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MANAGING THE ONLINE CHANNEL BY COORDINATING A THIRD-PARTY LOGISTICS AND SERVICE PROVIDER ALONG WITH A DUAL-CHANNEL RETAILER

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This paper considers traditional and online stores under the context of a dual-channel retailing system. Fully refunded returns are permissible in both forms: same-channel and cross-channel. We examined three different coordination strategies that may form between the retailer and a third-party logistics and service provider. The provider was tasked to manage the online store's orders through transaction-based fees, flat-based fees, and gain-sharing contracts. For each of those strategies, we found the online store's optimal pricing policy and the seasonal fee, if applicable. The performance ratings of the partners under the different strategies were compared, and the managerial insights were provided using analytical as well as numerical analysis. It was found that the retailer is always more profitable under the flat-based fee strategy compared to the gain-sharing strategy, while the provider was almost always more profitable under the latter strategy. Moreover, a low rate of return encouraged the retailer to have more independence by implementing the transaction-based fee strategy, while a high rate pushed the retailer to have more logistical involvement and support through the implementation of either the flat-based fee or gain-sharing strategies.

Keywords: Dual-Channel, Resalable Returns, Pricing, Stackelberg Game, Third-Party Logistics And Service Provider

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1. INTRODUCTION

Around 80% of all businesses and about every well-known business in the US have adopted the dual-channel retailing system (Zhang *et al.*, 2010). Thus, dual-channel retailers (DCRs) will gain the opportunity to use both traditional and online stores to sell their products and services (Ryan *et al.*, 2013). To name just a few, Wal-Mart, Costco, Target, Kmart, Barnes and Noble, Nike, and Kohl's are all considered to be DCRs. The emergence of COVID-19, the wide spread of the Internet, and the effectiveness of the third-party logistics and service providers (herein called providers) are among the reasons that enhanced the establishment of dual-channel retailing systems. Over the past years, providers have significantly advanced their competencies in providing services such as inventory management, warehousing, shipping, and fleet management. While successful outsourcing can enhance competitiveness and performance for a retailer, coordinating the retailer–provider alliance is a complex task, and literature has reported conflicting outsourcing outcomes (Hartmann and de Grahl, 2012).

Offering a full refund policy for unsatisfied purchases is a common practice applied by many retailers around the world to boost channels' demand, customer satisfaction, and customer loyalty. Following a country's legislation is another reason for the increase in full refund applications. However, this policy encourages customers to return purchases more often and for a wide range of reasons. Research shows that customer return rates have intensified as online stores are more common in today's market. Indeed, the credibility and fit of the online stores' items are much less compared to the traditional stores' items due to the different customer exposure. Accordingly, online stores are obliged to assure quality for their customers by offering a full refund policy. Akçay *et al.* (2013), Mostard and Teunter (2006), and Vlachos and Dekker (2003) have indicated that in-person purchases recorded a return rate of up to 35%, while online purchases recorded a return rate of up to 75% within the apparel industry. In practice, in-person purchases can be returned to the traditional store, while online purchases can be cross-returned to the traditional store or using the online store's return services.

DCRs' functions are greatly influenced by customer returns due to the accompanying impacts on operation management decisions. One of the known reasons that may lead to unsuccessful online start-ups is the inability to manage customers' orders and expenses. Indeed, unsatisfied customers may become logistically overwhelming to retailers due to their returns. It

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is usual for online stores to invest abundantly in marketing campaigns while lacking the necessary efforts to manage customers' orders and returns. Indeed, a premium online store is useless if goods are not delivered as promised, returns are not responsively handled, and the store is struggling to generate profit. Consequently, when customer returns are allowed, it is crucial for a DCR to successfully manage its online store's pricing strategy.

Due to the responsiveness and efficiency exerted by providers, many retailers choose to outsource certain online stores' related logistical and warehousing tasks to one or several providers. Such an outsourcing strategy allows retailers to focus on their main competency, i.e., retailing services while exploiting external resources and expertise. For instance, about 70% of retailers today outsource transportation needs to 3PLs (Lei *et al*., 2006). According to Min (2013), outsourcing policies range from an undeveloped alliance with a charge-per-service policy (most popular) to a real alliance with a gain-sharing policy (least popular). The partnership between the various providers and Sheetz Corp. or between Transplace and AutoZone Inc. are among the recent examples of retailer–provider alliances. According to Lei *et al*. (2006), gain-sharing is a significant compensation policy that provides an opportunity for a successful partnership. Additionally, Toys "R" Us formed a partnership with Amazon.com to provide the following: site development, inventory management, order fulfillment, and customer services for a span of ten years (Berger *et al*., 2006).

A profound task here is to determine the online store's pricing policy for a DCR when all common forms of customer returns are allowed. This paper examines three different outsourcing strategies that could be implemented by a DCR while using a third-party logistics and service provider, as depicted below:

(1) *Transaction-based fee strategy*: In this strategy, the DCR performs the needed logistical activities by using its own fleet or a provider that is compensated through a transaction-based fee policy. Therefore, a dollar amount is paid to the provider for each logistical activity without any substantial fee paid upfront. In this strategy, there is no long-term agreement between the DCR and the provider; thus, the amount paid is assumed to be exogenous, and the system has a sole decision maker.

(2) *Flat-based fee strategy*: In this case, the DCR manages the orders of the traditional store only, while a provider is outsourced to manage the orders of the online store. As a Stackelberg leader, the provider charges the DCR a demand-dependent flat fee. As a Stackelberg follower, the DCR determines the pricing policy for the online store.

(3) *Gain-sharing strategy*: Similar to the preceding strategy, the DCR fulfills the orders received by the traditional store, while the provider fulfills the orders received by the online store. In addition to the demand-dependent seasonal fee paid by the DCR, the partners reinforce their alliance by sharing the e-tail store's profit.

This paper has three contributions: first, online store's management is studied using different outsourcing policies while considering same- and cross-channel returns in a dual-channel retailing environment; second, mathematical models are devised to determine the optimal pricing policy for the online store and the optimal seasonal fee paid to the provider; third, decision-making insights are presented through analytical comparisons to maximize retailers' and providers' efficiencies and achieve successful alliances. As indicated by Keränen *et al*. (2023), such contributions will respond to numerous recent calls for more work in the field of B2B pricing behavior, where it remains a critical yet poorly understood issue. The rest of the paper is structured as follows. First, the literature review related to this article is provided. Second, the problem statement and the essential assumptions needed to build our model are presented. Then, the optimal online price for a DCR who is utilizing the transaction-based fee strategy is studied. After that, the pricing decisions for a DCR and a third-party logistics and service provider undergoing Stackelberg competition and flat-based fee strategic partnership are examined. The pricing decisions for the competitive partners are then studied under the gain-sharing scheme. In addition, analytical and numerical analyses are conducted to acquire important managerial insights. Finally, conclusions and recommendations for future research are presented.

2. RELATED WORKS

This section discusses three streams of literature. The outsourcing of third-party logistics and service providers and the corresponding contractual agreements are first reviewed. Customer return in non-competitive settings is reviewed next. Third, customer return under theoretical game frameworks is revised. Studies on outsourcing logistical activities to a third-party logistics and service provider have been increasing considerably in the last few decades. For instance, Fallahi *et al*. (2023) studied a centralized partnership between a retailer and a third-party logistics provider where profit sharing is implemented. Their model chose the optimal flow and selling price and helped lower pollution and harmful emissions.

Cao *et al*. (2023) examined the optimal operational and logistical strategies for sellers using a platform for their retailing businesses. The study offered conditions for whether to operate as a supplier or as a co-optor and whether to adopt platform logistics or non-platform logistics. Makhmudov *et al*. (2021) considered defective rates caused by service providers and the possible penalties enforced on them, if any. Chen *et al*. (2022) studied coordination among a manufacturer, a retailer, and a third-party logistics provider in a three-echelon closed-loop supply chain where the retailer is the Stackelberg leader. Tu *et* *al*. (2022) studied an e-tailer selling agricultural products through online platforms and third-party logistics providers. They assumed that e-tailer demand depends on promotion as well as logistical efforts.

Three types of contacts were used to synchronize the supply chain: fixed-price, revenue-sharing, and cost-sharing. Zhang *et al*. (2021) proposed centralized and decentralized coordination schemes for a supply chain consisting of a product supplier, a platform service provider, and a logistics provider. Wang *et al*. (2021) used a game theoretical approach to coordinate among a third-party logistics and service provider, a manufacturer, and an e-commerce retailer operating under a cross-shopping retailing environment. To maximize supply chain efficiency, an "altruistic preference joint fixed-cost" contract was implemented by their study. Giri and Sarker (2017) studied the performance of the supply chain when the manufacturer, third-party logistics service provider, and independent retailers experience stochastic and price-sensitive demand. Buyback- and revenue-sharing contracts were used to synchronize a supply chain facing disruption in production within the manufacturing facility. He *et al*. (2016) examined different policies that can be applied among the online stores of both the manufacturer and the retailer. They considered demand to be dependent on price, national advertising effort, and logistics service level. Jiang *et al*. (2014) studied coordination decisions for a manufacturer, a third-party logistics provider, and two competing retailers when product distribution functions are applied. Cai *et al*. (2013) examined a fresh products supplier, a distant distributor, and a third-party logistics provider where both the quantity and quality of products deteriorate while being transported. Market demand was assumed to be stochastic, and price and freshness were presumed sensitive.

Liu *et al*. (2013) studied the fairest revenue-sharing coefficient for a logistics integrator and a provider in a two-echelon system. They also investigated the coefficient for a logistics integrator, a provider, and a subcontractor in a three-echelon system. Lei *et al*. (2006) examined the effect of coordination and pricing policies on a system's performance when the provider has a concave cost function. Jharkharia and Shankar (2007) devised two methodologies that enable retailers to select the right third-party logistics and service provider. Fabbe-Costes *et al*. (2009) studied the role of providers in enhancing supply chain integration and performance. All previous papers have studied the contractual agreements between a retailer and a third-party provider without considering the impact of customer returns on policies and partners' decisions.

Moreover, several scholars examined customer returns under a centralized or cooperative framework. In this context, a single-echelon system may have been considered. For example, Nageswaran *et al*. (2020) examined pricing and return policy for a DCR running both a traditional and an online store. Returns to the traditional store were assumed to be fully refunded, while returns to the online store were presumed to be either fully or partially refunded. Reimann (2016) studied a retailing scheme where refurbished returns can be utilized to fulfill demand beyond the order quantity. Akçay *et al*. (2013) examined a system in which customers can differentiate between a new item and a returned item. Based on return timing, application of penalty, and return recoverability, Yu and Goh (2012) studied eight different return scenarios, while, based on return re-saleability and return recoverability, Vlachos and Dekker (2003) investigated six different scenarios. Wang *et al*. (2010)stated that at the beginning of the selling season, sales consume new items and returned items; at the middle of the selling season, sales consume only returned items; and toward the end of the selling season, there will be no sales to consume returned items. Other papers studied the possibility of infinite re-salability for returns (Mostard *et al*., 2005; Mostard and Teunter, 2006).

Moreover, cooperation within a two-echelon system in which contracts and information sharing may have been used to coordinate retailers and manufacturers has been inspected. For example, Chang and Yeh (2013) studied integration and disintegration between a retailer and a manufacturer wherein both experience returns. Additionally, Hu and Li (2012) examined the impact of information sharing on the performance of a system with customer returns. Furthermore, Hu *et al*. (2014) studied a vendor–retailer consignment contract wherein either the retailer or the vendor makes inventory management decisions.

Other papers have examined customer returns where market-share competition among players may rise. For example, Radhi (2022) studied service levels offered by the online stores of a DCR and a manufacturer under the theoretical game framework. The paper assumed that service levels have a tangible influence on channels' demand and customer return choice. Zhang *et al*. (2021) examined the pricing policy of a risk-averse DCR and a risk-neutral manufacturer. Returns to the traditional store were assumed to be fully refunded, while returns to the online store were assumed to be either fully or partially refunded. They studied the impact of the retailer's risk indicator and consumer returns rate on the performance of the retailing system. Jin *et al*. (2020) investigated the competitiveness and optimality of a cross-channel return policy when two DCRs compete in a duopolistic theoretical framework. The work assumed that a larger salvage value could be recovered from items returned to the traditional store compared to those returned to the online store. Liu *et al*. (2020) studied pricing strategies for a retailer with a traditional store and a manufacturer with an e-tail store. In their study, conditions for adopting single or dual money-back guarantee return strategies have been identified. While Radhi and Zhang (2019) examined four different return strategies, Radhi and Zhang (2018) investigated the optimal pricing policies for a DCR facing resalable same- and cross-channel returns. Chen and Bell (2012) studied a system with two customer types: return-sensitive customers, who pay more for being able to return products; and price-sensitive customers, who pay less for not being able to return products.

Furthermore, Chen and Grewal (2013) examined competition between a retailer that is new in the market and another one that is well-established with a full refund policy. Similarly, Chen and Zhang (2011) applied game theoretical approaches to investigate competition between two retailers offering full refunds to customers. Balakrishnan *et al*. (2014) studied the behavior of browsing and switching on a retailer's profitability and prices when returns are allowed for online purchases only. Ofek *et al*. (2011) considered pricing and assistance level competition within the context of a single-channel and a dual-channel system. The reader may observe the huge efforts made to study customer returns without much reflection exerted on the provider's role. In addition, Table 1 provides a comparative analysis that validates the position of this work within the literature.

In this paper, we provide a DCR offering full refunds with an option to outsource the online store's management to a third-party logistics and service provider. Accordingly, we studied the pricing decisions for the online store under three strategies: transaction-based fee, flat-based fee, and gain-sharing. A game theoretical approach was used for the latter two strategies to examine the seasonal fee paid to the provider in return for the offered managerial and logistical services.

Table 1. Position of the Present Paper in the Literature

Author	**Manufacturer/ Platform/Other**	**Retailer ***	**3PL**	**Return Type ***	**Coordination Scheme**	**Decisions**
The Present Paper	✗	DCR	✓	SCR and CCR	Stackelberg	Selling Price and Service Price
Fallahi *et al*., 2023	✗	SR	✓	✗	Centralization	Selling Price and Flow
Cao *et al*., 2023	Platform	SR	✓	✗	Stackelberg	Wholesale Price and Retail Price
Chen *et al*., 2022	Manufacturer	SR	✓	✗	Stackelberg	Wholesale Price, Service Price, Selling Price, Transfer Price, and Recycling Price
Tu *et al*., 2022	✗	SR	✓	✗	Stackelberg	Logistical Service, Retailing Service, and Selling Price
Zhang *et al*., 2021	Platform	SR	✓	✗	Centralization and Stackelberg	Selling Price, Logistical Service, and Platform Service
Wang *et al*., 2021	Manufacturer and Platform	✗	✓	✗	Stackelberg	Platform Service, Logistical Price, and Selling Price
Giri and Sarker, 2017	Manufacturer	Several SRs	✓	✗	Centralization and Stackelberg	Wholesale Price, Logistical Price, Selling Price, and Order Quantities
He *et al*., 2016	Manufacturer	Two SRs	✗	✗	Stackelberg	Logistical Service and Selling Price
Jiang *et al*., 2014	Manufacturer	Two SRs	✓	✗	Centralization and Stackelberg	Wholesale Price, Service Price, and Selling Price
Liu *et al*., 2013	Logistics Integrator	✗	✓	✗	Stackelberg	Revenue-Sharing Coefficient
Radhi, 2022	Manufacturer	DCR	✗	SCR and CCR	Stackelberg and Nash	Service Level
Nageswaran *et al*., 2020	✗	DCR	✗	SCR and CCR	Centralization	Selling Price and Refund Policy
Zhang *et al*., 2021	Manufacturer	DCR	✗	SCR	Stackelberg	Wholesale Price and Selling Price
Jin *et al*., 2020	✗	Two DCRs	✗	CCR	Stackelberg	Selling Price and Online Return Policy
Reimann, 2016	✗	SR	✗	SCR	Centralization	Order Quantity
Akçay *et al*., 2013	✗	SR	✗	SCR	Centralization	Order Quantity, Selling Price, and Refund Price
Yu and Goh, 2012	✗	SR	✗	SCR	Centralization	Order Quantity
Vlachos and Dekker, 2003	✗	SR	✗	SCR	Centralization	Order Quantity
Wang *et al*., 2010	✗	SR	✗	SCR	Centralization	Order Quantity and Selling Price
Mostard *et al*., 2005	✗	SR	✗	SCR	Centralization	Order Quantity
Mostard and Teunter, 2006	✗	SR	✗	SCR	Centralization	Order Quantity
Chang and Yeh, 2013	Manufacturer	SR	✗	SCR	Centralization and Stackelberg	Wholesale Price, Buyback Price, and Order Quantity
Hu and Li, 2012	Manufacturer	SR	✗	SCR	Stackelberg	Wholesale Price, Buyback Price, Refund Price, and Selling Price
Hu *et al*., 2014	Manufacturer	SR	✗	SCR	Stackelberg	Consignment Price, Buyback Price, Order Quantity, and Selling Price
Liu *et al*., 2020	Manufacturer	two SRs	✗	SCR		Wholesale Price and Selling Price
Radhi and Zhang, 2019	✗	DCR	✗	SCR and CCR	Centralization and Stackelberg	Order Quantity
Radhi and Zhang, 2018	✗	DCR	✗	SCR and CCR	Centralization, Stackelberg and Nash	Selling Price
Chen and Bell, 2012	✗	SR and DCR	✗	SCR	Centralization	Selling Price
Chen and Grewal, 2013	Manufacturer	Two SRs	✗	SCR	Stackelberg and Nash	Wholesale Price and Selling Price

Author	Manufacturer/ Platform/Other	Retailer *	3PL	Return Type *	Coordination Scheme	Decisions
Chen and Zhang, 2011	✗	Two SRs	✗	SCR	Stackelberg and Nash	Selling Price
Balakrishnan *et al.*, 2014	✗	Two SRs	✗	SCR	Stackelberg	Selling Price
Ofek *et al.*, 2011	✗	SR and DCR	✗	SCR	Stackelberg	Store Assistant Level and Selling Price

* SR is a sole retailer/e-tailer, DCR is a dual-channel retailer, SCR is same-channel return, CCR is cross-channel return

3. PROBLEM STATEMENT

This work studied a DCR (i.e., a retailer running both a traditional and an online store) offering full refunds for product returns. A rate of $0 \leq r_t \leq 1$ from the traditional store's purchases was returned to the traditional store. A rate of $0 \leq r_o \leq 1$ from the online store's purchases was returned to the online store, while a rate of $0 \leq r_{ot} \leq 1$ was cross-returned to the traditional store (Figure 1). Chen and Grewal (2013), Mostard *et al*. (2005), Mostard and Teunter (2006), Vlachos and Dekker (2003), and others have represented returns as ratios in their work.

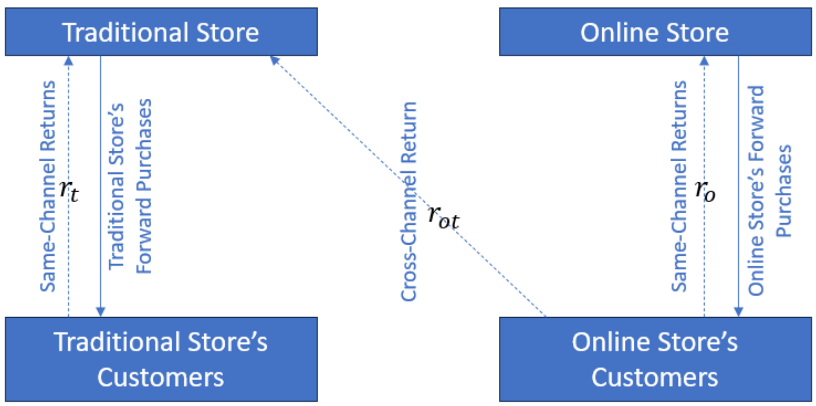


Figure 1. A dual-channel retailer with same- and cross-channel returns

Since many returns are in resalable condition, Akçay *et al*. (2013), Radhi and Zhang (2018), and Radhi and Zhang (2019) have assumed that such returns can be resold at least once in a selling season. Thus, k_t is the rate of resalability for traditional store returns, k_o is the rate of resalability for online store's returns that were sent back to the online store, and k_{ot} is the rate of resalability for online store returns that were dropped off at the traditional store. First-time same-channel resalable returns can be used to satisfy demand from their original channels. However, if returned again, they will be salvaged along with all non-resalable returns. All cross-channel resalable returns can be used once to satisfy demand from the traditional channel. Similarly, if returned again, they will be salvaged along with all non-resalable returns. Intuitively, the salvage value must be assigned a lesser or equivalent amount relative to the purchasing cost, i.e., $s \leq c$.

D_t and D_o denote total sales received by the traditional store and the online store, respectively. Q_t and Q_o are quantities purchased by the traditional store and the online store to satisfy sales, respectively. α denotes the base level of sales or the level of sales when products are offered to consumers free of charge (Chen *et al*., 2012; Huang *et al*., 2012). The traditional store's base level of sales is calculated as $\alpha_t = \alpha\theta$, where $0 \leq \theta \leq 1$ is a measure of the traditional store's customer preference. Moreover, the online store's base level of sales is calculated as $\alpha_o = \alpha(1-\theta)$, where $0 \leq 1-\theta \leq 1$ is a measure of the online store's customer preference. Customers mostly acquire customized, immature, and quality-differentiable products from the traditional channels, while they obtain standardized, mature, and quality-non-differentiable products from the online channels (Hua *et al*., 2010). The sales functions for the traditional store and the online store are given, respectively, as follows:

$D_t = \alpha_t - \beta p_t + \gamma p_o$, and
$D_o = \alpha_o - \beta p_o + \gamma p_t$.

While β is the self-price sensitivity measuring the effect of the channel's own price on its sales level, γ is the cross-price sensitivity measuring the effect of the cross-channel's price on the channel's sales level. We assumed that the channel's price decision has a higher effect on sales compared to the cross-channel's price decision, i.e., $\beta > \gamma$. Radhi and Zhang (2018), Chen *et al*. (2012), Huang *et al*. (2012), Ryan *et al*. (2013), and others have utilized linear sales functions for DCRs. In our study, the traditional store's price was assumed to be exogenous to the system; however, its implications still existed in our model. This may be the case when the traditional stores within a market experience vigorous competition due to maturity.

Several retailers did not achieve considerable success in their initial attempts to offer returnable and deliverable products through dual-channel retailing systems. Consequently, this work offers online pricing and seasonal fee policies for a DCR and a provider undergoing game theoretical competition wherein customer returns are allowed. For ease of recognition, we denoted the retailer as he and the provider as she. Moreover, in this paper, the following notations were used:

Table 2. Notations

Notation	Description
$\boldsymbol{r_t}$	Rate at which an item obtained from the traditional store is returned to the store
$\boldsymbol{r_o}$	Rate at which an item obtained from the online store is returned to the store
$\boldsymbol{r_{ot}}$	Rate at which an item obtained from the online store is cross-returned to the traditional store
$\boldsymbol{k_t}$	Likelihood that a traditional store's purchased and returned item is resalable
$\boldsymbol{k_o}$	Likelihood that an online store's purchased and returned item is resalable
$\boldsymbol{k_{ot}}$	Likelihood that a cross-channel returned item is resalable
$\boldsymbol{c}$ and $\boldsymbol{s}$	Unit purchasing cost and salvage value, respectively
$\boldsymbol{h_R}$ and $\boldsymbol{h_P}$	Per-unit retailer's and provider's handling costs, respectively. Note that $h_R > h_P$.
$\boldsymbol{D_t}$ and $\boldsymbol{D_o}$	Final and returned purchases experienced by the traditional and online stores, respectively
$\boldsymbol{Q_t}$ and $\boldsymbol{Q_o}$	Order quantity for traditional and online stores, respectively
$\boldsymbol{\alpha}$, $\boldsymbol{\alpha_t}$, and $\boldsymbol{\alpha_o}$	Retailer, traditional, and online stores' base levels of sale, respectively
$\boldsymbol{\theta}$	Preference of customers to the traditional store
$\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$	Store's self and cross-price sensitivities, respectively
$\boldsymbol{p_t}$ and $\boldsymbol{p_o}$	The traditional store's price that is exogenously determined, and the online store's price that is a decision variable, respectively
$\boldsymbol{\pi_R^i}$ and $\boldsymbol{\pi_P^i}$	Retailer and provider profits using strategy i, respectively

4. TRANSACTION-BASED FEE STRATEGY ($\boldsymbol{i} = \mathrm{T}$)

In this strategy, the provider is not a decision-maker, and the retailer makes the decisions for the whole system. Therefore, no strategic partnership exists between the two players. The retailer, in this case, optimizes the dual channel by selecting the online store's price. An online order or return is shipped either using the retailer's own fleet at a cost of h_R or using the provider's delivery services at a cost of h_P. To build our model, the former option was utilized; however, the latter cost may be used whenever the provider is performing the delivery.

According to Radhi and Zhang (2018), the existence of customer returns and the ability to resell a portion of them will induce an order quantity that is lower than the total sales for a channel. In other words, the online store can sell the quantity ordered by the channel (Q_o) and all the resalable returns received by the channel ($r_o k_o Q_o$). Thus, $D_o = Q_o(1 + r_o k_o)$, and the order quantity can be represented as the following:

$$Q_o = \frac{D_o}{1 + r_o k_o} \tag{1}$$

Due to the fraction (r_{ot}), a quantity ($r_{ot} D_o$) is purchased from the online store and cross-returned to the traditional store. A fraction (k_{ot}) of this quantity is resalable and can be used to satisfy part of the traditional store's total sales (D_t). Thus, the traditional store can sell the quantity ordered (Q_t), resell the quantity ($r_t k_t Q_t$) as same-channel resalable returns, and resell the quantity ($r_{or} k_{or} D_o$) as cross-channel resalable returns. Consequently, $D_t = Q_t(1 + r_t k_t) + D_o r_{ot} k_{ot}$, and the order quantity for the traditional channel can be represented as the following:

$$Q_t = \frac{D_t - D_o r_{ot} k_{ot}}{1 + r_t k_t} \tag{2}$$

The profit function for the online channel can be modeled as the following:

$$\pi_o^T = D_o\left[(1 - r_o - r_{ot})p_o + r_o(1 - k_o)s + \frac{s(r_o k_o)^2}{1 + r_o k_o} - h_R(1 + r_o)\right] - Q_o c \tag{3}$$

From the total sales D_o, a portion of $(1 - r_o - r_{ot})$ is a final sale and contributes positively, a portion of $r_o(1 - k_o)$ is returned as non-resalable and salvaged, a portion of $\frac{(r_o k_o)^2}{1 + r_o k_o}$ is returned as resalable late in the selling season and salvaged. All online store sales and same-channel returns will cost an amount of h_R due to handling. The second term of the profit function is the cost of ordering.

The profit function for the traditional channel can be modeled as the following:

$$\pi_t^T = D_t\left[(1 - r_t)p_t + r_t(1 - k_t)s + s\frac{(r_t k_t)^2}{1 + r_t k_t}\right] + r_{ot}D_o\left[(1 - k_{ot})s + s\frac{k_{ot} r_t k_t}{1 + r_t k_t}\right] - Q_t c \tag{4}$$

In a similar fashion, from the total sales D_t, a portion of $(1 - r_t)$ is a final sale and contributes positively, a portion of $r_t(1 - k_t)$ is returned as non-resalable and salvaged, a portion of $\frac{(r_t k_t)^2}{1 + r_t k_t}$ is returned as resalable late in the selling season and salvaged. Second, from the total sales D_o, a portion of $r_{ot}(1 - k_{ot})$ is cross-returned to the traditional store as non-resalable and salvaged. Moreover, a portion of $\frac{k_{ot} r_t k_t}{1 + r_t k_t}$ is cross-returned to the traditional store, used to satisfy sales, and then returned as resalable late in the selling season to be salvaged. The third term of the profit function is the cost of ordering.

The total profit function for the DCR can be modeled by adding Equation (3) and Equation (4) as the following:

$$\pi_R^T = \pi_o^T + \pi_r^T = D_o\left((1 - r_o - r_{ot})p_o - h_R(1 + r_o) + r_o(1 - k_o)s + \frac{s(r_o k_o)^2}{1 + r_o k_o} + r_{ot}\left((1 - k_{ot})s + k_{ot}\frac{s r_t k_t}{1 + r_t k_t}\right)\right) + D_t\left((1 - r_t)p_t + r_t(1 - k_t)s + s\frac{(r_t k_t)^2}{1 + r_t k_t}\right) - Q_o c - Q_t c \tag{5}$$

Quantities Q_o and Q_t can be substituted with their respective functions, i.e., Equation (1) and Equation (2), to have the total profit function transformed as the following:

$$\pi_R^T = D_o\left((1 - r_o - r_{ot})p_o - h_R(1 + r_o) + r_o(1 - k_o)s + \frac{s(r_o k_o)^2 - c}{1 + r_o k_o} + r_{ot}\left((1 - k_{ot})s + k_{ot}\frac{s r_t k_t + c}{1 + r_t k_t}\right)\right) + D_t\left((1 - r_t)p_t + r_t(1 - k_t)s + s\frac{(r_t k_t)^2 - c}{1 + r_t k_t}\right) \tag{6}$$

One may reformulate the profit function (6) as the following:

$$\pi_R^T = D_o\big(Jp_o + B - h_R(1 + r_o)\big) + D_t A \tag{7}$$

where

$J = 1 - r_o - r_{ot} > 0$, $A = (1 - r_t)p_t + r_t(1 - k_t)s + \frac{s(r_t k_t)^2 - c}{1 + r_t k_t}$, and

$$B = r_o(1 - k_o)s + \frac{s(r_o k_o)^2 - c}{1 + r_o k_o} + r_{ot}\left((1 - k_{ot})s + k_{ot}\frac{s r_t k_t + c}{1 + r_t k_t}\right)$$

While $Jp_o + B - h_R(1 + r_o)$ is the revenue generated by an online store's single sale, A is the revenue generated by a traditional store's single sale. Intuitively, the optimality conditions should promote positive sales, revenues, and order quantities as the following: $D_o \geq 0$, $D_t \geq 0$, $Jp_o + B - h_R(1 + r_o) \geq 0$, $A \geq 0$, and $Q_t \geq 0$.

Proposition 1: *The optimal pricing strategy for the online store is given as follows:*

$$p_o^T = \frac{h_R(1 + r_o)}{2J} - \frac{B}{2J} + \frac{\alpha_o}{2\beta} + \frac{\gamma p_t}{2\beta J} + \frac{\gamma A}{2\beta J} \tag{8}$$

The proof of Proposition 1 and all other propositions and lemmas is provided in the appendix placed at the end of this paper. The previous proposition provides a closed-form solution for the online store's optimal pricing policy, p_o^T, given that the traditional store's price, p_t, is exogenously determined. If we differentiate p_o^T with respect to p_t, we get $\frac{\partial p_o^T}{\partial p_t} = \frac{\gamma}{\beta}\left(\frac{2 - r_o - r_{ot} - r_t}{2 - 2r_o - 2r_{ot}}\right)$.

Lemma 1:

$\frac{\partial p_o^T}{\partial p_t} = \frac{\gamma}{\beta}$ if $r_t = r_o + r_{ot}$, $\frac{\partial p_o^T}{\partial p_t} > \frac{\gamma}{\beta}$ if $r_t < r_o + r_{ot}$, and $0 < \frac{\partial p_o^T}{\partial p_t} < \frac{\gamma}{\beta}$ if $r_t > r_o + r_{ot}$.

From the previous lemma, we can state that the increment in the traditional store's price provides an opportunity to capture more revenue from the market by increasing the online store's price. However, this increment is greatly dependent upon the different rates of returns. For example, if $r_t = r_o + r_{ot}$, then the rate of increase, as p_t increases, will be $\frac{\gamma}{\beta}$, i.e., similar to the case when the channels experience no returns. By examining the online store's sales function, one may notice that such increments in prices would cause the online store to retain its customer level. However, if r_t is higher (lower) than $r_o + r_{ot}$, then the rate of increase will be lower (higher) than $\frac{\gamma}{\beta}$. In other words, if the traditional rate of return is higher (lower) than the online rate of return, then the retailer should be less (more) encouraged to increase the online price. Such a low (high) responsiveness level will cause sales to switch from the more troublesome store, i.e., the traditional (online) store, to the less troublesome one, i.e., the online (traditional) store. Indeed, under typical conditions, the online store is known to overwhelm retailers with returns compared to the traditional store due to the lack of customer feel and touch before buying. One may observe that the rates of returns have a significant impact on the pricing strategy of both channels.

Since $\frac{\partial p_o^T}{\partial \theta} = -\frac{\alpha}{2\beta} < 0$, the online store's price will decline when customer preference for the online store decreases. Such a change will encourage more customers to stay active within the channel. However, a drop in profitability may be noticed. Thus, it is optimal for the online channel to sell products that naturally lead to low customer preference for the traditional channel, e.g., standardized, mature, and quality non-differentiable products. Such a fact is well documented in the literature (Hua *et al*., 2010; Radhi and Zhang, 2018).

5. FLAT-BASED FEE STRATEGY ($\boldsymbol{i = F}$)

This section considers another outsourcing strategy that demands a higher contribution from the provider. Since they lack the competency to handle small and unstable sales, many retailers outsource the online store's order fulfillment to a provider. Usually, those providers have maintained their competency and gained a strong reputation in the market. Such a strategy enables retailers to greatly lower their capital investment while being able to improve flexibility, productivity, and customer satisfaction. For instance, HP owns a warehouse in Memphis that is used to fulfill online store orders. Managing facility layout, customer orders, customer returns, delivery, labeling, bar coding/RFID, packaging, and packing were all outsourced to FedEx. This degree of collaboration allowed HP to better utilize the provider's efficient operation and economy of scale, thus reducing the handling cost for products sold over the Internet. A retailer may also utilize this strategy if the provider is willing to carry the online store's inventory in her distribution center, such as in the case between Global Sports and Kmart.com (Yao *et al*., 2009). The fulfillment center by Amazon (FBA) is another good example that exploits this strategy. It supports retailers and sellers with various services, such as storing, stocking, shipping, returning, restocking, picking, packing, and providing customer services to shoppers. The retailer, in such cases, compensates the provider with a sales-dependent seasonal fee, thus correlating the size of the retailing system (effort) to the seasonal fee (gain). We notify here that the retailer is still decides on the online store's pricing strategy.

In this strategy, each player selects his/her decision in isolation and aims to maximize his/her own profit. Even though outsourcing is considered to be a "strategic alliance," retailers and providers may have conflicting interests. Consequently, it is crucial for the retailer to compare between the double marginalization when forming an alliance with a provider and the high handling fees when avoiding this alliance. Indeed, it is not always advantageous for a retailer to form an alliance with a provider when the latter can be used for a single delivery instead. In this study, we assumed that the provider is the leader and the retailer is the follower in a Stackelberg game setting. The game's decisions were taken in the following order:

(1) To maximize her profit, the provider chooses the seasonal flat fee (τ) for managing all online orders. Thus, she will need to incorporate the online store's expected response function into her own profit function. We assumed here that the provider is familiar with customer demand and customer return related parameters.

(2) In response to the provider's decision, the retailer chooses the online store's price, i.e., p_o, to maximize his expected profit.

From the retailer's perspective, the traditional store's profit function does not change. However, a slight alteration to the online store's profit function is induced. Since the provider handles all online orders and returns, the cost of handling them is the provider's responsibility. Thus, the handling cost (i.e., $h_R(1 + r_o)D_o$) within the online store's profit function is replaced by the sales-dependent flat fee (i.e., $\tau D_o = \tau Q_o(1 + r_o k_o)$) paid to the provider. In the Amazon FBA example, the latter term may indicate that the provider is eligible to receive fees for stocking and shipping all items that were sold for the first time (i.e., Q_o). She is also eligible to receive fees for restocking and shipping all items that were returned as resalable and used to satisfy further sales (i.e., $Q_o r_o k_o$). Due to closeness in values and simplicity, the stocking and restocking fees are assumed to be similar. Furthermore, Amazon FBA is not eligible to receive any payment for damaged or non-resalable items, especially if she is proven accountable. Thus, the online store's profit function changes as follows:

$$\pi_o^F = D_o\left[(1 - r_o - r_{ot})p_o - \tau + r_o(1 - k_o)s + s\frac{(r_o k_o)^2}{1 + r_o k_o}\right] - Q_o c \tag{9}$$

By adding both functions, (4) and (9), one may reformulate the retailer's profit function as the following:

$$\pi_R^F = D_o[Jp_o + B - \tau] + D_t A \tag{10}$$

The profit function for the provider can be formulated as follows:

$$\pi_P^F = D_o\tau - h_P(1 + r_o)D_o = D_o\big(\tau - h_P(1 + r_o)\big) \tag{11}$$

Proposition 2: *The optimal online store's pricing strategy and the optimal seasonal fee for each item handled by the provider are, respectively, depicted below:*

$$p_o^F = \frac{3\gamma p_t}{4\beta} - \frac{B}{4J} + \frac{3\alpha_o}{4\beta} + \frac{\gamma A}{4\beta J} + \frac{h_P(1 + r_o)}{4J} \tag{12}$$

$$\tau^F = \frac{h_P(1 + r_o)}{2} + \frac{J\gamma p_t}{2\beta} + \frac{B}{2} + \frac{J\alpha_o}{2\beta} - \frac{\gamma A}{2\beta} \tag{13}$$

If we differentiate the optimal online store's price with respect to p_t, we get $\frac{\partial p_o^F}{\partial p_t} = \frac{\gamma}{\beta}\left(\frac{3}{4} + \frac{(1 - r_t)}{4(1 - r_o - r_{ot})}\right)$. One may notice that the term $\frac{(1 - r_t)}{(1 - r_o - r_{ot})}$ is always nonnegative, indicating that an increase in a traditional store's price coincides with a rise in the online store's price regardless of the different return ratios.

Lemma 2:

$\frac{\partial p_o^F}{\partial p_t} = \frac{\gamma}{\beta}$ if $r_t = r_o + r_{ot}$, $\frac{\partial p_o^F}{\partial p_t} > \frac{\gamma}{\beta}$ if $r_t < r_o + r_{ot}$, and $0 < \frac{\partial p_o^F}{\partial p_t} < \frac{\gamma}{\beta}$ if $r_t > r_o + r_{ot}$.

Similar to the previous strategy, if the rate of return in the traditional store is equivalent to the sum of the return rates within the online store, then the induced change in p_o^F as p_t changes will be $\frac{\gamma}{\beta}$. However, if it is lower (higher), then the induced change in p_o^F as p_t changes is higher (lower) than $\frac{\gamma}{\beta}$. The managerial implications of the previous insights have been explained in Proposition 1. Moreover, if we differentiate the optimal seasonal fee (τ^F) with respect to p_t, we get $\frac{\partial \tau^F}{\partial p_t} = \frac{\gamma(r_t - r_o - r_{ot})}{2\beta}$. This relationship indicates that an equivalent total rate of returns in both channels, i.e., $r_t = r_o + r_{ot}$, induces no change in the value of τ^F when p_t increases. This is logical since such an increase would not cause any change in the online total sales volume, as indicated above. However, if $r_o + r_{ot}$ is higher than r_t, i.e., if the online rate of return is higher than the traditional rate of return, which is normally the case, then the retailer should be more responsive in raising the online price when the traditional price increases. This would cause the online customer level to drop, which would diminish the total gain received by the provider. As a result, the provider should lower the seasonal fee and lessen the urge of the retailer to raise his online price. In other words, the provider should help in stabilizing the total sales received by the online channel. In contrast, if $r_o + r_{ot}$ is lower than r_t, i.e., if the online rate of return is lower than the traditional rate of return, then the retailer should be less responsive (more reluctant) in increasing the online price when the traditional price rises. This would cause the online customer level to increase. Consequently, the provider will have a chance to increase her seasonal fee and capture more from this agreement. Thus, to be financially more responsive, it is beneficial for the provider to make an effort to reduce the total customer returns from the online channel compared to the traditional channel. Therefore, offering reliable customer reviews, product descriptions, and technical comparisons among products will clarify the relative pros and cons, which may drastically reduce customer returns from the targeted channel and, consequently, boost partners' performances.

The increase in the value of θ indicates that fewer customers are interested in purchasing from the online store. To keep a higher customer volume within the channel, both entities should drop their earnings from the store, i.e., the online price as well as the provider's seasonal fee, as proposed by the following relationships: $\frac{\partial p_o^F}{\partial \theta} = -\frac{3\alpha}{4\beta} < 0$ and $\frac{\partial \tau^F}{\partial \theta} = -\frac{\alpha J}{2\beta} < 0$. Therefore, the provider should always observe the pricing strategy for the online channel, recognize the reasons behind any change, and act according to the circumstances. Moreover, the retailer should be clear about his parameters, such as customer preference for a certain channel, rate of returns, and reasons behind changes in prices.

6. GAIN-SHARING STRATEGY ($i = G$)

In this section, a higher level of alliance or partnership between the retailer and provider is studied. Hartmann *et al*. (2012) claim that sharing of gain and responsibilities is vital in forming a strong and successful alliance between a retailer and a provider, as it demonstrates the parties' commitment to accept hardships and success. In this strategy, partners share the total revenue of the online store, and on top of that, the provider charges the retailer a sales-dependent flat fee. For instance, Toys "R" Us (retailer) and Amazon.com (provider) formed a long-term alliance in 2001. Under the terms of their agreement, identifying, buying, and managing inventory were the retailer's responsibilities, while developing the site, fulfilling customer orders, conducting customer services, and carrying inventory were the provider's responsibilities. Consequently, the provider was entitled to collect a fixed payment, a per-unit payment, and a share of the total revenue.

Due to the significant risk involved and the difficulty of determining a satisfying share for each partner within the gain-sharing compensation policy, it is rarely implemented despite the potential improvement in firms' long-term performance, productivity, and profitability (Min, 2013). Liinamaa *et al*. (2016) indicate that practice resembles retailers' resistance to gain-sharing agreements due to possible unfairness in revenue sharing. In addition, such an alliance induces a tangible stress on the provider to perform well under different circumstances. Due to the facts stated above, this work offers tools and insights that will enable retailers and providers to form successful alliances. Indeed, rigorous research is needed to understand how and under which circumstances partners should apply gain-sharing contracts.

Here, we assume that partners share all costs, revenue, and demand-related parameters. Also, the revenue of the online store is split between partners based on their market position, negotiation power, and duty assignment. Therefore, the retailer acquires a share of $0 \geq \emptyset \geq 1$, while the provider is provided with a share of $1 - \emptyset$. On top of her share, the provider is granted a sales-dependent, fixed seasonal fee. According to Keränen *et al*. (2023), retailers prefer gain-sharing contracts with a fixed fee over gain-sharing contracts with no fixed fee. This concept is widely used within the context of an employee compensation scheme, where workers receive a salary and a pay-for-performance fee that associates financial rewards with the performance exerted. It is essential to state here that their work did not consider the different players' market power, which may drastically change their preference outcome. In this strategy, unsatisfied online customers are requested to return their products to the online store and may not use the cross-channel option. Several companies, including HP use such a policy, and it isolates channels for unambiguous monetary transactions. As a result, r_{ot} represents the ratio of online sales that would have cross-returned to the traditional store if this policy had not been implemented. In other words, it is another ratio for same-channel return rather than cross-channel return. Consequently, the order quantities will change as follows:

$$Q_o = \frac{D_o}{(1 + r_o k_o + r_{ot} k_{ot})} \tag{14}$$

and

$$Q_t = \frac{D_t}{1 + r_t k_t} \tag{15}$$

Moreover, the profit functions for both stores could be constructed as follows:

$$\pi_t^G = D_t\left[(1 - r_t)p_t + r_t(1 - k_t)s + s\frac{(r_t k_t)^2}{1 + r_t k_t}\right] - Q_t c \tag{16}$$

$$\pi_o^G = D_o\left[(1 - r_o - r_{ot})p_o - h_P(1 + r_o + r_{ot}) + r_o(1 - k_o)s + r_{ot}(1 - k_{ot})s + \frac{s(r_o k_o)^2}{1 + r_o k_o} + \frac{s(r_{ot} k_{ot})^2}{1 + r_{ot} k_{ot}}\right] - Q_o c \tag{17}$$

Consequently, the retailer's and the provider's profit functions are as given below:

$$\pi_R^G(p_o|\tau) = \emptyset\pi_o^G - \tau D_o + \pi_t^G = D_o(\emptyset J p_o + \emptyset E - \tau) + D_t A \tag{18}$$

and

$$\pi_P^G(\tau) = (1 - \emptyset)\pi_o^G + \tau D_o = D_o\big((1 - \emptyset)J p_o + (1 - \emptyset)E + \tau\big) \tag{19}$$

where

$$E = -h_P(1 + r_o + r_{ot}) + r_o(1 - k_o)s + r_{ot}(1 - k_{ot})s + \frac{s(r_o k_o)^2}{1 + r_o k_o} + \frac{s(r_{ot} k_{ot})^2}{1 + r_{ot} k_{ot}} - \frac{c}{(1 + r_o k_o + r_{ot} k_{ot})}$$

Similar to the previous two policies, the optimality conditions should promote positive sales, revenues, and order quantities.

Proposition 3: *The optimal online store's pricing strategy and the optimal seasonal fee are, respectively, presented below:*

$$p_o^G = \left(\frac{1 + 2\emptyset}{1 + \emptyset}\right)\frac{\alpha_o}{2\beta} + \left(\frac{1 + 2\emptyset}{1 + \emptyset}\right)\frac{\gamma p_t}{2\beta} - \frac{E}{2(1 + \emptyset)J} + \frac{\gamma A}{2(1 + \emptyset)\beta J} \tag{20}$$

$$\tau^G = \frac{\emptyset^2 E}{(1 + \emptyset)} + \frac{\emptyset^2 J\alpha_o}{(1 + \emptyset)\beta} + \frac{\emptyset^2 J\gamma p_t}{(1 + \emptyset)\beta} - \frac{\gamma A}{(1 + \emptyset)\beta} \tag{21}$$

Differentiating the optimal online store's price with respect to p_t provides $\frac{\partial p_o^G}{\partial p_t} = \frac{\gamma}{2\beta(1+\emptyset)}\left(1 + 2\emptyset + \frac{(1 - r_t)}{(1 - r_o - r_{ot})}\right)$. Similar to Strategies 1 and 2, the previous relationship is strictly nonnegative, implying that an increase in the traditional store's price will cause a rise in the online store's price regardless of the different return ratios. Indeed, the induced change in p_o^G depends greatly on the different return rates and share percentages ($\emptyset$). The explanation provided in the previous two cases may slightly change depending on the value of $\emptyset$; however, identical insight is granted if the retailer acquires all the shares and the providers acquire only the seasonal fee, i.e., $\emptyset = 1$.

In addition, differentiating the optimal seasonal fee (τ^G) with respect to p_t provides $\frac{\partial \tau^G}{\partial p_t} = \frac{\gamma\left(\emptyset^2(1 - r_o - r_{ot}) - (1 - r_t)\right)}{(1 + \emptyset)\beta}$. The previous relationship provides similar insights compared to the flat-based fee strategy if $\emptyset = 1$. Elsewise, if $\emptyset^2(1 - r_o - r_{ot}) = (1 - r_t)$, then a change in p_t induces no change in the value of τ^G; if $\emptyset^2(1 - r_o - r_{ot}) > (1 - r_t)$, then an increase in p_t induces a positive change in the value of τ^G; and if $\emptyset^2(1 - r_o - r_{ot}) < (1 - r_t)$, then an increase in p_t induces a negative change in the value of τ^G. It is mentioned before that a higher rate of returns within the online channel compared to the traditional channel forces the retailer to be more responsive in increasing the online price when the traditional price rises. Consequently, the provider should cooperate in stabilizing online sales by lowering her seasonal fee. However, it is evident from the previous relationships that an increase in the provider's share, i.e., a decrease in the value of $\emptyset$, will make her more cooperative in such a process and further willing to lower the seasonal fee compared to the previous strategy. Consequently, gain-sharing agreements will put more emphasis on the provider to reduce online returns and create a more operationally balanced retailing system.

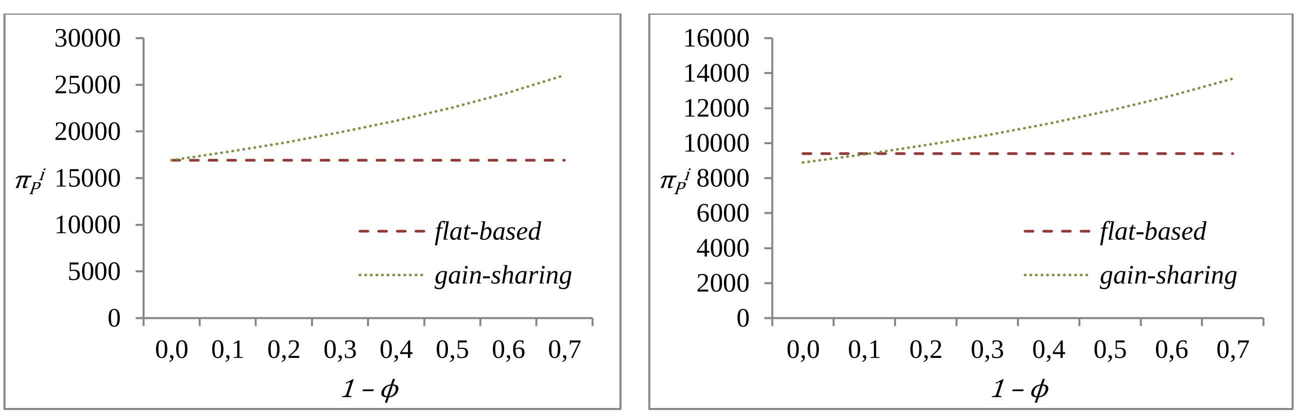
Relative to earlier findings, $\frac{\partial p_o^G}{\partial \theta} = -\frac{\alpha}{2\beta}\left(\frac{1+2\emptyset}{1+\emptyset}\right) < 0$, and $\frac{\partial \tau^G}{\partial \theta} = -\frac{\alpha J \emptyset^2}{(1+\emptyset)\beta} < 0$, signifying that the online store's price and seasonal fees should decrease when customers start to prefer the traditional channel over the online channel. In such a case, both parties should cooperate to stabilize the channel's performance and work to increase sales within the store. Indeed, to acquire higher seasonal fee and, thus, profitability, a provider may find herself more encouraged to manage an e-store offering standardized, mature, and quality non-differentiable products. Such products have a high customer preference for being purchased through the online channel. In addition, $\left|\frac{\partial p_o^F}{\partial \theta}\right| - \left|\frac{\partial p_o^G}{\partial \theta}\right| = \frac{\alpha}{4\beta}\left(\frac{1-\emptyset}{1+\emptyset}\right) > 0$, and $\left|\frac{\partial \tau^F}{\partial \theta}\right| - \left|\frac{\partial \tau^G}{\partial \theta}\right| = \frac{\alpha J}{\beta}\left(\frac{1}{2} - \frac{\emptyset^2}{1+\emptyset}\right) > 0$, indicating that the decision variables in the gain-sharing agreement are always less affected by the change in θ compared to the flat-based fee agreement. In Chapter 7, it is noticed that the provider will always price her fee higher when using the flat-based fee agreement compared to the gain-sharing agreement (Figure 4—d and Figure 5—d). Indeed, sharing a percentage of the gain will lift the burden of charging higher fees due to the existence of a second fiscal channel. Moreover, it is noticed that the retailer will always choose a higher online price when using the flat-based fee agreement (Figure 4—b and Figure 5—b). This is done to overcome the losses caused by the provider's pricing strategy and to boost his performance from the channel. However, such responses would lower the volume of sales from the online store. Consequently, when customers further prefer the traditional channel over the online channel, then a higher obligation is put upon players' shoulders to rectify such high pricing policies. Finally, $\left|\frac{\partial p_o^F}{\partial \theta}\right| - \left|\frac{\partial p_o^T}{\partial \theta}\right| = \frac{\alpha}{4\beta} > 0$, and $\left|\frac{\partial p_o^T}{\partial \theta}\right| - \left|\frac{\partial p_o^G}{\partial \theta}\right| = \frac{\alpha}{4\beta}\left(\frac{1+3\emptyset}{1+\emptyset}\right) > 0$, suggesting that the effect of θ on the price of the transaction-based fee strategy is somewhere between what it is for the other two strategies.

7. SENSITIVITY ANALYSIS AND MANAGERIAL INSIGHTS

The purpose of this numerical analysis is to provide further insights regarding the optimal retailer–provider compensation policies. The profitability ratios of the different strategies are compared and studied under various market conditions, especially those assumed to be exogenously determined. This study has capitalized on the parameters' validity used within many related research papers, such as Radhi (2022), Radhi and Zhang (2019), and Radhi and Zhang (2018).

7.1 Effect of retailer's share on partners' performance

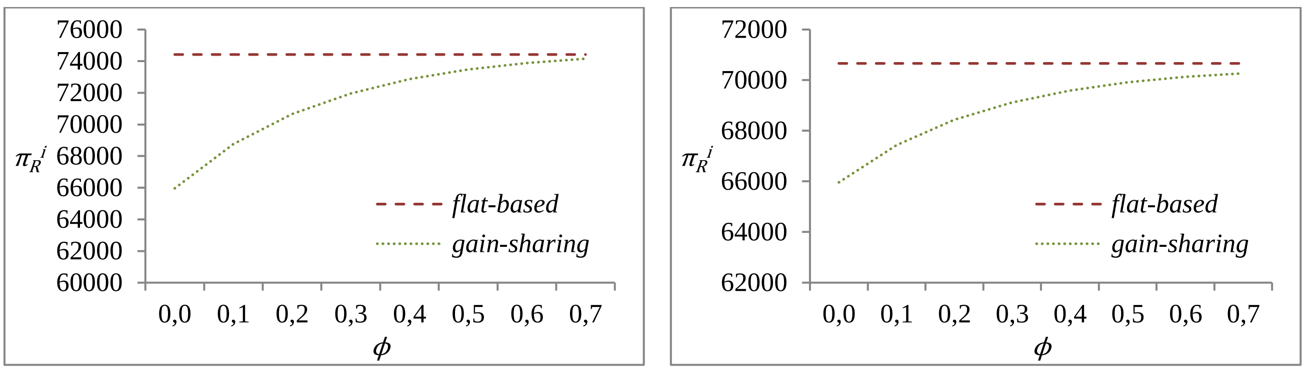
Figure 2 shows the increase in the provider's performance as she attains a higher portion of the online store's gain, i.e., a higher $1-\emptyset$ value. One may notice that the provider strictly generates a higher profit under a gain-sharing strategy compared to a flat-based fee strategy, i.e., $\pi_P^G \geq \pi_P^F$, especially when cross-channel returns are not allowed (Figure 1—a). Indeed, with a gain-sharing strategy, the provider is expected to be more involved in performing the different logistical tasks; however, her gain is expected to be worthy. However, when cross-channel returns are allowed (Figure 1—b), there might be cases where she is more profitable under a flat-based fee strategy than she is under gain-sharing, especially under lower values of $1-\emptyset$. Thus, she can have her mind set even before the negotiation process starts.



(a) (b)

Figure 2. Effect of retailer's share on provider's performance ($r_o = 0.2$, $r_{ot} = 0$ & 0.2, $r_t = 0.2$, $k_o = 0.2$, $k_{ot} = 0.2$, $k_t = 0.2$ $\alpha = 5000$, $\beta = 20$, $\gamma = 5$, $p_t = 100$, $h_R = 12$, $h_P = 5$, $c = 30$, $s = 10$, $\emptyset = variable$, $\theta = 0.5$)

Figure 3 shows the increase in the retailer's performance as he attains a higher portion of the online store's gain, i.e., a higher $\emptyset$ value. However, higher profitability for the retailer is always granted when he applies the flat-based fee strategy. Note that in this study, demand in the online store is not linked to the level of services provided by the provider, and further studies are needed in this direction. Moreover, it will be interesting to study the performance of the retailer under different game settings, such as the Nash game. In summary, a provider with abundant market power will attempt to exploit the gain-sharing policy and capture most of the financial enhancement created for the retailing system. However, a retailer with little market power will oppose the gain-sharing policy when compared to the flat-based fee strategy. Indeed, the negative and unfair realization exempted by the retailer may have led to the scarcity (abundance) of the former (latter) policy within the market. A similar conclusion was drawn by Keränen *et al*. (2023). They have indicated that retailers feel more entitled to gains than providers, even if the financial enhancement within the retailing system is due to the providers' support. Consequently, higher gains attained by the provider are perceived negatively, while limited (i.e., low $1-\emptyset$ value) to no gains (i.e., flat-based fee scheme) are perceived positively if it means having to pay the provider a higher fixed fee.



(a) (b)

Figure 3. Effect of retailer's share on his performance ($r_o = 0.2$, $r_{ot} = 0$ & 0.2, $r_t = 0.2$, $k_o = 0.2$, $k_{ot} = 0.2$, $k_t = 0.2$ $\alpha = 5000$, $\beta = 20$, $\gamma = 5$, $p_t = 100$, $h_R = 1$, $h_P = 5$, $c = 30$, $s = 10$, $\emptyset = variable$, $\theta = 0.5$)

7.2 Effect of online store's rate of returns on partners' performance

Both forms of online store returns, i.e., same-channel and cross-channel, negatively affect the profitability of both partners. For example, the partners' profit decreases as r_{ot} increases due to the burden exerted on the online channel. In an effort to mitigate the losses caused by returns, the retailer should increase the online store's price, which, consequently, drops the channel's demand. Interestingly, the provider should also cooperate and decrease the seasonal fee to stabilize sales within the channel (Figure 4). The increase in r_o will advocate similar responses as the ones registered in Figure 4; thus, the related figures are omitted. Notice that the increase in the seasonal fee is responded to with a further rise in price level, as $\frac{\partial p_o^G(\tau)}{\partial \tau} = \frac{\partial p_o^F(\tau)}{\partial \tau} = \beta > 0$. Consequently, online demand may drop, which may drastically decrease the provider's financial efficiency. In other words, the provider may argue that same-channel returns (i.e., online customers using the provider's services to return unwanted online purchases) require more handling efforts compared to cross-channel returns (i.e., online customers physically cross-returning their online purchases to the traditional store). Consequently, she may reach the conclusion of raising her seasonal fee when the retailing system experiences higher rates of same-channel return. Unfortunately, such actions may devastate the online channel, as the retailer will have the natural response of further increasing his price to reduce the negative impact of returns and shift demand from the online store to the traditional store. By realizing such action/reaction behavior, the provider's best response would be to increase her support level (i.e., exercise fee reduction) as the retailer experiences a higher return burden.

In addition, Figure 4 indicates that returns have a profound effect on the retailer's choice when it comes to his optimal partnership setting. Notice that if the online store experiences low return rates, then he may perform well under the transaction-based fee strategy. Hartmann *et al*. (2012) confirmed that not all partnerships developed with logistics and service providers improve retailers' performances, at least in the short run. In contrast, if the store experiences high return rates, then higher logistical involvement and support are needed. Since $h_R > h_P$, the previous explanation is comprehendible when the rate of same-channel return (i.e., r_o) is high. However, the reader may not link the previous explanation to the increase in cross-channel return rate (i.e., r_{ot}), as this type of return requires no logistical efforts from both parties. Notice that a retailer using the transaction-based fee strategy will have higher resistance to all forms of unsuccessful purchases, whether they will end up in the online or offline store, due to the high forward-handling cost. Thus, as the rate of return increases, the retailer responds more aggressively (when lowering the online store's price) under the transaction-based fee strategy compared to the other two strategies (Figure 4—b). Consequently, a considerable loss in demand and profitability is recorded, which makes partnering with a provider an appealing option.

Moreover, it is vital to shed some light on the provider's most critical tradeoff within this context. While she is eager to reduce the online store's return rates to capture more profit from the channel, the existence of high enough return rates will nourish her existence and survival within the market. Thus, the provider's best response would be to stabilize demand through optimal pricing decisions in addition to a thoughtful and balanced effort when reducing returns. Interestingly, at very high cross-channel return rates, the provider will be indifferent in choosing between the gain-sharing strategy or flat-based fee strategy, as they both offer the same performance.

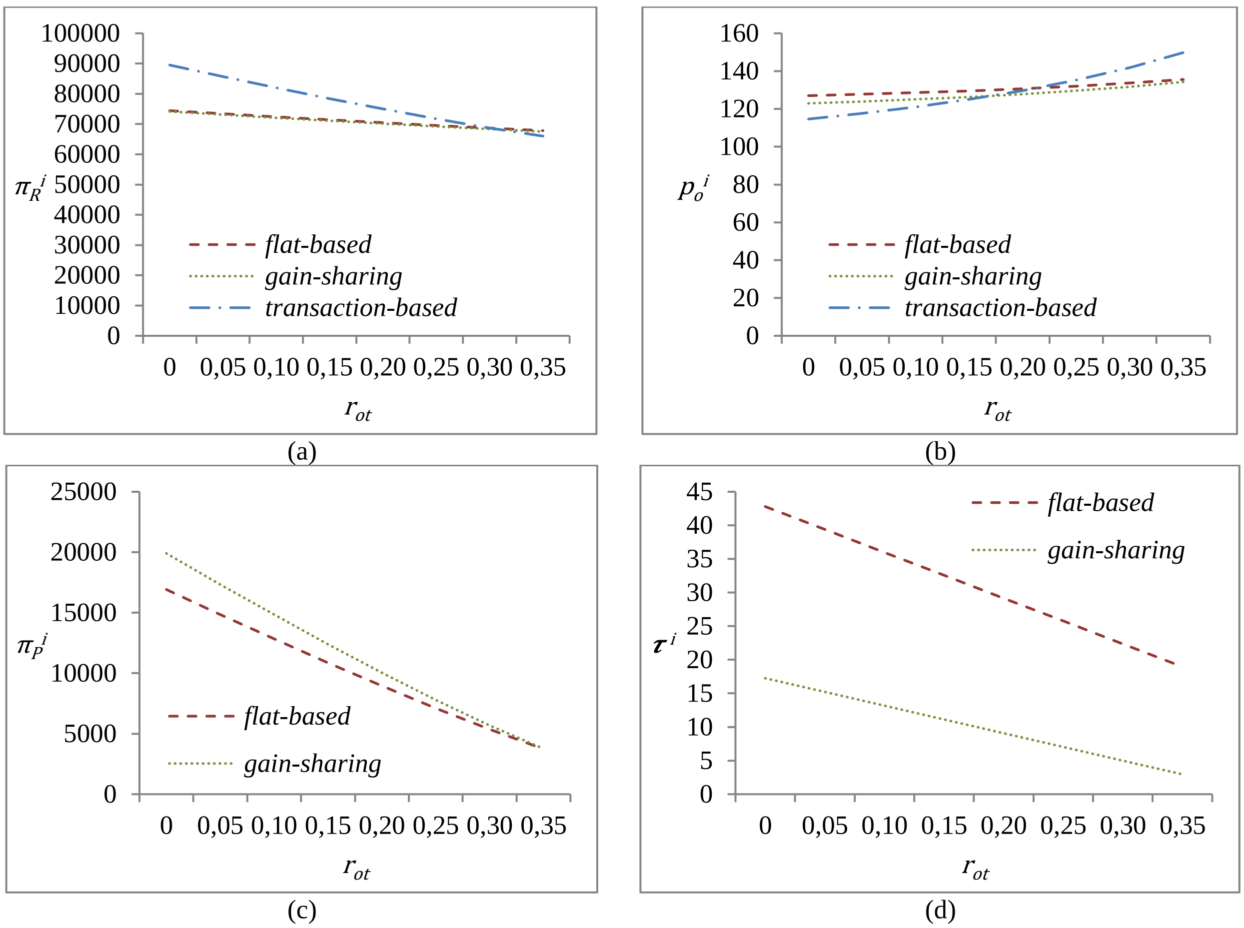


Figure 4. Effect of cross-channel return on partners' performance ($r_o = 0.2, r_{ot} = variable, r_t = 0.2, k_o = 0.2, k_{ot} = 0.2, k_t = 0.2\ \alpha = 5000, \beta = 20, \gamma = 5, p_t = 100, h_R = 15, h_P = 5, c = 30, s = 10, \emptyset = 0.7, \theta = 0.5$)

7.3 Effect of traditional store's rate of returns on partners' performance

As per Figure 5, traditional store's same-channel returns, r_t, negatively affects the profitability of the retailer due to the burden exerted on the traditional channel. To decrease its loss, the retailer should reduce the online store's price and switch demand from the traditional store to the online store. Such a decrease in price causes demand in the online store to revive, which provides an opportunity for the provider to increase the acquired seasonal fee and, consequently, her profitability. Notice that the retailer will have a dilemma whether to decrease the online store's price to mitigate the troublesome returns in the traditional store or increase the price to cope with a provider seeking to increase the seasonal fee whenever a chance arises. In response to what has been stated above, one may notice that the rate of change in the online store's price as return rates increase is the highest under the transaction-based fee strategy compared to all other strategies.

One may also notice here that the change in the traditional store's rate of return does not trigger strategy preference decisions for both the retailer and the provider. This may relate to the fact that the traditional store's price is exogenously determined based on its market position. However, considering the price of the traditional store, a decision variable may induce different insights that are more realistic and accurate.

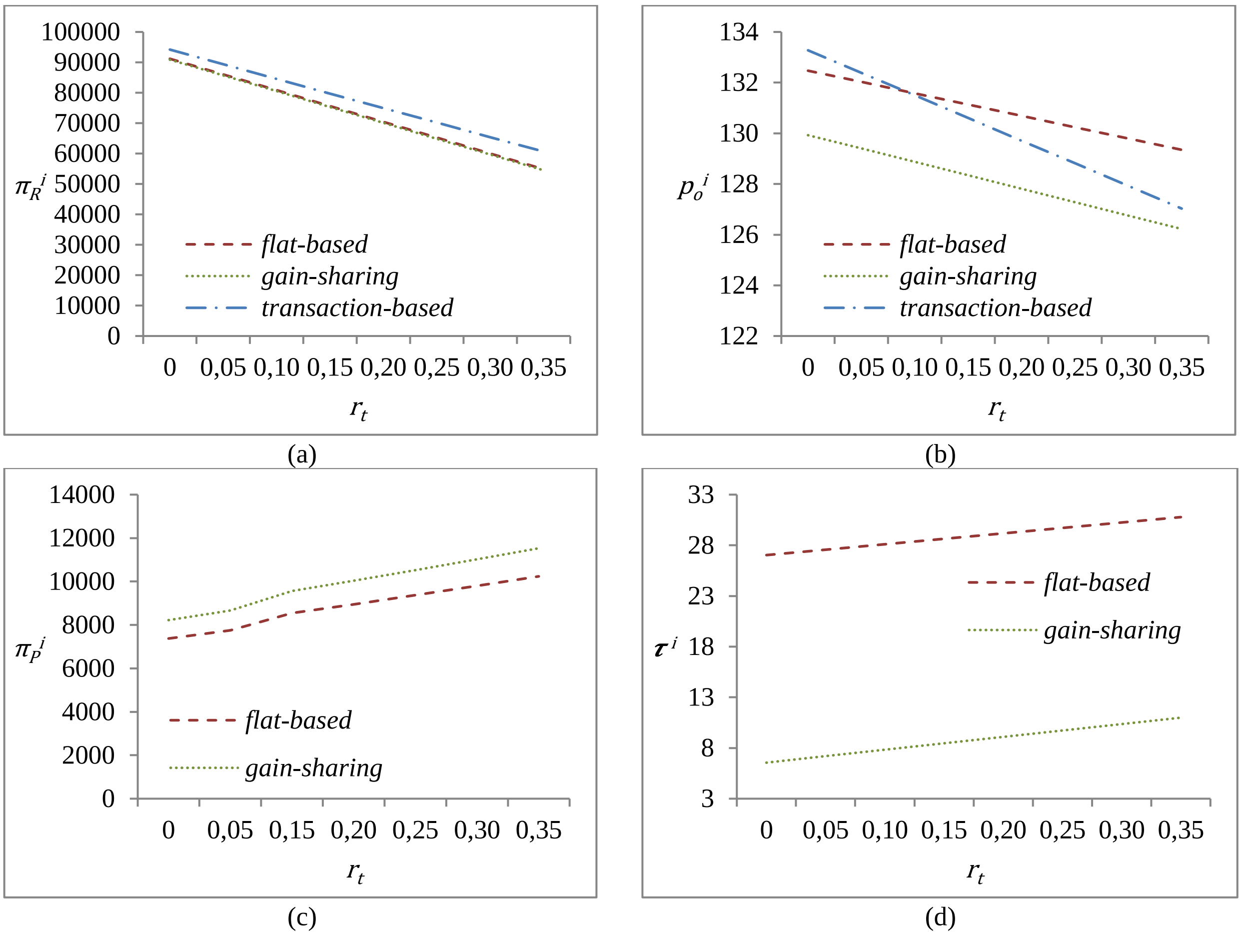


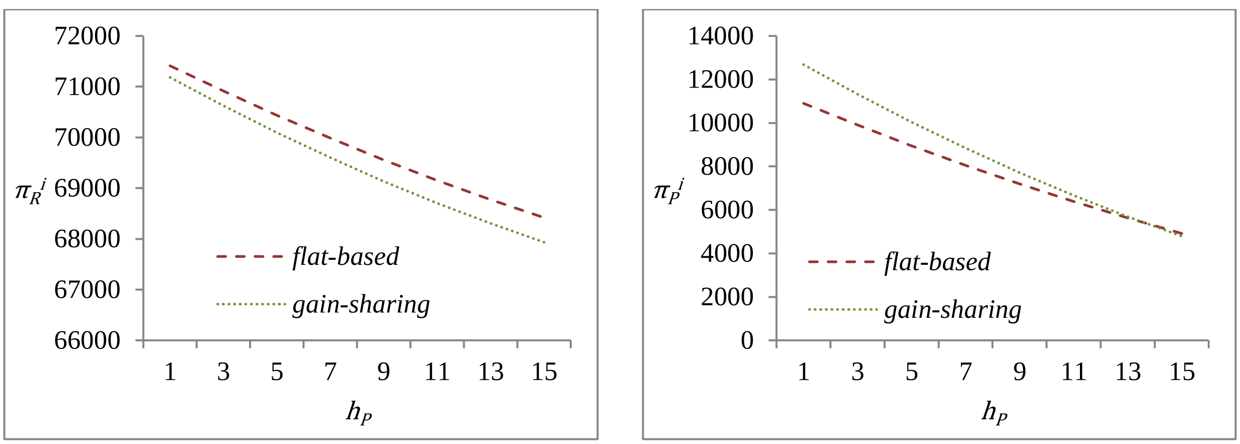
Figure 5. Effect of traditional store's same-channel return on partners' performance ($r_o = 0.2$, $r_{ot} = variable$, $r_t = 0.2$, $k_o = 0.2$, $k_{ot} = 0.2$, $k_t = 0.2$ $\alpha = 5000$, $\beta = 20$, $\gamma = 5$, $p_t = 100$, $h_R = 15$, $h_P = 5$, $c = 30$, $s = 10$, $\emptyset = 0.7$, $\theta = 0.5$)

When a partnership is created, the pricing decisions are dynamic in nature and comply with partners' interests and positions. Similar to Lu *et al*. (2003), a provider may indeed use opportunistic pricing decisions when she is not tied up to the retailer's total dual-channel performance. For instance, we have noticed how supportive a provider would be when the online demand and, consequently, her profitability are threatened with reduction. We have also noticed how exploitive she would be when the online channel is needed to host a higher volume of customers. Accordingly, the retailer's ability to use the differential pricing strategy and freely change customer flow between channels would diminish. The above findings provide an understanding of the scarcity of such partnership contracts within the market despite their great potential in certain circumstances. In any case, another study that captures the performance of all channels and all parties through a centralized approach is needed.

7.4 Effect of provider's per-unit handling cost on partners' performance

Given that $\frac{\partial p_o^F}{\partial h_P} = \frac{(1+r_o)}{4J} > 0$, $\frac{\partial \tau^F}{\partial h_P} = \frac{(1+r_o)}{2} > 0$, $\frac{\partial p_o^G}{\partial h_P} = \frac{(1+r_o+r_{ot})}{2(1+\emptyset)J} > 0$, and $\frac{\partial \tau^G}{\partial h_P} = \frac{-\emptyset^2(1+r_o+r_{ot})}{(1+\emptyset)} < 0$, one may conclude that coordination between partners will be slightly different under a flat-based fee strategy compared to the gain-sharing strategy. In the former strategy, the provider will increase the seasonal fee in response to the rise in the delivery cost, which, in turn, will force the retailer to increase the online store's price. However, when the different parties undergo a stronger commitment toward the success of the online channel by implementing the gain-sharing strategy, a different form of cooperation emerges. In this case, the provider will lower the seasonal fee to ease the financial burden put upon the channel. In response, the retailer will increase the selling price to mitigate the negative effect of the delivery cost. Due to the facts stated above, one may notice that the gain-sharing contract is more responsive in using the channel's price to lower the negative effect of handling cost, i.e., $\left|\frac{\partial p_O^G}{\partial h_P}\right| - \left|\frac{\partial p_O^F}{\partial h_P}\right| = \frac{(1+r_o)(1-\emptyset)+2r_{ot}}{4J(1+\emptyset)} > 0$. Interestingly, the negative effect of the handling cost lowers all parties' performances in all studied strategies (Figure 6).

In the flat-based fee strategy, it is common sense to realize that an increase in the handling cost would raise the seasonal fee charged by the provider. In return, the retailer will consider that as a hurdle and increase his price on the online channel as well. Such an increment would definitely reduce the volume of customers purchasing from the channel. Due to those pricing decisions, both parties will notice a reduction in their total performances. However, since the gain-sharing strategy distributes both risk and financial return between partners, the provider will have a higher incentive to possess self-regulating behavior when using such an agreement compared to the flat-based fee agreement (Keränen *et al*., 2023). Therefore, the inability to deliver cost-efficient services will force her to reduce the fee charged to the retailer and further depend financially on her share from the channel's gain. One should recall that in the gain-sharing policy, the provider has two streams of financial support: the fee paid at the beginning of the season and a share of the channel's revenue. Indeed, such a payment structure will make the retailer more aggressive in reducing his online price to the point that the flat-based strategy may outperform the gain-sharing strategy from the provider's perspective. Finally, it would be beneficial to carry on similar work where the retailer has a higher/equal market power and compare the performances and the responses.



(a) (b)

Figure 6. Effect of provider's per-unit cost on partners' performance ($r_o = 0.2$, $r_{ot} = 0.2$, $r_t = 0.2$, $k_o = 0.2$, $k_{ot} = 0.2$, $k_t = 0.2$ $\alpha = 5000$, $\beta = 20$, $\gamma = 5$, $p_t = 100$, $h_R = 15$, $h_P = variable$, $c = 30$, $s = 10$, $\emptyset = 0.7$, $\theta = 0.5$)

8. CONCLUSIONS AND FUTURE RESEARCH

With the decrease in hurdles related to trade and shipping across countries' borders and the increase in efficiencies related to transportation and product handling, modern retailing systems are moving toward additional globalization. Moreover, the rates of returns for online purchases are exceptionally high in several recorded cases, i.e., up to 70%. Due to the abovementioned facts, there is a substantial demand to use competent and responsive distribution systems that can efficiently handle complex supply chains. Thus, third-party logistics and service providers are becoming crucial partners for DCRs in today's era.

This paper has studied a DCR offering full refunds for unsatisfactory purchases in which both same- and cross-channel returns were considered. To exploit managerial excellence and logistical advancement, a third-party logistics and service provider can be used to manage the online channel and fulfill its orders. Thus, a game theoretical approach was implemented to synchronize between the follower retailer while taking his pricing decision and the leader provider while taking her seasonal fee decision. Accordingly, three strategies were examined: transaction-based fee, flat-based fee, and gain-sharing.

Due to the e-commerce nature, customer returns initiated due to online shopping are expected to be much higher than customer returns initiated due to traditional shopping. Thus, an increase in the traditional store's price is expected to trigger a higher rise in the online store's price compared to a case where the retailer offers no returns for unsatisfactory purchases. In addition, for the provider to be more financially responsive and boost her seasonal fee as the traditional store increases its price, an effort to reduce the total returns from the online channel is imperative. Such an effort should increase in magnitude if the partnership offered the provider a higher revenue share from the online channel. For example, offering reliable customer reviews, product descriptions, and technical comparisons may greatly help decline the rate of customer returns experienced by the online channel.

Furthermore, it was found that the increase in the traditional store's customer preference will trigger an online cooperation mechanism between the retailer and provider, in which both price and seasonal fee are lowered for better demand enhancement. When it comes to partnership, the provider may be better off making an alliance with a retailer selling products that are online-compatible from the customer's point of view. Indeed, products with higher customer preference for the online store or higher online compatibility would require a higher per-unit seasonal fee paid to the provider, which, consequently, boosts her profitability.

When the online service level does not influence demand, the retailer is always more profitable under the flat-based fee strategy compared to the gain-sharing strategy. However, the provider almost always performs better under the gain-sharing strategy than the flat-based fee strategy. An exception for that is the case when the provider is granted a lower share, and cross-channel returns are allowed. Nevertheless, the effect of the online store's service level on the performance of both parties is recommended for future research. Indeed, a higher service level offered by the online store will increase the channel's demand and reduce the rate of cross-channel returns. As a result, more same-channel returns may be experienced by the e-tail store.

Since cross-channel returns are handled by customers, it might not be obvious that they have a direct impact on the retailer's choice of strategy. A low rate of cross-channel return encourages the retailer to have more independence by implementing the transaction-based fee strategy, while a high rate pushes him to have more logistical involvement and support through the implementation of either the flat-based fee or gain-sharing strategies. From the provider's perspective, an increase in any of the online store's return rates will trigger a supportive response, and that is a lower value of the seasonal fee. Contrarily, an increase in the traditional store's return rate will force the retailer to switch demand to the e-tail store by lowering the price of the latter channel. This will unfold an opportunity for the provider to increase her seasonal fee. It is also noted that the retailer should be more cautious (less responsive) in switching demand between channels through the change in the online store's price when there is a higher involvement of the provider. Indeed, this study considered the price of traditional stores to be exogenously determined. However, to better analyze the synchronization process between partners, future studies may consider it as an endogenous variable.

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APPENDIX

Proof of Proposition 1.

First, substitute the sales functions $D_t = \alpha_t - \beta p_t + \gamma p_o$ and $D_o = \alpha_o - \beta p_o + \gamma p_t$ in Equation (7). For the concavity test, calculate the second partial derivative for the profit function π_R^T with respect to p_o. Consequently, $\frac{\partial^2 \pi_R^T}{\partial p_o^2} = -2\beta J < 0$. Due to the negativity, π_R^T is found to be strictly concave in p_o. Thus, a unique optimal solution that maximizes the retailer's profitability exists. To find the optimal online price p_o^T, calculate the partial derivative for the profit function π_R^T with respect to p_o, and equate the result to zero (i.e., $\frac{\partial \pi_R^T}{\partial p_o} = 0$). Therefore, the following expression can be found:
$\alpha_o J - 2J\beta p_o + J\gamma p_t - \beta B + \beta h_R(1 + r_o) + \gamma A = 0$. By solving for p_o, one may find the optimal online price (provided in Proposition 1) for the transaction-based fee strategy.

Proof of Lemma 1.

From the relationship $\frac{\partial p_o^T}{\partial p_t} = \frac{\gamma}{\beta}\left(\frac{2 - r_o - r_{ot} - r_t}{2 - 2r_o - 2r_{ot}}\right)$, we can find the following:

- $\frac{\partial p_o^T}{\partial p_t} = \frac{\gamma}{\beta}$ if $\frac{2 - r_o - r_{ot} - r_t}{2 - 2r_o - 2r_{ot}} = 1$ or if $(2 - r_o - r_{ot} - r_t) = (2 - 2r_o - 2r_{ot})$. By working out the previous relationship, one may find out that it holds true if $r_t = r_o + r_{ot}$.
- $\frac{\partial p_o^T}{\partial p_t} > \frac{\gamma}{\beta}$ if $\frac{2 - r_o - r_{ot} - r_t}{2 - 2r_o - 2r_{ot}} > 1$ or if $(2 - r_o - r_{ot} - r_t) > (2 - 2r_o - 2r_{ot})$. By working out the previous relationship, one may find out that it holds true if $r_t < r_o + r_{ot}$.
- $\frac{\partial p_o^T}{\partial p_t} < \frac{\gamma}{\beta}$ if $\frac{2 - r_o - r_{ot} - r_t}{2 - 2r_o - 2r_{ot}} < 1$ or if $(2 - r_o - r_{ot} - r_t) < (2 - 2r_o - 2r_{ot})$. By working out the previous relationship, one may find out that it holds true only and only if $r_t > r_o + r_{ot}$.

Proof of Proposition 2.

Since the provider is the game leader, then she chooses her fee first, followed by the retailer. Thus, given τ in Equation (10), we checked for the concavity of the retailers' profit function π_R^F with respect to p_o by calculating $\frac{\partial^2 \pi_R^F}{\partial p_o^2} = -2\beta J < 0$. Due to the negativity, we concluded that the function is strictly concave in p_o. Thus, a unique optimal solution that maximizes the retailer's profitability exists. To find the optimal online price p_o^F, calculate the partial derivative for the profit function π_R^F with respect to p_o, and equate the result to zero (i.e., $\frac{\partial \pi_R^F}{\partial p_o} = 0$). Therefore, the following expression can be found:
$J(\alpha_o + \gamma p_t) - 2J\beta p_o - \beta(B - \tau) + \gamma A = 0.$ By solving for p_o, one may find the best response function for the online store p_o^F given τ as follows:

$$p_o = \frac{J(\alpha_o + \gamma p_t) - \beta(B - \tau) + \gamma A}{2J\beta}. \tag{a.1}$$

Substitute the previous relationship in Equation (11), and find the second partial derivative with respect to τ for the concavity test. Since $\frac{\partial^2 \pi_P^F}{\partial \tau^2} = -\frac{\beta}{J} < 0$, then the leader's profit function is strictly concave in τ. By solving $\frac{\partial \pi_P^F}{\partial \tau} = 0$, one may find the following expression: $-\frac{\beta\tau}{J} + \frac{\beta h_P(1 + r_o)}{2J} + \frac{\alpha_o}{2} + \frac{\gamma p_t}{2} + \frac{B\beta}{2J} - \frac{\gamma A}{2J} = 0$. By solving for τ, one may find the optimal seasonal fee τ^F as presented in Equation (13). Substitute Equation (13) into (a.1) to get p_o^F in the form presented in Equation (12).

Proof of Lemma 2.

From the relationship $\frac{\partial p_o^F}{\partial p_t} = \frac{\gamma}{\beta}\left(\frac{3}{4} + \frac{(1 - r_t)}{4(1 - r_o - r_{ot})}\right)$, we can find the following:

- $\frac{\partial p_o^T}{\partial p_t} = \frac{\gamma}{\beta}$ if $\frac{3}{4} + \frac{(1 - r_t)}{4(1 - r_o - r_{ot})} = 1$, if $\frac{1 - r_t}{1 - r_o - r_{ot}} = 1$, or if $1 - r_t = 1 - r_o - r_{ot}$. By working out the previous relationship, one may find out that it holds true if $r_t = r_o + r_{ot}$.
- $\frac{\partial p_o^T}{\partial p_t} > \frac{\gamma}{\beta}$ if $\frac{3}{4} + \frac{(1 - r_t)}{4(1 - r_o - r_{ot})} > 1$, if $\frac{1 - r_t}{1 - r_o - r_{ot}} > 1$, or if $1 - r_t > 1 - r_o - r_{ot}$. By working out the previous relationship, one may find out that it holds true if $r_t < r_o + r_{ot}$.

- $\frac{\partial p_o^T}{\partial p_t} < \frac{\gamma}{\beta}$ if $\frac{3}{4} + \frac{(1-r_t)}{4(1-r_o-r_{ot})} < 1$, if $\frac{1-r_t}{1-r_o-r_{ot}} < 1$, or if $1 - r_t < 1 - r_o - r_{ot}$. By working out the previous relationship, one may find out that it holds true if $r_t > r_o + r_{ot}$.

Proof of Proposition 3.

The proof of this proposition is similar to Proposition 2; thus, only a brief one is provided. Given τ in Equation (18), we noticed that $\frac{\partial^2 \pi_R^G}{\partial p_o^2} = -2\beta\emptyset J < 0$. Thus, the function is strictly concave in p_o. By solving $\frac{\partial \pi_R^G}{\partial p_o} = 0$, one may find the best response function for the online store p_o^G. Substitute it in Equation (19), and eventually find the second partial derivative with respect to τ. Since $\frac{\partial^2 \pi_P^G}{\partial \tau^2} = -\frac{\beta(1+\emptyset)}{2J\emptyset^2} < 0$, then the leader's profit function is strictly concave in τ. By solving $\frac{\partial \pi_P^G}{\partial \tau} = 0$, one may find the optimal seasonal fee τ^G.