the end of the period. The bank will receive
all of the retailers income if the revenue is insufficient to repay the loan. If the retailer adopts TCF, she makes a zero initial payment to the manufacturer and repays to the manufacturer after her revenue realizes at the end of the period.

We assume that TCF has a lower cost than CWF in our model; thus, we can set the loan cost under CWF as the upper bound of the wholesale price under TCF, that is, \( w_T < w_C(1 + r_C) \). In addition, we assume that \( S(q) \) denotes the retailer’s expected sales, and then \( S(q) = E \min[q, D(p)] = E \min[q, Y(p) \epsilon] \). Expected sales volume is a result of a comprehensive evaluation of two cases and their expected probability: in the first, order quantity is less than market demand, and in the second, order quantity is greater than market demand.

We can derive \( S(q) = Y(p) \int_0^{\frac{Y(p)}{\epsilon}} f(\epsilon) \, d\epsilon + q \int_{\frac{Y(p)}{\epsilon}}^{\infty} f(\epsilon) \, d\epsilon \). Our model thus examines CWF versus TCF under a wholesale price contract.

4. **Confirmed warehouse financing.** In this section, we suppose that the retailer adopts CWF. At time zero, the manufacturer first chooses the wholesale cash price \( w_C \) under CWF; then, the retailer chooses order quantity \( q_C \). Observing \( w_C \) and \( q_C \), the banks simultaneously announce the interest rate \( r_C \). The retailer borrows a loan of size \( w_C q_C \) from a bank. For an order quantity \( q_C \) chosen by the retailer, the interest rate \( r_C \) equates the expected return from the loan to its costs.

Under CWF, if the order quantity \( q_C \) exceeds the market demand \( D \), the manufacturer will buy back the remainder at repurchase price \( \mu \). At the end of the period, the retailer obtains revenue \( p \min[D, q_C] + \mu E(q_C - D)^+ \); thus, her expected repayment to the lending bank is \( E \min[w_C q_C(1 + r_C), p \min[D, q_C] + \mu E(q_C - D)^+] \). The lending banks costs of extending this loan are \( w_C q_C (1 + r_f) \), \( r_f = 0 \). Its break-even condition is thus \( E \min[w_C q_C (1 + r_C), p \min[D, q_C] + \mu E(q_C - D)^+] = w_C q_C \).

4.1. **The retailer’s order quantity decision.** For a given \( w_C \), the retailers profit \( \Pi_C^R \) under CWF is

\[
\max_{q_C \geq 0} \Pi_C^R = E(p \min[D, q_C] + \mu E(q_C - D)^+) - w_C q_C (1 + r_C)^+
\]

subject to

\[
E \min[p \min[D, q_C] + \mu E(q_C - D)^+, w_C q_C (1 + r_C)] = w_C q_C
\]

where \( x^+ = \max[x, 0] \).

**Lemma 4.1.** Suppose that \( w_C (1 + r_C) < p \); the retailer’s problem under CWF is equivalent to the standard newsvendor problem without capital constraints, which considers the residual value of goods:

\[
\max_{q_C \geq 0} \Pi_C^R = p \min[D, q_C] + \mu E(q_C - D)^+ - w_C q_C
\]

subject to

\[
E \min[p \min[D, q_C] + \mu E(q_C - D)^+, w_C q_C (1 + r_C)] = w_C q_C
\]

Lemma 4.1 illustrates that a capital-constrained retailer under CWF is equivalent to a retailer with sufficient capital. Thus, under CWF, limited liability does not create any real benefit for the retailer.

\[
\frac{d \Pi_C^R}{dq_C} = p - w_C - (p - \mu) F\left(\frac{q_C}{Y(p)}\right) + \mu \frac{q_C}{Y(p)} f\left(\frac{q_C}{Y(p)}\right)
\]
For a given wholesale cash price $w_C$, the retailer’s optimal order quantity $q_C^*$ is given by $\frac{d\Pi^R_C}{dq_C} = 0$. We obtain that $q_C^*$ satisfies

$$w_C = p\overline{F}(\frac{q_C^*}{Y(p)}) + \mu [F(\frac{q_C^*}{Y(p)}) + \frac{q_C^*}{Y(p)}f'(\frac{q_C^*}{Y(p)})].$$

### 4.2. The manufacturer’s choice of wholesale price.

Under CWF, the manufacturer obtains revenue $w_Cq_C$ and will pay production costs of $cq_C^*(w_C)$ and buy back costs of $\mu E(q_C^*-D)^+$. The manufacturer’s profit function $\Pi^M_C$ thus can be given as follows:

$$\max_{w_C} \Pi^M_C = (w_C-c)q_C^* - \mu E(q_C^*-D)^+ \quad (3)$$

When choosing $w_C$, the manufacturer anticipates the retailer’s quantity response to satisfy $w_C = p\overline{F}(\frac{q_C^*}{Y(p)}) + \mu [F(\frac{q_C^*}{Y(p)}) + \frac{q_C^*}{Y(p)}f'(\frac{q_C^*}{Y(p)})].$

$$\frac{d\Pi^M_C}{dw_C} = q_C^* + (w_C-c) - \mu F(\frac{q_C^*}{Y(p)}) \frac{dq_C^*}{dw_C}$$

where

$$\frac{dq_C^*}{dw_C} = \frac{Y(p)}{(2\mu - p)f(\frac{q_C^*}{Y(p)}) + \frac{q_C^*}{Y(p)}f'(\frac{q_C^*}{Y(p)})}.$$

Let $\frac{d\Pi^M_C}{dw_C} = 0$, and we obtain the manufacturer’s wholesale price as $w_C^* = \mu F(\frac{q_C^*}{Y(p)}) + c - q_C^* \frac{dw_C}{dq_C}$. That is, the capital-constrained retailers optimal strategy $q_C^*$ satisfies

$$p\overline{F}(\frac{q_C^*}{Y(p)}) - c + \frac{q_C^*}{Y(p)}[\frac{q_C^*}{Y(p)} - (3\mu - p)f(\frac{q_C^*}{Y(p)}) + \frac{q_C^*}{Y(p)}f'(\frac{q_C^*}{Y(p)})] = 0.$$

Then, Proposition 1 below summarizes the market equilibrium under CWF.

**Proposition 1.** In the sub-game perfect equilibrium of CWF, 1) given the capital-constrained retailers optimal strategy $q_C^*$, where $q_C^*$ is given by $p\overline{F}(\frac{q_C^*}{Y(p)}) - c + \frac{q_C^*}{Y(p)}[\frac{q_C^*}{Y(p)} - (3\mu - p)f(\frac{q_C^*}{Y(p)}) + \frac{q_C^*}{Y(p)}f'(\frac{q_C^*}{Y(p)})] = 0$, the manufacturer’s optimal wholesale price is $w_C^* = p\overline{F}(\frac{q_C^*}{Y(p)}) + \mu [F(\frac{q_C^*}{Y(p)}) + \frac{q_C^*}{Y(p)}f'(\frac{q_C^*}{Y(p)})]$. 2) The banks interest rate $r_C$ is the unique solution to $E\min[p\min[D,q_C] + \mu E(q_C^*-D)^+, w_Cq_C(1+r_C)] = w_Cq_C$.

**Proof.** Under CWF, the retailers profit $\Pi^R_C = E(p\min[D,q_C] + \mu E(q_C^*-D)^+, w_Cq_C(1+r_C))^+$, subject to $E\min[p\min[D,q_C] + \mu E(q_C-D)^+, w_Cq_C(1+r_C)] = w_Cq_C$, can be written as

$$\max_{q_C \geq 0} \Pi^R_C = pq_C - pq_C \int_0^{\frac{q_C}{Y(p)}} F(\epsilon)de + \mu \int_0^{\frac{q_C}{Y(p)}} (q_C-D) f(\epsilon)de - w_Cq_C$$

Then, the first derivative of the retailers profit is $\frac{d\Pi^R_C}{dq_C} = p - w_C - (p - \mu) F(\frac{q_C}{Y(p)}) + \mu \frac{q_C}{Y(p)}f(\frac{q_C}{Y(p)})$; let $\frac{d\Pi^R_C}{dq_C} = 0$, and then $w_C = p\overline{F}(\frac{q_C^*}{Y(p)}) + \mu [F(\frac{q_C^*}{Y(p)}) + \frac{q_C^*}{Y(p)}f'(\frac{q_C^*}{Y(p)})].$

Substituting this into the manufacturers profit function $\Pi^M_C = (w_C-c)q_C^* - \mu \int_0^{\frac{q_C^*}{Y(p)}} (q_C-D) f(\epsilon)de$, we obtain $\frac{d\Pi^M_C}{dw_C} = q_C^* + (w_C-c) - \mu \frac{q_C^*}{Y(p)} f'(\frac{q_C^*}{Y(p)}) \frac{dq_C^*}{dw_C}$; then, let $\frac{d\Pi^M_C}{dw_C} = 0$, that is, $w_C^* = \mu F(\frac{q_C^*}{Y(p)}) + c - q_C^* \frac{dw_C}{dq_C}$. □
The capital-constrained retailer under CWF is equivalent to a retailer who has sufficient working capital in the traditional wholesale price contract. As the bank operates in a competitive credit market, it earns zero profit. The bank’s break-even rate \( r_C \) exceeding the risk-free rate \( (r_f = 0) \) compensates for the possibility of retailer default due to low realized revenue. Thus, the retailer’s lending cost from the bank is equal to that of using her own capital when she has sufficient capital. However, the manufacturer under CWF needs to bear the responsibility of repurchase; thus, he would have to pay extra for poor sales compared with the case in a traditional supply chain. In this case, whether the supply chain under CWF can achieve coordination is worthy of our attention.

4.3. The whole supply chains decision. Supply chain coordination refers to supply chain performance under decentralized decision making being equal to that under centralized decision making. That is, the optimal order quantity under a decentralized decision is equal to that under a centralized decision.

It is obvious that the whole supply chains profit can be given as \( \pi^{total}_C \)

\[
\pi^{total}_C = \pi_R + \pi^M_C = p \min[D, q_C] - q_C(w_C r_C + c) \tag{4}
\]

Then, we can obtain the derivative of \( \pi^{total}_C \) with respect to \( q_C \)

\[
\frac{d\pi^{total}_C}{dq_C} = p \bar{F}(\frac{q_C}{Y(p)}) - (w_C r_C + c)
\]

As \( \frac{d\pi^{total}_C}{dq_C} = -\frac{p}{Y(p)} \bar{f}(\frac{q_C}{Y(p)}) \), we can give the optimal order quantity \( q^{total}_C \) as \( \frac{d\pi^{total}_C}{dq_C} = p \bar{F}(\frac{q_C}{Y(p)}) - (w_C r_C + c) = 0 \), that is, \( F(\frac{q^{total}_C}{Y(p)}) = 1 - \frac{w_C r_C + c}{p} \). The capital-constrained retailers optimal strategy \( q^{*}_C \) satisfies \( w_C = p \bar{F}(\frac{q^{*}_C}{Y(p)}) + \mu[F(\frac{q^{*}_C}{Y(p)}) + \frac{q^{*}_C}{Y(p)} \bar{f}(\frac{q^{*}_C}{Y(p)})] \). If the supply chain achieves coordination, we obtain \( q^{total}_C = q^{*}_C \). Thus, the manufacturers wholesale price in the coordinated supply chain should be given as \( w^{total}_C, w^{total}_C = \frac{c + p[F(\frac{q^{*}_C}{Y(p)}) + \frac{q^{*}_C}{Y(p)} \bar{f}(\frac{q^{*}_C}{Y(p)})]}{1 - r_C} \).

**Proposition 2.** For the manufacturer under CWF, when his wholesale price \( w_C \) strategy satisfies \( w_C = \frac{c + p[F(\frac{q^{*}_C}{Y(p)}) + \frac{q^{*}_C}{Y(p)} \bar{f}(\frac{q^{*}_C}{Y(p)})]}{1 - r_C} \), we say that the supply chain can be coordinated.

**Proof.** In a decentralized channel, the retailers optimal order quantity satisfies \( w_C = p \bar{F}(\frac{q^{*}_C}{Y(p)}) + \mu[F(\frac{q^{*}_C}{Y(p)}) + \frac{q^{*}_C}{Y(p)} \bar{f}(\frac{q^{*}_C}{Y(p)})] \). Under centralized decision making, the optimal order quantity is \( F(\frac{q^{total}_C}{Y(p)}) = 1 - \frac{w_C r_C + c}{p} \). Let \( q^{*}_C = q^{total}_C \), that is, \( F(q^{*}_C) = F(q^{total}_C) \); then, we can obtain the wholesale price to coordinate the supply chain as \( w_C = \frac{c + p[F(\frac{q^{*}_C}{Y(p)}) + \frac{q^{*}_C}{Y(p)} \bar{f}(\frac{q^{*}_C}{Y(p)})]}{1 - r_C} \) \( \square \)

5. Trade credit financing. In this section, we suppose that the retailer adopts TCF. At time zero, the manufacturer first declares the postponed wholesale price \( w_T \) under TCF, and the retailer then orders \( q_T \) units of product. The retailers working capital is insufficient to cover the full payment, and the manufacturer allows the retailer to delay payment until the market demand is realized. At the end of the period, the manufacturer receives from the retailer a repayment of \( w_T q_T \) if the revenue \( p \min[D, q_T] \) exceeds \( w_T q_T \) and a repayment of \( p \min[D, q_T] \) otherwise.
5.1. The retailers order quantity decision. For a given \( w_T \), the retailers profit \( \Pi^R_T \) under TCF is

\[
\max_{q_T \geq 0} \Pi^R_T = E(p \min[D, q_T] - w_T q_T)^+ \tag{5}
\]

When \( q_T^r \leq D(p) \), the retailers revenue is \( pq_T^r \), and she can repay her purchase; she cannot pay off the order only when \( q_T^r > D(p) \). If the revenue \( pD \) is less than \( w_T q_T^r \), that is, \( D(p) < \frac{w_T q_T^r}{p} \) (\( \epsilon < \frac{w_T q_T^r}{p} \)), the retailer will face bankruptcy.

Lemma 5.1. Suppose that \( w_T < p \). Under TCF, we obtain that 1) the optimal order quantity of the retailer, \( q_T^r \), is uniquely given by \( p \mathcal{F}(\frac{q_T^r}{Y(p)}) = w_T \mathcal{F}(\frac{w_T q_T^r}{pY(p)}) \). 2) \( q_T^r \) is decreasing in \( w_T \),

\[
\frac{dq_T^r}{dw_T} = \frac{Y(p) \mathcal{F}(\frac{w_T q_T^r}{pY(p)})}{w_T \mathcal{F}(\frac{w_T q_T^r}{pY(p)})} = \frac{q_T^r}{w_T \mathcal{H}(\frac{w_T q_T^r}{pY(p)}) - \mathcal{H}(\frac{w_T q_T^r}{pY(p)})}.
\]

That \( q_T^r \) is decreasing in \( w_T \) is intuitive. As the postponed wholesale price increases, using TCF becomes more costly, and the retailer adjusts her order quantity accordingly.

5.2. The manufacturers choice of wholesale price. Under TCF, at time zero, the manufacturer incurs production costs of \( cq_T^r(w_T) \). It receives a repayment of \( E \min[w_T q_T^r, p \min[D, q_T^r]] \) at the end of the period. Therefore, the manufacturers profit function \( \Pi^M_T \) can be written as follows:

\[
\max_{w_T} \Pi^M_T = E \min[w_T q_T^r, p \min[D, q_T^r]] - cq_T^r
\]

subject to:

\[
p \mathcal{F}(\frac{q_T^r}{Y(p)}) = w_T \mathcal{F}(\frac{w_T q_T^r}{Y(p)}) \tag{6}
\]

When choosing \( w_T \), the manufacturer anticipates the retailer’s quantity response to satisfy \( p \mathcal{F}(\frac{q_T^r}{Y(p)}) = w_T \mathcal{F}(\frac{w_T q_T^r}{Y(p)}) \). The manufacturers profit function can be written as follows:

\[
\max_{w_T} \Pi^M_T = w_T q_T \int_{\frac{w_T q_T^r}{pY(p)}}^{\infty} f(\epsilon) d\epsilon + p[q_T - Y(p)] \int_{0}^{\frac{q_T^r}{Y(p)}} F(\epsilon) d\epsilon \int_{0}^{\frac{w_T q_T^r}{pY(p)}} f(\epsilon) d\epsilon - cq_T
\]

Then, we can obtain the first derivative of the manufacturers profit with respect to \( w_T \). Let \( Z = \frac{q_T}{Y(p)} \), \( Z_1 = \frac{w_T q_T^r}{pY(p)} \)

\[
\frac{d\Pi^M_T}{dw_T} = \frac{q_T^r}{H(Z_1) - H(Z)} \left( 1 - \frac{c}{w_T} - F^2(Z_1) + [(Z - Z_1) f(Z_1) + Z f(Z)] \right) + f(Z_1) \int_{0}^{Z} F(\epsilon) d\epsilon \left[ 1 + H(Z_1) - H(Z) \right]
\]

Proposition 3. Under TCF, the equilibrium postponed wholesale price is \( w_T^* \),

\[
w_T^* = \frac{c}{1 - F^2(Z_1) + [(Z - Z_1) f(Z_1) + Z f(Z)]} \int_{0}^{Z} F(\epsilon) d\epsilon \left[ 1 + H(Z_1) - H(Z) \right]
\]

and the retailers optimal order quantity satisfies \( p \mathcal{F}(\frac{q_T^r}{Y(p)}) = w_T^* \mathcal{F}(\frac{w_T q_T^r}{pY(p)}) \).
Proof. Under TCF, the retailers profit \( \max_{q_T \geq 0} = E(p \min[D, q_T] - w_T q_T) \) can be written as \( \Pi^T_R = \int_{Y(p)}^{\infty} (D - w_T q_T) dF(e) + \int_{0}^{\infty} (q_T - w_T q_T) dF(e) \). Then, the first derivative of the retailers profit is \( \frac{d\Pi^T_R}{dq_T} = p\bar{F}(\frac{w_T q_T}{Y(p)}) \); let \( \frac{d\Pi^T_R}{dq_T} = 0 \), and then we can derive \( p\bar{F}(\frac{q^*_T}{Y(p)}) = w_T \bar{F}(\frac{w_T q^*_T}{Y(p)}) \). Plugging it into the manufacturers profit function

\[
\Pi^M_T = w_T q_T \int_{Y(p)}^{\infty} f(e) de + p[q_T - Y(p)] \int_{Y(p)}^{\infty} \bar{F}(e) de \int_{0}^{w_T q_T} f(e) de - c q_T,
\]

we can obtain that \( Z = \frac{q^*_T}{Y(p)}, Z_1 = \frac{w_T q^*_T}{Y(p)} \).

\[
\frac{d\Pi^M_T}{dw_T} = \frac{q^*_T}{H(Z_1) - H(Z)} (1 - \frac{c}{w_T} - F^2(Z_1) + [(Z - Z_1)f(Z_1) + f(Z_1) \int_{0}^{Z} F(e) de][1 + H(Z_1) - H(Z)]);
\]

then, let \( \frac{d\Pi^M_T}{dw_T} = 0 \), that is,

\[
w^*_T = \frac{c}{1 - F^2(Z_1) + [(Z - Z_1)f(Z_1) + f(Z_1) \int_{0}^{Z} F(e) de][1 + H(Z_1) - H(Z)]}.
\]

\[
\square
\]

5.3. The whole supply chains decision. The whole supply chains profit can be given as \( \Pi^T_{\text{total}} \)

\[
\Pi^T_{\text{total}} = \Pi^R_T + \Pi^M_T = p \min[D, q_T] - c q_T
\]

Then, we can obtain the derivative of \( \Pi^T_{\text{total}} \) with respect to \( q_T \)

\[
\frac{d\Pi^T_{\text{total}}}{dq_T} = p \bar{F}(\frac{q_T}{Y(p)}) - c
\]

As \( \frac{d^2 \Pi^T_{\text{total}}}{dq_T^2} = -\frac{p}{Y(p)} f(Y(p)) < 0 \), we can get the optimal order quantity \( q^*_T \) as \( \frac{d\Pi^T_{\text{total}}}{dq_T} = p \bar{F}(\frac{q_T}{Y(p)}) - c = 0 \), that is, \( F(\frac{q^*_T}{Y(p)}) = \frac{p - c}{p} \). To maximize the manufacturers profit, the wholesale price can be given as

\[
w^*_T = \frac{c}{\bar{F}(\frac{w^*_T q^*_T}{Y(p)})}.
\]

Proposition 4. For the manufacturer under TCF, when his wholesale price \( w_T \) strategy satisfies \( w_T = \frac{c}{\bar{F}(\frac{w_T q^*_T}{Y(p)})} \), we say that the supply chain can achieve coordination.

Proof. Under a decentralized channel, the retailers optimal order quantity satisfies \( p\bar{F}(\frac{q^*_T}{Y(p)}) = w_T \bar{F}(\frac{w_T q^*_T}{Y(p)}) \). Under centralized decision making, the optimal order quantity is \( F(\frac{q^*_T}{Y(p)}) = \frac{p - c}{p} \). Let \( q^*_T = q^*_T \), that is, \( F(q^*_T) = F(q^*_T) \); then, we can obtain the wholesale price to coordinate the supply chain as \( w_T = \frac{c}{\bar{F}(\frac{w_T q^*_T}{Y(p)})}. \)

\[
\square
\]

6. Comparative analysis based on a wholesale price contract. Wholesale price contracts are a relatively simple form employed in many supply chain contracts. The manufacturer first establishes the wholesale price, and the retailer determines the best corresponding order quantity. Wholesale price contracts are widely employed by enterprises in practice because they are relatively simple to implement and can save on management costs for the enterprise.
We consider a two-stage supply chain consisting of a single manufacturer and a single retailer in which the manufacturer is the leader, the retailer is the follower, and a capital constraint is involved. When the sales season is approaching, to encourage the retailer to order more, the manufacturer is willing to provide financial assistance to the retailer (TCF or CWF) to ease the financial pressure on the retailer under the wholesale price contract.

For the upcoming sales season, the manufacturer sets a set of contract parameters for the retailer; the retailer determines whether to accept the manufacturer’s contract. If the retailer accepts the contract, she will submit an optimal order quantity. If the retailer does not accept the contract, the game is over, and each supply chain member will receive the default revenue of zero. There is only one optimal wholesale price contract that does not involve the redistribution of the overall profit across the supply chain. As long as the retailer’s profit is greater than zero, the supply chain members are satisfied.

To facilitate the analysis, we assume that the random component of market demand follows a uniform distribution \([A, B]\), that is, \(f(\epsilon) = \frac{1}{B-A}\). Therefore, under CWF, the manufacturer’s optimal wholesale price is

\[
W^*_C = \frac{pA(p-3\mu)+c+3\mu^2B}{3\mu(B-A)},
\]

and the retail optimal order quantity is 

\[
q^*_C = \frac{(p\mu+c)B(p)}{3\mu},
\]

and the banks optimal interest rate is 

\[
r^*_C = \frac{[B(p-\mu)-(w^*_C-\mu)q^*_C][2(p-w^*_C)(B-A)+(p-\mu)(2B-\mu)]}{w^*_C(B-A)[(2B-1)(p-\mu)-2p^2-w^*_C(q^*_C-\mu)]}.
\]

It can be concluded that the profit of the supply chain participants and the whole supply chain are as follows:

\[
\Pi^M_C = (w^*_C - c) - \frac{\mu(2BY(p) - q^*_C)}{2Y(p)(B-A)}q^*_C
\]

\[
\Pi^R_C = [p - w^*_C(1 + r^*_C) + \frac{(\mu - p)(2BY(p) - q^*_C)}{2Y(p)(B-A)}]q^*_C
\]

\[
\Pi^C_{total} = [p - c - w^*_Cr^*_C - \frac{p(2BY(p) - q^*_C)}{2Y(p)(B-A)}]q^*_C
\]

Under TCF, the manufacturers optimal wholesale price \(w^*_T\) is the root of the equation 

\[
\frac{2A(B-A)}{p}x^4 + 2A(A-B)x^3 + \lambda_2x^2 + \lambda_1x + \lambda_0 = 0,
\]

where \(\lambda_2 = (p-2c)(2B-A)A - 2B^2(2p-c), \lambda_1 = pA(p + 4c)(2B-A) + 2pB^2(1 + p - 2c), \lambda_0 = p^2A(4B-3A) - 2p^2c(B-A)^2\), and the retailer’s optimal order quantity \(q^*_T\) is

\[
q^*_T = \frac{pA(p)}{p+w^*_T}.
\]

It can be concluded that the profit of the supply chain participants and the whole supply chain are as follows:

\[
\Pi^M_T = \frac{(w^*_Tq^*_T)^2 - ApY(p)w^*_Tq^*_T + (BpY(p) - w^*_Tq^*_T)(2Y(p)(B-Bq^*_T - A) + q^*_T)^2)}{pY(p)(B-A)^2} - cq^*_T
\]

\[
\Pi^R_T = (p - w^*_T)q^*_T - \frac{w^*_T^2 + p}{2Y(p)(B-A)}q^*_T
\]

\[
\Pi^C_{total} = (p-c)q^*_T + \frac{Bq^*_T(BY(p) - q^*_T)}{2(B-A)Y^2(p)}
\]

It is unclear whether CWF or TCF is optimal for the manufacturer. On the one hand, the bank, not the manufacturer, bears the credit risk of the bankruptcy of the retailer under CWF, while the manufacturer promises stock repurchases and thus needs to bear inventory risk. On the other hand, the manufacturer bears the credit risk for the bankruptcy of the retailer under TCF. The choice of financing model...
for the retailer depends on the dominant manufacturer. Thus, the manufacturer can make a choice by comparing his profit under the two modes. When $\Delta \Pi^M = \Pi^M_C - \Pi^M_T > 0$, it is better for the manufacturer to provide the CWF financing mode to the retailer, and TCF will be optimal otherwise.

Supply chain coordination could bring about more profits for both the manufacturer and the retailer as long as the manufacturers wholesale price, $w$, is within a mutually beneficial range, which is referred to as the Pareto region. We perform a numerical example with a uniform distribution with $A = 50$, $B = 200$, $c = 20$, $\mu = 10$, $a = 1$, $b = 2$, and $p = 60$. Fig. 3 and Fig. 4 show the players profits under CWF and TCF, respectively.

Figure 3. The Pareto region under CWF

Figure 4. The Pareto region under TCF

As long as the wholesale price is in the Pareto region, the supply chain can achieve a win-win outcome, and the retailer and manufacturer are willing to participate in
financing. We find that the Pareto region is larger under CWF than under TCF. In addition, the supply chain members profit is higher under CWF than under TCF under the wholesale price contract. Thus, the supply chain is more efficient and easier to coordinate in the CWF mode.

7. Numerical analysis. In this section, we conduct a set of numerical experiments to further compare the two supply chain financing modes and explore some exogenous variables impacts on the supply chains equilibrium decision. To perform these experiments, we consider price-sensitive demand as noted above. The random component follows an $[A, B]$ uniform distribution, where $A = 50$, $B = 200$. For the other component determining the retail price, $Y(p) = ap - b$, we set the constant $a = 1$ for simplicity.

Our first set of experiments illustrates how the product retail price, $p$, affects the value of CWF and TCF. Not only does the price directly affect the size of the retailers income, but it also indirectly affects the retailers income through the impact on market demand. Thus, the products retail price has an important impact on the retailers bankruptcy risk and in turn affects the manufacturers optimal decision. Let the production cost $c = 20$, the repurchase price $\mu = 10$, and the price elasticity of demand $b = 2$. Fig. 5 presents the manufacturers profit under the two supply chain financing modes, CWF and TCF, with the product retail price ranging from 50 to 120. We find that when the market demand elasticity of the product is certain, the manufacturers profits exhibit a decreasing trend after initially increasing under both financing modes. However, the price fluctuation has a greater impact on the manufacturers profit under CWF. Fig. 4 shows that the two profit curves have two intersection points, and we denote by $p_1$ and $p_2$ the prices at the respective intersections. When the product price changes, neither kind of financing is dominant. When the price is in the range of $[p_1, p_2]$, providing CWF is more favorable to the manufacturer. Otherwise, the manufacturer will choose to provide TCF. In addition, the analysis indicates that only when the price is relatively low and fluctuates within a narrow range does CWF has an advantage. Thus, it is appropriate to use CWF in a relatively stable market.

Market demand in our model is price-sensitive, and we use the multiplicative form of the demand function. Thus, the demand elasticity factor $b$ is the main factor influencing market demand. Our second computational example measures the impact of the price elasticity of demand on the manufacturers performance under CWF and TCF. We treat the demand elasticity factor as an independent variable, lying in the range $[0, 4]$, and we set the retail price $p = 95$. Fig. 6 shows the manufacturers profit under CWF and TCF with different price elasticities of demand. Fig. 6 shows that the manufacturer’s profit decreases as the price elastic of demand increases under both CWF and TCF. Additionally, providing CWF is more favorable to the manufacturer when the market demand elasticity of the product is relatively low, $b < b_1$, which is approximately 2. Products with low market demand elasticity are often necessities, such as cooking oil; they have stable sales channels, and their risk is relatively low. This is consistent with the actual practice of Ping An Bank in providing CWF for its downstream retailers.

Our last computational experiment studies the impact of the repurchase price on supply chain members under CWF. An important feature of the difference between the CWF model and typical bank credit is the manufacturers commitment to repurchase. Therefore, the repurchase price is an important factor affecting the supply
chains decision-making. We let the production cost $c = 20$, the retail price $p = 95$, and the price elasticity of demand $b = 2$. Fig. 7 shows the supply chain members profits under CWF with different repurchase prices in the range $[10, 40]$. According to Fig. 7, the manufacturers profit decreases as the repurchase price increases, while the profits of the retailer and the whole supply chain decrease with the repurchase price. When the repurchase price exceeds a certain value in $[\mu_1, \mu_2]$, the profit of the retailer will be greater than that of the manufacturer. If the repurchase price is too high, the manufacturers profit will be less than zero; thus, the manufacturer is reluctant to participate in CWF. However, for the retailer and the whole supply chain, their profits will be less than zero when the repurchase price is low, and then they will not finance with CWF in such a case. The repurchase price should be held
within the range \([\mu_1, \mu_2]\) to satisfy the interests of the participants in the supply chain.

![Figure 7. The supply chain members profits under CWF with different repurchase prices](image)

8. **Conclusion.** This paper describes the present financing difficulties facing SMEs and puts forward possible solutions. We study the choice between CWF and TCF as a supply chain financing mode from the manufacturers perspective in a supply chain with a capital-constrained retailer. Considering the close relationship between market demand and retail price, we assume that demand is price sensitive. Based on the wholesale price contract, we calculate the equilibrium decision under CWF and TCF in a Stackelberg game model and obtain the condition for supply chain coordination. Thus, we obtain the manufacturers optimal pricing decision in the two modes under the wholesale price contract. In addition, we find that the contract coordinates the supply chain with a wider range of wholesale prices in CWF and that the profit is higher under CWF than under TCF.

We further conduct a set of numerical analyses, mainly from the perspective of the manufacturer regarding his choice of financing mode. We explore the impact of the retail price and demand elasticity of a product on a manufacturers decision making. First, the results show that there is no consistently dominant financing mode when the price of the product changes. When the products retail price is within a certain range, \([p_1, p_2]\), the manufacturers best choice is CWF, and he will set a postponed wholesale price that encourages the retailer to choose CWF. He raises the wholesale cash price to make the retailer willing to borrow via TCF. Then, regarding the price elasticity of demand, we find that for necessity goods with a low elasticity of demand, the manufacturer prefers CWF to TCF. Based on the above results, it is not clear that CWF is more suitable for products with stable demand and a high frequency of purchase, where it is possible to quickly profit from the market segment. TCF is suitable for market segments for which the purchase frequency of products is low but the value of each transaction is large, and it is suitable for long-term investment.
As the manufacturers commitment to repurchase is an important difference between CWF and traditional bank credit, we study the impact of the repurchase price on supply chain decision making under CWF. The results show that there is a reasonable interval, \( [\mu_1, \mu_2] \), in which the repurchase price ensures the supply chain members willingness to participate in CWF. Therefore, the repurchase price cannot be set too low if one wishes to ensure that the retailer is willing to participate in trade.

There are some possible directions that can be addressed in future research. First, our paper assumes that the retailer has zero capital endowment to ease exposition, so it would be worth exploring the impact that the retailers initial capital level will have on the supply chains decision. In addition, a possible extension is to consider the case in which both the manufacturer and the retailer are capital constrained. The demand distribution in the final market is assumed to be common knowledge to potential creditors, while in practice the supply chain members usually face asymmetric information, and this issue require further in-depth study. Finally, it is also worth studying the case in which the bank operates in a monopolistic capital market.

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E-mail address: qianglintju.edu.cn
E-mail address: tjuxiaoyang163.com
E-mail address: 1364470884@qq.com