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# PRICING AND COORDINATION STRATEGIES OF DUAL-CHANNEL SUPPLY CHAIN CONSIDERING CONSUMER CHANNEL PREFERENCE WITH PLATFORM REBATE

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**Abstract.** In dual-channel supply chains (DCSC), where firms operate both online and offline channels, traditional pricing and coordination models typically adopt fixed rebate structures. However, the interaction between consumer channel preference and platform rebate policies remains underexplored, leaving a gap in understanding their combined impact on pricing and coordination decisions. To address this issue, this study develops a Stackelberg game model to examine how consumer behavior and rebate flexibility jointly influence the strategic decisions of manufacturers, retailers, and platforms. Numerical simulations are further conducted to evaluate different consumer channel preference intensities and rebate adjustment scenarios. The results indicate that a stronger offline channel preference increases wholesale and retail prices, rebate levels, and retailer effort. Under manufacturer-led structures, consumers bear higher costs compared with centralized coordination, while in decentralized systems, flexible rebates play a crucial role in shaping profits and overall efficiency. The novelty of this research lies in integrating platform rebate mechanisms into the DCSC framework, providing new insights into how consumer channel preference drive pricing and coordination outcomes. Practically, the findings offer guidance for e-commerce supply chain managers to align rebate strategies with consumer behavior, thereby enhancing both strategic alignment and operational performance.

**Mathematics Subject Classification.** 91A80.

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## 1. Introduction

With the rapid development of e-commerce, manufacturers have increasingly adopted a dual-channel sales model that integrates both online and offline channels [39]. To accelerate market penetration and stimulate potential demand, manufacturers integrate online and offline channels by expanding online presence. In the context of China's rapidly growing e-tailing market, manufacturers have diversified their sales models. The distinctive features of the rebate promotion model are garnering increasing attention from both consumers and manufacturers. With the ongoing development and evolution of rebate promotions in business, a new

*Keywords.* Platform rebate, dual-channel supply chain, Stackelberg game, two-part pricing contract, cost-sharing contract.

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business model for rebate promotions has emerged "Platform rebate". The primary function of platform rebate is to provide incentives, such as reward programs, coupons, and free shipping, to enhance consumer purchase intentions. In practice, platforms utilize this strategy to increase market share, while delegating decisions related to pricing, advertising, and other aspects to sellers [34].

Recently, the intensification of online retail competition and the rapid expansion of e-commerce have driven the widespread adoption of platform rebate promotions. As an effective marketing instrument, platform rebate promotions enable online retailers to attract consumers and enhance market competitiveness [21]. Platforms such as Pinduoduo, JD.com, and Taobao have successfully implemented this platform rebate strategy to expand user engagement, boost sales, and strengthen platform stickiness. For instance, during the 2023 "Double 11" shopping festival, the e-commerce giant Alibaba achieved a gross merchandise volume (GMV) of 84.5 billion USD through a combination of price reductions, discounts, and rebate strategies on its retail platforms[1]. The PDD Holdings Inc. has implemented a comprehensive platform rebate and "cash-back" mechanism that integrates coupon-based promotions with social-sharing incentives[2]. Through activities such as "group-buying rewards and brand membership rebates", users can receive direct refunds or discount credits after completing purchases or inviting friends to participate. Similarly, JD.com collaborates with multiple third-party rebate applications, such as Guitao and Zhuiquan, to establish a commission-sharing mechanism[3]. Consumers who make purchases through these rebate channels receive partial refunds, whereas the platform and sellers share the commission. It highlights the significant role of platform rebates in stimulating consumer demand and boosting sales performance. Consequently, many manufacturers increasingly depend on high-traffic, large-scale, and highly visible e-commerce platforms with strong operational capabilities to implement rebate promotions and expand their market reach.

Under the platform rebate model, manufacturers pay a commission based on increased sales from the platform. The platform leverages its "asset-light" model, traffic aggregation, and information scale to operate, locking consumers into its marketplace and discouraging them from switching to other sales channels by offering rebates. Manufacturers benefit by reducing promotion expenses and boosting sales. From the platform's perspective, rebates raise the average unit commission. In addition, unredeemed rebates generate extra revenue. Traditional retailers, benefiting from ease of shopping in the manufacturer's online channel, enhance online price advantages through platform rebate, leading them to improve experiential and delivery services. Consumers have varied preferences: some favor traditional channels for prompt rebate redemption, while others prefer platform rebate links. In fact, two different supply chain models were found. Manufacturers possess the pricing power to dominate the supply chain. Online stores like Taobao operate as intermediaries, facilitating sales on behalf of manufacturers and earning commissions from manufacturers [39, 61]. Retailer-led supply chain is when suppliers sell products to retailers at wholesale price, and retailers have pricing power and dominate the supply chain. Yili Group provides products to JD.com self-supporting stores, and JD.com self-supporting stores price and sell products [31]. The increasing use of platform rebate mechanisms as a promotional tool highlights the need to understand their dynamic impact on the supply chain.

This paper introduces the combination of the platform channel and the traditional retail channel as DCSC. Manufacturers sell products through platform channels. Products are also distributed through traditional retailers, forming two distinct sales channels. Many studies have regarded direct sales and traditional retail as components of DCSC. But, the rapid development of the platform economy has shifted perspectives. The combination of platform channel and traditional retail channel is now viewed as a novel form of DCSC [53]. In this DCSC, where direct sales and platform sales coexist, rebates often intensify price conflicts between channels [4]. Conflicts distort demand allocation, leading to inefficiencies in supply chain coordination. A potential reduction in profits for both manufacturers and retailers may occur. As consumer channel preference for platforms increases, traditional channels may lose competitiveness. Improved platform rebates or service experiences drive shifts in consumer channel preference. Shifts in consumer behavior may cause traditional channels to lose ground. Plat-

[1]https://queue-it.com/blog/singles-day-statistics/ (Accessed date 23 September 2025).

[2]https://www.wlcbw.com/47926.html (Accessed date 4 October 2025).

[3]https://finance.sina.com.cn/tech/roll/2025-07-15/doc-inffpncr5705733.shtml (Accessed date 4 October 2025).

forms gain an advantage by offering rebates or enhanced service. Traditional Manufacturers and retailers must adapt to evolving market conditions. A balance must be struck between incentives provided through platform channel. Traditional retail strategies must remain competitive.

Despite the increasing adoption of platform rebate mechanisms, a limited understanding exists regarding their strategic impact on channel pricing decisions and the impact on profit distribution under varying leadership structures. The **motivation** of this study is to examine how platform rebate strategies are implemented and how consumer channel preference influences pricing decisions in DCSC. Furthermore, the study aims to explore effective mechanisms for mitigating channel conflicts and achieving coordination within DCSC. Accordingly, this study addresses the following key research questions: (1) How do consumer channel preference affect pricing strategies and demand allocation within DCSC under platform rebate? (2) What differences arise in supply chain performance under different leadership structures when platform rebate mechanisms are implemented? (3) To what extent can coordination contracts mitigate double marginalization and align the interests of all supply chain members within a dual-channel framework that incorporates platform rebate?

This paper introduces three key **innovations** to address these questions. Firstly, this study explores the impact of consumer channel preference on pricing decisions and coordination outcomes in DCSC. Particular emphasis is placed on the distinctions between the platform rebate channel and the traditional retail channel, thereby offering insights into how consumer behavioral tendencies influence strategic decisions across multiple channels. Secondly, this study develops a decision-making and coordination model for DCSC that integrates consumer channel preference within a platform rebate framework. While many manufacturers have adopted platform rebate strategies for direct online sales, existing research primarily focuses on single-channel supply chains employing traditional rebate mechanisms. This paper extends the literature by explicitly modeling the interaction between consumer behavior and platform rebate policies in a dual-channel context. Thirdly, the study addresses inefficiencies arising from double marginalization in decentralized DCSC by introducing two widely adopted coordination contracts – the two-part pricing contract and the cost-sharing contract. These mechanisms are selected for their simplicity, practicality, and effectiveness in aligning incentives among supply chain members while preserving decision-making autonomy [24,32]. Compared with alternative mechanisms such as buy-back, quantity-flexibility, or revenue-sharing contracts, the two-part pricing contract and cost-sharing contract provide clearer cost and benefit allocations. They are particularly suitable for modeling platform rebate scenarios under dual-channel structures. Their effectiveness in enhancing overall supply chain performance under platform rebate is analyzed through comparative modeling and evaluation.

The primary objective of this study is to integrate consumer channel preferences with platform rebate strategies and to examine their impact on pricing decisions and profit allocation within DCSC. This research introduces two-part pricing and cost-sharing contracts as coordination mechanisms to enhance the overall performance of the DCSC. These mechanisms strike a balance between incentive compatibility and decision-making autonomy, ensuring mutually beneficial outcomes for both manufacturers and platforms while alleviating the inefficiencies associated with decentralized decision-making. The analytical results reveal that a stronger consumer preference for traditional retail channels leads to higher wholesale and retail prices, greater retailer effort, and more intensive platform rebate levels. Moreover, the platform rebate mechanism is shown to effectively motivate retailer investment and strengthen consumer engagement, ultimately promoting a win–win outcome among all supply chain participants.

The structure of the remainder of the paper is as follows. Section 2 provides a review of the relevant literature. Section 3 presents the problem description and assumptions. Section 4 outlines the model construction and solution analysis. Section 5 introduces contractual coordination. Section 6 presents a numerical analysis. Section 7 concludes the paper. All proofs are presented in Appendix A.

## 2. Review of the literature

The current study is interconnected with three areas of literature: rebate strategies, pricing decisions in DCSC, and coordination contracts in DCSC.

### 2.1. Research on rebate strategies

As e-commerce advances and consumer inclination toward online shopping grows, the introduction of the cost-per-sale (CPS) commerce model has given rise to a novel rebate strategy known as platform rebates. The model is significant for manufacturers in enhancing product sales. In the supply chain context, platform rebates entail manufacturers providing a commission to a platform for sales, and subsequently, the platform offers a rebate to encourage consumer purchases [62]. Research in several well-established foreign literatures has examined the impact of consumer acceptance and rebate strategies on the decisions of supply chain members. Khouja *et al.* (2010) [29] examined the effect of delayed rebates on supply chain profitability and demonstrated that delayed rebates encourage retailers to raise retail prices. Caliskan-Demirag *et al.* (2011) [5] investigated manufacturers' rebate strategies and indicated that retailers with low risk aversion tend to prefer receiving manufacturer rebates. Gao *et al.* (2012) [18] found that weather condition rebates during early sales periods boost sales while reducing inventory and holding costs. Saha *et al.* (2013) [43] integrated rebates with revenue-sharing and cost-sharing contracts to explore hybrid contract combinations under linear demand conditions. Huang *et al.* (2014) [27] analyzed the strategy selection issue in seasonal product supply chains and concluded that a wholesale price rebate contract effectively coordinates the supply chain when capacity is high during a single sales period. Saha *et al.* (2015) [44] compared joint rebate, wholesale price rebate, and cost-sharing contracts, finding that retailers with higher bargaining power prefer wholesale price rebate contracts. Zhou *et al.* (2017) [69] demonstrated that rebate platforms can improve retailer profitability in both decentralized and centralized decision-making environments. Mou *et al.* (2018) [40] explored optimal pricing strategies for rebate platforms and merchants using game theory, showing how platform rebates expand market reach. Cao *et al.* (2019) [6] investigated "trade-in" rebates for third-party B2C platforms, finding that rebates do not always benefit the platform and that the structure and context of rebate programs are crucial for their success. These strategies influence manufacturer pricing and also play a significant role in shaping consumer behavior and platform profitability. Yu *et al.* (2020) [61] investigated manufacturer pricing and rebate strategies in online reselling platforms and found that higher consumer sensitivity to rebates leads platforms to offer greater rebates. Xu and Xiao (2022) [54] examined e-retailers' commission selection strategies and the impact of different rebate structures on supply chain decision-making. Wang and Sun (2022) [52] developed a game-theoretic model to analyze rebate distribution by manufacturers through e-commerce platforms. Bai *et al.* (2023) [2] examined the impact of various rebate modes on consumer behavior and found that while cash rebates encourage product returns, voucher rebates are more effective in encouraging first-time purchases. Sarkar *et al.* (2023) [45] analyzed supply chain coordination with varying risk attitudes and found that rebate contracts yield better outcomes than wholesale price contracts. Zhang and Xiao (2024) [64] found that in an e-tailer-Stackelberg supply chain, rebate strategies are more effective in driving consumer purchases when consumers are less likely to leave positive reviews. Jiang *et al.* (2024) [28] found that in a supply chain with two competing sellers on a common platform, rebates are consistently offered under the wholesale format and only under the agency format when the commission rate is low. Finally, Zhuo *et al.* (2025) [71] examined rebate mechanisms in information-sharing alliances and proposed split-return and swap-return strategies to incentivize sharing and ensure fair benefit distribution.

As can be seen, existing studies on rebate strategies mainly focus on single-channel supply chains and examine the impact of rebates on pricing and profits from the perspective of either consumers or retailers. However, few studies have explored the role of platform rebates in DCSC, where channel conflict and strategic interactions between direct and platform channels create more complexity. Additionally, the CPS model and its commission-based rebate mechanism have not been extensively studied in this context. This paper aims to fill this gap by investigating the influence of platform rebates on pricing and coordination in DCSC. The goal is to offer new insights into how these strategies can enhance overall supply chain performance while reducing double marginalization and channel conflict.

### 2.2. Research on pricing decisions in DCSC

A DCSC involves a manufacturer distributing products or services through two distinct sales channels [9]. This model typically consists of a direct channel and an indirect channel. The direct channel involves transactions between the manufacturer and consumers or customers. The indirect channel involves the manufacturer selling through a third party, such as a retailer, wholesaler, or distributor. Due to the emergence and expansion of the online sales channel, more manufacturers are choosing to launch online channels in parallel with traditional retail channels to broaden market reach and attract more consumers. In research on manufacturers' DCSC, some scholars propose that expanding manufacturers' online direct sales channels can enhance the overall profitability of the supply chain. Based on the relationship between manufacturers and distributors, Tsay *et al.* (2004) [51] demonstrated that profits can be synchronized across channels. Manufacturers can achieve synchronization by strategically adjusting wholesale prices. Such adjustments enhance overall supply chain profitability. Similarly, Chiang *et al.* (2005) [14] concluded that a well-coordinated dual-channel structure yields superior profits compared to retail-only and online-only models. Contrary to concerns about channel competition, Cattani *et al.* (2006) [8] argued that manufacturers and retailers benefit from dual-channel systems when pricing is optimized. Pricing consistency and coordination mechanisms are recurring themes in DCSC literature. Cai *et al.* (2009) [4] emphasized that uniform pricing across channels enhances retailer profits and mitigates conflicts. Tsao *et al.* (2011) [49] examined dynamic pricing strategies that incorporate supplier incentives, such as cash discounts. Other studies, such as Dan *et al.* (2012) [15], incorporated retailer service levels into pricing models, recognizing value-added services as justifying price differentials. To further reconcile channel competition, Panda *et al.* (2015) [41] studied how product compatibility influences pricing, with cost reductions and product differentiation reshaping optimal strategies.

Pricing strategies in DCSC are further complicated by factors such as channel substitutability, consumer behavior, and power dynamics among members. Research increasingly focuses on how these variables interact to shape optimal pricing decisions. For instance, Amrouche *et al.* (2016) [1] showed that the degree of channel substitutability, influenced by consumers viewing online and offline channels as interchangeable, directly affects profitability. Similarly, Batata *et al.* (2017) [3] showed that in supply chains with reverse logistics, dual-channel structures outperform single-channel models, with pricing accounting for both forward and reverse flows. Meanwhile, Chen *et al.* (2020) [12] emphasized that aligning pricing strategies with heterogeneous consumer channel preference adds complexity due to the interplay of power structures. Sun *et al.* (2020) [48] found that dominance by manufacturers or retailers influences channel-specific pricing and profit distribution, with insights from behavioral economics refining DCSC pricing models. Yan *et al.* (2022) [58] identified that consumers' internal reference prices positively influence optimal pricing, enabling strategic price anchoring closer to perceived values. Yang *et al.* (2024) [59] confirmed that pricing efficacy is directly related to cross-channel data mining, with improved data conversion efficiency boosting total supply chain profits. Chen *et al.* (2025) [13] investigated the showrooming effect, finding that its profitability impact varies with channel power structures.

Extensive research has explored pricing decisions in DCSC. Most studies focus on traditional pricing mechanisms, including channel conflict, service levels, and consumer behavior. However, existing models often overlook dynamic pricing mechanisms. Platform participation plays a key role in driving dynamic pricing. New business models, such as CPS, introduce platform rebates and commissions. This paper fills the research gap by integrating platform rebate mechanisms into the pricing framework of DCSC. The model considers the cooperation between a manufacturer and a CPS-based e-commerce platform, while the manufacturer also operates a direct sales channel. The study investigates the impact of platform rebates on pricing decisions and analyzes channel coordination. Overall supply chain performance is also evaluated. The research provides a comprehensive understanding of pricing strategies in a modern DCSC under platform intervention.

### 2.3. Research on coordination contracts in DCSC

Supply chain contracts represent a form of cooperative agreement. These contracts align individual motivations with system goals, thereby achieving coordination in the supply chain. Double marginalization is avoided through these contracts [36]. Various coordination contracts have been proposed to address inefficiencies, such as double marginalization and channel conflicts. The two-part pricing contract is a commonly used coordination tool. The simple and efficient profit-sharing feature facilitates the widespread adoption of this contract [10]. The revenue-sharing contract ensures incentive compatibility, with channel revenue-sharing supporting this compatibility. Significant effects in harmonizing manufacturer and retailer interests have been demonstrated [55]. Cost-sharing contracts provide an effective solution and support retailer investments in services or sustainability programs [37]. Differentiated mechanism designs are employed in these contracts, offering systematic solutions to address efficiency losses. These solutions address double marginalization and channel conflicts in DCSC.

Two-part pricing contracts have been widely studied in various DCSC contexts. Double marginalization effects have been effectively resolved through this contractual approach in closed-loop supply chains. Zheng *et al.* (2017) [66] maintained channel harmony and established the versatility of two-part pricing contracts. Recent research has broadened the scope of two-part pricing contracts, addressing more complex supply chain scenarios. Hosseini-Motlagh *et al.* (2019) [25] incorporated demand disruption factors into coordination models, optimizing pricing, sustainability levels, and CSR decisions during market uncertainties. He *et al.* (2020) [23] adapted the framework for perishable product supply chains, achieving dual benefits of profit maximization and waste reduction, while validating the effectiveness of two-part pricing contracts. E-commerce-dominated supply chains represent another validation context. Huang *et al.* (2021) [26] successfully coordinated a three-tier sustainable supply chain, establishing the contract's adaptability to different power structures with a dominant retailer as a key participant. Cao *et al.* (2021) [7] developed a hybrid coordination mechanism for perishable goods supply chains, combining cost-sharing strategies and compensation approaches. Liang and Sun (2022) [32] designed a specialized two-part pricing contract for green supply chain systems, aligning the economic interests of manufacturers and retailers.

Recent research has advanced coordination contract design. Behavioral and marketing considerations have been incorporated into these contracts. Zhang *et al.* (2022) [63] advanced the field with an innovative framework integrating customer rebate programs and retailer risk preferences. Guo *et al.* (2022) [22] developed a cost-sharing contractual model to improve retailer service levels and mitigate manufacturer free-riding behavior in DCSC. Service-intensive retail environments have benefited from recent innovations. Gu *et al.* (2023) [19] developed an optimized two-part pricing contract that enhanced supply chain performance by addressing offline in-store services and their impact on pricing and profitability. Coordination contracts are now applied to complex, multi-echelon supply chain structures. Das *et al.* (2024) [16] introduced a two-part pricing contract for three-stage green supply chains, achieving fairness, Pareto improvements, and compatibility with both centralized and decentralized decision-making. Zhou *et al.* (2025) [70] proposed a bilateral cost- and revenue-sharing contract that better aligns brand firms and suppliers, enhancing both coordination and labor rights protection.

Current research has thoroughly investigated multiple coordination contracts in DCSC. Two-part pricing mechanisms have been examined. Revenue-sharing arrangements have received considerable attention. Cost-sharing approaches have been analyzed as well. Several critical research gaps remain unexplored. Platform rebates require further investigation. Consumer channel preference needs further examination. Previous studies have mainly focused on traditional pricing strategies. Conventional coordination approaches have dominated the existing research. The growing influence of e-commerce platforms has often been neglected. The impact of platform rebate policies on supply chain dynamics requires more attention. Consumer channel preference has been recognized as an important factor. The interaction between channel preference and platform-driven incentives remains underexplored. The effects of rebate programs need deeper analysis. Combined impacts on pricing decisions require further exploration. Different power structures must be considered. Manufacturer-led scenarios require specific investigation. Retailer-led situations require separate examinations.

### 2.4. Research gaps

The literature review identifies research gaps based on existing findings. Firstly, insufficient investigation exists regarding the interaction between platform rebate mechanisms and consumer channel preference. Different power structures require examination in this context. Joint influences on pricing strategies require detailed analysis.

Commission rates and operational effort levels must be incorporated into this analysis. Secondly, current coordination contract designs predominantly use single-mechanism approaches. The advantages of integrated solutions remain underexplored. Benefit distribution in platform-involved supply chains could be enhanced through such solutions. Thirdly, current models fail to fully capture the evolution of profit distribution within dual-channel systems. As consumer channel preferences shift over time, the profit allocation among manufacturers, retailers, and platforms also changes.

Research limitations are particularly relevant when analyzing empirical results. A specific phenomenon was observed in this study. Increased preference for traditional channels leads to a higher wholesale price. Retail prices also rise with this shift in preference. Effort levels also increase correspondingly. Simultaneously, platform profits decrease. This phenomenon underscores the need for novel theoretical approaches. New frameworks must be developed to measure complex relationships. Platform rebates should be incorporated as core decision variables. Integrated contractual solutions require development. Fair profit distribution among all supply chain participants must be ensured through such solutions.

Three major developments define the core purpose of this study. First, a game-theoretic model is constructed to capture the dual role of the platform as both a market facilitator and a rebate provider. This modeling approach enables a comprehensive analysis of DCSC, revealing how platform rebate mechanisms interact with pricing and coordination decisions. Second, the study examines the ripple effects arising from shifts in consumer channel preferences, identifying their cascading impacts on pricing structures, operational efforts, and rebate strategies. This analysis provides insights into the interdependence and feedback mechanisms among these decision variables. Third, the study validates the effectiveness of integrated coordination contracts designed to sustain supply chain performance under complex dynamic conditions. By introducing coordination mechanisms, the study demonstrates how overall system efficiency can be enhanced and maintained. Collectively, these contributions advance the understanding of DCSC coordination within platform-based ecosystems, extending the traditional two-party supply chain framework into a three-dimensional interaction model.

## 3. Problem description and assumptions

The paper formulates a Stackelberg model involving three entities: a manufacturer, an e-commerce platform, and a traditional retailer. The manufacturer collaborates with retailers and concurrently establishes a presence on e-commerce platforms. The process unfolds as follows: the retailer acquires products from the manufacturer at wholesale price $w$ and subsequently sells them to customers at retail price $p$. Traditional retailers exert sales effort $s$. Concurrently, the manufacturer sells identical products to consumers through the platform channel at a consistent retail price $p$.

Price parity policies are commonly implemented by manufacturers across sales channels. Under these policies, both online and offline channels maintain identical pricing. Channel conflict is prevented through uniform pricing strategies. Brand consistency is maintained according to industry practices [38]. The current study adopts the assumption of uniform pricing. Retail prices are set identically across both channels within the model. This approach simplifies the analytical framework. Strategic interplay among channel members is emphasized. This assumption is particularly relevant for specific industries. Brand image and consistency are critical factors in these sectors. Major brands such as Apple, Nike, Zara, and Sony adopt this practice [53]. Identical pricing is maintained across their online platforms. Traditional retail channel mirrors these prices precisely. A consistent brand image is ensured through this strategy. Channel conflicts are effectively prevented. Operational costs may result in price variations in practice. Platform commissions may lead to different pricing. Promotional strategies may result in temporary deviations. The uniform pricing scenario serves as a benchmark model. Theoretical exploration of sales effort dynamics is facilitated. The effectiveness of coordination mechanisms can be properly evaluated. The assumption of uniform pricing remains justified. Real-world prevalence supports the choice of this model. Industries that prioritize brand integrity commonly adopt this approach. Channel conflict avoidance is achieved through consistent pricing.

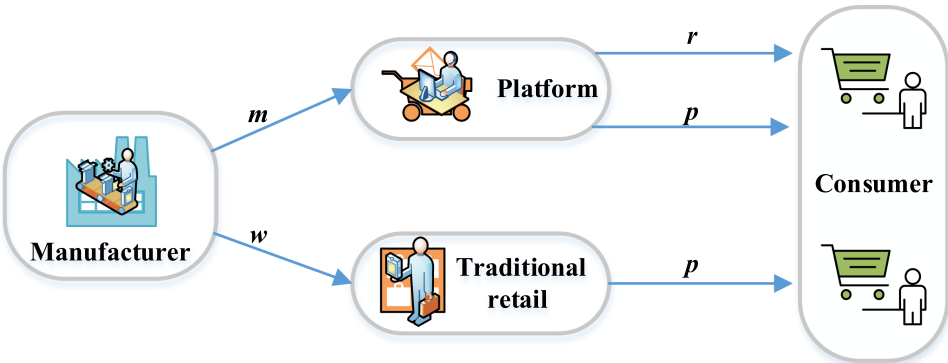


FIGURE 1. Platform rebate flow chart.

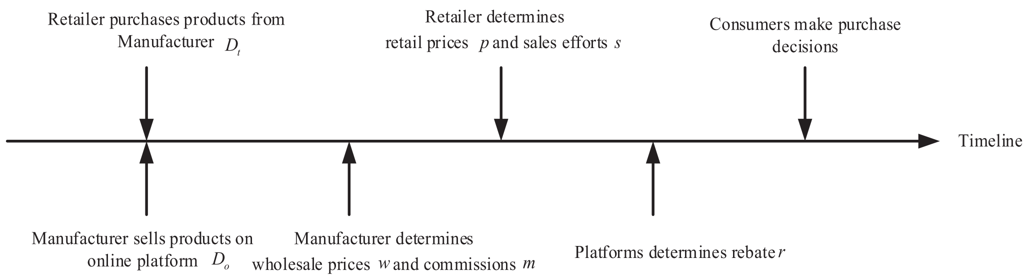


FIGURE 2. The decisions sequence of manufacturer-led model.

Additionally, the manufacturer remits a promotional commission $m$ for each unit sold to the platform, which allocates a portion of the commission revenue as a rebate $r$ to entice consumers to the platform. The paper assumes diverse consumer channel preference for the platform rebate channel and the traditional retail channel. The specific flow chart depicting the DCSC under the platform rebate model is illustrated in Figure 1.

In the manufacturer-led model, the manufacture, retailer and platform are in a Stackelberg game. The manufacture, retailer and platform are the leader, sub-leader and follower, respectively [15]. The decision sequence is shown in Figure 2. The manufacturer determines wholesale price $w$ and commissions $m$ in the first stage. In the second stage, the retailer makes decisions on retail price $p$ and sales efforts $s$ based on the results of the manufacturer's decisions. In the third stage, platform determines rebate $r$.

In the retailer-led model, the retailer, manufacturer and platform are in a Stackelberg game. The retailer, manufacturer and platform are the leader, sub-leader and follower, respectively. The decision sequence is shown in Figure 3. Retailer determines retail markup $\Delta w$ and sales effort $s$ in the first stage. In the second stage, the manufacturer makes decisions on wholesale price $w$ and platform commissions $m$ based on the results of retailer's decisions and rebates $r$ are determined by the platform in the third stage.

Specifically, Table 1 consolidates parameters and describes the assumptions employed in the paper.

(1) Competition exists between online direct and retail channels, and the manufacturer possesses ample supply capacity to fulfill market demand [15].
(2) The products sold in both channels are identical, and the consumer valuation or retention value of the same product is consistent across channels [6].
(3) According to relevant research [33], the selling price is consistent between the platform channel and the traditional retail channel.

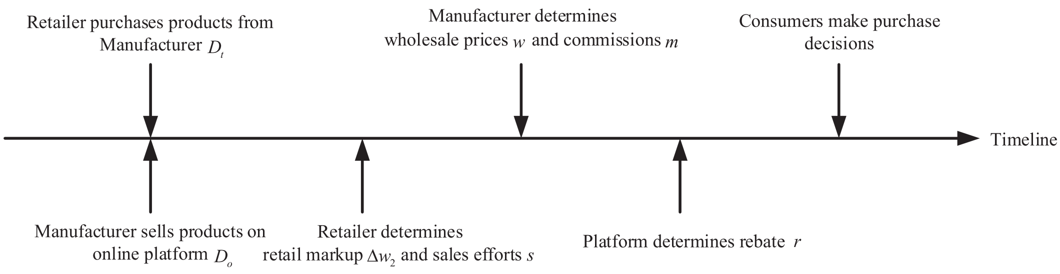


FIGURE 3. The decisions sequence of retailer-led model.

TABLE 1. Definition of parameter symbols.

| Symbols | Definition | Symbols | Definition |
|---|---|---|---|
| $a$ | The size of the market base demand, $a > 0$ | $r^j$ | The unit product rebate is given to consumers by the platform in $j$, $j =$ ML, RL, C, co. $r > 0$ |
| $\theta$ | Consumer channel preference for traditional retailer channel, $0 < \theta < 1$ | $F$ | The fixed fee charged by the manufacturer to the retailer, $F > 0$ |
| $1 - \theta$ | Consumer channel preference for platform channel, $0 < \theta < 1$ | $\phi$ | The cost-sharing ratio of the manufacturer, $0 < \phi < 1$ |
| $p^j$ | The retail price per unit of product in model $j$, $j =$ ML, RL, C, co. $p > w$ | $D_o^j$ | The market needs of Internet platform channel in $j$, $j =$ ML, RL, C, co. |
| $w^j$ | The wholesale price per unit of product $j$, $j =$ ML, RL, C, co. (No consideration of production costs), $w > 0$ | $D_t^j$ | The market needs of traditional retail channel in $j$, $j =$ ML, RL, C, co. |
| $\lambda$ | The coefficient of cross-price elasticity, $0 < \lambda < \frac{1}{2}$ | $\pi_R$ | Retailer profits |
| $l$ | The cost of sales effort factor, $l \geq 0$ | $\pi_M$ | Manufacturer profits |
| $s^j$ | The level of retailer effort in $j$, $j =$ ML, RL, C, co. $s \geq 0$ | $\pi_P$ | Platform profits |
| $n$ | The effect factor of the retailer sales effort, $n > 0$ | $\pi$ | The overall profitability of the supply chain |
| $m^j$ | The commissions are given to the platform by manufacturer in $j$, $j =$ ML, RL, C, co. $m > 0$ | $\pi_i^j$ | The profit of $i$ in $j$, $i = M$, $P$, $R$. $j =$ ML, RL, C, co. |

(4) Only the platform provides rebates to consumers, the cost of consumers searching for product rebate information and the rebate redemption rate are not taken into account, meaning the consumer search cost is 0, and the rebate redemption rate is 1 [62].

(5) $\lambda$ represents the cross-price elasticity coefficient between different channel [15], and the cross-price elasticity coefficient is deemed moderately weak regarding product sales, *i.e.* $0 < \lambda < \frac{1}{2}$. $\lambda$ in this range indicates a moderately weak relationship regarding product sales, suggesting that changes in the price of one channel have a limited impact on the demand for products on another channel. This range is typically assumed when channels are relatively independent yet still exert limited influence on each other [45].

(6) The retailer effort cost is $\frac{1}{2}ls^2$ [15, 33].

(7) The demand and price of the product are linearly related under the condition that consumer channel preference is considered. Price elasticity measures the sensitivity of demand to price changes, while cross-price elasticity reflects how the price of related products affects demand [15]. The demand function of the

DCSC under the platform rebate model is established as: [11, 12, 15, 33]

$$D_t = \theta a - p + \lambda(p - r) + ns. \tag{1}$$

The demand function reflects the change in demand for traditional retail channels under the platform rebate model. The market needs of traditional retail channel $D_t$ is affected by multiple factors: First, consumers' preference for traditional retail channel $\theta$ determines the basic demand. Second, the retail price of the product $p$ is negatively correlated with demand, and the higher the price, the lower the demand; in addition, the platform's rebate $r$ stimulates demand by reducing the actual payment price $(p - r)$, and the cross-price elasticity coefficient $\lambda$ describes the impact of this rebate on demand, indicating how changes in the prices of related products affect demand. Finally, the retailer's sales efforts $n$ and the level of retailer effort $s$ would also increase demand through promotions and other means.

$$D_o = (1 - \theta)a - (p - r) + \lambda p. \tag{2}$$

The market needs of the Internet platform channel $D_o$ is affected by multiple factors. Among them, $(1-\theta)a$ reflects the overall preference of consumers for the platform channel. The higher the preference, the greater the demand. $(p - r)$ represents the actual price borne by consumers in the platform channel, that is, the retail price minus the platform rebate. The higher the price, the lower the demand. $\lambda p$ is a correction term used to describe the impact of price changes on demand.

(8) The optimal decision outcome in the Centralized Decision-making (C) is denoted by superscript "C" in the subsequent text, while the optimal decision outcome in the Manufacturer-Led (ML) model is marked with superscript "ML", the optimal decision outcome in the Retailer-Led (RL) model is indicated by superscript "RL", and the contractually coordinated optimal decision outcome is annotated with superscript "co", with "*" used to signify the optimal decision.

## 4. Model construction and solution analysis

The model is constructed by assuming diverse consumer channel preference for retail and online channels, and backward induction is used to solve the model and derive equilibrium solutions for the decision variables. Further sensitivity analyses are performed on the equilibrium solutions and profits of DCSC.

### 4.1. Centralized decision-making model (C)

In the centralized decision-making model, manufacturers, retailers, and platforms collaboratively make decisions. The overall goal of all members of the DCSC is the maximization of overall profitability. Thus, the overall profit function of the DCSC $\pi^C$ in the C model is:

$$\pi^C(p, r, s) = wD_t + (p - m)D_o + (p - w)D_t - \frac{1}{2}ls^2 + (m - r)D_o. \tag{3}$$

The optimal decision in the model C is as follows.

The optimal decision of the retail price in the model C $p^{C^*}$ is:

$$p^{C^*} = \frac{al\theta\lambda - al\theta - al\lambda}{n^2 + 2l\lambda^2 - 2l}. \tag{4}$$

The optimal decision of the rebate in the model C $r^{C^*}$ is:

$$r^{C^*} = -\frac{an^2 + 4al\theta + 2al\lambda - an^2\theta - 4al\theta\lambda - 2al}{2(n^2 + 2l\lambda^2 - 2l)}. \tag{5}$$

The optimal decision of the sales effort in the model C $s^{C^*}$ is:

$$s^{C^*} = \frac{n(a\theta\lambda - a\theta - a\lambda)}{n^2 + 2l\lambda^2 - 2l}. \tag{6}$$

The optimal decision for the market needs of the Internet platform channel in the model C $D_t^{C^*}$ is:

$$D_t^{C^*} = \frac{a\left(n^2(\theta-1)\lambda + 2l\theta\left(\lambda^2-1\right)\right)}{2(n^2+2l(\lambda^2-1))}. \tag{7}$$

The optimal decision for the market needs of traditional retail channel in the model C $D_o^{C^*}$ is:

$$D_o^{C^*} = \frac{1}{2}(a - a\theta). \tag{8}$$

The optimal decision for the overall profit of the DCSC in the model C $\pi^{C^*}$ is:

$$\pi^{C^*} = \frac{a^2\left(n^2(\theta-1)^2 + l\left(4\theta^2(\lambda-1) - 4\theta(\lambda-1) - 2\right)\right)}{4(n^2+2l(\lambda^2-1))}. \tag{9}$$

To ensure that all optimal equilibrium solutions are greater than 0, the retailer effort effect factor $n$, retailer effort cost factor $l$, and consumers' preference $\theta$ must be satisfied with $0 < n \leq \sqrt{\frac{3}{2}}$, $l > \frac{n^2}{2-2\lambda}$, $\frac{n^2+2l\lambda-2l}{n^2+4l\lambda-4l} < \theta < 1$, respectively.

## 4.2. Manufacturer-led model (ML)

In the manufacturer-led model, the timeline of manufacturer-led model is illustrated in Figure 2. Thus, the profit functions of the manufacturer $\pi_M^{\mathrm{ML}}$, retailer $\pi_R^{\mathrm{ML}}$, and platform $\pi_P^{\mathrm{ML}}$ are expressed as:

$$\pi_M^{\mathrm{ML}}(w,m) = wD_t + (p-m)D_o \tag{10}$$

$$\pi_R^{\mathrm{ML}}(p,s) = (p-w)D_t - \frac{1}{2}ls^2 \tag{11}$$

$$\pi_P^{\mathrm{ML}}(r) = (m-r)D_o. \tag{12}$$

According to the backward induction, the commission $m$ given by the manufacturer is already known to the platform. From $\frac{\partial^2\pi_P^{\mathrm{ML}}}{\partial r^2} = -2 < 0$, $\pi_P^{\mathrm{ML}}$ is a concave function with respect to $r$ and the existence of a maximum value for $\pi_P^{\mathrm{ML}}$ can be proved. Subsequently, taking the first order derivative of equation (12) with respect to $r$ and setting the derivation result equal to 0, the reaction function of $r$ can be obtained as:

$$r = \frac{1}{2}(m + p + a(\theta-1) - p\lambda). \tag{13}$$

By substituting equation (13) into equation (11), the manufacturer's wholesale price $w$ and platform commission $m$ are available and known to the retailer. Subsequently, the retailer makes decisions on $p$, $s$. From $\frac{\partial^2\pi_R^{\mathrm{ML}}}{\partial p^2} = \left(\lambda+\lambda^2-2\right) < 0$, $\frac{\partial^2\pi_R^{\mathrm{ML}}}{\partial s^2} = -l < 0$, $\frac{\partial^2\pi_R^{\mathrm{ML}}}{\partial s\partial p} = n > 0$, $\frac{\partial^2\pi_R^{\mathrm{ML}}}{\partial p^2} \times \frac{\partial^2\pi_R^{\mathrm{ML}}}{\partial s^2} - \left(\frac{\partial^2\pi_R^{\mathrm{ML}}}{\partial p\partial s}\right)^2 = -n^2 - l\left(\lambda+\lambda^2-2\right) > 0$, the $\pi_R^{\mathrm{ML}}$ is a strictly concave function with respect to $p$ and $s$ when $l > \frac{-n^2}{\lambda+\lambda^2-2}$. Meanwhile, $\pi_R^{\mathrm{ML}}$ has a maximum value. The first-order partial derivatives are calculated for $p$, $s$ and setting the derivative result equal to 0, the reaction function of $p$ and $s$ can be obtained:

$$p = -\frac{2lw + 2al\theta + al\lambda - 2n^2w - lm\lambda - lw\lambda - al\theta\lambda - lw\lambda^2}{2(n^2 + l\lambda + l\lambda^2 - 2l)} \tag{14}$$

$$s = -\frac{n\left(2a\theta + a\lambda + w\lambda - m\lambda - a\theta\lambda + w\lambda^2 - 2w\right)}{2(n^2 + l\lambda + l\lambda^2 - 2l)}. \tag{15}$$

Substituting equations (14) and (15) into equations (13) and (10), from

$$\frac{\partial^2 \pi_M^{\mathrm{ML}}}{\partial w^2} = \frac{8n^4(\lambda-1) + 2l^2(\lambda-1)(5+2\lambda)\left(\lambda+\lambda^2-2\right)^2 + 4ln^2(\lambda-1)^2\left(8+6\lambda+\lambda^2\right)}{8(n^2 + l(\lambda+\lambda^2-2))^2} < 0,$$

$$\frac{\partial^2 \pi_M^{\mathrm{ML}}}{\partial m^2} = \frac{2l^2(\lambda-1)\left(16+8\lambda-11\lambda^2-6\lambda^3\right) - 8n^4 - 4ln^2\left(2\lambda+5\lambda^2-8\right)}{8(n^2 + l(\lambda+\lambda^2-2))^2} < 0,$$

$$\frac{\partial^2 \pi_M^{\mathrm{ML}}}{\partial w^2} \times \frac{\partial^2 \pi_M^{\mathrm{ML}}}{\partial m^2} - \left(\frac{\partial^2 \pi_M^{\mathrm{ML}}}{\partial w \partial m}\right)^2 = \frac{\begin{array}{c} n^4\lambda^2 + 4ln^2(\lambda-1)^2\left(2+3\lambda+\lambda^2\right) \\ +2l^2(\lambda-1)^2\left(3\lambda^2+7\lambda^3+2\lambda^4-8-10\lambda\right) \end{array}}{-4(n^2 + l(\lambda+\lambda^2-2))^2} > 0,$$

the $\pi_M^{\mathrm{ML}}$ is a strictly concave function on $w$, $m$, so, $\pi_M^{\mathrm{ML}}$ has a maximum value.

Therefore, taking the first order derivatives of equation (10) with respect to $w$, $m$ respectively and setting the derivative result equal to 0.

Then, the optimal equilibrium solution for the wholesale price in the model ML $w^{\mathrm{ML}^*}$ can be obtained as:

$$w^{\mathrm{ML}^*} = \frac{a\begin{pmatrix} 2n^4(\theta-1)\lambda + 2l^2(\theta(\lambda-1)-\lambda)(\lambda-1)(2+\lambda)\left(2\lambda^2+\lambda-4\right) \\ +ln^2(\lambda(12-5\lambda(1+\lambda)) + \theta(\lambda-1)(\lambda(8+5\lambda)-8)) \end{pmatrix}}{2n^4\lambda^2 + 8ln^2(\lambda-1)^2(1+\lambda)(2+\lambda) + 4l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(2\lambda^2+\lambda-4)}. \tag{16}$$

The optimal equilibrium solution for the commission in the model ML $m^{\mathrm{ML}^*}$ can be obtained as:

$$m^{\mathrm{ML}^*} = \frac{a\begin{pmatrix} 2n^4(\theta-1)\lambda + ln^2\left(\lambda+\lambda^2-2\right)(4-\lambda(5+\lambda)+\theta(\lambda-1)(8+\lambda)) \\ +2l^2(\lambda-1)^2(2+\lambda)\left(4-\lambda(2+3\lambda)+\theta\left(\lambda+5\lambda^2-10\right)\right) \end{pmatrix}}{2n^4\lambda^2 + 8ln^2(\lambda-1)^2(1+\lambda)(2+\lambda) + 4l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)}. \tag{17}$$

Substituting $w^{\mathrm{ML}^*}$ and $m^{\mathrm{ML}^*}$ into equations (13)–(15), the optimal equilibrium solutions for the platform rebate $r$, retail price $p$, and effort level $s$ are obtained as follows.

The optimal equilibrium solution for platform rebate in the Model ML $r^{\mathrm{ML}^*}$ is:

$$r^{\mathrm{ML}^*} = \frac{a\begin{pmatrix} 2n^4(\theta-1)\lambda + ln^2\left(\lambda+\lambda^2-2\right)\left(6-5\lambda-2\lambda^2+2\theta\left(4\lambda+\lambda^2-5\right)\right) \\ +l^2(\lambda-1)^2(2+\lambda)\left(12+\theta\left(\lambda+14\lambda^2+\lambda^3-24\right)-\lambda-8\lambda^2-\lambda^3\right) \end{pmatrix}}{2n^4\lambda^2 + 8ln^2(\lambda-1)^2(2+3\lambda+\lambda^2) + 4l^2(\lambda-1)^2(3\lambda^2+7\lambda^3+2\lambda^4-8-10\lambda)}. \tag{18}$$

The optimal equilibrium solution for retail price in the Model ML $p^{\mathrm{ML}^*}$ is:

$$p^{\mathrm{ML}^*} = \frac{a\begin{pmatrix} 2n^4(\theta-1)\lambda + ln^2\left(\lambda+\lambda^2-2\right)(\theta(5\lambda-4)-5\lambda) \\ +2l^2\left(\lambda+\lambda^2-2\right)\left(-\lambda\left(\lambda+3\lambda^2-5\right)+3\theta\left(2-2\lambda-\lambda^2+\lambda^3\right)\right) \end{pmatrix}}{2n^4\lambda^2 + 8ln^2(\lambda-1)^2(2+3\lambda+\lambda^2) + 4l^2(\lambda-1)^2(3\lambda^2+7\lambda^3+2\lambda^4-8-10\lambda)}. \tag{19}$$

The optimal equilibrium solution for effort level in the Model ML $s^{\mathrm{ML}^*}$ is:

$$s^{\mathrm{ML}^*} = \frac{-an^3(1+\theta(\lambda-1))\lambda + aln(\theta(\lambda-2)-\lambda)(\lambda-1)^2\left(2+3\lambda+\lambda^2\right)}{n^4\lambda^2 + 4ln^2(\lambda-1)^2(2+3\lambda+\lambda^2) + 2l^2(\lambda-1)^2(3\lambda^2+7\lambda^3+2\lambda^4-8-10\lambda)}. \tag{20}$$

Substituting equations (18)–(20) into equations (1) and (2), $D_t^{\mathrm{ML}^*}$ and $D_o^{\mathrm{ML}^*}$ can be obtained as follows.

The optimal equilibrium solution for the market needs of the Internet platform channel in the model ML $D_t^{\mathrm{ML}^*}$ is:

$$D_t^{\mathrm{ML}^*} = -\frac{al\left(\lambda+\lambda^2-2\right)\left(n^2\lambda(\theta-\theta\lambda-1)+l(\theta(\lambda-2)-\lambda)(\lambda-1)^2\left(2+3\lambda+\lambda^2\right)\right)}{2n^4\lambda^2+8ln^2(\lambda-1)^2(2+3\lambda+\lambda^2)+4l^2(\lambda-1)^2(3\lambda^2+7\lambda^3+2\lambda^4-8-10\lambda)}. \tag{21}$$

The optimal equilibrium solution for the market needs of traditional retail channel in the model ML $D_o^{\mathrm{ML}^*}$ is:

$$D_o^{\mathrm{ML}^*} = -\frac{al\left(\lambda+\lambda^2-2\right)\begin{pmatrix} n^2\left(2-\lambda^2+\theta\left(\lambda+\lambda^2-2\right)\right) \\ +l\left(\lambda^2-1\right)\left(4-\lambda-\lambda^2+\theta\left(3\lambda+\lambda^2-4\right)\right)\end{pmatrix}}{2n^4\lambda^2+8ln^2(\lambda-1)^2(2+3\lambda+\lambda^2)+4l^2(\lambda-1)^2(3\lambda^2+7\lambda^3+2\lambda^4-8-10\lambda)}. \tag{22}$$

Therefore, the optimal profit of manufacturers $\pi_M^{\mathrm{ML}^*}$, retailers $\pi_R^{\mathrm{ML}^*}$, and platforms $\pi_P^{\mathrm{ML}^*}$ are:

$$\pi_M^{\mathrm{ML}^*} = \frac{-a^2l\left(\lambda+\lambda^2-2\right)\begin{pmatrix} -2n^2(\theta-1)(1+\theta(\lambda-1)) \\ +l\begin{pmatrix} \lambda-\lambda^2+\lambda^3+\lambda^4-4 \\ +\theta^2(\lambda-1)^2\left(\lambda^2-\lambda-8\right) \\ -2\theta\left(7\lambda-3\lambda^2-\lambda^3+\lambda^4-4\right)\end{pmatrix}\end{pmatrix}}{4\begin{pmatrix} n^4\lambda^2+4ln^2(\lambda-1)^2\left(2+3\lambda+\lambda^2\right) \\ +2l^2(\lambda-1)^2\left(3\lambda^2+7\lambda^3+2\lambda^4-8-10\lambda\right)\end{pmatrix}} \tag{23}$$

$$\pi_R^{\mathrm{ML}^*} = -\frac{a^2l\left(n^2+l\left(\lambda+\lambda^2-2\right)\right)\begin{pmatrix} n^2\lambda(\theta-\theta\lambda-1) \\ +l(\theta(\lambda-2)-\lambda)(\lambda-1)^2\left(2+3\lambda+\lambda^2\right)\end{pmatrix}^2}{2\begin{pmatrix} n^4\lambda^2+4ln^2(\lambda-1)^2\left(2+3\lambda+\lambda^2\right) \\ +2l^2(\lambda-1)^2\left(3\lambda^2+7\lambda^3+2\lambda^4-8-10\lambda\right)\end{pmatrix}^2} \tag{24}$$

$$\pi_P^{\mathrm{ML}^*} = \frac{a^2l^2\left(\lambda+\lambda^2-2\right)^2\begin{pmatrix} n^2\left(2-\lambda^2+\theta\left(\lambda+\lambda^2-2\right)\right) \\ +l\left(\lambda^2-1\right)\left(4-\lambda-\lambda^2+\theta\left(3\lambda+\lambda^2-4\right)\right)\end{pmatrix}^2}{4\begin{pmatrix} n^4\lambda^2+4ln^2(\lambda-1)^2\left(2+3\lambda+\lambda^2\right) \\ +2l^2(\lambda-1)^2\left(3\lambda^2+7\lambda^3+2\lambda^4-8-10\lambda\right)\end{pmatrix}^2}. \tag{25}$$

**Proposition 1.** $\frac{\partial w^{\mathrm{ML}^*}}{\partial\theta}>0,\ \frac{\partial m^{\mathrm{ML}^*}}{\partial\theta}>0,\ \frac{\partial r^{\mathrm{ML}^*}}{\partial\theta}>0,\ \frac{\partial p^{\mathrm{ML}^*}}{\partial\theta}>0,\ \frac{\partial s^{\mathrm{ML}^*}}{\partial\theta}>0.$

Proposition 1 posits that in the ML, an uptick in consumer channel preference for traditional retail channel corresponds to an elevation in wholesale price, commissions, platform rebates, retail price, and retailer effort levels. During DCSC competition, as consumer channel preference for traditional retail channel increases, the manufacturer needs to offer higher commissions to keep platform channel competitive, so the platform would increase rebates to retain consumers. At the same time, the manufacturer would also increase the wholesale price of products to mitigate the increase in commission costs. Elevated wholesale price and augmented rebates from the platform would result in heightened purchasing costs and intensified sales pressure for retailers. Retailer would seize the opportunity to raise retail price and enhance sales efforts, aiming to improve profit margins. The proof of this proposition can be found in Appendix A. A specific case involving Nike and Tmall illustrates the observed market trend. Consumer channel preference shifted toward traditional retail outlets after the pandemic. Nike increased wholesale price to offset rising commission fees. The Tmall platform charged commission fees. Tmall maintained competitive pricing by raising rebates[4]. Retailers faced higher costs in this scenario and subsequently increased retail price. Retailers intensified promotional efforts to attract consumers. Various strategies, including discount offers, were implemented. Free shipping services were offered as additional incentives. The example highlights the chain reaction of increased costs and efforts across the supply chain as consumer channel preference shift toward traditional retail channels.

[4]http://www.nikeinc.com.cn/html/page-3768.html (Accessed date September 23 2025).

**Proposition 2.** $\frac{\partial D_t^{\mathrm{ML}^*}}{\partial \theta} > 0, \frac{\partial D_o^{\mathrm{ML}^*}}{\partial \theta} < 0.$

Proposition 2 posits that within the realm of ML, an upswing in consumer channel preference for traditional retail channel results in an increase in demand for traditional retail channel, accompanied by a decrease in demand for direct online sales channel. The proof of this proposition can be found in Appendix A. Apple exemplifies this trend. An increase in foot traffic was observed in Apple retail stores. Consumer channel preference shifted back to physical shopping after the pandemic. Apple enhanced in-store experiences in response. Online sales through direct channels declined[5].

**Proposition 3.** *In the ML, according to* $\frac{\partial \Delta p^{\mathrm{ML}^*}}{\partial \theta} > 0$*, the more consumers prefer traditional retail channel, the more expensive the price consumers would pay for a product in the direct online channel.*

Proposition 3 posits that in the ML, with the increasing preference of consumers for traditional retail channel, the platform has raised rebates to sustain the competitiveness of the online channel. Additionally, the platform has increased selling prices to compensate for the rising costs. Due to the manufacturer's consistent pricing strategies, the retailer leverages consumer channel preference to raise prices. Higher prices also lead to greater increases in retail price than rebates, trapping some consumers in the "high rebate" price dilemma. The proof of this proposition can be found in Appendix A. Samsung's promotional campaign with JD.com exemplifies this trend. The Galaxy S24 series smartphones were launched in January 2024[6]. JD.com offered multiple incentives to compete with traditional retail. An upgrade to JD Plus membership for 1 yuan was included. Time-limited discounts were offered. Installment payment options were available. High rebates were introduced despite these measures. Prices were increased by Samsung and JD.com. Rising costs were offset by these price increases. Increased demand for offline shopping contributed significantly to these cost pressures.

**Proposition 4.** *From* $\frac{\pi_M^{\mathrm{ML}^*}}{\partial \theta} > 0$, $\frac{\pi_R^{\mathrm{ML}}}{\partial \theta} > 0$, $\pi_M^{\mathrm{ML}^*}$ *and* $\pi_R^{\mathrm{ML}^*}$ *are positively correlated to* $\theta$*. From* $\frac{\pi_P^{\mathrm{ML}^*}}{\partial \theta} < 0$, $\pi_P^{\mathrm{ML}^*}$ *is negatively correlated with* $\theta$*.*

Proposition 4 posits that in the ML, an escalation in consumer channel preference for traditional retail channel results in augmented profits for traditional the retailer and the manufacturer. Concurrently, platform profits experience a decline. The augmented profits for both traditional retailer and manufacturer stem from the elevation of retail price and the intensified sales efforts by retailer in a competitive model. The rise in retail price diminishes the inclination to purchase from the online channel, leading to a reduction in the demand for the online channel and subsequently diminishing platform profits. The proof of this proposition can be found in Appendix A. Three Squirrels is a leading snack brand in China. The firm shifted its focus to offline stores[7]. Rising online traffic costs prompted the strategic shift. Revenue from traditional retail channel increased. Higher operational costs were incurred in physical stores. These costs reduced overall profit margins. At the same time, online sales declined. Consequently, e-commerce platforms saw lower profits.

### 4.3. Retailer-led model (RL)

In the retailer-led Stackelberg game model, the timeline of retailed-led model is illustrated in Figure 3. The retail price $p$ in RL is expressed as:

$$p = w + \Delta w. \tag{26}$$

The profit functions of the manufacturer $\pi_M^{\mathrm{RL}}$, retailer $\pi_R^{\mathrm{RL}}$, and platform $\pi_P^{\mathrm{RL}}$ are expressed as:

$$\pi_M^{\mathrm{RL}}(w, m) = wD_t + (w + \Delta w - m)D_o \tag{27}$$

$$\pi_R^{\mathrm{RL}}(w + \Delta w, s) = (w + \Delta w - w)D_t - \frac{1}{2}ls^2 \tag{28}$$

[5] https://news.qq.com/rain/a/20210625A01TCR00 (Accessed date 23 September 2025).
[6] https://tech.chinadaily.com.cn/a/202401/26/WS65b35690a310af3247ffd7ac.html (Accessed date 23 September 2025).
[7] https://www.jiemian.com/article/3532213.html (Accessed date 23 September 2025).

$$\pi_P^{\mathrm{RL}}(r) = (m - r)D_o. \tag{29}$$

According to the backward induction solution, the commission $m$ given by the manufacturer is already known by the platform. From $\frac{\partial^2 \pi_P^{\mathrm{RL}}}{\partial r^2} = -2 < 0$, $\pi_P^{\mathrm{RL}}$ is a concave function with respect to $r$, and the maximum value of $\pi_p^{\mathrm{RL}}$ exists. Subsequently, taking the first order derivative of equation (29) with respect to $r$ and setting the derivation result equation equal to 0, the reaction function of $r$ can be obtained as:

$$r = \frac{1}{2}(m + w + \Delta w + a(\theta - 1) - (w + \Delta w)\lambda). \tag{30}$$

Substituting equation (30) into equation (27), the retailer's retail markup and effort level $s$ are available and known to the manufacturer. Subsequently, the manufacturer makes decisions on wholesale price $w$ and commission $m$. From $\frac{\partial^2 \pi_M^{\mathrm{RL}}}{\partial w^2} = \left(2\lambda + \lambda^2 - 3\right) < 0$, $\frac{\partial^2 \pi_M^{\mathrm{RL}}}{\partial m^2} = -1 < 0$, $\frac{\partial^2 \pi_M^{\mathrm{RL}}}{\partial w \partial m} = (1 - \lambda) > 0$, $\frac{\partial^2 \pi_M^{\mathrm{RL}}}{\partial w^2} \times \frac{\partial^2 \pi_M^{\mathrm{RL}}}{\partial m^2} - \left(\frac{\partial^2 \pi_M^{\mathrm{RL}}}{\partial w \partial m}\right)^2 = 2 - 2\lambda^2 > 0$, the $\pi_M^{\mathrm{RL}}$ is a strictly concave function with respect to $w$ and $m$. Meanwhile, $\pi_M^{\mathrm{RL}}$ has a maximum value. The first-order partial derivatives are calculated for $w$, $m$, and setting the derivative result equal to 0, the reaction function of $w$ and $m$ can be obtained:

$$w = \frac{ns + a(\theta + \lambda - \theta\lambda) + \Delta w\left(\lambda^2 - 1\right)}{2 - 2\lambda^2} \tag{31}$$

$$m = \frac{ns + \Delta w + a(2\theta - 1) + \Delta w\lambda}{2(1 + \lambda)}. \tag{32}$$

Substituting equations (31) and (32) into equation (28), from $\frac{\partial^2 \pi_M^{\mathrm{RL}}}{\partial \Delta w^2} = \frac{1}{2}\left(\lambda^2 - 2\right) < 0$, $\frac{\partial^2 \pi_R^{\mathrm{RL}}}{\partial s^2} = -1 < 0$, $\frac{\partial^2 \pi_R^{\mathrm{RL}}}{\partial \Delta w \partial s} = \frac{1}{4}\left(4l - n^2 - 2l\lambda^2\right) > 0$, $\frac{\partial^2 \pi_R^{\mathrm{RL}}}{\partial \Delta w^2} \times \frac{\partial^2 \pi_R^{\mathrm{RL}}}{\partial s^2} - \left(\frac{\partial^2 \pi_R^{\mathrm{RL}}}{\partial \Delta w \partial s}\right)^2 = \frac{1}{4}\left(4l - n^2 - 2l\lambda^2\right) > 0$, the $\pi_R^{\mathrm{RL}}$ is a strictly concave function with respect to $\Delta w$ and $s$, and $\pi_R^{\mathrm{RL}}$ has a maximum value.

Therefore, taking the first order derivatives of equation (28) with respect to $\Delta w$, $s$ respectively and setting the derivative result equal to 0, the optimal equilibrium solutions for the retail markup $\Delta w$ and sales effort per unit of product $s$ can be obtained as:

The optimal equilibrium solution for the retail markup in the model RL $\Delta w^{\mathrm{RL}^*}$ can be obtained as:

$$\Delta w^{\mathrm{RL}^*} = \frac{al(\theta(\lambda - 2) - \lambda)}{n^2 + 2l(\lambda^2 - 2)}. \tag{33}$$

The optimal equilibrium solution for the sales effort per unit of product in the model RL $s^{\mathrm{RL}^*}$ is:

$$s^{\mathrm{RL}^*} = \frac{an(\theta(\lambda - 2) - \lambda)}{2(n^2 + 2l(\lambda^2 - 2))}. \tag{34}$$

Take equations (33) and (34) into retailer-led model, the wholesale price $w$ and platform rebate $r$ are obtained as follows.

Then, the optimal equilibrium solution for the wholesale price in the model RL $w^{\mathrm{RL}^*}$ can be obtained as:

$$w^{\mathrm{RL}^*} = \frac{a\left(4l\theta + \left(n^2 - 6l\right)(\theta - 1)\lambda + 2l(\theta - 1)\lambda^3\right)}{4(\lambda^2 - 1)(n^2 + 2l(\lambda^2 - 2))}. \tag{35}$$

The optimal equilibrium solution for platform rebates in the model RL $r^{\mathrm{RL}^*}$ is:

$$r^{\mathrm{RL}^*} = \frac{a\left(n^2(\theta - 1)(3 + 2\lambda) + l(12 - \lambda(-2 + \lambda(7 + \lambda)) + \theta(\lambda(-4 + \lambda(13 + \lambda)) - 24))\right)}{4(1 + \lambda)(n^2 + 2l(\lambda^2 - 2))}. \tag{36}$$

The optimal equilibrium solution for retail price in the model RL $p^{\mathrm{RL}^*}$ is:

$$p^{\mathrm{RL}^*} = \frac{a\big(n^2(\theta-1)\lambda + 2l\big(5\lambda - 3\lambda^3 + \theta\big(6 - 5\lambda - 4\lambda^2 + 3\lambda^3\big)\big)\big)}{4(\lambda^2-1)(n^2+2l(\lambda^2-2))}. \tag{37}$$

The optimal equilibrium solution for the commission in the model RL $m^{\mathrm{ML}^*}$ can be obtained as:

$$m^{\mathrm{RL}^*} = \frac{a\big(n^2(\theta-1)(2+\lambda) + 2l\big(4 - 10\theta - (1+\theta)\lambda + (5\theta-3)\lambda^2\big)\big)}{4(1+\lambda)(n^2+2l(\lambda^2-2))} \tag{38}$$

Further taking equations (34), (37), and (38) into equations (1) and (2) respectively, $D_t^{\mathrm{RL}^*}$ and $D_o^{\mathrm{RL}^*}$ can be obtained as follows.

The optimal equilibrium solution for the market needs of the Internet platform channel in the model RL $D_t^{\mathrm{RL}^*}$ is:

$$D_t^{\mathrm{RL}^*} = -\frac{al(\theta(\lambda-2)-\lambda)\big(\lambda^2-2\big)}{4(n^2+2l(\lambda^2-2))}. \tag{39}$$

The optimal equilibrium solution for the market needs of traditional retail channel in the model RL $D_o^{\mathrm{RL}^*}$ is:

$$D_o^{\mathrm{RL}^*} = \frac{a\big(l\big(4\theta + \lambda^2 - \theta\lambda(2+\lambda) - 4\big) - n^2(\theta-1)\big)}{4(n^2+2l(\lambda^2-2))}. \tag{40}$$

Therefore, the optimal profit of manufacturer profit $\pi_M^{\mathrm{RL}^*}$, retailer profit $\pi_R^{\mathrm{RL}^*}$ and platforms $\pi_P^{\mathrm{RL}^*}$ are:

$$\pi_M^{\mathrm{RL}^*} = \frac{-\Big(a^2\big(\lambda^2-2\big)\Big(C - n^4(\theta-1)^2 - 8ln^2(\theta-1)(1+\theta(\lambda-1))\Big)\Big)}{\Big(16(\lambda^2-1)(n^2+2l(\lambda^2-2))^2\Big)} \tag{41}$$

$$\pi_R^{\mathrm{RL}^*} = -\frac{a^2 l(\lambda - \theta(\lambda-2))^2}{8(n^2+2l(\lambda^2-2))} \tag{42}$$

$$\pi_P^{\mathrm{RL}^*} = \frac{a^2\big(\big(n^2-4l\big)(\theta-1) + 2l\theta\lambda + l(\theta-1)\lambda^2\big)^2}{16(n^2+2l(\lambda^2-2))^2}. \tag{43}$$

**Proposition 5.** $\frac{\partial s^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial w^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial m^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial r^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial p^{\mathrm{RL}^*}}{\partial\theta} > 0$.

Proposition 5 suggests that in the RL, an augmentation in consumer channel preference for traditional retail channel results in an increase across wholesale price, platform commissions, platform rebates, retail price, and retailer effort levels. The reason for the increase is that the retailer exploits the preference to raise retail price, simultaneously, the retailer employs sales efforts, such as experiential services, to retain customers. In contrast, the manufacturer takes measures to raise wholesale price in response to the growing consumer channel preference for traditional retail channel, aiming to capture additional profit. Additionally, The Manufacturer would offer additional commissions to aid the platform in increasing rebates and retaining online consumers. The proof of this proposition can be found in Appendix A. Nike's strategic shift is a relevant example. Wholesale relationships were reestablished with retail partners, including Designer Shoe Warehouse (DSW)[8]. Consumer channel preference for traditional retail channels increased. Consequently, wholesale price for Nike products were raised. These products were sold in traditional retail outlets. Retail price adjustments were made by DSW and other retailers. Enhanced focus was placed on customer experience in physical stores. A wider range of Nike products was available in stores. Nike provided increased rebates as incentives. These rebates supported competition with online channels. These measures strengthened the manufacturer–retailer relationship.

[8] https://www.sohu.com/a/683638701_121123884 (Accessed date 23 September 2025).

**Proposition 6.** $\frac{\partial D_t^{\mathrm{RL}^*}}{\partial \theta} > 0, \frac{\partial D_o^{\mathrm{RL}^*}}{\partial \theta} < 0.$

Proposition 6 demonstrates that in the model RL, an upswing in consumer channel preference for traditional retail channel leads to an increase in demand for both traditional retail channel and direct online channel. Walmart's omnichannel strategy provides a relevant example. Brick-and-mortar stores were integrated with the e-commerce platform[9]. Consumer channel preference for traditional retail stores increased significantly. Walmart enhanced the in-store shopping experience. Simultaneous improvements were implemented on the online platform. Substantial growth in online sales was observed. Consumers utilized services such as online ordering. In-store pickup options were frequently chosen. Home delivery services were widely used. Traditional and online retail channels were effectively integrated. Demand growth occurred across both platforms. These outcomes align with the dynamics suggested by Proposition 7.

**Proposition 7.** *The actual purchase price of the direct online channel tends to increase and then decrease as consumer channel preference for traditional retail channels increases, subject to a range of retailer effort cost factors.*

Proposition 7 suggests that in the RL, when the retailer effort cost factor falls within a lower threshold, the retailer sets higher levels of sales efforts to stimulate demand in traditional channel, and the increased cost of these efforts leads to a rise in retail price. Consequently, the platform is compelled to raise rebates to retain consumers, but the increment in rebates is insufficient to offset the increase in retail price. Therefore, online channel products become more expensive. In cases where the threshold for the cost factor of retail efforts is high, retailers opt for a modest increase in sales efforts and retail price, the surge in rebates surpasses the increment in retail price, leading to a reduction in the consumer's purchase price for the product. The proof of this proposition can be found in Appendix A. Best Buy's pricing strategies provide a relevant example. Consumer channel preference for physical stores increased significantly. Best Buy increased in-store promotions. Various measures enhanced the customer experience. As a result, retail price increased. Rebate adjustments maintained competitive online positioning. The firm increased rebates for online purchases. However, these rebates did not fully offset the higher retail price. This imbalance initially led to higher online prices. Operational improvements later optimized in-store costs. Best Buy shifted its focus to e-commerce. Online prices were subsequently lowered. Eventually, rebate increases surpassed previous price hikes[10].

**Proposition 8.** *From* $\frac{\pi_R^{\mathrm{RL}^*}}{\partial \theta} > 0$, $\pi_R^{\mathrm{RL}^*}$ *is positively correlated with* $\theta$. $\pi_M^{\mathrm{RL}^*}$ *and* $\pi_P^{\mathrm{RL}^*}$ *both show a trend of decreasing and then increasing with* $\theta$.

Proposition 8 suggests that in the RL, when consumer channel preference for traditional channels increases, traditional retailer profits experience an upswing, manufacturer profits and platform profits exhibit a tendency to first decrease and then increase. At the onset of the platform rebate period, the initial small size of the platform rebate fails to attract consumers. Due to consumer channel preference, demand for direct online sales channels remains modest, resulting in decreased profits for manufacturers and platforms. However, as retailer retail price rise and a certain level of effort is exerted, retail price in the direct online channel increase under a consistent pricing strategy. Commissions from manufacturers to platforms increase and the platform offers additional rebates, resulting in lower prices for online products, compensating for the loss of demand in the direct online channel, ultimately, the profits of both the manufacturer and the platform are increasing. Consequently, when consumer traditional channel preference increases, the Model RL enables an increase in profitability between manufacturer, retailer and platform, thus mitigating channel conflict. The proof of this proposition can be found in Appendix A. Target's strategic evolution offers a relevant case. Historically, heavy reliance was placed on physical stores. Target emphasized in-store promotions. Significant focus was placed on customer experience[11]. Consumer channel preference gradually shifted to online channels. Target introduced

[9] https://www.hishop.com.cn/xls/show_51055.html (Accessed date 23 September 2025).
[10] https://blog.contactpigeon.com/best-buy-marketing-strategies/ (Accessed date 23 September 2025).
[11] https://www.163.com/dy/article/JKO68LE10519FEEC.html (Accessed date 23 September 2025).

online rebates and discounts. Initial incentive amounts were insufficient. The impact on consumer behavior was not significant. These efforts led to modest growth in online sales. Website improvements were made over time. Rebate amounts were significantly increased. E-commerce operations received greater emphasis. These measures effectively lowered online prices. Consequently, demand across channels was boosted. Profitability increased in both physical and online operations.

## 5. Contractual coordination

In the decentralized decision model, the principle of self-interest maximization by the supply chain members can cause channel conflicts that reduce the profitability of the whole supply chain. To improve overall profitability, reducing conflicts between supply chain members' goals and collective goals is essential.

From the model ML perspective, coordination is primarily achieved through product sales and wholesale pricing decisions. The manufacturer exerts control by setting the wholesale price, thereby directly influencing the retailer's order quantity. A two-part pricing contract, composed of a fixed lump-sum fee and a per-unit wholesale price, is considered effective as surplus redistribution is facilitated and the retailer's ordering incentives are aligned through the adjustment of both the fixed payment and the marginal wholesale price. The mechanism is effective when the upstream firm retains control over wholesale pricing and coordination requires direct adjustment of marginal incentives [42,63]. An illustrative case is observed in the electronic book market, where coordination with publishers was established through an agency model adopted by Apple. Under the arrangement, publishers accepted revenue-sharing terms combining a fixed commission and variable revenue components, while also complying with pricing restrictions imposed by Apple[12]. The integration of fixed commitments and variable charges illustrates the rationale of two-part pricing in realizing channel coordination effectively.

By contrast, in the model RL, the emphasis shifts to product attributes and sales efforts undertaken by the retailer. In such settings, demand is typically effort-sensitive, shaped by promotional investments, green marketing initiatives, and other market-facing activities. The imposition of lump-sum fees is relatively constrained, whereas cost-sharing contracts are regarded as more effective. Under cost-sharing, a portion of the retailer's expenditures is subsidized by the manufacturer, thereby reducing the effective cost of exerting effort and reinforcing incentives to invest in demand-enhancing activities [49,66]. An example is provided by the 2024 commercial dispute between Carrefour and PepsiCo, which highlighted the influence of expanding retail-media and advertising operations on negotiations with suppliers[13]. In the case, advertising expenditures and access to retailer-controlled channels functioned as central bargaining instruments, illustrating that negotiated contributions to promotional and advertising programs serve as cost-sharing mechanisms aligning the incentives of retailers and suppliers.

The choice between contractual forms under the model ML and model RL is shaped by both structural and behavioral factors. First, the allocation of decision rights and bargaining power determines which party can set contractual terms. In the model ML, two-part pricing is effective because it directly coordinates order quantities while enabling surplus redistribution. In the model RL, cost-sharing is more suitable, as it enhances effort incentives in contexts where demand depends on the retailer's activities [21]. Second, the strategic variable that requires coordination differs, involving quantity incentives in the model ML and effort incentives in the model RL. Finally, although this study adopts two-part pricing for the model ML and cost-sharing for the model RL to preserve analytical clarity, prior research has demonstrated that hybrid or alternative contracts may outperform under certain conditions. For instance, Zhong *et al.* (2022) [68] emphasized the importance of robust contract design under uncertainty, whereas Samanta *et al.* (2023) [45] reported that hybrid mechanisms combining revenue sharing and greening cost-sharing can enhance effort incentives and improve surplus allocation simultaneously.

[12] https://www.rieti.go.jp/en/special/p_a_w/035.html (Accessed date 26 September 2025).

[13] https://www.reuters.com/business/retail-consumer/carrefour-pepsico-dispute-sheds-light-key-role-retailers-ad-business-2024-04-04(Accessed date 26 September 2025).

In summary, the analysis indicates that two-part pricing contract is more appropriate under the manufacturer-led model, whereas cost-sharing contract is more effective under the model RL. The model-based distinction clarifies the rationale for adopting different contractual forms in the model ML and model RL establishes a foundation for future research extensions.

### 5.1. Manufacturer-led coordination of two-part pricing contract

In the ML model, the paper employs a two-part pricing contract to facilitate coordination within a two-channel supply chain under the platform rebate model. Initially, the manufacturer establishes a wholesale price for the product denoted as $w$. Subsequently, the retailer issues a one-time transfer payment to the upstream manufacturer, denoted as $F(F>0)$. Consequently, the profit functions for the manufacturer $\pi_M^{\mathrm{co}}$, retailer $\pi_R^{\mathrm{co}}$, and platform $\pi_P^{\mathrm{co}}$ are:

$$\pi_M^{\mathrm{co}}(w,m) = wD_t + (p-m)D_o + F \tag{44}$$

$$\pi_R^{\mathrm{co}}(p,s) = (p-w)D_t - \frac{1}{2}ls^2 - F \tag{45}$$

$$\pi_P^{\mathrm{co}}(r) = (m-r)D_o. \tag{46}$$

According to the backward induction, from $\frac{\partial^2 \pi_P^{\mathrm{co}}}{\partial r^2} = -2 < 0$, $\pi_P^{\mathrm{co}}$ is a concave function with respect to $r$, meanwhile $\pi_P^{\mathrm{co}}$ has a maximum value. Subsequently, the first-order partial derivatives are calculated for $r$ and setting the derivative result equal to 0, the reaction function of $r^{\mathrm{co}}$ can be obtained:

$$r^{\mathrm{co}} = \frac{1}{2}(m + p + a(\theta-1) - p\lambda). \tag{47}$$

Taking equation (47) into equation (44), the manufacturer's wholesale price $w$ and commission $m$ are available and known to the retailer, so that the retailer makes decisions on $p$ and $s$. From $\frac{\partial^2 \pi_R^{\mathrm{co}}}{\partial p^2} = \frac{1}{2}\left(2\lambda + 2\lambda^2 - 4\right) < 0$, $\frac{\partial^2 \pi_R^{\mathrm{co}}}{\partial s^2} = -1 < 0$, $\frac{\partial^2 \pi_R^{\mathrm{co}}}{\partial s \partial p} = n > 0$, $\frac{\partial^2 \pi_R^{\mathrm{co}}}{\partial p^2} \times \frac{\partial^2 \pi_R^{\mathrm{co}}}{\partial s^2} - \left(\frac{\partial^2 \pi_R^{\mathrm{co}}}{\partial p \partial s}\right)^2 = -n^2 - \frac{1}{2}l\left(2\lambda + 2\lambda^2 - 4\right) > 0$, $\pi_R^{\mathrm{co}}$ is a strictly concave function with respect to $p$ and $s$ when $l > -\frac{n^2}{\lambda+\lambda^2-2}$. Meanwhile, $\pi_R^{\mathrm{co}}$ has a maximum value. Taking the first order derivatives of equation (45) with respect to $p$, $s$ respectively and setting the derivative result equal to 0, the reaction functions of $p^{\mathrm{co}}$ and $s^{\mathrm{co}}$ can be obtained as::

$$p^{\mathrm{co}} = \frac{2n^2 w + l\left((m + a(\theta-1))\lambda + w\left(\lambda + \lambda^2 - 2\right) - 2a\theta\right)}{2(n^2 + l(\lambda + \lambda^2 - 2))} \tag{51}$$

$$s^{\mathrm{co}} = -\frac{n\left(2a\theta - (m + a(\theta-1))\lambda + w\left(\lambda + \lambda^2 - 2\right)\right)}{2(n^2 + l(\lambda + \lambda^2 - 2))}. \tag{52}$$

The retailer's willingness to make a lump sum transfer payment is contingent upon the condition that the retailer's profit, following participation in the coordination of the two-pricing contract, surpasses the profit prior to coordination, denoted as $\pi_R^{\mathrm{co}} \geq \pi_R^{\mathrm{ML}^*}$. Consequently, based on the conditions for the involvement of both parties in contractual coordination, $F$ is derived:

$$F = \frac{a^2 l\left(l(\theta(\lambda-2) - \lambda)(\lambda-1)^2(1+\lambda)(2+\lambda) + n^2\lambda(\theta - \theta\lambda - 1)\right)^2\left(n^2 + l\left(\lambda + \lambda^2 - 2\right)\right)}{2\left(n^4\lambda^2 + 4ln^2(\lambda-1)^2(1+\lambda)(2+\lambda) + 2l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda + 2\lambda^2 - 4)\right)^2} - \frac{l\left(2a\theta - (m + a(\theta-1))\lambda + w\left(\lambda + \lambda^2 - 2\right)\right)^2}{8(n^2 + l(\lambda + \lambda^2 - 2))}. \tag{53}$$

Take equations (47), (51), (52), and (53) into $\pi_m^{co}$, from

$$\frac{\partial^2\pi_M^{co}}{\partial w^2}=\frac{(\lambda-1)\Big(4n^4+ln^2(\lambda-1)(2+\lambda)(6+\lambda)+l^2(3+\lambda)\big(\lambda+\lambda^2-2\big)^2\Big)}{4\big(n^2+l(\lambda+\lambda^2-2)\big)^2}<0,$$
$$\frac{\partial^2\pi_M^{co}}{\partial m^2}=\frac{ln^2(16-\lambda(4+11\lambda))+l^2(\lambda(8+\lambda(21-\lambda(6+7\lambda)))-16)-4n^4}{4\big(n^2+l(\lambda+\lambda^2-2)\big)^2}<0,$$
$$\frac{\partial^2\pi_M^{co}}{\partial w\partial m}=-\frac{\big(n^2(\lambda-2)+l(\lambda-1)((\lambda-1)\lambda)-4\big)\big(2n^2+l\big(\lambda+\lambda^2-2\big)\big)}{4\big(n^2+l(\lambda+\lambda^2-2)\big)^2},$$
$$\frac{\partial^2\pi_M^{co}}{\partial w^2}\times\frac{\partial^2\pi_M^{co}}{\partial m^2}-\left(\frac{\partial^2\pi_M^{co}}{\partial w\partial m}\right)^2=-\frac{n^4\lambda^2+2l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+2ln^2\big(2-2\lambda-3\lambda^2+2\lambda^3+\lambda^4\big)}{4\big(n^2+l(\lambda+\lambda^2-2)\big)^2}>0,$$

$\pi_M^{co}$ is a strictly concave function with respect to $w$, $m$, meanwhile $\pi_M^{co}$ has a maximum value.

Therefore, the optimal equilibrium solution for the manufacturer's wholesale price $w$, commission $m$, is obtained by taking the first order derivatives of equation (44) with respect to $w$, $m$ respectively, and setting the solution equal to 0.

Then, the optimal decision for the wholesale price in contract coordination $w^{co^*}$ can be obtained as:

$$w^{co^*}=\frac{a\big(n^2(\theta-1)+2l(2\theta-1)(\lambda-1)\big)\lambda\big(2n^2+l\big(\lambda+\lambda^2-2\big)\big)}{2n^4\lambda^2+4l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+4ln^2(\lambda-1)(1+\lambda)(\lambda(2+\lambda)-2)}. \tag{54}$$

The optimal decision for the commission in contract coordination $m^{co^*}$ can be obtained as:

$$m^{co^*}=\frac{a\big(n^2(\theta-1)+2l(2\theta-1)(\lambda-1)\big)\Big(2n^2\lambda+l\big(\lambda+\lambda^2-2\big)^2\Big)}{2n^4\lambda^2+4l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+4ln^2(\lambda-1)(1+\lambda)(\lambda(2+\lambda)-2)}. \tag{55}$$

Taking $w^{co^*}$, $m^{co^*}$ further into equations (47), (51), (52) and (53), the platform optimal rebate $r$, retailer optimal retail price $p$, and optimal effort level $s$ can be obtained as follows.

The optimal decision for platform rebates in contract coordination $r^{co^*}$ is:

$$r^{co^*}=\frac{a\left(\begin{array}{c}2n^4(\theta-1)\lambda+l^2(\lambda-1)^3(2+\lambda)^2(\theta(5+\lambda)-3-\lambda)\\+ln^2(\lambda-1)\big(6-4\lambda-5\lambda^2-2\lambda^3+2\theta\big(4\lambda+2\lambda^2+\lambda^3-3\big)\big)\end{array}\right)}{2n^4\lambda^2+4l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+4ln^2(2-2\lambda-3\lambda^2+2\lambda^3+\lambda^4)}. \tag{56}$$

The optimal decision for retail price in contract coordination $p^{co^*}$ is:

$$p^{co^*}=\frac{a\left(\begin{array}{c}2n^4(\theta-1)\lambda+2l^2(\theta(\lambda-1)-\lambda)\big(\lambda+\lambda^2-2\big)^2\\+ln^2\lambda\big(4-5\lambda-\lambda^2+\theta\big(7\lambda+\lambda^2-8\big)\big)\end{array}\right)}{2n^4\lambda^2+4l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+4ln^2(2-2\lambda-3\lambda^2+2\lambda^3+\lambda^4)}. \tag{57}$$

The optimal decision for effort level in contract coordination $s^{co^*}$ is:

$$s^{co^*}=\frac{-an^3(1+\theta(\lambda-1))\lambda+aln(\theta(\lambda-2)-\lambda)(\lambda-1)^2\big(2+3\lambda+\lambda^2\big)}{n^4\lambda^2+2l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+2ln^2(2-2\lambda-3\lambda^2+2\lambda^3+\lambda^4)}. \tag{58}$$

Substituting equations (56)–(58) into equations (1) and (59), $D_t^{co^*}$ and $D_o^{co^*}$ can be obtained as follows.

The optimal decision for the market needs of the Internet platform channel in contract coordination $D_t^{co^*}$ is:

$$D_t^{co^*}=-\frac{al\big(\lambda+\lambda^2-2\big)\Big(n^2\lambda(\theta-\theta\lambda-1)+l(\theta(\lambda-2)-\lambda)(\lambda-1)^2\big(2+3\lambda+\lambda^2\big)\Big)}{2n^4\lambda^2+4l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+4ln^2(2-2\lambda-3\lambda^2+2\lambda^3+\lambda^4)}. \tag{60}$$

The optimal decision for the market needs of traditional retail channel in contract coordination $D_o^{\mathrm{co}^*}$ is:

$$D_o^{\mathrm{co}^*}=-\frac{al(\lambda-1)\Big(l(\theta-1)(1+\lambda)\big(\lambda+\lambda^2-2\big)^2+n^2\big(2-2\lambda^2-\lambda^3+\theta\big(\lambda^2+\lambda^3-2\big)\big)\Big)}{2n^4\lambda^2+4l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+4ln^2(2-2\lambda-3\lambda^2+2\lambda^3+\lambda^4)}. \tag{61}$$

The fixed costs $F^*$ is expressed as:

$$F^*=\frac{1}{2}a^2l\big(n^2+l\big(\lambda+\lambda^2-2\big)\big)\left(\begin{array}{c}\dfrac{\left(\begin{array}{c}l(\theta(\lambda-2)-\lambda)(\lambda-1)^2(1+\lambda)(2+\lambda)\\+n^2\lambda(\theta-\theta\lambda-1)\end{array}\right)^2}{\left(\begin{array}{c}n^4\lambda^2+4ln^2(\lambda-1)^2(1+\lambda)(2+\lambda)\\+2l^2(\lambda-1)^2(1+\lambda)(2+\lambda)\big(\lambda+2\lambda^2-4\big)\end{array}\right)^2}\\+\dfrac{\big(n^2\lambda(1-\theta+\theta\lambda)-l(\theta(\lambda-2)-\lambda)(\lambda-1)^2\big(2+3\lambda+\lambda^2\big)\big)^2}{\left(\begin{array}{c}n^4\lambda^2+2l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2\\+2ln^2\big(2-2\lambda-3\lambda^2+2\lambda^3+\lambda^4\big)\end{array}\right)^2}\end{array}\right). \tag{62}$$

Taking all the optimal equilibrium solutions into $\pi_M^{\mathrm{co}^*}$, $\pi_R^{\mathrm{co}^*}$, $\pi_P^{\mathrm{co}^*}$, the manufacturer profit $\pi_M^{\mathrm{co}^*}$, the retailer's profit $\pi_R^{\mathrm{co}^*}$, and the platform's profit $\pi_P^{\mathrm{co}^*}$ can be obtained as:

$$\pi_M^{\mathrm{co}^*}=\frac{1}{4}a^2l\big(2\big(n^2+l\big(\lambda+\lambda^2-2\big)\big)+G+H+(I-J)\big) \tag{63}$$

$$\pi_R^{\mathrm{co}^*}=\frac{-a^2l\big(n^2+l\big(\lambda+\lambda^2-2\big)\big)\Big(n^2\lambda(\theta-\theta\lambda-1)+l(\theta(\lambda-2)-\lambda)(\lambda-1)^2\big(2+3\lambda+\lambda^2\big)\Big)^2}{2\Big(n^4\lambda^2+4ln^2(\lambda-1)^2(2+3\lambda+\lambda^2)+2l^2(\lambda-1)^2(3\lambda^2+7\lambda^3+2\lambda^4-8-10\lambda)\Big)^2} \tag{64}$$

$$\pi_P^{\mathrm{co}^*}=\frac{a^2l^2(\lambda-1)^2\Big(l(\theta-1)(1+\lambda)\big(\lambda+\lambda^2-2\big)^2+n^2\big(2-2\lambda^2-\lambda^3+\theta\big(\lambda^2+\lambda^3-2\big)\big)\Big)^2}{4\Big(n^4\lambda^2+2l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+2ln^2(2-2\lambda-3\lambda^2+2\lambda^3+\lambda^4)\Big)^2} \tag{65}$$

where

$$G=\frac{\left(\begin{array}{c}\left(\begin{array}{c}n^2(\theta-1)\\+2l(2\theta-1)(\lambda-1)\end{array}\right)\lambda\big(\lambda+\lambda^2-2\big)\\ \times\big(2n^2+l\big(\lambda+\lambda^2-2\big)\big)\left(\begin{array}{c}n^2(1+\theta(\lambda-1))\lambda\\+l(\lambda-\theta(\lambda-2))(\lambda-1)^2\big(2+3\lambda+\lambda^2\big)\end{array}\right)\end{array}\right)}{\Big(n^4\lambda^2+2l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+2ln^2(2-2\lambda-3\lambda^2+2\lambda^3+\lambda^4)\Big)^2},$$

$$H=\frac{l(\lambda-1)\left(\begin{array}{c}l(\theta-1)(1+\lambda)\big(\lambda+\lambda^2-2\big)^2\\+n^2\big(2-2\lambda^2-\lambda^3+\theta\big(\lambda^2+\lambda^3-2\big)\big)\end{array}\right)\left(\begin{array}{c}2l(1+\theta(\lambda-1))\big(\lambda+\lambda^2-2\big)^2\\+n^2\left(\begin{array}{c}4\lambda+4\lambda^2-\lambda^3-\lambda^4\\+\theta\big(4-4\lambda-2\lambda^2+\lambda^3+\lambda^4\big)-4\end{array}\right)\end{array}\right)}{\Big(n^4\lambda^2+2l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+2ln^2(2-2\lambda-3\lambda^2+2\lambda^3+\lambda^4)\Big)^2},$$

$$I=\frac{\Big(l(\theta(\lambda-2)-\lambda)(\lambda-1)^2(1+\lambda)(2+\lambda)+n^2\lambda(\theta-\theta\lambda-1)\Big)^2}{\Big(n^4\lambda^2+4ln^2(\lambda-1)^2(1+\lambda)(2+\lambda)+2l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)\Big)^2},$$

$$J=\frac{\Big(n^2\lambda(\theta-\theta\lambda-1)+l(\theta(\lambda-2)-\lambda)(\lambda-1)^2\big(2+3\lambda+\lambda^2\big)\Big)^2}{\Big(n^4\lambda^2+2l^2(\lambda-1)^3(1+\lambda)(2+\lambda)^2+2ln^2(2-2\lambda-3\lambda^2+2\lambda^3+\lambda^4)\Big)^2}.$$

**Proposition 9.** *In the ML, the two-part pricing pact can increase the profitability of the manufacturer and the retailer compared to the pre-coordination model but also result in lower platform profits when wholesale price and fixed costs are satisfied with* $(w, F) = \left(w^{\mathrm{co}^*}, F^*\right)$. *An example can be seen in Amazon's third-party marketplace, where the combination of fixed fees and commission charges boosts profitability for sellers*[14]. *However, Amazon's profits may not rise if the fixed fees do not cover operational costs, especially when high incentives or discounts are offered to attract sellers. The proof of this proposition can be found in Appendix A.*

## 5.2. Retailer-led coordination of cost-sharing contract

In the RL, costs for both the manufacturer and the retailer are considered self-interested, and retailers are the leaders. When the retailer initiates a sales effort, the choose to bear a proportion denoted as $\phi(0 < \phi < 1)$. The decision aims to alleviate the channel conflict arising from the manufacturer's platform rebate sales. The Stackelberg game persists among the members of the DCSC, and the profit functions for each member of the DCSC are as follows:

$$\pi_M^{\mathrm{co}}(w, m) = wD_t + (w - m)D_o - \frac{1}{2}\phi l s^2 \tag{66}$$

$$\pi_R^{\mathrm{co}}(p, s) = (p - w)D_t - \frac{1}{2}(1 - \phi)l s^2 \tag{67}$$

$$\pi_P^{\mathrm{co}}(r) = (m - r)D_o. \tag{68}$$

According to the backward induction, from $\frac{\partial^2 \pi_P^{\mathrm{co}}}{\partial r^2} = -2 < 0$, $\pi_P^{\mathrm{co}}$ is a concave function with respect to $r$, the maximum value of $\pi_P^{\mathrm{co}}$ exists. Thus, the first order derivative of $r$ for equation (68) is equal to 0, the reaction function of $r$ can be obtained as:

$$r = \frac{1}{2}(m + w + \Delta w + a(\theta - 1) - (w + \Delta w)\lambda). \tag{69}$$

Take equation (66) into equation (64), retailer retail markup $\Delta w$ and effort level $s$ are already known to the manufacturer. From $\frac{\partial^2 \pi_M^{\mathrm{co}}}{\partial w^2} = (\lambda - 1)(3 + \lambda) < 0$, $\frac{\partial^2 \pi_M^{\mathrm{co}}}{\partial m^2} = -1 < 0$, $\frac{\partial^2 \pi_M^{\mathrm{co}}}{\partial w_2 \partial m} = 1 - \lambda > 0$, $\frac{\partial^2 \pi_M^{\mathrm{co}}}{\partial w^2} \times \frac{\partial^2 \pi_M^{\mathrm{co}}}{\partial m^2} - \left(\frac{\partial^2 \pi_M^{\mathrm{co}}}{\partial w \partial m}\right)^2 = 2 - 2\lambda^2 > 0$, $\pi_m^{\mathrm{co}}$ is a strictly concave function with respect to $w$, $m$, the existence of a maximum value for $\pi_m^{\mathrm{co}}$ can be proved. Subsequently, taking the first order derivative of equation (63) with respect to $r$, $m$ and setting the derivation result equal to 0, the reaction function of $w$ and $m$ can be obtained as:

$$w = \frac{ns + a(\theta + \lambda - \theta\lambda) + \Delta w\left(\lambda^2 - 1\right)}{2 - 2\lambda^2} \tag{73}$$

$$m = \frac{ns + \Delta w + a(2\theta - 1) + \Delta w\lambda}{2(1 + \lambda)}. \tag{74}$$

Substituting equations (73) and (74) into equation (67), subsequently, the retailer determines the retail markup $\Delta w$ and sales effort $s$. From $\frac{\partial^2 \pi_R^{\mathrm{co}}}{\partial \Delta w^2} = \frac{1}{2}\left(\lambda^2 - 2\right) < 0$, $\frac{\partial^2 \pi_R^{\mathrm{co}}}{\partial s^2} = l(\phi - 1) < 0$, $\frac{\partial^2 \pi_R^{\mathrm{co}}}{\partial \Delta w \partial s} = \frac{n}{2} > 0$, $\frac{\partial^2 \pi_M^{\mathrm{co}}}{\partial w^2} \times \frac{\partial^2 \pi_M^{\mathrm{co}}}{\partial s^2} - \left(\frac{\partial^2 \pi_M^{\mathrm{co}}}{\partial w \partial s}\right)^2 = \frac{1}{4}\left(2l\left(\lambda^2 - 2\right)(\phi - 1) - n^2\right) > 0$, $\pi_r^{\mathrm{co}}$ is a strictly concave function with respect to $\Delta w$ and $s$ when $0 < \phi < \frac{n^2 + 2l\lambda^2 - 4l}{2l\lambda^2 - 4l}$, so the $\pi_r^{\mathrm{co}}$ has a maximum value. Taking the first-order derivatives of equation (67) for $\Delta w$, $s$ and setting the derivation result equal to 0, the reaction function of $\Delta w$, $s$ can be obtained as follows.

The optimal equilibrium solution for the retail markup in contract coordination $\Delta w^{\mathrm{co}^*}$ can be obtained as:

$$\Delta w^{\mathrm{co}^*} = \frac{al(\theta(\lambda - 2) - \lambda)(\phi - 1)}{2l(\lambda^2 - 2)(\phi - 1) - n^2}. \tag{75}$$

[14] http://www.cifnews.com/article/170053 (Accessed date 23 September 2025).

The optimal equilibrium solution for the sales effort per unit of product in contract coordination $s^{\mathrm{co}^*}$ is:

$$s^{\mathrm{co}^*} = \frac{an(\lambda - \theta(\lambda-2))}{4l(\lambda^2-2)(\phi-1) - 2n^2}. \tag{76}$$

Substituting equations (75) and (76) into each expression, $w^{\mathrm{co}^*}$, $r^{\mathrm{co}^*}$, $p^{\mathrm{co}^*}$, and $m^{\mathrm{co}^*}$ are expressed as:

$$w^{\mathrm{co}^*} = \frac{a\big(2l\big(\theta\big(2-3\lambda+\lambda^3\big)\big)(\phi-1) - \lambda\big(\lambda^2-3\big) - n^2(\theta-1)\lambda\big)}{4(\lambda^2-1)(2l(\lambda^2-2)(\phi-1)-n^2)} \tag{77}$$

$$r^{\mathrm{co}^*} = \frac{a\big(l\big(12+2\lambda-7\lambda^2-\lambda^3+\theta\big(13\lambda^2+\lambda^3-24-4\lambda\big)\big)(\phi-1) - n^2(\theta-1)(3+2\lambda)\big)}{4(1+\lambda)(2l(\lambda^2-2)(\phi-1)-n^2)} \tag{78}$$

$$p^{\mathrm{co}^*} = \frac{a\big(2l\big(5\lambda-3\lambda^3+\theta\big(6-5\lambda-4\lambda^2+3\lambda^3\big)\big)(\phi-1) - n^2(\theta-1)\lambda\big)}{4(\lambda^2-1)(-n^2+2l(\lambda^2-2)(\phi-1))} \tag{79}$$

$$m^{\mathrm{co}^*} = \frac{a\big(2l\big(4-\lambda-3\lambda^2+\theta\big(5\lambda^2-10-\lambda\big)\big)(\phi-1) - n^2(\theta-1)(2+\lambda)\big)}{4(1+\lambda)(2l(\lambda^2-2)(\phi-1)-n^2)}. \tag{80}$$

Substituting equations (76), (78) and (79) into equations (1) and (2), $D_t^{\mathrm{co}^*}$ and $D_o^{\mathrm{co}^*}$ can be obtained as:

$$D_t^{\mathrm{co}^*} = -\frac{al(\theta(\lambda-2)-\lambda)\big(\lambda^2-2\big)(\phi-1)}{8l(\lambda^2-2)(\phi-1)-4n^2} \tag{81}$$

$$D_o^{\mathrm{co}^*} = \frac{a\big(n^2(\theta-1) - l\big(4-\lambda^2+\theta\big(-4+2\lambda+\lambda^2\big)\big)(\phi-1)\big)}{8l(\lambda^2-2)(\phi-1)-4n^2}. \tag{82}$$

All the optimum equilibrium solutions are brought into $\pi_M^{\mathrm{co}^*}$, $\pi_R^{\mathrm{co}^*}$ and $\pi_P^{\mathrm{co}^*}$ to obtain the manufacturer profit $\pi_M^{\mathrm{co}^*}$, retailer profit $\pi_R^{\mathrm{co}^*}$, and platform profit $\pi_P^{\mathrm{co}^*}$ respectively as:

$$\pi_M^{\mathrm{co}^*} = \frac{(a^2(n^4(\theta-1)^2\big(\lambda^2-2\big) - 2l^2\big(\lambda^2-2\big)\begin{pmatrix} +\lambda^4+\theta^2\big(-12+20\lambda-5\lambda^2-4\lambda^3+\lambda^4\big)-8-\lambda^2 \\ -2\theta\big(-8+10\lambda-\lambda^2-2\lambda^3+\lambda^4\big)(-1+\phi)^2 - K \end{pmatrix}}{\Big(16(\lambda^2-1)(n^2-2l(\lambda^2-2)(\phi-1))^2\Big)} \tag{83}$$

$$\pi_R^{\mathrm{co}^*} = -\frac{a^2l(\lambda-\theta(\lambda-2))^2(\phi-1)}{16l(\lambda^2-2)(\phi-1)-8n^2} \tag{84}$$

$$\pi_P^{\mathrm{co}^*} = \frac{a^2\big(n^2(\theta-1) - l\big(4-\lambda^2+\theta\big(2\lambda+\lambda^2-4\big)\big)(\phi-1)\big)^2}{16(n^2-2l(\lambda^2-2)(\phi-1))^2} \tag{85}$$

where $K = -2ln^2\begin{pmatrix} \lambda^2(4-5\phi)+8(\phi-1)+\lambda^4\phi \\ +\theta^2(\lambda-1)\big(8+\lambda^2(\phi-4)-4\phi+\lambda^3\phi\big) \\ -2\theta(\lambda-2)\big(4+2\lambda^2(\phi-1)-4\phi-\lambda\phi+\lambda^3\phi\big) \end{pmatrix}$.

**Proposition 10.** *In the RL, the contract coordinates the DCSC under the platform rebate model when the manufacturer's cost-sharing ratio satisfies* $0 < \phi^* < \frac{n^2+2l\lambda^2-4l}{2l\lambda^2-4l}$. *An example can be seen in Walmart's supplier agreements [19]. Walmart uses cost-sharing models with suppliers, providing rebates or discounts based on a balanced cost-sharing ratio. When properly structured, this coordination benefits both the retailer and manufacturer by aligning logistics, pricing, and marketing strategies. However, an imbalanced cost-sharing ratio can lead to inefficiencies and reduced effectiveness in the supply chain. The proof of this proposition can be found in Appendix A.*

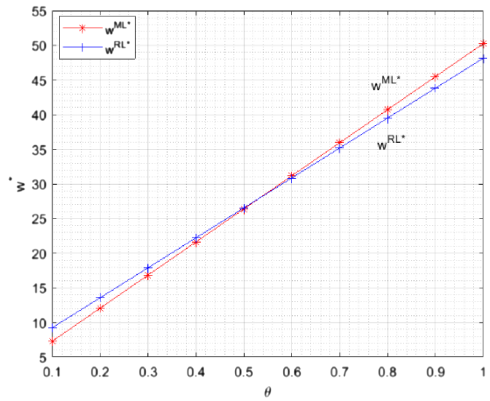


FIGURE 4. Influence of consumer channel preference on wholesale price under decentralized decision-making.

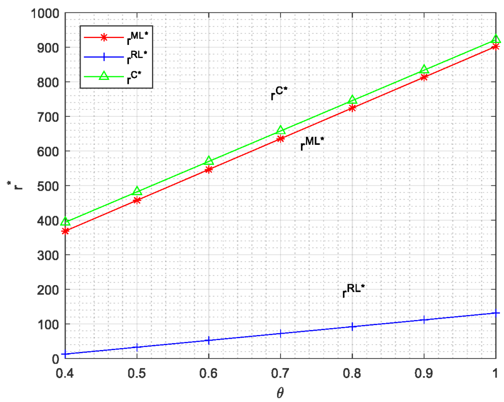


FIGURE 5. Influence of consumer channel preference on rebate.

## 6. Numerical analysis

Sensitivity analyses were performed to investigate the influence of consumer channel preference ($\theta$) on the pricing decisions of DCSC members and to compare profits before and after contract coordination. Parameters related to two-dimensional plots are presumed to take values of $a = 100$ [17], $n = 0.8$ [57], $\lambda = 0.1$ [56], $l = 0.34$ [35], $\phi = 0.1$ [60]. The values of $F$, $l$, and $\phi$ in the three-dimensional graph are determined by constraints.

**Remark 1.** From Figure 4, $w^{\mathrm{ML}^*} < w^{\mathrm{RL}^*}$ when $\theta$ is $(0, 0.5]$, and $w^{\mathrm{ML}^*} > w^{\mathrm{RL}^*}$ when $\theta$ is $(0.5, 1)$. From Figures 5 to 8, $p^{C^*} > p^{\mathrm{ML}^*} > p^{\mathrm{RL}^*}$, $r^{C^*} > r^{\mathrm{ML}^*} > r^{\mathrm{RL}^*}$, $s^{C^*} > s^{\mathrm{ML}^*} > s^{\mathrm{RL}^*}$, $m^{\mathrm{ML}^*} > m^{\mathrm{RL}^*}$. Also, from Figures 4 to 8, wholesale price, rebate, retail price, retailer effort level, and platform commission all exhibit an increase under the decentralized decision model as consumer traditional channels preference rises.

As consumers' preference for traditional channels increases, the manufacturer, the retailer, and the platform in a competitive market environment would all adjust their decisions to capture the market. Manufacturers would raise commissions to platforms and wholesale price to offset online channel costs. Platforms would increase rebates to attract online buyers. Retailers would raise prices to cover higher purchasing costs and adopt tactics like experiential services to retain customers.

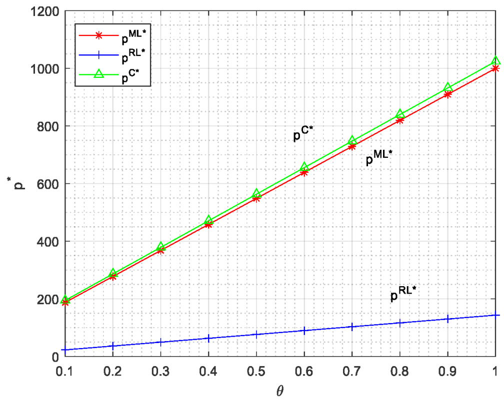


FIGURE 6. Influence of consumers preference on retail price.

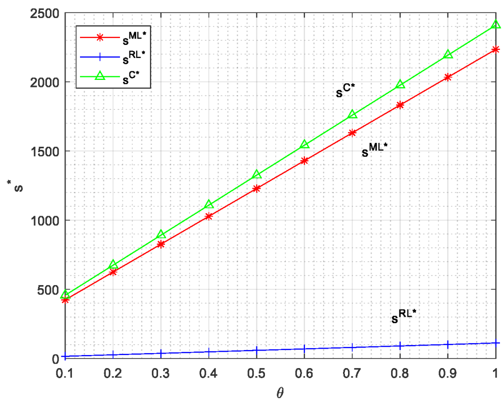


FIGURE 7. Influence of consumer channel preference on retailers' effort level.

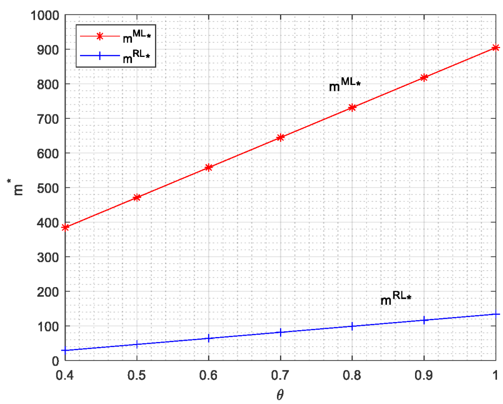


FIGURE 8. Influence of consumer channel preference on platform commission under decentralized decision-making.

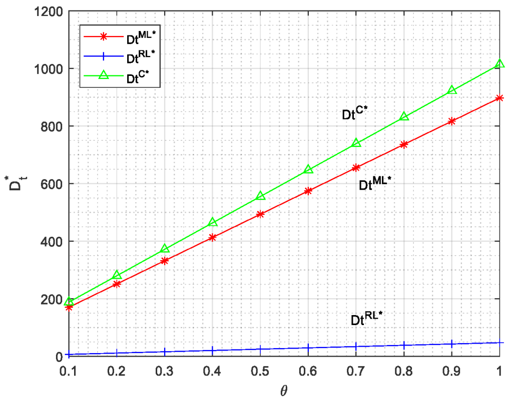


FIGURE 9. Influence of consumer channel preference on demand of traditional retail channel.

Manufacturer, retailer, and platform should make strategic adjustments. These adjustments must consider consumer channel preference for traditional channels. The manufacturer may increase the wholesale price to pass on part of the rising costs. Platform commissions are also likely to grow as a means of covering online operating expenses. At the same time, platforms may expand rebate programs to stimulate demand, since higher rebate levels are effective in attracting buyers. Evidence from studies on Amazon's revenue-sharing mechanism indicates that manufacturers are often required to pay higher commissions, which subsequently raise wholesale prices and shift part of the cost burden downstream[15]. Retailer could enhance in-store services. Exclusive discounts may retain customers. Zara's frequent product refresh strategy provides a real example, where constantly updated store assortments encourage repeated visits and support higher prices[16]. These added-value measures justify higher prices. Coordinated efforts across the supply chain are implemented. All parties maintain competitive positioning through these actions. Such actions enable all parties to maintain competitive positioning. For example, the integration of an omni-channel supply chain by Macy's, which allowed the sharing of online and offline inventories, illustrates that coordinated efforts among participants can address shifting consumer channel preference effectively[17]. These efforts ensure profitability for each supply chain participant.

**Remark 2.** From Figures 9 and 10, $D_t^{C^*} > D_t^{\mathrm{ML}^*} > D_t^{\mathrm{RL}^*}$, $D_o^{\mathrm{RL}^*} > D_o^{\mathrm{ML}^*}$ can be seen, but the comparison between $D_o^{C^*}$ and $D_o^{\mathrm{RL}^*}$, $D_o^{\mathrm{ML}^*}$ depends on the magnitude of consumers' preferences.

As consumer channel preference for the traditional retail channel increases, demand for that channel rises under model C, while demand for direct online channel declines. This pattern indicates that competition between traditional and online channels is shaped not only by prices or discounts but also by the reconfiguration of channel attributes, consumer psychology, and service differentiation. If uniform strategies such as unilateral price reductions or extensive online subsidies continue to be adopted by supply-side participants, the imbalance between channels may intensify and overall profitability may be eroded.

Therefore, supply chain members should adopt adaptive strategies to accommodate shifting demand patterns. Manufacturers need to balance wholesale pricing and commission policies to stabilize both channels and avoid excessive reliance on the single market side. The Wiglaf Pricing case, "Price Optimization-Manufacturing and Distribution", illustrates how a manufacturer and distributor enhanced margins by implementing more

[15] `https://www.marketplacepulse.com/articles/amazon-takes-a-50-cut-of-sellers-revenue` (Accessed date 25 September 2025).

[16] `https://www.iese.edu/insight/articles/fast-fashion-business-model-zara` (Accessed date 25 September 2025).

[17] `https://technologyadvice.com/blog/information-technology/macys-omnichannel-supply-chain-case-study` (Accessed date 25 September 2025).

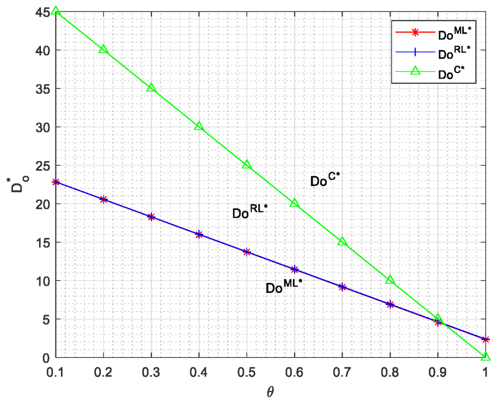


FIGURE 10. Influence of consumer channel preference on demand of online direct selling channel.

disciplined wholesale pricing and structured rebate schemes[18]. For retailers, enhancement of service differentiation and experiential value is necessary to capture expanding demand in traditional channels. For instance, the Italian luxury brand Gucci transformed flagship stores into cultural and experiential spaces through the integration of art installations and personalized services, thereby sustaining customer visits and supporting premium pricing[19]. Meanwhile, platforms should redesign rebate mechanisms with greater flexibility to counteract declining demand in the direct online channel, for example, by more precisely targeting online-oriented consumer segments. Evidence from Enable's rebate management solution demonstrates this approach, as differentiated rebate schemes were developed for distinct customer groups. In the "AAH's Growth Journey" case, flexible rebate targeting enabled sales teams to offer more competitive proposals to online-focused customers, thereby enhancing overall sales and customer satisfaction[20]. Coordinated efforts among all supply chain participants can improve overall efficiency and mitigate profit loss arising from structural imbalances in consumer channel preference.

**Remark 3.** The Figures 11 and 12 reveal that as consumer traditional channels preference increases, profits for both the retailer and the manufacturer rise in the model ML, whereas profits for the platform decrease.

The surge in demand for traditional retail channel boosts profits for the manufacturer and the retailer, while platform profits decline due to higher commissions and rebates failing to attract enough online consumers. In the Model RL, retailer profits increase, while manufacturer and platform profits initially decrease before rebounding. Platform rebates raise costs for the manufacturer and the platform, and retailer's suppression of wholesale price further reduces manufacturer profitability. However, as consumer channel preference for traditional channel grows, the retailer raises prices and expends effort, while increased platform rebates drive online traffic, benefiting the manufacturer from higher selling prices. Therefore, a platform rebate strategy is recommended for RL when consumer channel preference for traditional channels exceeds a high threshold.

In real-world scenarios, manufacturer, retailer, and platform must adapt strategically. Shifting consumer channel preference for traditional channels must be considered. Manufacturer should adjust pricing strategies when demand increases. Increased wholesale price must be balanced with higher platform rebates. These rebate adjustments encourage online sales. For example, Unilever partnered with Amazon to coordinate wholesale

[18]https://wiglafpricing.com/case-studies/price-optimization-manufacturing-and-distribution (Accessed date 25 September 2025).

[19]https://www.voguebusiness.com/consumers/guccis-new-london-flagship-targets-true-luxury-customers (Accessed date 25 September 2025).

[20]https://www.enable.com/customer-stories/aahs-growth-journey-supported-by-rebate-management-software (Accessed date 25 September 2025).

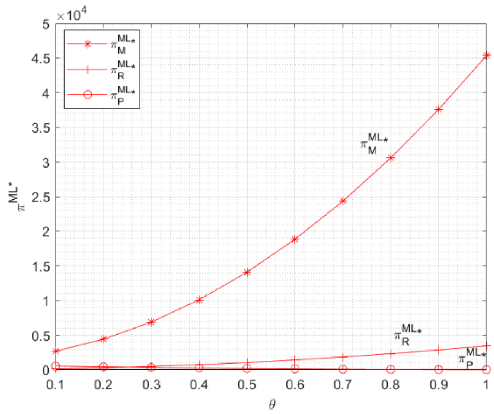


FIGURE 11. Manufacturer-led supply chain member profits.

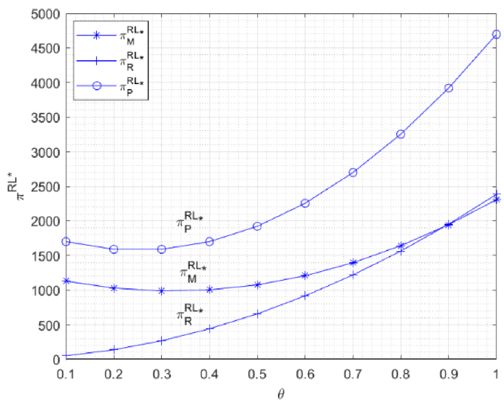


FIGURE 12. Retailer-led supply chain members' profits.

pricing, promotional activities, and fulfillment, illustrating that collaboration with platforms stabilizes margins and sustains online demand[21]. Retailer in the model RL can leverage the shift in consumer channel preference. These retailers may increase in-store prices. Service levels should be enhanced to attract greater demand. The Glenpark case shows modernization of rebate programs through Vendio Channel and Rebate Manager, with automation of processes and improvement in the accuracy and transparency of rebate agreements and payments. Such improvements maintain profitability and strengthen the management of channel incentives[22]. Platform coordination drives online traffic. Platforms must carefully calibrate rebate policies. Attractiveness to both traditional and online consumers must be maintained. Traffic increase must be balanced with rebate costs. A holistic approach ensures supply chain profitability. All players can maintain earnings despite shifts in consumer behavior.

[21] https://www.unilever.com/news/news-search/2025/customer-collaboration-and-kaizen-strengthen-unilevers-supply-chain-with-amazon(Accessed date 25 September 2025).

[22] https://www.vendavo.com/all/how-packaging-manufacturers-can-improve-rebates-with-vendavo (Accessed date 25 September 2025).

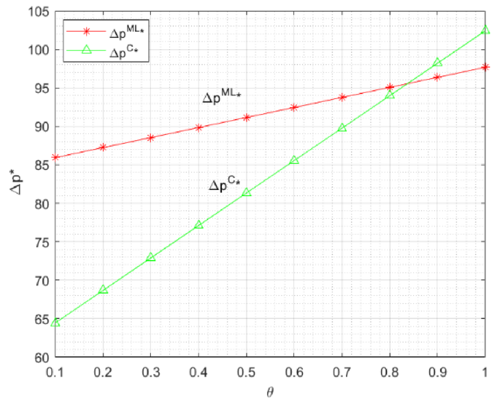


FIGURE 13. The purchase price of consumers under manufacturer-led and centralized decision-making.

**Remark 4.** Figure 13 shows that the comparison of the magnitude of $\Delta p^{\mathrm{ML}^*}$ and $\Delta p^{C^*}$ depends on the specific value of $\theta$. With an increase in consumer channel preference for traditional channel, the consumers' purchasing price rises in both model C and model ML.

The observed increase in consumer purchasing prices under both model C and model ML reflects both the transfer of higher channel costs and the willingness of consumers to pay for additional value provided by traditional channels. With intensified consumer channel preference for offline shopping, attributes such as service quality, physical interaction, and immediate product availability become more prominent. The shift reduces the relative role of price competition and emphasizes the importance of differentiated offerings. Consequently, the effectiveness of wholesale pricing, rebate strategies, and in-store service enhancements depends on the extent to which supply chain participants capture evolving consumer priorities.

Manufacturers should adapt pricing strategies in response to rising demand. Increases in wholesale prices require balancing with higher platform rebates, while targeted promotions are employed to sustain competitiveness. For example, Terreal, a building products manufacturer, implemented dynamic pricing through Zilli ant's Price IQ, with adjustments based on market conditions and customer segments. The approach resulted in a 2.3% improvement in margins without reducing market share[23]. Retailers in the model RL may capitalize on shifts in consumer channel preference through higher in-store prices, enhanced service levels, and exclusive deals designed to capture greater demand. An illustrative case is Adore Beauty, an Australian online beauty retailer that expanded into physical retail by opening its first store in Melbourne[24]. The store integrates curated products, networked displays, and in-store experiences aligned with online offerings, thereby enhancing customer engagement and revenue. Platforms must likewise adjust rebate strategies and carefully calibrate incentives to remain attractive to both online and traditional consumers. For instance, CarParts.com utilized Enable's rebate management platform to optimize vendor rebate programs, resulting in an estimated \$200 000 increase in rebate earnings. The case demonstrates that platform-level adjustments preserve profitability while increasing online traffic[25].

**Remark 5.** Figure 14 indicates that in the RL model with a relatively low effort cost factor, the product price rises as consumer channel preference for traditional channels increases.

[23] https://zilliant.com/case-studies/topic/manufacturing (Accessed date 25 September 2025).

[24] https://insideretail.com.au/sectors/health-beauty/adore-beauty-to-open-first-brick-and-mortar-store-202501 (Accessed date 25 September 2025).

[25] https://www.enable.com/customer-stories/why-carparts-is-using-enable-to-help-them-become-a-1bn-company (Accessed date 25 September 2025).

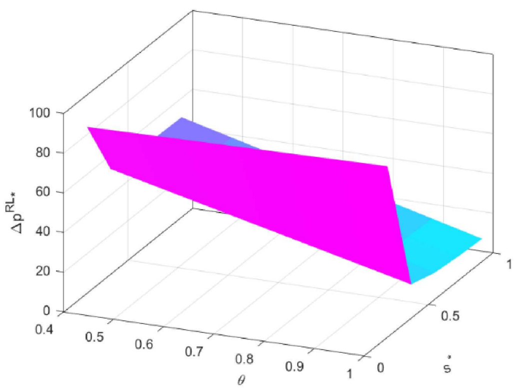


FIGURE 14. The actual purchase price of consumers under retailer-led.

The reason is that, at lower retailer cost factors, the increase in rebates is outweighed by the rise in the retail price. In contrast, when the retailer effort cost factor is high, the channel becomes more competitive, leading to an increase in rebates offered by the platform that surpasses the increase in retail price. Therefore, the price of consumer purchases depends on both consumer channel preference and the retailer effort cost factor.

Retailers should strengthen product appeal in physical stores and enhance the customer experience in traditional channels. Pricing strategies should be adjusted to reflect increased demand when the cost of exerting effort is low. For example, Best Buy invests in optimized store layouts, specialized staff, and in-store product demonstration zones as part of its omnichannel strategy, thereby boosting customer engagement and supporting price premiums[26]. When the cost of exerting effort is high, platforms need to increase rebates and maintain competitive online pricing. For example, Alibaba has consistently deployed targeted rebate and coupon programs during shopping festivals such as Singles' Day, effectively sustaining online channel traffic despite intensifying competition from offline retailers[27]. Continuous collaboration between platforms and retailers is critical to preserving channel attractiveness, and pricing and promotional strategies must be dynamically optimized to respond to evolving consumer channel preference.

**Remark 6.** Figure 15 shows that supply chain profit is highest in C, *i.e.* $\pi^{C^*} > \pi^{\mathrm{ML}^*} > \pi^{\mathrm{RL}^*}$. In other words, the "double marginalization" still exists in the decentralized DCSC.

Recent research on supply chain coordination confirms that centralized decision-making effectively mitigates the "double marginalization" problem and yields higher overall profits compared with decentralized structures. Prior studies indicate that centralized coordination mechanisms outperform decentralized models in terms of efficiency and profitability [20,56]. Evidence from durable-goods supply chains further suggests that even partial centralization can reduce double marginalization and improve overall performance [30]. More recent findings indicate that centralized pricing and effort decisions enable the supply chain to achieve higher collective profits while reducing inefficiencies among channel members [59].

Nonetheless, providing formal analytical proof of this property remains challenging. The difficulty arises from multiple interdependent decision variables, including wholesale price, retail price, platform commission, rebate, and retailer effort, all interacting with consumer channel preference parameters. Deriving a closed-form inequality explicitly demonstrating the superiority of centralized profits over aggregate decentralized profits

[26] `https://www.customerexperiencedive.com/news/best-buy-omnichannel-experience-sales-growth/741951/` (Accessed date 25 September 2025).

[27] `https://www.reuters.com/business/retail-consumer/chinas-singles-day-wraps-up-with-e-commerce-firms-reporting-growth-shoppers-2024-11-12`(Accessed date 25 September 2025).

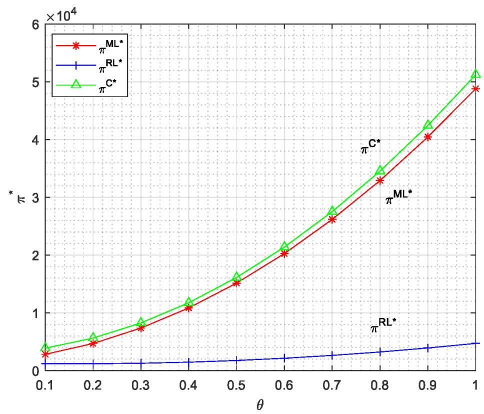


FIGURE 15. Influence of consumer channel preference on total profit.

requires handling highly nonlinear expressions and multiple case distinctions, rendering purely analytical proof intractable.

Numerical analysis is thus employed as a complementary and essential tool to illustrate this phenomenon. Figure 15 shows that profits under model C consistently exceed those under model ML or model RL across the full spectrum of consumer channel preference for traditional retail channels. The results provide evidence of the superiority of centralized coordination in enhancing overall supply chain profitability.

In this case, supply chain members must collaborate in this scenario. Manufacturer and retailer must be particularly involved. Coordination mechanisms must be implemented through this collaboration. Two-part pricing contract may be employed. Cost-sharing contract could be utilized alternatively. Measures should reduce the effects of double marginalization. The interests of both parties must be properly aligned. Pricing structures must be optimized. Cost structures must undergo similar optimization. Overall supply chain profitability may be increased. Mutual benefits must be achieved through these coordinated efforts. For instance, Walmart and Procter & Gamble established a long-term collaboration featuring Vendor Managed Inventory, in which P&G directly managed product stock levels within Walmart's warehouses. The arrangement aligned pricing and cost structures, reduced inefficiencies, and improved overall profitability across the supply chain[28].

**Remark 7.** Figures 16–19 compare the sizes of profits for two-channel supply chain members before and after implementing the two-part pricing contract in the model ML. The results illustrate that the two-part pricing contract achieves partial coordination. However, the profits of the platform post-coordination are less than the profits before coordination *i.e.* $\pi_P^{\text{co}^*} < \pi_P^{\text{ML}^*}$.

Consequently, the adoption of a two-part pricing contract under the rebate model does not effectively coordinate the profits of all members of the DCSC. The recommendation is for the manufacturer to share a portion of the revenue with the platform to ensure the platform's willingness to participate in the contract coordination. A similar recommendation is proposed for implementing cost-sharing contract in model RL.

Closer collaboration must be established between manufacturer and platform in real-life scenarios. Such coordinated efforts are required in real-life scenarios. Mutual benefits must be ensured through coordination contracts. The effectiveness of two-part pricing contract requires specific considerations. Manufacturer should implement revenue sharing with platforms. Revenue sharing enhances the attractiveness of platform participation. For example, Apple's long-term partnership with AT&T in the early years of the iPhone launch included a revenue-sharing arrangement on service contracts, which secured AT&T's participation and highlighted how

[28] https://www.extensiv.com/blog/supply-chain-management/walmart (Accessed date 25 September 2025).

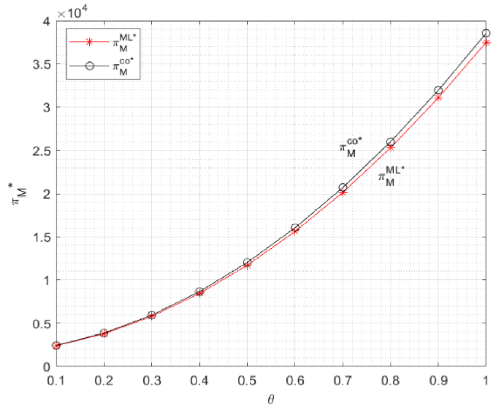


FIGURE 16. Comparison of manufacturer profits coordination under the two-part pricing contract.

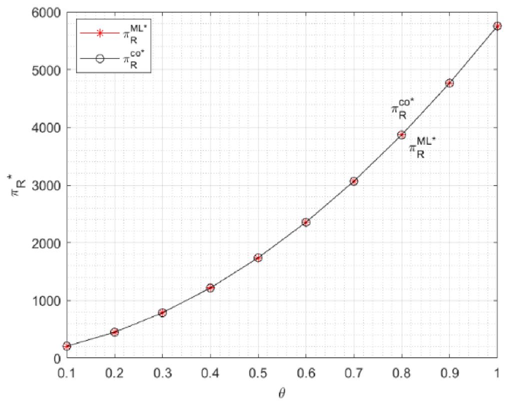


FIGURE 17. Comparison of retailer profits coordination under a two-part pricing contract.

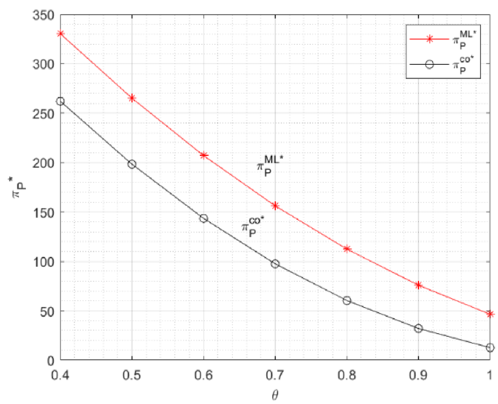


FIGURE 18. Comparison of platform profits coordination under a two-part pricing contract.

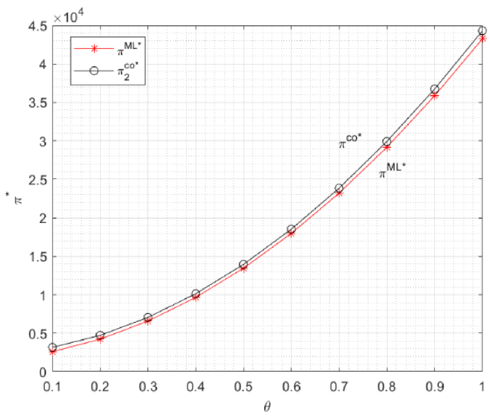


FIGURE 19. Comparison of the total profits of the supply chain of two-part pricing contract before and after coordination.

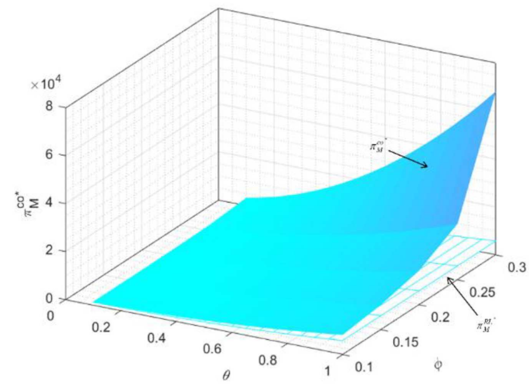


FIGURE 20. Comparison of manufacturer profits coordination under cost-sharing contract.

manufacturer-led models can align platform incentives to ensure coordination[29]. The RL model presents alternative approaches. Cost-sharing contract must be properly implemented. The interests of all supply chain members must be aligned. Retailer and platform must cooperate. Common goals must be pursued through this cooperation. Overall supply chain profitability must be improved. Conflict reduction is achieved through these coordinated mechanisms. A recent example is Food panda Singapore's partnership with DFI Retail Group to offer one-hour grocery delivery from brands like Cold Storage, CS Fresh and Giant. The strategy involves sharing inventory, operational resources, and delivery logistics between retailers and platforms, helping to maintain service speed and price consistency across channels while managing cost pressures[30].

**Remark 8.** From Figures 20 to 23, the use of cost-sharing contract can be seen to be successful in aligning supply chain members as well as overall profitability. Therefore, the implementation of a cost-sharing contract under RL alone can enhance the profitability of the DCSC as a whole and all its members under the rebate model.

[29] `https://macdailynews.com/2013/08/16/how-steve-jobs-got-atts-cingular-wireless-to-share-revenue` (Accessed date 25 September 2025).

[30] `https://retailasia.com/e-commerce/news/foodpanda-dfi-retail-group-partner-enable-one-hour-grocery-delivery` (Accessed date 25 September 2025).

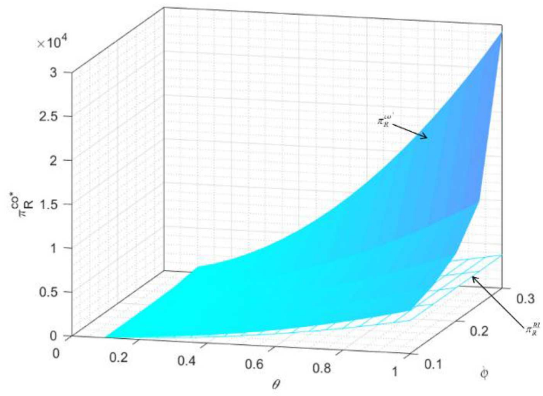

FIGURE 21. Comparison of retailer profits coordination under cost-sharing contract.

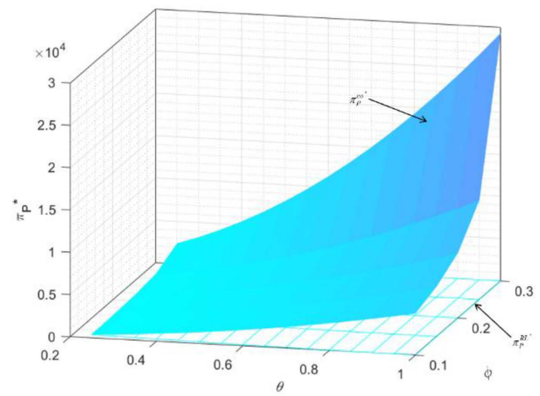

FIGURE 22. Comparison of platform profits coordination under cost-sharing contract.

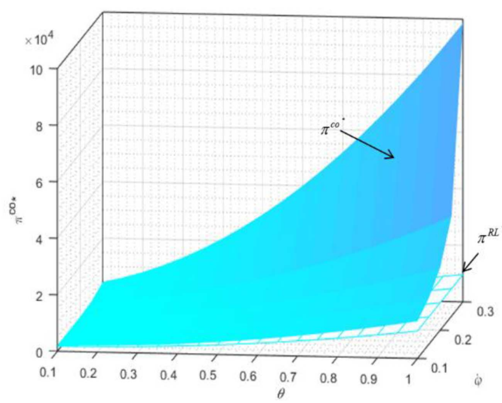

FIGURE 23. Comparison of total profit coordination in dual channel supply chain under cost-sharing contract before and after coordination.

A closer examination of the mechanism shows that cost-sharing contracts reduce risk asymmetry between retailers and platforms. When retailers incur high effort costs in promoting products or managing logistics, platforms can absorb a portion of these expenses, creating more balanced incentives. Conversely, platforms benefit from enhanced demand stimulation and higher order volumes resulting from retailer investments in services and in-store experiences. The reciprocal arrangement mitigates opportunistic behavior and fosters stable partnerships, particularly in contexts where consumer channel preference shift between online and offline channels.

Platform and retailer must consider cost-sharing contracts. Practical implementation of these contracts is recommended. Supply chain coordination must be improved through these measures. Profitability can be enhanced through proper contract adoption. Costs must be shared by both parties. Incentive alignment is achieved through the cost-sharing approach. Decision-making processes must consider long-term success. The interests of the entire supply chain must be prioritized. Manufacturers benefit from this contractual arrangement. A collaborative pricing approach is enabled. Rebate strategies can be optimized through cooperation. Inefficiencies must be minimized through coordinated efforts. Conflicts must be reduced through proper mechanisms. For example, Carrefour partnered with Uber Eats to expand rapid grocery delivery in Europe, where both parties shared logistics and operational costs to strengthen last-mile efficiency and enhance profitability across the supply chain[31].

## 7. Conclusions and limitations

### 7.1. Conclusions

In the context of the DCSC with platform rebate, the Stackelberg game model is employed to formulate a pricing strategy and coordination. Subsequently, an analysis is conducted on the impact of consumer channel preference on the pricing strategy and profit of supply chain members. The DCSC is coordinated using a single contract with two-part pricing contract and cost-sharing contract. A numerical example and numerical analysis based on key parameters illustrate the theoretical findings. From these models, the following conclusions can be drawn:

(1) The rise in consumer channel preference for traditional retail channel leads to increases in wholesale price, retail price, retailer effort levels, commissions, and platform rebates. As consumer demand for traditional retail channel rises, manufacturers and retailers adjust their pricing strategies accordingly. This demonstrates that consumer channel preference significantly influences both pricing strategies and the allocation of demand between the direct online and traditional retail channels under the platform rebate model. Consumer channel preference influence pricing strategies and demand allocation between platform and traditional retail channels within the platform rebate model.
(2) In the model ML, as consumer channel preference for traditional retail channel increases, the rebate provided by the platform increases. However, the price of the product purchased by the consumer is also higher, leading the consumer into the "price trap" set by the merchant. The product price is further influenced by the retailer's effort level in the model RL. Specifically, with higher consumer channel preference for traditional channels, prices rise at lower effort levels in less competitive dual-channel markets, but decrease at higher effort levels in more competitive environments. Supply chain outcomes vary between manufacturer-led and retailer-led models, with notable differences in pricing, demand, and platform rebates.
(3) Two-part pricing and cost-sharing contracts are applied in both model ML and model RL. These mechanisms help alleviate the double marginalization problem by aligning the interests of all supply chain members. As consumer channel preference shift, the profits of traditional retailer increase. Similarly, manufacturer profits also rise in this scenario. In model ML, platform profits may decline, while retailer profits increase under model RL. In this model, manufacturer and platform profits initially decrease but later rise.

[31] https://www.cnbc.com/2021/10/25/uber-launches-rapid-grocery-delivery-service-in-paris.html (Accessed date 25 September 2025).

Coordination contracts effectively address double marginalization and improve supply chain coordination. The strategic implementation of these contracts aligns the interests of all members, leading to a more profitable and efficient system.

### 7.2. Managerial implications

The results yielded the following managerial implications:

Firstly, the platform rebate strategy impacts consumer channel preference. These preferences affect pricing decisions and demand allocation. Shifts in consumer channel preference toward traditional retail channels lead retailers to adjust pricing strategies and modify their effort levels. As a result, profitability increases across the supply chain. A practical illustration is provided by David Jones, a leading Australian department store, which implemented a systematic rebate management system with suppliers. By coordinating rebate policies and promotional strategies, David Jones influenced consumer channel preference toward retail channels, thereby improving profitability across the supply chain[32].

Secondly, coordination contracts effectively mitigate price conflicts. These mechanisms include two-part pricing contract. Cost-sharing contract are equally effective. Double marginalization is reduced within the supply chain. Contract implementation enhances supply chain efficiency. Profitability improves for all parties involved. Retailer-led model is particularly effective. Platform rebate policies motivate increased sales efforts. These efforts promote greater consumer engagement. For example, Cargo, a U.S.-based platform selling goods in ride-sharing vehicles, implemented wholesale and revenue-sharing contracts with suppliers[33]. The contract design coordinated pricing and effort decisions, alleviated profit conflicts, and enhanced efficiency across the supply chain.

However, platform rebate mechanisms may distort prices and lead to imbalanced demand distribution across channels. Supply chain managers must optimize pricing strategies and implement coordination mechanisms properly. Conflicts of interest should be avoided, as rebate policies can potentially cause such conflicts. Platforms need to adjust rebate policies while considering consumer purchasing behavior. Monitoring market demand fluctuations and maintaining competitiveness between channels are also essential. A relevant case is Amazon's use of "price-parity" and "most-favored-nation" clauses with third-party sellers. These clauses restricted sellers from offering lower prices in other channels, raising price floors and limiting flexibility. Although Amazon removed its explicit parity rule in 2019, its later "Fair Pricing Policy" was alleged to have similar effects. In 2021, the U.S. Federal Trade Commission and several states challenged these practices, arguing that loosening such policies would restore fairer channel competition[34].

Finally, the e-commerce market continues to evolve. Manufacturers and retailers must closely monitor platform rebate mechanisms and observe the implementation processes. The impacts on the supply chain should be regularly assessed. A deeper understanding of consumer channel preference is needed through market research. Rebate policies should be applied strategically based on research findings. Coordinated contracts must be effectively implemented in operation. Supply chain processes can be optimized by integrating these approaches. Proper implementation can lead to competitive advantages. Market positioning strengthens with these strategies. Overall efficiency improves across the supply chain, and sustainability benefits arise from well-coordinated efforts. The Walmart case illustrates this dynamic approach: the Retail Link system allows suppliers to access real-time sales and inventory data, enabling continuous refinement of rebate policies and contractual mechanisms in response to evolving consumer channel preference and market conditions[35]. The system strengthens Walmart's supply chain competitiveness and enhances coordination and sustainability outcomes.

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[32] https://www.enable.com/customer-stories/david-jones-seasonal-and-collaborative-approach-to-rebate-management (Accessed date 27 September 2025).

[33] https://caseworks.business.columbia.edu/caseworks/supply-chain-coordination-and-contracts-sharing-economy-case-study-cargo(Accessed date 27 September 2025).

[34] https://oag.dc.gov/release/ag-racine-files-antitrust-lawsuit-against-amazon (Accessed date 27 September 2025).

[35] https://blog.inymbus.com/walmart-retail-link (Accessed date 27 September 2025).

## 7.3. Limitations

The study contains several important limitations. Firstly, the general form of platform rebates is considered in the DCSC. However, consumer rebate redemption rates are not addressed. Actual redemption rates play a crucial role. Significant influence may be exerted on consumer behavior. These factors directly impact pricing decisions. Both consumer demand and supply chain profitability are affected. Secondly, information symmetry is assumed in the modeling process. Linear market demand is also presumed. Real-world supply chains exhibit information asymmetry. Random fluctuations commonly occur in market demand. These factors may complicate pricing strategies. Coordination decisions become more challenging. Finally, two different pricing contracts are examined in the study. Two-part pricing is implemented in the ML model. Cost-sharing is applied in the RL model. These contracts demonstrate profitability improvements. Conflict reduction is achieved within the DCSC. Perfect coordination is not achieved compared.

## 7.4. Future directions

The following research directions are recommended for future investigation: Firstly, the relationship between rebate redemption rates and supply chain pricing strategies requires further investigation. A detailed analysis of how rebate mechanisms affect consumer demand patterns is necessary. A comprehensive assessment of their impact on supply chain profitability should be conducted. A deeper understanding of the behavioral effects of rebate policies across supply chains is needed. Secondly, information asymmetry in pricing decisions demands systematic investigation. The effects of demand fluctuations on operations should be thoroughly examined. The relationships between manufacturers and retailers under asymmetric information require analysis. The interactions between platforms in such conditions should also be explored. Thirdly, the impact of random demand on supply chains needs exploration. Decision-making under uncertainty should be evaluated. The effectiveness of coordination in volatile conditions requires assessment. Practical insights for strategic adjustments should be derived. Finally, advanced contract mechanisms warrant further investigation. Comprehensive coordination frameworks aimed at achieving near-optimal alignment should be developed. Alternative contractual structures should be explored theoretically, including the possibility of reversing the roles of two-part pricing and cost-sharing contracts between the model ML and model RL. Hybrid coordination approaches that integrate elements of both contract types could be evaluated empirically to determine whether such designs can simultaneously improve surplus allocation and effort incentives. These innovations have the potential to enhance the effectiveness of dual-channel supply chain coordination and provide more robust guidance for practical supply chain management. These innovations can enhance DCSC coordination effectiveness.

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Conflicts of interest

The authors declare no conflict of interest.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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## Appendix A.

**Proposition 1.** $\frac{\partial w^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\partial m^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\partial r^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\partial p^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\partial s^{\mathrm{ML}^*}}{\partial\theta} > 0$.

*Proof.* Taking the first order derivative of equations (16)–(20) with respect to $\theta$ respectively, the following derivations are obtained:

$$\frac{\partial w^{\mathrm{ML}^*}}{\partial\theta} = \frac{a\Big(2n^4\lambda + 2l^2(\lambda-1)^2(2+\lambda)\big(\lambda+2\lambda^2-4\big) + ln^2(\lambda-1)(\lambda(8+5\lambda)-8)\Big)}{2n^4\lambda^2 + 8ln^2(\lambda-1)^2(1+\lambda)(2+\lambda) + 4l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)},$$

$$\frac{\partial m^{\mathrm{ML}^*}}{\partial\theta} = \frac{a\Big(2n^4\lambda + ln^2(\lambda-1)(8+\lambda)\big(\lambda+\lambda^2-2\big) + 2l^2(\lambda-1)^2(2+\lambda)\big(\lambda+5\lambda^2-10\big)\Big)}{2n^4\lambda^2 + 8ln^2(\lambda-1)^2(1+\lambda)(2+\lambda) + 4l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)},$$

$$\frac{\partial r^{\mathrm{ML}^*}}{\partial\theta} = \frac{a\Big(2n^4\lambda + 2ln^2(\lambda-1)^2(2+\lambda)(5+\lambda) + l^2(\lambda-1)^2(2+\lambda)\big(\lambda+14\lambda^2+\lambda^3-24\big)\Big)}{2n^4\lambda^2 + 8ln^2(\lambda-1)^2(1+\lambda)(2+\lambda) + 4l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)},$$

$$\frac{\partial p^{\mathrm{ML}^*}}{\partial\theta} = \frac{a\Big(2n^4\lambda + ln^2(\lambda-1)(2+\lambda)(5\lambda-4) + 6l^2(\lambda-1)^2(2+\lambda)\big(\lambda^2-2\big)\Big)}{2n^4\lambda^2 + 8ln^2(\lambda-1)^2(1+\lambda)(2+\lambda) + 4l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)},$$

$$\frac{\partial s^{\mathrm{ML}^*}}{\partial\theta} = \frac{an(\lambda-1)\big(l\big(4-5\lambda^2+\lambda^4\big)-n^2\lambda\big)}{n^4\lambda^2 + 4ln^2(\lambda-1)^2(1+\lambda)(2+\lambda) + 2l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)}.$$

Due to $\frac{-n^2}{\lambda+\lambda^2-2} < l \le \frac{6n^2-5n^2\lambda-2n^2\lambda^2}{2(12-13\lambda-7\lambda^2+7\lambda^3+\lambda^4)} + \frac{1}{2}\sqrt{\frac{\begin{array}{c}72n^4+12n^4\lambda-66n^4\lambda^2\\ -23n^4\lambda^3+20n^4\lambda^4+4n^4\lambda^5\end{array}}{(\lambda-1)^2(2+\lambda)(\lambda+8\lambda^2+\lambda^3-12)^2}}$, $\frac{\partial w^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\partial m^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\partial r^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\partial p^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\partial s^{\mathrm{ML}^*}}{\partial\theta} > 0$ can be obtained by calculations. Proof complete. □

**Proposition 2.** $\frac{\partial D_t^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\partial D_o^{\mathrm{ML}^*}}{\partial\theta} < 0$.

*Proof.* Taking the first order derivative of equations (21) and (22) with respect to $\theta$ respectively, the following derivations are obtained:

$$\frac{\partial D_t^{\mathrm{ML}^*}}{\partial\theta} = -\frac{al(\lambda-1)^2(2+\lambda)\big(l\big(4-5\lambda^2+\lambda^4\big)-n^2\lambda\big)}{2n^4\lambda^2 + 8ln^2(\lambda-1)^2(1+\lambda)(2+\lambda) + 4l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)},$$

$$\frac{\partial D_o^{\mathrm{ML}^*}}{\partial\theta} = -\frac{al(\lambda-1)^2(2+\lambda)\big(n^2(2+\lambda)+l(\lambda-1)(1+\lambda)(4+\lambda)\big)}{2n^4\lambda^2 + 8ln^2(\lambda-1)^2(1+\lambda)(2+\lambda) + 4l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)}.$$

From $\frac{-n^2}{\lambda+\lambda^2-2} < l \le \frac{6n^2-5n^2\lambda-2n^2\lambda^2}{2(12-13\lambda-7\lambda^2+7\lambda^3+\lambda^4)} + \frac{1}{2}\sqrt{\frac{72n^4+12n^4\lambda-66n^4\lambda^2-23n^4\lambda^3+20n^4\lambda^4+4n^4\lambda^5}{(\lambda-1)^2(2+\lambda)(\lambda+8\lambda^2+\lambda^3-12)^2}}$, $\frac{\partial D_t^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\partial D_o^{\mathrm{ML}^*}}{\partial\theta} < 0$ can be obtained by calculations. Proof complete. □

**Proposition 3.** *In the ML, according to* $\frac{\partial\Delta p^{\mathrm{ML}^*}}{\partial\theta} > 0$*, the more consumers prefer traditional retail channel, the more expensive the price consumers would pay for a product in the direct online channel.*

*Proof.* According to the difference between equations (19) and (18):

$$\Delta p^{\mathrm{ML}^*} = \frac{-al\big(\lambda+\lambda^2-2\big)\left(\begin{array}{c} n^2\big(6+\theta\big(3\lambda+2\lambda^2-6\big)-2\lambda^2\big) \\ +l\big(\theta\big(12-13\lambda-7\lambda^2+7\lambda^3+\lambda^4\big)+3\lambda+9\lambda^2-\lambda^3-\lambda^4-12\big)\end{array}\right)}{2n^4\lambda^2 + 8ln^2(\lambda-1)^2(2+3\lambda+\lambda^2) + 4l^2(\lambda-1)^2(3\lambda^2+7\lambda^3+2\lambda^4-8-10\lambda)},$$

$\frac{\partial\Delta p^{\mathrm{ML}^*}}{\partial\theta} > 0$ can be obtained when $\frac{-n^2}{\lambda+\lambda^2-2} < l \le \frac{6n^2-5n^2\lambda-2n^2\lambda^2}{2(12-13\lambda-7\lambda^2+7\lambda^3+\lambda^4)} + \frac{1}{2}\sqrt{\frac{72n^4+12n^4\lambda-66n^4\lambda^2-23n^4\lambda^3+20n^4\lambda^4+4n^4\lambda^5}{(\lambda-1)^2(2+\lambda)(\lambda+8\lambda^2+\lambda^3-12)^2}}$. Proof complete. □

**Proposition 4.** *From* $\frac{\pi_m^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\pi_r^{\mathrm{ML}}}{\partial\theta} > 0$, $\pi_m^{\mathrm{ML}^*}$ *and* $\pi_r^{\mathrm{ML}^*}$ *are positively correlated to* $\theta$*. From* $\frac{\pi_p^{\mathrm{ML}^*}}{\partial\theta} < 0$, $\pi_p^{\mathrm{ML}^*}$ *is negatively correlated with* $\theta$*.*

*Proof.* Taking the first order derivative of equations (10), (24) and (25) with respect to $\theta$ respectively, the following derivations are obtained:

$$\frac{\partial\pi_m^{\mathrm{ML}^*}}{\partial\theta} = \frac{\begin{pmatrix} a^2l^2(\lambda-1)^3(2+\lambda)^2\left(n^2(2+\lambda)+l(\lambda-1)(1+\lambda)(4+\lambda)\right) \\ \left(l\left(\lambda^2-1\right)(4-\lambda(1+\lambda)+\theta(\lambda-1)(4+\lambda))+n^2\left(2-\lambda^2+\theta\left(\lambda+\lambda^2-2\right)\right)\right)\end{pmatrix}}{\left(2\left(n^4\lambda^2+4ln^2(\lambda-1)^2(1+\lambda)(2+\lambda)+2l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)\right)^2\right)},$$

$$\frac{\partial\pi_r^{\mathrm{ML}^*}}{\partial\theta} = \frac{-a^2l(\lambda-1)\begin{pmatrix} l(\theta(\lambda-2)-\lambda)(\lambda-1)^2(1+\lambda)(2+\lambda) \\ +n^2\lambda(\theta-\theta\lambda-1)\end{pmatrix}\left(n^2+l\left(\lambda+\lambda^2-2\right)\right)\left(l\left(4-5\lambda^2+\lambda^4\right)-n^2\lambda\right)}{\left(n^4\lambda^2+4ln^2(\lambda-1)^2(1+\lambda)(2+\lambda)+2l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)\right)^2},$$

$$\frac{\partial\pi_p^{\mathrm{ML}^*}}{\partial\theta} = \frac{\begin{pmatrix} a^2l^2(\lambda-1)^3(2+\lambda)^2\left(n^2(2+\lambda)+l(\lambda-1)(1+\lambda)(4+\lambda)\right) \\ \left(l\left(\lambda^2-1\right)(4-\lambda(1+\lambda)+\theta(\lambda-1)(4+\lambda))+n^2\left(2-\lambda^2+\theta\left(\lambda+\lambda^2-2\right)\right)\right)\end{pmatrix}}{\left(2\left(n^4\lambda^2+4ln^2(\lambda-1)^2(1+\lambda)(2+\lambda)+2l^2(\lambda-1)^2(1+\lambda)(2+\lambda)(\lambda+2\lambda^2-4)\right)^2\right)}.$$

From $\frac{-n^2}{\lambda+\lambda^2-2} < l \le \frac{6n^2-5n^2\lambda-2n^2\lambda^2}{2(12-13\lambda-7\lambda^2+7\lambda^3+\lambda^4)} + \frac{1}{2}\sqrt{\frac{72n^4+12n^4\lambda-66n^4\lambda^2-23n^4\lambda^3+20n^4\lambda^4+4n^4\lambda^5}{(\lambda-1)^2(2+\lambda)(\lambda+8\lambda^2+\lambda^3-12)^2}}$, $\frac{\pi_r^{\mathrm{ML}}}{\partial\theta} > 0$, $\frac{\pi_m^{\mathrm{ML}^*}}{\partial\theta} > 0$, $\frac{\pi_p^{\mathrm{ML}^*}}{\partial\theta} < 0$ can be obtained by calculations. Proof complete. □

**Proposition 5.** $\frac{\partial s^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial w^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial m^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial r^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial p^{\mathrm{RL}^*}}{\partial\theta} > 0$.

*Proof.* Taking the first order derivative of equations (34)–(38) with respect to $\theta$ respectively, the following derivations are obtained: $\frac{\partial s^{\mathrm{RL}^*}}{\partial\theta} = \frac{an(\lambda-2)}{2(n^2+2l(\lambda^2-2))}$, $\frac{\partial w^{\mathrm{RL}^*}}{\partial\theta} = \frac{a\left(n^2\lambda+2l\left(2-3\lambda+\lambda^3\right)\right)}{4(\lambda^2-1)(n^2+2l(\lambda^2-2))}$, $\frac{\partial m^{\mathrm{RL}^*}}{\partial\theta} = \frac{a\left(n^2(2+\lambda)+2l(\lambda(5\lambda-1)-10)\right)}{4(1+\lambda)(n^2+2l(\lambda^2-2))}$, $\frac{\partial r^{\mathrm{RL}^*}}{\partial\theta} = \frac{a\left(n^2(3+2\lambda)+l(\lambda(\lambda(13+\lambda)-4)-24)\right)}{4(1+\lambda)(n^2+2l(\lambda^2-2))}$, $\frac{\partial p^{\mathrm{RL}^*}}{\partial\theta} = \frac{a\left(n^2\lambda+2l(\lambda-1)(\lambda(3\lambda-1)-6)\right)}{4(\lambda^2-1)(n^2+2l(\lambda^2-2))}$. From $0 < \lambda \le \frac{1}{24}\left(-11+\sqrt{217}\right)$, $l > \frac{2n^2}{7}$, $\frac{\partial s^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial w^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial m^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial r^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial p^{\mathrm{RL}^*}}{\partial\theta} > 0$ can be obtained by calculations. Proof complete. □

**Proposition 6.** $\frac{\partial D_t^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial D_o^{\mathrm{RL}^*}}{\partial\theta} < 0$.

*Proof.* Taking the first order derivative of equations (39) and (40) with respect to $\theta$ respectively: $\frac{\partial D_{t2}^{\mathrm{RL}^*}}{\partial\theta} = -\frac{al(-2+\lambda)\left(-2+\lambda^2\right)}{4(n^2+2l(-2+\lambda^2))}$, $\frac{\partial D_{o2}^{\mathrm{RL}^*}}{\partial\theta} = -\frac{a\left(n^2+l(-4+\lambda(2+\lambda))\right)}{4(n^2+2l(-2+\lambda^2))}$, due to $0 < \lambda \le \frac{1}{24}\left(-11+\sqrt{217}\right)$, $l > \frac{2n^2}{7}$, therefore, $\frac{\partial D_{t2}^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\frac{\partial D_{o2}^{\mathrm{RL}^*}}{\partial\theta} < 0$, proof complete. □

**Proposition 7.** *The actual purchase price of the direct online channel tends to increase and then decrease as consumer channel preference for traditional retail channels increases, subject to a range of retailer effort cost factors.*

*Proof.* According to the difference between equations (37) and (36):

$$\Delta p^{\mathrm{RL}^*} = p^{\mathrm{RL}^*} - r^{\mathrm{RL}^*} = -\frac{a\left(n^2(\theta-1)\left(2\lambda^2-3\right)+l\left(9\lambda^2-\lambda^4+\theta\left(12-10\lambda-9\lambda^2+6\lambda^3+\lambda^4\right)-12\right)\right)}{4(\lambda-1)(1+\lambda)(n^2+2l(\lambda^2-2))},$$

$\frac{\partial\Delta p^{\mathrm{RL}^*}}{\partial\theta} > 0$ can be obtained when the retailer effort cost factor $l$ satisfies $\frac{2n^2}{7} < l < \frac{3n^2-2n^2\lambda^2}{12-10\lambda-9\lambda^2+6\lambda^3+\lambda^4}$. When the retailer effort cost factor $l$ satisfies $l > \frac{3n^2-2n^2\lambda^2}{12-10\lambda-9\lambda^2+6\lambda^3+\lambda^4}$, $\frac{\partial\Delta p^{\mathrm{RL}^*}}{\partial\theta} < 0$ can be obtained by calculations. Proof complete. □

**Proposition 8.** *From* $\frac{\pi_r^{\mathrm{RL}^*}}{\partial\theta} > 0$, $\pi_r^{\mathrm{RL}^*}$ *is positively correlated with* $\theta$. $\pi_m^{\mathrm{RL}^*}$ *and* $\pi_p^{\mathrm{RL}^*}$ *both show a trend of decreasing and then increasing with* $\theta$.

*Proof.* Taking the first order derivative of equations (41)–(43) with respect to $\theta$ respectively, the following derivations are obtained:

$$\frac{\partial\pi_r^{\mathrm{RL}^*}}{\partial\theta} = -\frac{a^2 l(\theta(\lambda-2)-\lambda)(\lambda-2)}{4(n^2+2l(\lambda^2-2))} > 0,$$

$$\frac{\partial\pi_m^{\mathrm{RL}^*}}{\partial\theta} = \frac{-a^2\left(\lambda^2-2\right)\begin{pmatrix} -n^4(\theta-1)+4ln^2(\lambda-2-2\theta(\lambda-1)) \\ +2l^2(\lambda-1)\begin{pmatrix} -(2+\lambda)(4+(\lambda-3)\lambda) \\ +\theta(12+\lambda((\lambda-3)\lambda-8)) \end{pmatrix} \end{pmatrix}}{8(\lambda^2-1)(n^2+2l(\lambda^2-2))^2},$$

$$\frac{\partial\pi_p^{\mathrm{RL}^*}}{\partial\theta} = \frac{a^2\begin{pmatrix} n^4(\theta-1)\left(2\lambda^2-3\right)+2ln^2(\lambda(7+(8-5\lambda)\lambda-12)+2\theta(\lambda-1)(\lambda(5\lambda-1)-8)) \\ -l^2(\lambda-1)\begin{pmatrix} 48+\lambda(\lambda(-44-(\lambda-3)\lambda(6+5\lambda))-16) \\ +\theta(\lambda(32+\lambda(96+\lambda(1+\lambda)(5\lambda-28)))-96) \end{pmatrix} \end{pmatrix}}{8(\lambda^2-1)(n^2+2l(\lambda^2-2))^2}.$$

When the retailer's effort cost factor $l$ satisfies $l > \frac{-6n^2-n^2\lambda}{10\lambda-2\lambda^2+4\lambda^3-12}$ and consumers' preference $\theta$ satisfy $\frac{3n^2-2l\lambda+2n^2\lambda+7l\lambda^2+l\lambda^3-12l}{3n^2-4l\lambda+2n^2\lambda+13l\lambda^2+l\lambda^3-24l} < \theta < \frac{8ln^2-n^4+20l^2\lambda-4ln^2\lambda-2l^2\lambda^2-4l^2\lambda^3+2l^2\lambda^4-16l^2}{8ln^2-n^4+40l^2\lambda-8ln^2\lambda-10l^2\lambda^2-8l^2\lambda^3+2l^2\lambda^4-24l^2}$, $\frac{\partial\pi_m^{\mathrm{RL}^*}}{\partial\theta} < 0$ can be obtained by calculations. When consumers' preference $\theta$ satisfy $\frac{8ln^2-n^4+20l^2\lambda-4ln^2\lambda-2l^2\lambda^2-4l^2\lambda^3+2l^2\lambda^4-16l^2}{8ln^2-n^4+40l^2\lambda-8ln^2\lambda-10l^2\lambda^2-8l^2\lambda^3+2l^2\lambda^4-24l^2} < \theta < 1$, $\frac{\partial\pi_m^{\mathrm{RL}^*}}{\partial\theta} > 0$ can be obtained by calculations. When retailer effort cost $l > \frac{6n^2+10n^2\lambda-5n^2\lambda^2-4n^2\lambda^3}{18\lambda^2-18\lambda^3-11\lambda^4+11\lambda^5}$ and consumer channel preference $\theta$ satisfies $\frac{3n^2-2l\lambda+2n^2\lambda+7l\lambda^2+l\lambda^3-12l}{3n^2-4l\lambda+2n^2\lambda+13l\lambda^2+l\lambda^3-24l} < \theta < D$, $\frac{\partial\pi_p^{\mathrm{RL}^*}}{\partial\theta} < 0$ can be obtained by calculations, where

$$D = \frac{\begin{matrix} 48l^2-24ln^2+3n^4-64l^2\lambda+14ln^2\lambda-28l^2\lambda^2 \\ +16ln^2\lambda^2-2n^4\lambda^2+62l^2\lambda^3-10ln^2\lambda^3-9l^2\lambda^4-14l^2\lambda^5+5l^2\lambda^6 \end{matrix}}{\begin{matrix} 96l^2-32ln^2+3n^4-128l^2\lambda+28ln^2\lambda-64l^2\lambda^2 \\ +24ln^2\lambda^2-2n^4\lambda^2+124l^2\lambda^3-20ln^2\lambda^3-5l^2\lambda^4-28l^2\lambda^5+5l^2\lambda^6 \end{matrix}}.$$

When consumer channel preference $\theta$ satisfies $D < \theta < 1$, $\frac{\partial\pi_p^{\mathrm{RL}^*}}{\partial\theta} > 0$. Proof complete. □

**Proposition 9.** *In the ML, the two-part pricing pact can increase the profitability of manufacturers and retailers compared to the pre-coordination model but also result in lower platform profits when wholesale price and fixed costs are satisfied with* $(w,F) = \left(w^{\mathrm{co}^*}, F^*\right)$.

*Proof.* Based on the range of parameters coordinated by the two pricing compacts $-\frac{n^2}{-2+\lambda+\lambda^2} < l \leq \frac{6n^2-5n^2\lambda-2n^2\lambda^2}{2(12-13\lambda-7\lambda^2+7\lambda^3+\lambda^4)} + \frac{1}{2}\sqrt{\frac{72n^4+12n^4\lambda-66n^4\lambda^2-23n^4\lambda^3+20n^4\lambda^4+4n^4\lambda^5}{(-1+\lambda)^2(2+\lambda)(-12+\lambda+8\lambda^2+\lambda^3)^2}}$, $\pi_m^{\mathrm{co}^*} \geq \pi_m^{\mathrm{ML}^*}$, $\pi_p^{\mathrm{co}^*} < \pi_p^{\mathrm{ML}^*}$, and $\pi_r^{\mathrm{co}^*} \geq \pi_r^{\mathrm{ML}^*}$ can be obtained. From $\pi^{\mathrm{co}^*} - \pi^{\mathrm{ML}^*} > 0$, $\pi^{\mathrm{co}^*} > \pi^{\mathrm{ML}^*}$ can be obtained. Proof complete. □

**Proposition 10.** *In the RL, the contract coordinates the DCSC under the platform rebate model when the manufacturer's cost-sharing ratio satisfies* $0 < \phi^* < \frac{n^2+2l\lambda^2-4l}{2l\lambda^2-4l}$.

*Proof.* DCSC members express a willingness to engage in cost-sharing contract coordination exclusively if the profit of DCSC members surpasses the profit before coordination, denoted as $\pi_m^{\mathrm{co}^*} > \pi_m^{\mathrm{RL}^*}$, $\pi_r^{\mathrm{co}^*} > \pi_r^{\mathrm{RL}^*}$, $\pi_p^{\mathrm{co}^*} > \pi_p^{\mathrm{RL}^*}$. Supply chain members would actively participate only under these circumstances, and the range of $\phi$ can be determined by solving the inequality and identifying its intersection.

From $\pi_m^{\mathrm{co}^*} - \pi_m^{\mathrm{RL}^*} > 0$, $0 < \phi < \frac{\left(n^2+2l\left(\lambda^2-2\right)\right)\left(8l(1+\theta(\lambda-1))\lambda\left(\lambda^2-2\right)+n^2\left(3\lambda-\lambda^3+\theta((\lambda-1)\lambda(3+\lambda)-2)\right)\right)}{l(\lambda^2-2)(4l(\lambda^2-2)(5\lambda-\lambda^3+\theta(\lambda-1)(\lambda(3+\lambda)-2))+n^2(9\lambda-3\lambda^3+\theta(2+\lambda(\lambda(2+3\lambda)-9))))}$ can be calculated to obtain. From $0 < \phi < 1$, $\pi_r^{\mathrm{co}^*} - \pi_r^{\mathrm{RL}^*} > 0$ can be obtained. According to $\pi_p^{\mathrm{co}^*} - \pi_p^{\mathrm{RL}^*} > 0$, $0 < \phi < \frac{2\left(\left(n^2-4l\right)(\theta-1)+2l\theta\lambda+l(\theta-1)\lambda^2\right)\left(n^2+2l\left(\lambda^2-2\right)\right)}{l(n^2(8-3\lambda^2+\theta(2+\lambda)(3\lambda-4))+4l(\lambda^2-2)(4-\lambda^2+\theta(\lambda(2+\lambda)-4)))}$ can be obtained. According to the intersection of the range of $\phi$, the cost-sharing contract can achieve Pareto improvement in the DCSC under the platform rebate model when $\frac{2n^2}{7} < l < \frac{3n^2-n^2\lambda^2}{8-12\lambda^2+4\lambda^4}$, the manufacturer cost-sharing ratio is $0 < \phi^* < \frac{n^2+2l\lambda^2-4l}{2l\lambda^2-4l}$. As defined in Table 1, the parameter ranges satisfy $l \geq 0$ and $0 < \lambda < \frac{1}{2}$. The upper bound of $\phi$ can be algebraically expressed as $\phi^* = 1 + \frac{n^2}{2l(\lambda^2-2)}$. Since $\lambda^2 - 2 < 0$ and $l \geq 0$, the denominator $2l\left(\lambda^2 - 2\right)$ is negative, hence the fraction $\frac{n^2}{2l(\lambda^2-2)}$ is negative. Consequently, $\phi^* < 1$, and the feasible domain of $\phi$ is contained in $(0, 1)$. $\square$