Supply Chain Decisions Considering Micro and Small Retailers' Financial Constraints and Platform Altruistic Preferences

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Abstract: *E-commerce platform as a new type of carrier for data integration and resource allocation has become a key subject of supply chain competition, which can empower small and micro retailers to a certain extent and drive the coordinated development of upstream and downstream of the supply chain. This paper constructs a supply chain composed of brand owners, e-commerce platforms and capital constrained micro and small retailers, considers three kinds of altruistic empowerment of e-commerce platforms with wholesale price, financing and commercial credit period, and analyzes the impact of platform altruistic preference on the ordering of micro and small retailers, the willingness of platform financing, and the performance of the supply chain with capital constraints. The study shows that: micro and small retailers' ordering volume increases with the platform's altruistic preference, and the ordering volume of well-funded micro and small retailers under the financing strategy varies inversely with the altruistic preference; e-commerce platforms have a certain degree of willingness to provide financing for relatively fund-constrained micro and small retailers, and considering the risk of default, e-commerce platforms are reluctant to provide commercial credit periods for poorly-funded micro and small retailers; micro and small retailers are more likely to provide commercial credit periods based on the fund The micro and small retailers are more likely to benefit from the financing strategy based on their financial situation and platform altruistic preference; the financing strategy from the altruistic perspective is the preferred strategy for e-commerce platforms. This study provides management insights for platform-based supply chains to rationally formulate altruistic empowerment strategies.*

Keywords: Platform supply chain, Altruistic preference, Capital constraints, Newsboy model.

1. Introduction

The river and sea do not choose the smallest streams; therefore, they can be as deep as they are. Small and medium-sized enterprises (SMEs) have always been an important foundation for China's economic resilience, and they are capillaries that facilitate the smooth flow of the double cycle, both internally and externally. At present, there are about 7 million small stores in China, and the stock size of husband and wife stores is around 6.8 million, with their shipments accounting for 40% of the entire retail channel. As the most grassroots basic economic unit of our economy, they radiate like "capillaries" in the streets, alleys, towns, and villages, and make great contributions to absorbing employment, raising residents' income, and stabilizing the market, which are collectively referred to as small and micro-retailers in this paper. Small and micro retailers have the advantages of flexibility, accessibility, and diversity, but they also face developmental difficulties, such as lack of capital, poor risk resistance, and weak bargaining power in the supply chain. The level of economic vitality of small and micro retailers has become a barometer of regional economic convenience and activity. With the rise of the Internet economy, platforms + and other technological elements to help small and micro retailers to improve the quality of efficiency has been practiced on the road.

Currently in the Chinese market, both matching platforms represented by Taobao, JD.com, and Pinduoduo, and social commerce platforms exemplified by Douyin, Kuaishou, and Xiaohongshu, are creating growth opportunities for small and micro-sized retailers. There are more relevant studies on platform operation by scholars, for example, Wang et al. (2019) showed that online retailers can obtain larger ordering volume as well as profit and achieve supply chain coordination by financing through e-commerce platforms, Guo et al. (2022) argued that smaller residual value of the products would motivate platforms to encourage retailers to provide hassle-free shopping, and Zhen et al. found that retailers prefer to use third-party platform channels under differentiated pricing strategies. In order to better serve the development of small and micro retailers, Jingdong New Channel, Ali 1688 Retail Pass, Palm Harmony World, and Easy Wine Batch have built FMCG B2B platforms specifically for small and micro retailers, and Jingdong Palm Bao provides low wholesale prices and an efficient distribution system compared to traditional wholesalers, in this process, platforms pay more and more attention to the implementation of corporate social responsibility and the importance of benefit distribution as well as upstream and downstream coordination in the supply chain, showing obvious altruistic attributes. Thus, the research on altruistic preference in the platform supply chain mainly focuses on the game between platforms and upstream manufacturers, and there is a lack of research on the altruistic preference of platforms for downstream micro and small retailers.

Based on the newsboy model, this paper portrays the random demand of the market faced by micro and small retailers, constructs a three-tier platform supply chain consisting of brands, e-commerce platforms and micro and small retailers, and researches the supply chain performance problem of micro and small retailers under capital constraints, where the platform empowers the micro and small retailers with three altruistic strategies: wholesale price, financing and commercial credit period. The following issues are mainly addressed:

Q1: How to determine the optimal order quantity for a capital-constrained micro-retailer to maximize the profit

target under wholesale price, financing and commercial credit period considering altruism?

Q2: How will the optimal ordering volume under different altruisms change as the degree of altruism of e-commerce platforms increases, and do the profits of brands, e-commerce platforms, and micro and small retailers increase with the degree of altruistic preference of e-commerce platforms?

Q3: How do e-commerce platforms determine the optimal interest rate as well as the commercial credit period under the influence of capital constraints and altruistic preferences, and does altruism affect the willingness of e-commerce platforms to raise capital? How to determine the effective interval for solving the funding problem of micro and small retailers?

The remainder of the paper is organized as follows: Section II reviews and analyzes research in related areas. Section III describes the model and hypotheses. Section IV constructs the model and analyzes it. Section V conducts a comparative analysis. Section VI summarizes the findings of the study and presents the corresponding managerial implications.

2. Literature Review

The following three streams of literature are closely related to this study: studies on altruistic preferences, platform empowerment, and retailer financial constraints.

2.1 Altruistic Preference

Loch & Wu (2008) showed that companies consider altruistic preferences to varying degrees when making decisions about implementing social responsibility. Wang et al. (2021) found that in an e-commerce supply chain consisting of a manufacturer and an e-commerce platform, a decentralised system is more profitable and more able to maintain the relationship between the platform and the manufacturer when the platform's altruistic preferences are kept within a certain range. Liu et al. (2021) consider the altruistic preference of platforms in an e-commerce supply chain and conclude that when the elasticity coefficient of consumers' carbon emission reductions increases, the level of service, selling price, carbon emission reductions, supply chain members' profits and system profits increase, which ultimately improves the economic and environmental performances. Wan et al. (2020) study concludes that when the altruistic preference of the platforms of online travel agencies increases, the online travel agency platform model is more profitable than the merchant model.

In traditional supply chain altruistic preference studies, many results show that an increase in altruistic preference leads to a reduction in wholesale prices, concessions from the strong to the weak and an increase in the overall profits of the supply chain, while the participation of platforms in upstream and downstream transactions changes the operation mechanism and distribution of benefits in the supply chain. Platforms can be divided into self-operated and aggregation categories, which are different from the transaction methods under traditional supply chains, and platforms have the ability to provide financing and commercial credit period for micro and small retailers, so it is possible to consider how the altruistic

attribute of platforms affects other members of the supply chain under a variety of transaction methods and the provision of financing.

2.2 Platform Empowerment

In the platform operation with the participation of micro and small retailers, micro and small retailers are not only the participants of the platform transaction, but also the key carrier of platform empowerment. Currently, Dong et al. (2023) show that the adoption of blockchain technology by e-commerce platforms not only promotes the development of supply chain finance but also benefits suppliers, Wang et al. (2023) find that manufacturers with high unit production costs and high competitive intensity prefer platform financing even when faced with higher platform interest rates than those under bank financing., Phan et al. (2023) show that manufacturers' cooperation with third parties providing financing services leads to longer credit time and higher profits for both manufacturers and platforms, Bi et al. (2023) show that manufacturers adopt platform financing strategy when platforms are not encroaching, and that the platform financing strategy is a Pareto-dominant strategy when the commission rate is high, with the consideration of the participating subject's capital constraints are more in the literature, especially manufacturer funding constraints, regarding retailer funding constraints, Yang et al. (2022) concluded that Pareto improvement can be achieved within the region of interest rates charged by banks and e-commerce platforms and the number of orders and expected profits of retailers increase with the increase of bank lending ratios. Gao et al. (2018) found that when funding constraints are in place, the retailer's optimal order quantity and manufacturer's optimal wholesale price decrease with the platform's service rate, and as the platform's service rate increases, the manufacturer's optimal wholesale price increases but the retailer's optimal order quantity decreases.

2.3 Retailer Capital Constraints

Scholars have proposed ways to alleviate retailers' capital shortage from different perspectives. capital-constrained retailers can obtain financing from banks or third parties. jiang et al. (2022) demonstrated that retailers can benefit from bank financing, and suppliers' preferences are determined by the retailers' credit ratings and production costs. Shi (2021) investigated how a reduction in demand uncertainty will affect the supply chain's decision dynamics, where the supply chain consists of suppliers and capital-constrained retailers, with bank credit and trade credit financing making the decisions. Cheng (2022) investigates the impact of preferential credit policies faced by capital-constrained retailers on supply chain coordination. Xie (2023) investigates a dual-channel financing model, where capital-constrained retailers can either seek a loan from a bank or trade credit from a manufacturer, and finds that dual-channel financing increases supply chain coordination. credit and finds that dual-channel financing increases the number of orders placed by the retailer. Xiao et al. (2017) assumes that retailers do not have access to bank financing for channel coordination, and that revenue-sharing and repurchase covenants coordinate the supply chain only if the supply chain has sufficient working capital. In the field of platform-led supply chain financing

with upstream manufacturers, research has been conducted around joint marketing between e-commerce and brands, choice of platform financing under fairness for manufacturers, choice of e-commerce financing under competition, platform credit on manufacturer selection strategy, and Pareto-optimal financing strategy under platform encroachment. And platform empowerment regarding capital constrained retailers, Tao et al. (2022) found that retailers preferred to obtain financing from platforms compared to bank financing. To solve the cash flow problem, we focus on third-party financing or contract design. However, the inherent limitations of small and micro retailers, such as low credit rating, few mortgaged assets and unsound finance, are difficult to meet the mortgage guarantee requirements of banks and obtain financial capital from formal financial channels.

In the current research on retailers' financial constraints, some scholars have studied the mechanism of inventory risk sharing with retailers from the perspective of platform purchasing empowerment, as well as through bank financing or supply chain internal financing, while ignoring the situation of micro and small retailers who are difficult to obtain loans for reasons such as incomplete collateral. The platform has been deepening into the field of supply chain finance, and has gradually achieved the goal of providing retailers with fast and convenient financing services, and there have been some studies on whether retailers are financed by banks or by the platform, but very few studies have paid attention to the characteristics of retailers, especially physical small and micro retailers, and it is worthwhile to conduct in-depth research on how their behavioural decisions affect the platform's supply chain behaviours.

3. Model Description and Symbol Explanation

For the above problem, a three-level platform supply chain system consisting of a brand owner, an e-commerce platform operator and a micro-retailer is constructed. The downstream micro-retailer has the problem of shortage of funds, and it is difficult to pay for the purchasing activities in full with the funds B it owns, while the platform, as a dominant supply chain owner, possesses a good ability of liquidity as well as the social attribute of having altruistic preference, as shown in Figure 1(a). The e-commerce platform collects goods from upstream brands at wholesale prices w, and sells them at wholesale prices w_1 to micro-retailers, who decide the order quantity q^n and sell them at prices p according to random market demand and their own funds.

As shown in Figure 1(b), own capital is not sufficient to cover the order and a small amount of short-term financing is considered necessary. The platform, as a supply chain dominator, has good liquidity and due corporate social responsibility, with the social attribute of altruistic preference, taking financial financing as the form of altruistic empowerment manifestation, and considering altruism in the fund-constrained supply chain.

Consider the aggregation-type e-commerce platform, charging a commission of β, with partial payment financing altruistic form of decision-making financing interest rate, to solve the small and micro-retailers due to financial constraints and difficult to achieve the purchase, the loan amount of $w^b q^b - B$, w^b for the brand's wholesale price, small and micro-retailers according to the market demand as well as their own funds to decide to order the amount q^b and at the price of sales p.

As shown in Figure 1(c), the capital B possessed is not enough to cover the procurement cost, and the platform, as a supply chain dominator with good liquidity and due corporate social responsibility, has the social attribute of altruistic preference to provide commercial credit period, i.e., deferred payment, to the small and micro-retailers. Aggregate-type e-commerce platforms participate in transactions between brands and small and micro-retailers, where small and micro-retailers decide on the quantity q^d to be ordered and the price p to be sold based on market demand and their own funds, and where small and micro-retailers find it difficult to pay for all the purchases in one go due to financial constraints, and where e-commerce platforms allow small and micro-retailers to delay payment, i.e., to provide alternative forms of commercial credit facilities to alleviate pressure on capital turnover, and where small and micro-retailers pay a portion of the payment for the goods with their own funds. The small and micro-retailers pays a portion of the purchase price with its own funds, and the remainder of the purchase price is repaid after the commercial credit period.

Assume that the market demand is stochastic and that the market random demand is x, with a density function $f(x)$, and a distribution function $F(x)$, continuous, differentiable and strictly increasing, $\bar{F}(x) = 1 - F(x)$. Assume that micro and small retailers aim at maximizing their own profits, and as a risk-neutral fully rational economic agent, the e-commerce platform takes the maximization of altruistic utility as its decision-making goal. Let the subscripts s, o, r denote the brands, e-commerce platforms and micro-retailers respectively, and be π_z the total expected profit of the supply chain. The superscript W is the case under no capital constraint. Define the degree of capital adequacy as the ratio of the initial capital to the capital required to implement the optimal strategy, and the subscripts b and d denote the cases under the financing provided by the e-commerce platform and the commercial credit period, respectively.

Let $\sigma = \begin{cases} B/\hat{B} & B < \hat{B} \\ 1 & B \geq \hat{B} \end{cases}$, $\sigma \in [0,1]$ denote the degree of capital adequacy. At $\sigma = 1$ the time, the micro-retailer has sufficient funds, i.e., it is an unconstrained problem to determine the number of orders q in order to maximise the expected profit, so that $\hat{B} = \tilde{w}\tilde{q}$, where $\tilde{w}$ is the optimal wholesale price of e-commerce platform without constraints, and $\tilde{q}$ is the optimal number of orders without constraints.
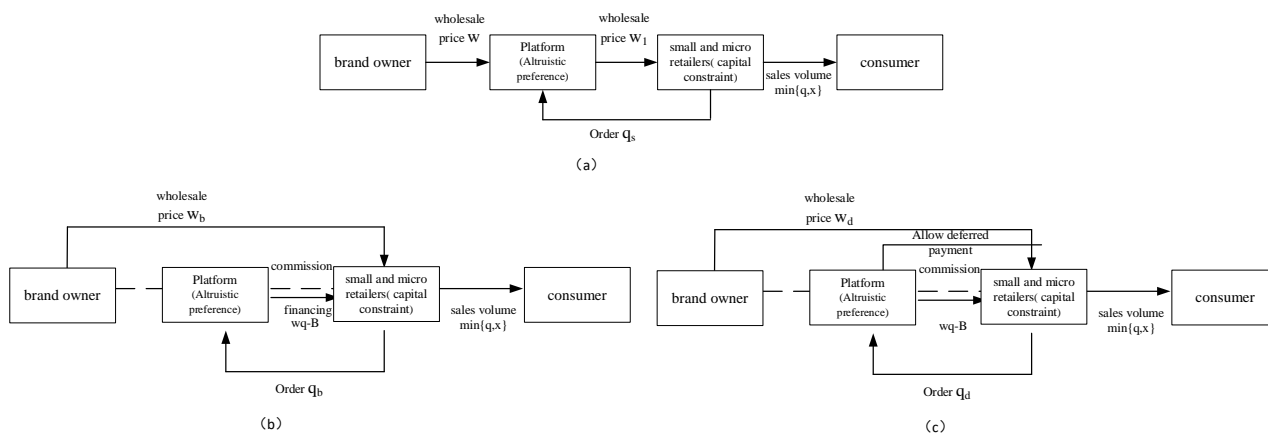
Figure 1: Model structure of platform supply chain

Based on the problem description, the following assumptions are made about the model:

Assumption 1 Micro and small retailers have a small market share and customers can buy substitutes at other retailers without taking into account stock-out losses.

Assumption 2 The platform's ability to collect and distribute goods allows for more efficient replenishment of goods, i.e., it does not take into account the cost of inventory redundancy for micro and small retailers.

Assumption 3 The e-commerce platform considers altruistic attributes to maximize utility as a criterion, and drawing on Loch & Wu's (2008) representation of the utility function of altruistic preferences, the e-commerce platform decision objective function is $U_o = \pi_o + \lambda \pi_r$.

Assumption 4 Drawing on HEYDARI (2020), this paper uses a uniform distribution to solve for a closed solution. The demand is assumed to follow a continuous uniform distribution in the interval $[0, N]$ (minimum market demand is equal to 0 and maximum demand is given by), with a specific distribution function:

$$f(x) = \begin{cases} \dfrac{1}{N} & 0 \leq x \leq N \\ 0 & \text{others} \end{cases}$$

Assumption 5 Brand owners are required to pay a security deposit z, which is set as a constant, to join the platform.

Assumption 6 To ensure positive profits for brand owners, e-commerce platforms and micro and small retailers, it is assumed that $p > w_1 > w > c$.

Assumption 7 Drawing on Lin (2024), the e-commerce platform links brands and micro and small retailers in a collocation format with exogenous variation in commission rates.

Assumption 8 Financially constrained micro and small retailers borrowing from e-commerce platforms can obtain sufficient loan amount.

Assumption 9 To ensure positive profits for brand owners, e-commerce platforms and micro and small retailers, it is assumed that the $(1-\beta)p > w > c, (1-\beta)p > w^I > c$.

Assumption 10 Kaur (2019) E-commerce platforms offering commercial credit periods generate commercial credit risk, the longer the credit period, the higher the risk of default, assuming that commercial credit risk is an exponential function of the commercial credit period, $F(t) = 1 - e^{-\theta t}$, where $0 < \theta < 1$.

Assumption 11 The residual value of the remaining product at the end of the period is zero and is not used for the next sale.

Assumption 12 Replenishment is immediate, which means that once an order is placed with a brand, the micro-retailer can start selling the products from that order to their customers. There is no time lag between ordering and selling for micro-retailers.

Based on the above research questions, decision variables and related parameters are defined as shown in Tables 1 and 2.

Table 1: Definition of related parameters

Decision variables	Statement of meaning
w_1	Wholesale prices on e-commerce platforms
w	brand owners wholesale price
q	Ordering by micro and small retailers when funds are unconstrained
q^n	Ordering by micro and small retailers when capital is constrained
w^I	Wholesale prices for brands when funding is unconstrained under financing
w^b	Wholesale prices for brands when capital constraints are under financing
r^b	Financing rates for e-commerce platforms
q^I	Subscription rates of micro and small retailers when funding under financing is unconstrained
q^b	Ordering by micro and small retailers when funds are constrained under financing
w^d	Wholesale prices of brand owners under the commercial credit period
t	Commercial credit terms for e-commerce platforms
q^b	Ordering by micro and small retailers under the commercial credit period

Table 2: Definition of related parameters

Parametric	Statement of meaning
B	Micro and small retailers own funds
σ	Capital adequacy of micro and small retailers
λ	E-commerce platform altruistic preference coefficient
p	Retail prices for micro and small retailers
c	brand owners production costs
z	Brand Margin
β	Commission rates for e-commerce platforms
θ	Default risk factor for micro and small retailers
a	Demand growth factor

4. Model Construction and Analysis

4.1 Altruistic Preference Modelling of E-commerce Platforms with a Wholesale Price Model

The e-commerce platform conducts aggregate purchases from brands at price w and wholesales to micro and small retailers at w_1 to earn revenue in the form of price difference. Micro and small retailers purchase according to market demand and sell to the market at retail price p. The decision-making sequence of the supply chain consisting of brand owners, e-commerce platforms and micro and small retailers is: First, the e-commerce platform with dominant power decides the price w_1, the ordering quantity q after observing the price of the e-commerce platform, and the brand owner decides the wholesale price w based on the purchasing quantity of the micro and small retailers, and the optimal equilibrium solution is obtained by using the backward induction method.

(1) At $\sigma = 1$, the micro-retailer is well-funded, i.e., it is an unconstrained problem.

The brand owner's profit consists of the revenue generated from wholesaling the merchandise as well as production costs and margins, expressed as: $\pi_s^w = (w - c)q - z$.

The e-commerce platform collects goods at w wholesale price and sells them to micro and small retailers at a profit expressed as: $\pi_o^w = (w_1 - w)q + z$.

The expected utility of an e-commerce platform with altruistic preferences is: $EU_o^w = (w_1 - w)q + z + \lambda\left(p \int_0^q \bar{F}(x)\, dx - w_1 q\right)$.

The micro-retailer purchases from the e-commerce platform based on random market demand and sells at the retail price p, with $min\{q, x\}$ being the actual sales volume, $min\{q, x\} = \int_0^q \bar{F}(x)\, dx$, the expected profit is expressed as: $E\pi_r^w = pmin\{q, x\} - w_1 q = p \int_0^q \bar{F}(x)\, dx - w_1 q$.

The total expected profit of the supply chain is expressed as $E\pi_z^w = E\pi_r^w + \pi_o^w + \pi_s^w$.

Proposition 1: $\sigma = 1$, When micro and small retailers are not capital constrained, the equilibrium solution of the game for the supply chain members is (w^*, w_1^*, q^*), where $w^* = \frac{c+p}{2}$, $w_1^* = p + \frac{c-p}{4-2\lambda}$, $q^* = N\frac{(p-c)}{2p(2-\lambda)}$.

(2) When $0 < \sigma < 1$, Micro and small retail funds approximately, order quantity based on own funds, $q^n = \frac{B}{w}$, substituting $B = \hat{B}\sigma$ into q^n gives $q^n = \frac{B}{w_1} = \frac{\hat{B}\sigma}{w_1} = N\frac{(p-c)}{2p(2-\lambda)}\sigma$, substitute the equilibrium solution into the expected profit functions of brand merchants, e-commerce platforms, and small and micro retailers, $\pi_s = \frac{N(c-p)^2\sigma}{4p(2-\lambda)} - z$, $\pi_o = \frac{N(c-p)^2(1-\lambda)\sigma}{4p(-2+\lambda)^2} + z$, $E\pi_r = \frac{N(c-p)^2(2-\sigma)\sigma}{8p(-2+\lambda)^2}$, the total expected profit of the supply chain is $E\pi_z = \frac{N(c-p)^2\sigma(8-4\lambda-\sigma)}{8p(-2+\lambda)^2}$. It is clear that the financial adequacy of micro-retailers affects

their optimal ordering decisions, and thus the upstream and downstream returns.

Lemma 1: The more well-funded the micro and small retailers are, the trend is towards an increase in brand profits, e-commerce platform profits, micro and small retailers' expected profits, and the total expected profits of the supply chain, i.e. $\frac{\partial E\pi_r}{\partial \sigma} > 0, \frac{\partial \pi_o}{\partial \sigma} > 0, \frac{\partial \pi_s}{\partial \sigma} > 0, \frac{\partial E\pi_z}{\partial \sigma} > 0$.

Lemma 1 shows that the financial situation of micro and small retailers not only affects their own survival and development, but also restricts the access to the benefits of the upstream of the supply chain. When the capital is more abundant, the profit of brand owners is greater than that of the e-commerce platform, followed by the profit of micro and small retailers, and the e-commerce platform pays more attention to the micro and small retailers; when the degree of financial constraints is tighter, it is difficult for brands to obtain enough orders, and thus the profit is extremely tiny. As the e-commerce platform acts as a bridge between upstream and downstream, the profit margin is large enough to realise social responsibility to help small and micro retailers. In conclusion, the free capital status of micro and small retailers directly affects supply chain decisions.

Lemma 2: Under the wholesale price model of e-commerce platforms, the optimal order quantity and the expected profit of micro and small retailers are positively related to the altruistic preference of the platform, i.e., the $\frac{\partial q^n}{\partial \lambda} > 0, \frac{\partial E\pi_r}{\partial \lambda} > 0$, the e-commerce platform's wholesale price and profit decreases as the platform's altruistic preference increases, i.e. $\frac{\partial w_1}{\partial \lambda} < 0, \frac{\partial \pi_o}{\partial \lambda} < 0$, the total expected profit of the brand owner and the supply chain increases with the altruistic preference of the platform, i.e. $\frac{\partial \pi_s}{\partial \lambda} > 0, \frac{\partial E\pi_z}{\partial \lambda} > 0$.

Lemma 2 shows that the altruistic preference of the e-commerce platform is manifested in the lowering of its own wholesale price, which stimulates micro and small retailers to have incentives to increase their ordering volume, when the e-commerce platform gives benefits to micro and small retailers, and this altruism indirectly increases the profit of the brand due to the increase in the ordering volume of micro and small retailers, which improves the profit of the supply chain as a whole. The value-added process of the e-commerce platform to the members of the supply chain will attract more micro and small retailers as well as brands to join the platform, which will in turn increase the profit of the e-commerce platform.

Although the nature of the above has illustrated that with the increase in the degree of altruistic preference of e-commerce platforms, e-commerce platforms will make more concessions to small and micro-retailers and is beneficial to the overall efficiency of the supply chain altruistic behaviours, but from the point of view of the e-commerce platform's own interests, as a supply chain dominant, not only to focus on each other's interests, to achieve the overall supply chain, but also to ensure that their own utility, and therefore $\Delta = E\pi_o - \pi_r = \frac{N(c-p)^2(1-\lambda)\sigma}{4p(-2+\lambda)^2} + z - \frac{N(c-p)^2(2-\sigma)\sigma}{8p(-2+\lambda)^2} = z - \frac{N(c-p)^2(2\lambda-\sigma)\sigma}{8p(-2+\lambda)^2} > 0$. As shown in Figure 2. From the figure, it can be seen that the

e-commerce platform profit in the lower left part of the curve is greater than the profit of small and micro-retailers, when the small and micro-retailers are more abundant in funds, the e-commerce platform should not be more altruistic concern, the reason is that at this time, the profit of small and micro-retailers has been close to the profit of the e-commerce platform, instead of making the e-commerce platform in a disadvantageous position, when the financial constraints of small and micro-retailers are greater, the e-commerce platform should show more altruistic, due to the worse financial situation, affecting the profit of all members of the supply chain, and thus more focus on the attention to small and micro retailers, so the platform chooses to make decisions in the lower region of the curve.(Refer to Yang et al. (2022) Gao et al. (2018))
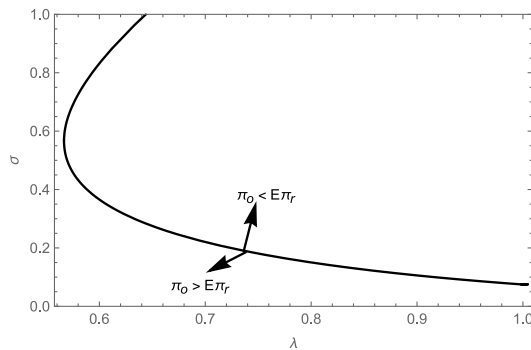

Figure 2: Profit comparison chart under wholesale price model

4.2 Construction of Altruistic Preference Model for E-commerce Platform's Choice of Financing Model

The e-commerce platform participates in transactions between brands and small and micro-retailers in a collocation-type model, where the two join the e-commerce platform, displaying the brand's wholesale price on the platform w^I, the small and micro-retailer decides on the order based on the market demand, and the e-commerce platform obtains revenues in the form of commissions and deposits, respectively, and establishes the situation when the small and micro-retailer has or does not have financial constraints, and the e-commerce platform provides financing and decides on the financing interest rate under financial constraints.

(1) When $\sigma = 1$, the micro-retailer has sufficient funds, i.e., it is an unconstrained problem, and the brand owner in the platform supply chain decides the wholesale price w^I, and the micro-retailer decides the optimal order quantity.

The profit function of the brand owner is denoted as: $\pi_s^I = (w^I - c)q^I - z$.

The expected profit of the e-commerce platforms includes a draw on micro and small retailers as well as margins from brands, denoted as: $E\pi_o^I = \beta min\{q^I, x\} + z = \beta p \int_0^{q^I} \bar{F}(x)\,dx + z$.

The expected profit of the micro-retailer is the revenue under random demand minus the e-commerce platform's drawback and purchasing cost, denoted as: $E\pi_r^I = (1 - \beta)p min\{q^I, x\} - w^I q^I = (1 - \beta)p \int_0^{q^I} \bar{F}(x)\,dx - w^I q^I$.

(2) When $0 < \sigma < 1$, the micro-retailer is financially constrained and needs partial financing for the purchase price, and receives financing amount of $w^b q^b - B$ when the e-commerce platform performs altruistically with financing. The decision sequence of supply chain members is: the e-commerce platform decides the optimal interest rate financing r based on its own utility maximization, then the brand owner decides the optimal wholesale price w^b, and finally the micro-retailer decides the optimal order quantity q^b.

The brand name displays its wholesale price on the e-commerce platform and produces according to the quantity ordered by the micro and small retailers with a profit function of: $\pi_s^b = (w^b - c)q^b - z$.

The e-commerce platform pays $w^b q^b$ Goods in advance to the brand in the financing process, and at the end of the period the micro-retailer repays the principal of the loan as well as the interest and a portion of the payment for the goods paid with its own funds, and the expected profit is expressed as: $E\pi_o^b = \beta min\{q^b, x\} + z + (1 + r)(w^b q^b - B) - w^b q^b + B = \beta p \int_0^{q^b} \bar{F}(x)\,dx + z + (w^b q^b - B)r$.

The expected utility of the e-commerce platform considering altruistic preferences is: $EU_o^b = (\beta p + \lambda(1 - \beta)p)min\{q^b, x\} + z + (r - \lambda(1 + r))(w^b q^b - B) - B\lambda$.

The micro-retailer's expected profit, which includes revenue net of commissions, principal and interest repayments to the platform at the end of the period, and a portion of the purchase costs covered by its own funds, is expressed as: $E\pi_r^b = (1 - \beta)p min\{q^b, x\} - (w^b q^b - B)(1 + r) - B = (1 - \beta)p \int_0^{q^b} \bar{F}(x)\,dx - (w^b q^b - B)r - w^b q^b$.

Proposition 2: Consider the equilibrium solution for supply chain members when an e-commerce platform with altruistic preferences finances micro and small retailers as:

$$w^b = \frac{2p^3(-1+\beta)^3 - 2c^2 p(-1+\beta)(-1+\lambda) + c^3(-1+(-1+\lambda)\sigma) - cp^2(-1+\beta)^2(3+(-1+\lambda)\sigma)}{2\left(cp(\beta+\lambda-\beta\lambda) + c^2(-1+(-1+\lambda)\sigma) - p^2(-1+\beta)^2(3+(-1+\lambda)\sigma)\right)}$$

$$q^b = \frac{N\left(2c^2 p - 2p^3(-1+\beta)^3 + c^3(-1+(-1+\lambda)\sigma) - cp^2(-1+\beta)^2(3+(-1+\lambda)\sigma)\right)}{4p^3(-1+\beta)^3 + 2c^2(-2+\beta+\lambda-\beta\lambda)}$$

$$r^* = \frac{cp(-1+\beta)(\beta(-1+\lambda)-\lambda) + p^2(-1+\beta)^3(1+(-1+\lambda)\sigma) + c^2(1+(-1+\beta)\sigma+\lambda(-1+\beta+\sigma-\beta\sigma))}{2p^2(-1+\beta)^3 + c^2(-2+\beta+\lambda-\beta\lambda)}.$$

Lemma 3: $\bar{\sigma} = -\frac{c(c^3 - 2c^2 p + 3cp^2(-1+\beta)^2 + 2p^3(-1+\beta)^3)(-1+\beta)}{c^4 + 2p^4(-1+\beta)^5 - c^2 p^2(-1+\beta)^2(-1+2\beta)}$, Within $[0, \bar{\sigma})$, $\frac{\partial r}{\partial \lambda} < 0$, $\frac{\partial r}{\partial \lambda} > 0$ in $[\bar{\sigma}, 1]$. Within $[0, \bar{\sigma})$, $\frac{\partial q^b}{\partial \lambda} > 0$, $\frac{\partial q^b}{\partial \lambda} < 0$ in $[\bar{\sigma}, 1]$. w^b varies the same as q^b.

Lemma 3 shows that when the e-commerce platform expresses altruistic attributes in the form of financing, for the micro and small retailers with a greater degree of financial constraints, i.e., when the micro and small retailers have a scarcity of their own funds, an increase in the e-commerce platform altruism leads to a decrease in the interest rate, i.e., the platform's altruism manifests itself in the form of the provision of a lower financing interest rate, which in turn affects willingness to finance, and at the same time the order quantity of small and micro retailers increases with the increase of altruism coefficient of e-commerce platform., i.e. lower financing rates attract ordering behaviour, the e-commerce platform reaps a larger loan amount, the wholesale price of brands increases with the increase of the e-commerce platform's altruistic preference, which indirectly creates a motivation to increase the price during the e-commerce platform's concessions to micro- and small retailers; and the more the micro and small retailers have more funds, the e-commerce platform's altruistic preference is in the same direction as the change in the interest rate, and the altruism of the e-commerce platform becomes self-interested in disguise. It makes micro and small retailers bear more costs, and in order to reduce the cost of the loan will shrink the order quantity, so that brands have difficulty in obtaining downstream orders to increase the wholesale price strategy.
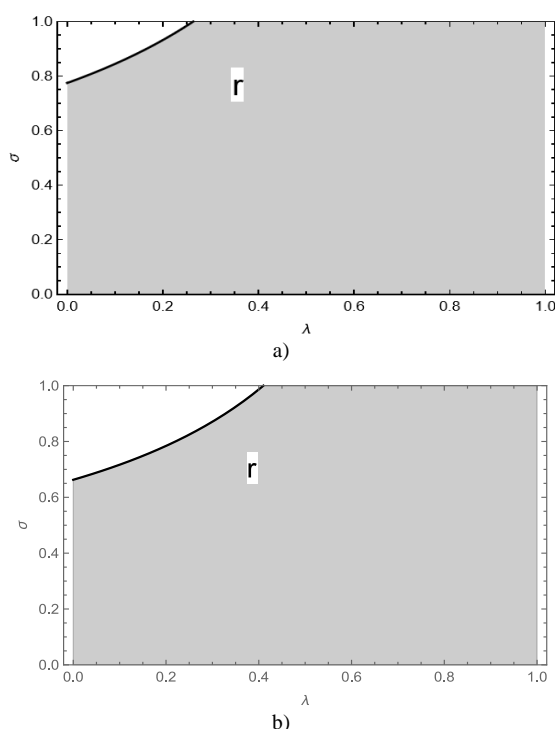

a)

b)

Figure 3: Financing interest rate change chart

Figure 3 shows the interest rates of e-commerce platforms under different commissions, i.e., (a) for $\beta = 0.1$, (b) for $\beta = 0.3$. The effect on the financing willingness of micro and small retailers, it can be seen that the e-commerce platforms do not have the willingness to finance when the micro and small retailers are more well-funded and have a low altruistic preference, at this time, micro and small retailers will not bear the interest cost for a small number of goods, and the means of financing is mainly solved for the cash flow problem of the poor financial situation. The comparison found that the commission rate of the e-commerce platform and the interest rate of the loan have the opposite change. In the financing process, the increase of interest rate will make the small and

micro retailers reduce the order quantity, at this time the commission of the platform will be reduced. When micro-retailers have more funds and lower altruistic preference, the e-commerce platform has no willingness to finance, at this time, micro-retailers will not bear the interest cost for a small portion of the goods, and the financing tool mainly solves the cash flow problem of the micro-retailers with poor financial status.
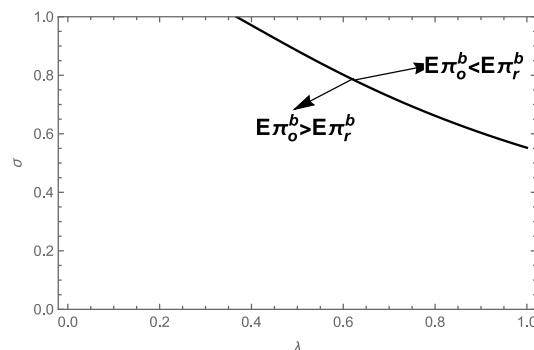

Figure 4: Comparison of profits between platform and small and micro retailer

Making a difference between the profits of the two, $\Delta_1 = \pi_o^b(w^b, q^b, r^*) - \pi_r^b(w^b, q^b, r^*) > 0$. As can be seen from Figure 4, the e-commerce platform below the curve in most of the region's profit share over the micro-retailers, can give full play to its own altruistic preference attributes, to alleviate the profitability of micro-retailers under different degrees of capital abundance, when the e-commerce platform's altruistic preference for the larger, although the interest rate increases, but the micro-retailers do not use financing, but rather damage their own profits. In order to ensure corporate profitability, the interest of micro and small retailers does not exceed the profit of the e-commerce platform, so the e-commerce platform avoids making concessions in a small area. While in $0 < \sigma < \frac{356}{1995} = \bar{\sigma}$, the e-commerce platform altruistic preference is favourable to the total profit of the supply chain, in $\frac{356}{1995} < \sigma < 1$, the e-commerce platform altruistic preference instead harms the overall interests of the supply chain, i.e., when the e-commerce platform adopts the financing strategy, the analysis of the various equilibrium solutions as well as the total profit of the supply chain yields that the willingness to finance mainly occurs in the case that the funds of the micro and small retailers are scarce.

4.3 Scenarios Where the Platform Altruistically Demonstrates a Commercial Credit Period

E-commerce platforms offer interest-free credit in the form of altruism, i.e. the e-commerce platforms offer a credit period in which micro and small retailers can enter their goods first and pay for them without interest at the end of the credit period granted by the e-commerce platforms. The e-commerce platform pays the micro-retailer's purchase price in advance to the brand, the micro-retailer pays for a portion of the goods with its own funds B, and the remaining $(w^d q^d - B)$ payment is made to the e-commerce platform at the end of the period. The credit period t in which it is offered stimulates demand, drawing on Bi (2021) to assume a demand function $D = e^{at}x$ under the credit period. The longer the credit period offered by the e-commerce platform, the greater the commercial credit risk. Assume that the credit risk, i.e. the probability of

default, is $F(t) = 1 - e^{-\theta t}$. The decision process is that the e-commerce platform decides the optimal credit period t based on its own utility maximization, then the brand decides the optimal wholesale price w^d, and finally the micro-retailer decides the optimal order quantity q^d.

The brand owner's receives revenue at the wholesale price w^d and deducts the cost of production, and the profit formula is expressed as: $\pi_s^d = (w^d - c)q^d - z$.

The profit of the e-commerce platform includes the draw on the micro and small retailers, the margin of the brand owners, the advance payment to the brand owners and the payment of the micro and small retailers at the beginning of the period with the funds B, $(w^d q^d - B)(1 - F(t))$ is the receivable at the end of the credit period considering the commercial risk, and the e-commerce platform expects to make a profit of: $E\pi_o^d = \beta p \min\{q^d, D\} + z - w^d q^d + B + (w^d q^d - B)(1 - F(t)) = \beta p \min\{q^d, D\} + z - F(t)(w^d q^d - B)$.

The expected profit of a micro and small retailer consists of

actual revenue after commissions minus the cost of purchases at the beginning and end of the period, expressed as $E\pi_r^d = (1 - \beta)p \min\{q^d, D\} - (w^d q^d - B) - B = (1 - \beta)p \min\{q^d, D\} - w^d q^d$.

Where $\min\{q^d, D\} = \min\{q^d, e^{at}x\} = e^{at} \min\left\{\frac{q^d}{e^{at}}, x\right\} = e^{at} \int_0^{\frac{q^d}{e^{at}}} \bar{F}(x)\, dx$.

The expected utility of an e-commerce platform considering altruistic preferences can be expressed as: $EU_o^d = \left((1 - \beta)p\lambda + \beta p\right) \min\{q^d, D\} + z - (w^d q^d - B)F(t) - w^d q^d \lambda$.

Proposition 3: When the e-commerce platform expresses the altruistic form in terms of commercial credit period, the equilibrium solution for the brand owner's wholesale price, the e-commerce platform's commercial credit period and the micro-retailer's order quantity is:

$$w^d = \frac{c + p - p\beta}{2}, \quad t^* = \frac{a(c - 3p(-1+\beta))\beta + a(c + p(-1+\beta))(-1+\beta)\lambda - 2(-1+\beta)(c + p - p\beta)\theta(-1+\sigma)}{4a(1-\beta)(c + p - p\beta)\theta},$$

$$q^d = -\frac{N(c + p(-1+\beta))\left(a(c - 3p(-1+\beta))\beta + a(c + p(-1+\beta))(-1+\beta)\lambda - 2(-1+\beta)(c + p - p\beta)\theta(1+\sigma)\right)}{8p(-1+\beta)^2(c + p - p\beta)\theta}.$$
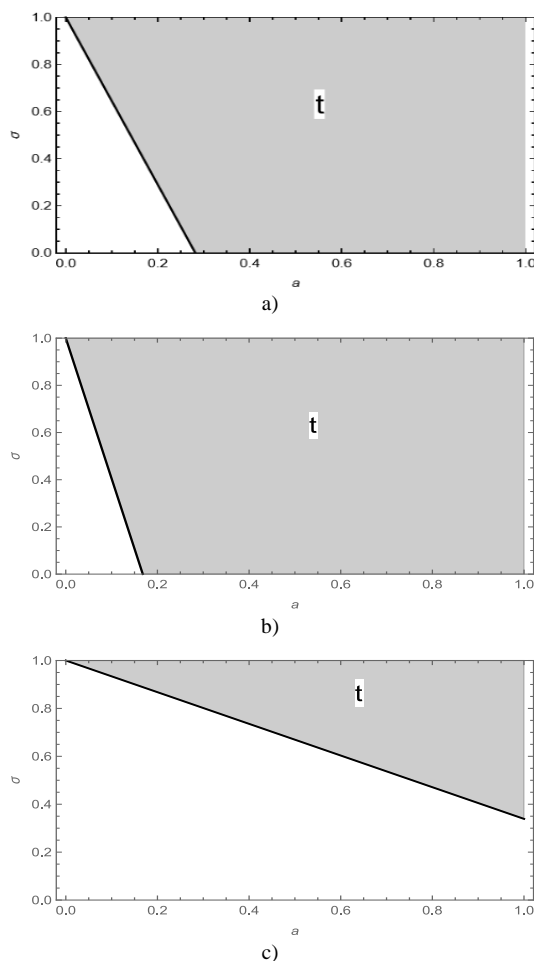

a)

b)

c)

Figure 5: The degree of capital constraint and the credit period under the demand growth coefficient

As can be seen from the figure, there is no value of the value, mainly due to the small value, the degree of response to the

market demand is very weak, micro and small retailers are difficult to observe the better market demand from the commercial credit period, it is often difficult to take the commercial credit period.

From Figure 5 (a) to (b) i.e. credit period under $\lambda = 0.1$ and $\lambda = 0.9$, it is obvious that the area of credit period has become larger, indicating that the increase in altruistic preference of e-commerce platforms will lead to an increase in the credit period, which is undoubtedly favourable to the capital turnover of micro- and small-scale retailers, however, the lengthening of the commercial credit period is highly probable to have the possibility of default of micro and small-scale retailers, which will instead result in a larger loss for e-commerce platforms, thus in Figures (b) to (c), i.e., $\theta = 0.1$ vs. $\theta = 0.9$ lower credit period comparisons, it is obvious that the increase of the default coefficient makes the credit period plummet, even if the altruistic attribute of the e-commerce platform can not offset the loss caused by the default risk, it is more difficult to provide the commercial credit period.(Shown in figure 5, $N = 20, p = 40, c = 8, z = 10, \beta = 0.2$ where (a) $\theta = 0.1, \lambda = 0.1$, (b) $\theta = 0.1, \lambda = 0.9$, (c) $\theta = 0.9, \lambda = 0.9$)
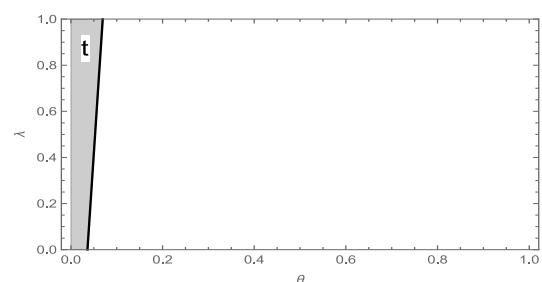

Figure 6: Default coefficient and credit duration under altruistic preference

Figure 6 shows the effect of default coefficient and altruistic

preference on credit period when the financial situation is poor, it is more obvious that there is only a small part of the region of credit period, that is, micro and small retailers have a great probability of defaulting when the financial situation is poor, at this time, the e-commerce platform to provide commercial credit period is no longer the optimal decision, only when the coefficient of default is small, the e-commerce platform's altruistic make it willing to provide the credit period, in order to avoid more commercial losses.
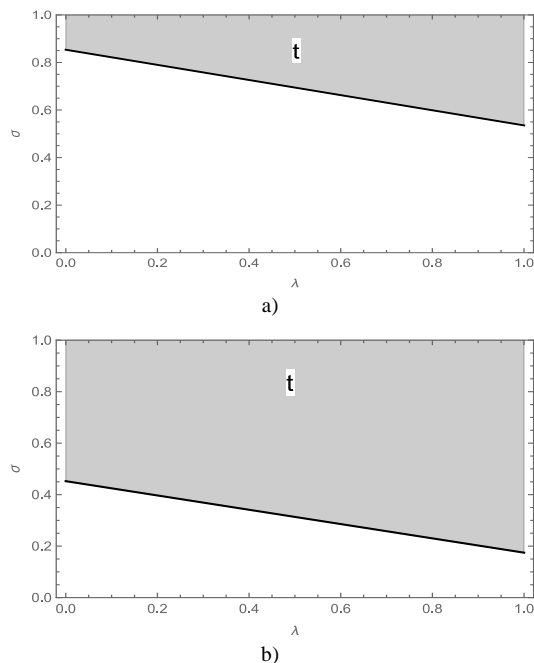

Figure 7: Effect of commission rate on credit duration

Due to financial constraints, the commercial credit willingness of e-commerce platforms is stronger for the more well-funded micro and small retailers, and only when the altruistic preference of e-commerce platforms is large enough to be concerned about the situation around $\sigma = 0.5$. From Figures (a) to (b) show that an increase in the commission rate of e-commerce platforms also provides a longer credit period, and an increase in the commission rate of e-commerce platforms increases the cost borne by micro and small retailers in a relative manner, thus, it is going to offer longer credit periods to stimulate demand, enable micro and small retailers to gain revenue and ease the pressure on capital flows.

Lemma 4: $\frac{\partial t^*}{\partial \lambda} = -\frac{c+p(-1+\beta)}{4(c+p-p\beta)\theta} > 0$, $\frac{\partial q^d}{\partial \lambda} =$
$-\frac{aN(c+p(-1+\beta))^2}{8p(-1+\beta)(c+p-p\beta)\theta} > 0$, $\frac{\partial \pi_r^d}{\partial \lambda} = \frac{aN(c+p(-1+\beta))^3}{32p(-1+\beta)(c+p-p\beta)\theta} > 0$,
$\frac{\partial \pi_o^d}{\partial \lambda} = -\frac{aN(c+p(-1+\beta))^3\lambda}{32p(-1+\beta)(c+p-p\beta)\theta} < 0$, $\frac{\partial \pi_z^d}{\partial \lambda} =$
$-\frac{aN(c+p(-1+\beta))^3(-3+\lambda)}{32p(-1+\beta)(c+p-p\beta)\theta} > 0$.

Lemma 4 indicates that the active concessions of the e-commerce platforms are manifested in the increased duration of the commercial credit period, and the longer credit period not only eases the financial pressure on the micro and small retailers to a certain extent, but also stimulates the market demand, and thus the micro and small retailers increase their purchases with the change in the demand end of the spectrum. Although e-commerce platforms focus on the interests of micro and small retailers at the expense of their

own, the altruistic behaviour of the commercial credit period has improved the overall profitability of the supply chain.

Figure 8 shows $\pi_o^d - \pi_r^d$. As can be seen in each graph, the e-commerce platforms are not concerned with more than their own profits. By comparing Figure (a) $\lambda = 0.3$ with Figure (b) $\lambda = 0.6$, the area where the profit of the e-commerce platform is greater than the profit of the micro and small retailers is decreasing, which shows that the concessions of the e-commerce platform have narrowed the profit difference between the two, while comparing Figure (b) $\theta = 0.3$ with Figure (c) $\theta = 0.6$, the coefficient of default has become larger for the e-commerce platform is detrimental, and should be greater than that of the micro and small retailers in the area of a smaller area, However, Figure (c) shows an increase in the area of the profit margin, which is attributed to the increase in the area of this component due to the reduction in demand brought about by the shortening of the commercial credit period as a result of a larger coefficient of default, which results in a decrease in the revenue of the micro and small retailers and a decrease in the loss of the e-commerce platforms.
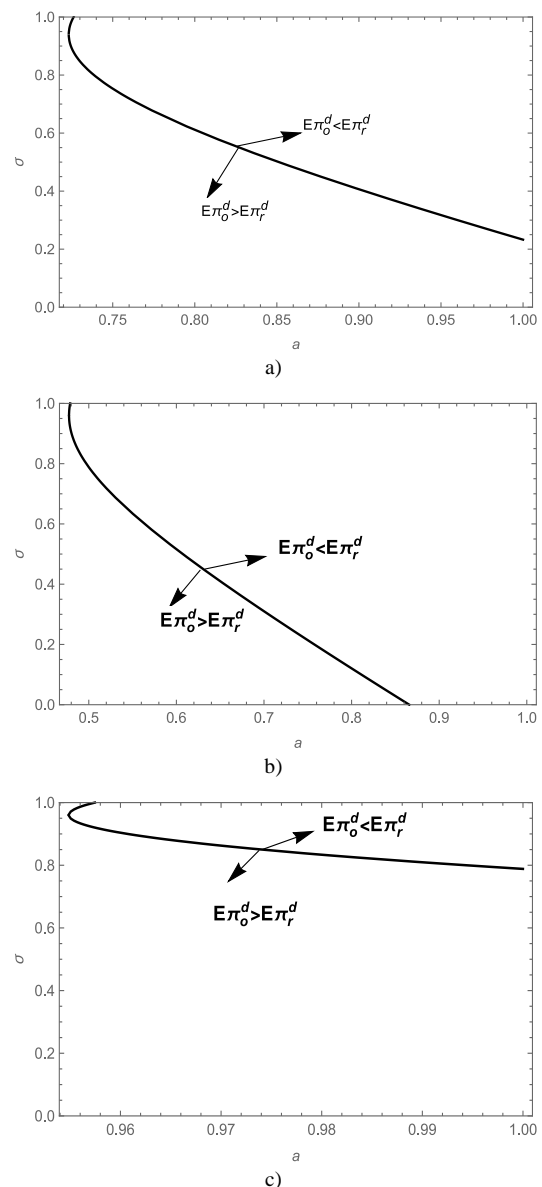

Figure 8: Expected profit comparison chart between e-commerce platform and small and micro retailers

5. Comparative Analysis

By comparing the optimal order quantity of micro and small retailers, the profit of micro and small retailers and the profit of e-commerce platforms under the three altruistic models of e-commerce platforms' wholesale price to obtain revenues, financing and commercial credit period, the analysis is made from the comparison.

5.1 Optimal Order Quantity for Micro and Small Retailers

By solving for $q^w = q^b$, $q^w = q^d$ and $q^b = q^d$, the optimal order quantity for the micro-retailer's own level of capital and the platform's altruistic preference is given by

$$\sigma_1 = -\frac{(c^3-2c^2p+3cp^2(-1+\beta)^2+2p^3(-1+\beta)^3)(-2+\lambda)}{2p^3(-1+\beta)^3+c^2p(-2+\beta+\lambda-\beta\lambda)-cp^2(-1+\beta)^2(-4+2\beta-(-3+\lambda)\lambda)+c^3(\beta(-1+\lambda)-(-2+\lambda)\lambda)},$$

$$\sigma_2 = -\frac{(c+p(-1+\beta))(-2+\lambda)(a(c-3p(-1+\beta))\beta-2(-1+\beta)(c+p-p\beta)\theta+a(c+p(-1+\beta))(-1+\beta)\lambda)}{2(-1+\beta)(c+p-p\beta)\theta(2c\beta-(c+p(-1+\beta))\lambda)},$$

$$\sigma_3 = \frac{(-1+\beta)\left(\frac{(c+p(-1+\beta))(a(c-3p(-1+\beta))\beta-2(-1+\beta)(c+p-p\beta)\theta)}{(-1+\beta)^2(c+p-p\beta)\theta}-\frac{4(c^3-2c^2p+3cp^2(-1+\beta)^2+2p^3(-1+\beta)^3)}{-2p^2(-1+\beta)^3+c^2(2+\beta(-1+\lambda)-\lambda)}+\frac{a(c+p(-1+\beta))^2\lambda}{(-1+\beta)(c+p-p\beta)\theta}\right)\left(2p^2(-1+\beta)^3+c^2(-2+\beta+\lambda-\beta\lambda)\right)}{2(c+p(-1+\beta))(2p^2(-1+\beta)^3+c^2(\beta(-1+\lambda)-\lambda)-2cp(-1+\beta)^2(-1+\lambda))}.$$

While the availability of funds restricts the purchasing activities of micro and small retailers, altruistic preferences in different scenarios stimulate micro and small retailers to purchase upstream. Parametric analyses are conducted to compare the optimal order quantities of micro and small retailers under different scenarios. Figure 9 shows the variation of the optimal order quantity of micro-retailers under different scenarios when the capital adequacy and the altruistic preference of the e-commerce platform are varied. For altruistic preference and capital less than the threshold, the order quantity in the financing case is larger than that in the wholesale price case, and on the contrary, the order quantity in the wholesale price case is larger than that in the financing case; similarly, for altruistic preference and capital less than the threshold, the order quantity is larger than that in the wholesale price model in the commercial credit period, and larger than that in the financing model than that in the commercial credit period model. From the two comparisons, it can be concluded that the commercial credit period stimulates micro and small retailers to order more than the wholesale price mode, and the financing mode stimulates their ordering more than the commercial credit period mode;

therefore, the altruistic preference is more favourable for micro and small retailers to order under the financing mode.
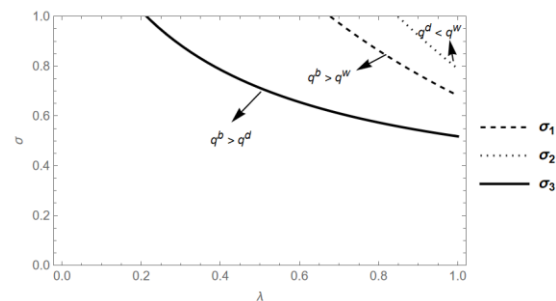

Figure 9: The order quantity of small and micro retailers changes under different circumstances

5.2 Micro and Small Retailers Expect Profits

For the micro-retailer's expected profit by solving for $E\pi_r^w = E\pi_r^b$, $E\pi_r^w = E\pi_r^d$ and $E\pi_r^b = E\pi_r^d$ the critical values at the micro-retailer's level of capital and platform altruistic preference are respectively

$$\sigma_1 = \frac{\left(7750-\frac{376810452900}{(9043-1521\lambda)^2}-\frac{5733}{(-2+\lambda)^2}\pm13\sqrt{\frac{(9043-1521\lambda)^2(-2+\lambda)^2}{\frac{77383866181729+\lambda(-315036636748046+\lambda(466151404844211+15500\lambda(-20415358270+\lambda(6843971933+34875\lambda(-30254+1521\lambda)))))}{(9043-1521\lambda)^2(-2+\lambda)^4}}}\right)}{117\left(11911948399+\lambda(-31951679506+\lambda(22708709641+240250\lambda(-24170+1521\lambda)))\right)},$$

$$\sigma_2 = -\frac{2}{49}(-2+\lambda)^2\left(\frac{125}{36}-\frac{49}{2(-2+\lambda)^2}\pm\sqrt{\left(\frac{125}{36}-\frac{49}{2(-2+\lambda)^2}\right)^2-\frac{30625(125+9\lambda)}{20088(-2+\lambda)^2}}\right),$$

$$\sigma_3 = \frac{1172366151+81775849\sqrt{\frac{13992547789-25\lambda(696306154+27\lambda(-5618687+314340\lambda))}{(9043-1521\lambda)^2}}\pm117\lambda(-18086+1521\lambda)\left(555+13\sqrt{\frac{13992547789-25\lambda(696306154+27\lambda(-5618687+314340\lambda))}{(9043-1521\lambda)^2}}\right)}{172980(-1+\lambda)(-16565+1521\lambda)}.$$

For micro-retailers, if $\sigma_0 < \sigma_1$, then $\pi_r^b > \pi_r^w$; if $\sigma_0 < \sigma_2^+$ or $\sigma_0 > \sigma_2^-$, then $\pi_r^d > \pi_r^w$; if $\sigma_0 < \sigma_3^+$ or $\sigma_0 > \sigma_2^-$, then $\pi_r^b > \pi_r^d$. Figure 10 shows the changes of profits of small and micro retailers in different situations when the capital adequacy and altruistic preference of e-commerce platforms change. Intuitively, in Figure (a), when small and micro retailers have abundant funds and the e-commerce platform has a high

degree of altruism, the profit of small and micro retailers under the wholesale price mode of e-commerce platform is higher, and the profit of small and micro retailers from the financing strategy of e-commerce platform in the remaining areas is higher than that under the wholesale price strategy and larger than the previous area; In Figure (b), small and micro retailers have abundant funds and the e-commerce platform is

less altruistic or the funds are short and altruistic, and the small and micro retailers make more profits from the commercial credit period strategy. On the contrary, in the remaining areas, the small and micro retailers make more profits from the wholesale price model of e-commerce platform than from the commercial credit period. In Figure (c), when the e-commerce platform is highly altruistic and most of the small and micro retailers' funds are in a stable state, they get more profits from financing. When a small part of the funds is extremely poor, the funds are good and the e-commerce platform has a certain degree of altruism, small and micro retailers get more profits from the e-commerce platform's commercial credit period strategy than the e-commerce platform's financing strategy.
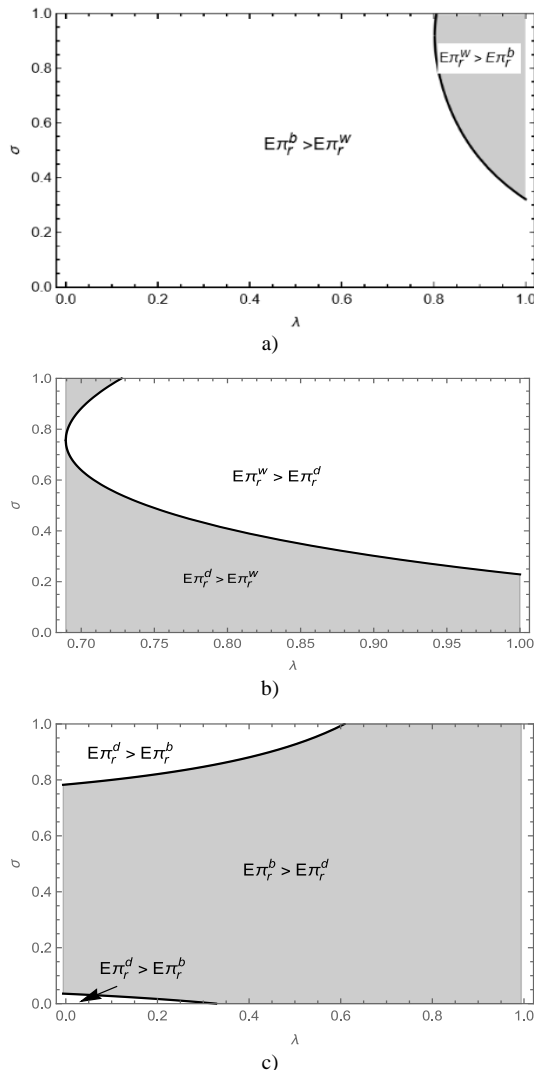

a)

b)

c)

Figure 10: Comparison of expected profits of small and micro retailers under different circumstances

5.3 E-commerce Platform Profit Comparison

By solving for e-commerce platform profits $\pi_o^w - E\pi_o^b$, $\pi_o^w - E\pi_o^d$ and $E\pi_o^b - E\pi_o^d$, then $\pi_o^w < E\pi_o^b$. $\pi_o^w - E\pi_o^d = \frac{72(1-\lambda)\sigma}{(-2+\lambda)^2} - \frac{5(151321 - 50625\lambda^2 + 468\sigma(-79+117\sigma))}{37908}$, $\frac{\partial\pi_o^w - \pi_o^b}{\partial\lambda} = \lambda\left(\frac{3125}{234} + \frac{72\sigma}{(-2+\lambda)^3}\right) > 0$, $\pi_o^w < E\pi_o^d$ in $\lambda \in [0,1]$ and $\sigma \in [0,1]$. There is an interval of $\sigma \in [0.79,0.81]$ and λ' makes $E\pi_o^b - E\pi_o^d = 0$, when λ_0 is in the interval of σ and greater than λ', $\pi_o^b > \pi_o^d$.

Figure 11 shows the changes of profit of e-commerce platform in different situations when the capital adequacy and altruistic preference of e-commerce platform change. For the e-commerce platform, the profit under the commercial credit period strategy and financing strategy is greater than that under the wholesale price strategy, which shows that the e-commerce platform will choose the latter in the two modes of wholesale price and commission. It can be intuitively seen from the figure that in the areas of $\sigma \in [0,0.79]$ and $\sigma > 0.81$ and λ' curve, the profit of e-commerce platform under financing strategy is greater than that when choosing commercial credit period, and in the shaded areas, the commercial credit period strategy is dominant.
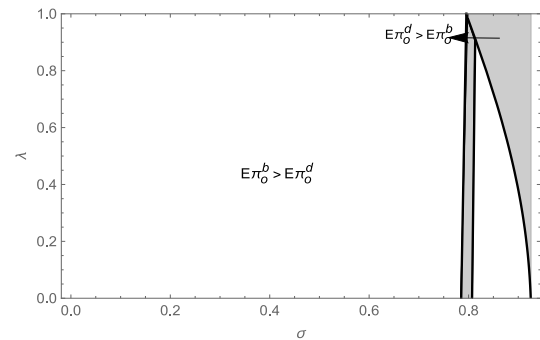

Figure 11: Comparison chart of expected profit of e-commerce platforms under different circumstances

6. Conclusions

The altruistic empowerment of the platform helps to improve the purchasing decisions of micro and small retailers under the shortage of funds, focus on the pain points of upstream and downstream transactions, and break the realistic dilemmas in the development of the supply chain, which in turn improves the overall performance of the supply chain. This paper consists of a platform supply chain system composed of brands, e-commerce platforms and micro- and small retailers. Considering the altruistic attribute of e-commerce platforms and the random demand of the market, we analyse the impact of e-commerce platforms' empowerment of capital-constrained micro- and small retailers in the form of strategies of wholesale price, financing and commercial credit period on ordering volume, profit and supply chain efficiency, and explore the optimal strategies of micro- and small retailers and platforms to arrive at the following main conclusions:

(1) The altruistic strategy of e-commerce platforms affects micro and small retailers' ordering decisions through three modes: wholesale price adjustment, financing support and commercial credit period. The altruistic effect of the financing strategy is closely related to the retailer's financial status: financing has a significant stimulating effect when funds are tight, and ordering tends to be conservative when funds are abundant. Among the three strategies, the financing model has the best incentive effect on micro and small retailers, and all the altruistic strategies lead to lower wholesale prices. In setting the financing interest rate and credit period, the platform focuses on the funding gap response in the former, and pays more attention to default risk control in the latter.

(2) Altruism restructures the profit distribution mechanism of the supply chain and alleviates the channel squeeze problem

in the traditional model. By lowering the wholesale price and stimulating the order quantity, it not only improves the overall profit of the supply chain, but also improves the channel relationship. It should be noted that there is a boundary between the supply chain efficiency of financing strategies: altruism can only achieve a win-win situation when micro- and small retailers are significantly short of funds; if they are well-funded, excessive altruism will reduce the performance of the supply chain.

(3) The choice of strategy follows the principle of dynamic matching between capital and altruism: wholesale pricing is preferred when capital is good and altruism is high, and financing is preferred when capital is good and altruism is high; commercial credit is preferred when capital is abundant/highly scarce, and financing is suitable for a medium level of capital. For platforms, the commission model offers stable returns, and the financing strategy offers more certainty of returns than the credit term strategy.

Small and micro retailers in the development of capital and cost constraints, at the end of the supply chain of dispersed individuals is difficult to seek to bank or third-party financing help, the platform as a dominant player in the supply chain, will channel sinking empowered to the small and micro retailers, can be empowered to solve the small and micro retailers capital constraints of the survival of the situation of the altruistic preference form of the wholesale contract, financing and commercial credit period, for example, in 2022 For example, during the "Double Eleven" period, Guangdong Suning Eshop offered a 10% discount on top of the government subsidy, together with discounts from home appliance brands, to drive the sinking of intelligent green home appliances; Alibaba provides all small shops with interest-free credit for goods shipped by Ali, so that small shop owners can purchase goods first and then repay the loan, providing a free billing period to alleviate the pressure on funds and make replenishment worry-free for small stores. Small shops replenish goods without worry. The platform should adsorb more small and micro-retailers for cooperation, pay more attention to the survival situation and guide its enthusiasm, which is conducive to the stability of cooperation between the supply chain. This paper considers the newsboy model of financial constraints under a single cycle, and in actual operation, small and micro retailers will realise purchasing in multiple batches, which also proposes a new direction for future research.

Funding

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