Proceedings of the 5th International Conference on Business and Policy Studies
DOI: 10.54254/2754-1169/2026.31210

Platform Pricing and Service Strategies: Consumer Segmentation and Full Coverage Replacement Decisions in Digital Supply Chains

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Abstract. This study examines how platform operators and manufacturers set pricing and channel strategies when offering optional product full coverage replacement services. A game-theoretic model is developed with two consumer groups: those purchasing only the base product and those choosing product–service solutions. The model considers commission rates, product failure risks, and the added utility of replacement services. The results show that when replacement services bring only modest consumer benefits, a unified market-wide pricing equilibrium arises. By contrast, when replacement services strongly enhance consumer value and key thresholds are met, premium pricing strategies within the bundled segment become optimal. This research integrates market segmentation with product full coverage replacement services and sheds light on the links between consumer preferences, commission mechanisms, and product risks.

Keywords: Consumer segmentation, Full coverage replacement, Pricing strategy, Supply chain management

1. Introduction

In today's highly competitive e-commerce environment, platform operators must move beyond basic transaction functions and create multifaceted value propositions to attract and retain consumers. In recent years, value-added service penetration has increased substantially, with product replacement services emerging as the fastest-growing category after shipping insurance. First, replacement services extend protection beyond statutory warranties, offering strong consumer appeal in reducing accidental damage risks. Second, replacement programs are three times more efficient than standard repair procedures, significantly enhancing customer satisfaction and lifetime value.

This study examines how consumer heterogeneity and product full coverage replacement service dynamics influence platform and manufacturer strategies. Using a game-theoretic approach, we analyze how product failure rates, commission structures, and consumer preferences interact to shape pricing equilibria. The findings shed light on commission thresholds that benefit both platforms and manufacturers, providing insights into how post-purchase services can be optimized in digital marketplaces.

DOI: 10.54254/2754-1169/2026.31210

2. Literature review

2.1. Warranty/alternative service models

Cao et al. [1] and Hu et al. [2] showed that third-party maintenance providers often achieve cost efficiencies, generating systemic benefits for e-commerce platforms but also creating new challenges for brand owners. Pbnda et al. [3] highlighted the profit asymmetry in hybrid supply chains, with retailers frequently capturing higher margins than manufacturers, while Chai et al. [4] suggested that retailer-led warranties can still produce mutual benefits for supply chain participants.

Most of this literature has been rooted in traditional retail settings or offline channels (Lin Li and Guo Li [5]; Gao, R. et al. [6]). Wang et al. [7] extend the discussion to e-channels, demonstrating how warranty design and pricing change when platforms rather than suppliers control underwriting. Shang and Cai [8] has examined warranty extension policies from the consumer perspective, showing that consumer preferences and cost coefficients play a crucial role in shaping warranty demand and profitability.

2.2. Platform service strategy

Trade-in studies have examined pricing, remanufacturing, and resale mechanisms (Feng et al. [9]; Xiao et al. [10]). Miao et al. [11] showed that trade-in schemes improve profitability when the net value of recycled products surpasses threshold levels. Parallel research has investigated VAS in bilateral platforms. For instance, Dou et al. [12] examined how VAS investments influence demand expansion, while Zhang et al [13] analyzed time-based pricing and cross-network effects in product–service bundles. Studies by Lin and Chen's [14] illustrated both opportunities and coordination challenges when retailers adopt VAS strategies.

2.3. Research on consumer heterogeneity

Zheng et al. [15] demonstrated that heterogeneity in valuation and peer influence can actually improve firm profits under certain conditions. Sajeesh et al. [16] linked heterogeneity to optimal pricing and return strategies, while Lizin et al. [17] provided empirical evidence on how preference differences guide positioning and pricing. Recent work on digital services, Liu et al. [18] further confirmed that heterogeneous expectations fundamentally shape platform pricing models.

2.4. Literature review conclusion

Prior research has provided important insights into warranties, trade-ins, and consumer heterogeneity, but three critical gaps remain. First, full coverage replacement services have not been systematically examined as independent value-added offerings within platform ecosystems. Second, the strategic interactions between manufacturers and platforms in offering full coverage replacement services remain underexplored. Third, consumer heterogeneity toward replacement services has not been adequately incorporated into pricing and channel strategy models. Our study addresses these gaps by developing a framework that integrates platform–manufacturer interactions, consumer heterogeneity, and commission failure dynamics.

3. Model hypothesis

3.1. Basic hypothesis

The manufacturer sells products through the platform and pays the platform a commission at a rate of α. A fraction $(1-\beta)$ distrusts the platform's replacement service and only purchases the product,

DOI: 10.54254/2754-1169/2026.31210

forming a standalone product market (Segment 1). The remaining fraction β trusts the replacement service and purchases both the product and the service (Segment 2). The following assumptions are made in this study:

(1) Assume that the product retail price is p_b, and the fee for the replacement service is p_a.

(2) Assume that the market size is normalized to one, the product is a durable good, and each consumer purchases one unit of the product either from the manufacturer or the platform.

(3) Assume that the product failure rate is γ. The product quality is q_b when no failure occurs, and q_c otherwise. And, the unit production cost is normalized to zero.

(4) Platform's full coverage replacement cost function is established as $\gamma \cdot p_b$. According to the actual situation, the replacement fee price is higher than the replacement cost, so $\gamma \cdot p_b < p_a$.

(5) Assume that consumers' quality preference θ is uniformly distributed over [0,1]. Then, the expected utility for a consumer purchasing the product is: $U = \theta \cdot [(1-\gamma) \cdot q_b + \gamma \cdot q_c] - p_b$. The expected utility function is formulated for purchasers of replacement services as: $U = \theta \cdot q_b - p_b - p_a$

Table 1. Notation description

Symbol	Definition
q_i	The quality of the product i, which $i = b, c$
α	Platform commission rate, $\alpha \in [0,1]$
γ	Product failure probability, $\gamma \in [0,1]$
U_i	Consumer utility, among $i = 1,2$
θ	Consumer preference for product quality, $\theta \sim U[0,1]$
β	Consumer trust ratio in platform replacement service, $\beta \in [0,1]$
p_b	Product retail price
p_a	Price of replacement service
d_b	Total market demand for products
d_a	Total market demand for replacement services
d_{1b}	Demand for product in Segment 1
d_{2b}	Demand for product in Segment 2
d_{2a}	Demand for replacement services in Segment 2

(1) Product demand in the product-alone consumer market

In Segmented Market 1, where consumption is limited to products only, purchasing processes are finalized without consideration of replacement services. The following benefit is anticipated for consumers: $U_1 = \theta[(1-\gamma)q_b + \gamma q_c] - p_b$, purchase occurs when $p_b \leq (1-\gamma)q_b + \gamma q_c$, consumer product preference intensity is θ, $\overline{\theta} = p_b/(1-\gamma)q_b + \gamma q_c$, the purchase range is $[\overline{\theta}, 1]$. The market demand capacity of market segment 1 is $1-\beta$, the product demand in Market Segment 1 is expressed as follows: $d_{1b} = (1-\beta) \cdot [1 - p_b/(1-\gamma)q_b + \gamma q_c]$.

(2) Product demand in the common consumption market

In Segment 2, physical products and replacement services are acquired simultaneously. Expected utility is enhanced by replacement service fee payment, which reduces product failure risks. The expected utility function for consumers is formulated as: $U_2 = \theta \cdot q_b - p_b - p_a$, purchase occurs when $p_b + p_a \leq q_b$. Analogously, in the product-service co-consumption market, product demand and replacement requirements are quantified as follows: $d_{2b} = \beta(1 - (p_a + p_b)/q_b)$, $d_{2a} = \beta(1 - (p_a + p_b)/q_b)$.

DOI: 10.54254/2754-1169/2026.31210

3.2. Demand function across varied pricing strategies

In Segmented Market 1, the consumer utility is expressed as:$(1-\gamma)q_b+\gamma q_c$, the cost for consumers is p_b, and the condition for participation is $p_b \le (1-\gamma)q_b+\gamma q_c$; In Segmented Market 2, simultaneous procurement of both product and service is observed. Utility functions incorporate risk mitigation components, expressed as: q_b, the total expenditure is defined as: p_b+p_a.

(1) Pricing strategy 1: Comprehensive pricing implementation across all market segments

When $p_b \le (1-\gamma)q_b+\gamma q_c$, in Segment 1, product acquisition occurs without service procurement. In Segment 2, simultaneous acquisition of products and platform-provided replacement services is observed. Product demand originates from both segments, with aggregate value expressed as: $d_b = d_{1b}+d_{2b}$, replacement service demand is quantified as: $d_a = d_{2a}$. Consequently, the pricing strategy achieves full market coverage, with total demand formulated as:

$$d_b^1=(1-\beta)[1-\frac{p_b}{(1-\gamma)q_b+\gamma q_c}]+\beta(1-\frac{p_b+p_a}{q_b}),d_a^1=\beta(1-\frac{p_b+p_a}{q_b})$$

(2) Pricing Strategy 2: Focus on the pricing of products and services in the common consumer market

When $(1-\gamma)q_b+\gamma q_c \le p_b \le q_b$, in Segment 1, product acquisition is precluded due to utility-based pricing constraints. Consumers in segment 2 may still buy products and trade-in new services, only to be satisfied $p_a+p_b \le q_b$. Consequently, the pricing strategy targets product-service co-consumption markets, with total demand formulated as:

$$d_b^2=\beta\cdot(1-\frac{p_b+p_a}{q_b}),d_a^2=\beta\cdot(1-\frac{p_b+p_a}{q_b})$$

4. Equilibrium in platform-based supply chain pricing

4.1. Pricing strategy 1: comprehensive pricing implementation across all market segments

The full-coverage pricing strategy generates simultaneous demand in market segments 1 and 2, with current supply meeting $p_b \le (1-\gamma)q_b+\gamma q_c$ equilibrium conditions. Manufacturer and platform merchant profit functions are following mathematical expressions:

$$\pi_p=\alpha\{(1-\beta)[1-\frac{p_b}{(1-\gamma)q_b+\gamma q_c}]+\beta(1-\frac{p_b+p_a}{q_b})\}+(p_a-\gamma p_b)\beta(1-\frac{p_b+p_a}{q_b})$$

$$\pi_m=(1-\alpha)\cdot p_b\cdot d_b^1+(p_a-\gamma p_b)\cdot d_a^1=(1-\alpha)\cdot p_b\{(1-\beta)[1-\frac{p_b}{(1-\gamma)q_b+\gamma q_c}]+\beta(1-\frac{p_b+p_a}{q_b})\}$$

The equilibrium results are derived through inverse solution as follows:

Lemma 1. According to pricing strategy 1, that is, under the pricing of all market segments, the equilibrium solutions of product retail price and product full coverage replacement service price are $p_b^*=\frac{((1-\gamma)q_b+\gamma q_c)(\beta-2)q_b}{[2(\alpha-\gamma-1)((1-\gamma)q_b+\gamma q_c)+4q_b]\beta-4q_b}$, $p_a^*=\frac{q_b}{2}+\frac{(-\alpha+\gamma-1)((1-\gamma)q_b+\gamma q_c)(\beta-2)q_b}{2((2(\alpha-\gamma-1)((1-\gamma)q_b+\gamma q_c)+4q_b)\beta-4q_b)}$ respectively; The balance of product demand and replacement service demand is $d_a^*=\frac{\beta(\alpha-1)((1-\gamma)q_b+\gamma q_c)+4(\beta-1)q_b}{4\beta(\alpha-\gamma-1)((1-\gamma)q_b+\gamma q_c)+8(\beta-1)q_b}$, $d_b^*=\frac{2-\beta}{4}$ respectively; The profit equilibrium of brand manufacturers and platform operators is $\pi_m^*=\frac{(\alpha-1)((1-\gamma)q_b+\gamma q_c)(\beta-2)^2q_b}{[(8\alpha-8\gamma-8)((1-\gamma)q_b+\gamma q_c)+16q_b]\beta-16q_b}$, $\pi_p^*=\frac{S}{16[((\alpha-\gamma-1)((1-\gamma)q_b+\gamma q_c)+2q_b]\beta-2q_b)^2}$ respectively.

Among, $S=(((\alpha-\gamma-1)(\alpha-9\gamma-9)((1-\gamma)q_b+\gamma q_c)^2+12q_b(\alpha-2\gamma-2)((1-\gamma)q_b+\gamma q_c)+16q_b^2)\beta^2+4(3(-\gamma^2+\alpha^2-2\gamma-1)((1-\gamma)q_b+\gamma q_c)^2+q_b(\alpha+10\gamma+10)((1-\gamma)q_b+\gamma q_c)-8q_b^2)\beta^2+$

DOI: 10.54254/2754-1169/2026.31210

$$4(-(3\alpha+\gamma+1)(\alpha-\gamma-1)((1-\gamma)q_b+\gamma q_c)^2-4(2\alpha+\gamma+1)q_b((1-\gamma)q_b+\gamma q_c)+4q_b^2)\beta+16\alpha q_b((1-\gamma)q_b+\gamma q_c))q_b$$

Proposition 1. When $p_b \le (1-\gamma)q_b+\gamma q_c$, the supply chain pricing equilibrium solution demonstrates correlation with three parameters: the utility ratio, the market segment 2 proportion, and platform commission rates under two consumption scenarios (exclusive product purchase versus combined purchases), as follows:

(1) When $\rho \le \frac{2\beta(1+\gamma-\alpha)}{3\beta-2}$, $[p_b^*, p_a^*]$ is the pricing equilibrium solution;

(2) When $\rho \ge \frac{2\beta(1+\gamma-\alpha)}{3\beta-2}$, $[p_b^c, p_a^*]$ is the pricing equilibrium solution, $p_b^c=(1-\gamma)q_b+\gamma q_c$, p_b^c where is the corner solution.

In proposition 1, when the retail price of the product is satisfied $p_b \in [0,(1-\gamma)q_b+\gamma q_c]$, two situations will occur: ①When $\rho \le \eta$, the retail price of the product and the price of the replacement service can be taken to the inner point solution p_b^* and p_a^*, then the equilibrium pricing of the supply chain is $[p_b^*, p_a^*]$. ②When $\rho > \eta$, the retail price of the product can't get the optimal solution within the interval $p_b \in [0,(1-\gamma)q_b+\gamma q_c]$, then the optimal solution is reached at the boundary,that is $p_b^c = (1-\gamma)q_b+\gamma q_c$. Dynamic pricing strategies in e-commerce platform-manufacturer collaborations necessitate continuous adaptation according to four determinants: consumer utility variance, product failure probability, commission percentage, and trust coefficient. Elevated product failure probability coupled with high consumer trust indices necessitates manufacturer adoption of boundary pricing models, with platform alignment maintained via maximized commission structures.

Inference 1.1. When given $\rho \le \frac{2\beta(1+\gamma-\alpha)}{3\beta-2}$, that is, when the retail price of the product p_b is solved p_b^* at the inner point, there is $\frac{dp_b^*}{d\alpha} > 0, \frac{dp_a^*}{d\alpha} < 0$.

Inference 1.1 demonstrates an inverse relationship between platform commission ratios and replacement service prices, with product retail prices exhibiting positive correlation. Elevated commission ratios necessitate retail price adjustments by manufacturers to compensate for cost increments, whereas proportional reductions in replacement service fees by the platform optimize tripartite benefit distribution among stakeholders.

Inference 1.2. When given $\rho \le \frac{2\beta(1+\gamma-\alpha)}{3\beta-2}$, that is, when the retail price of the product p_b is solved p_b^* at the inner point, there is $\frac{dp_b^*}{d\beta} > 0, \frac{dp_a^*}{d\beta} < 0$.

Inference 1.2 demonstrates an inverse relationship between segmented Market 2 proportion and replacement service pricing, with retail prices exhibiting positive correlation. Increased replacement service penetration necessitates coordinated pricing adjustments: retail price elevation by manufacturers coupled with platform-initiated service fee reductions to stimulate Market 2 growth.

Inference 1.3. When given $\rho \le \frac{2\beta(1+\gamma-\alpha)}{3\beta-2}$, that is, when the retail price of the product p_b is solved p_b^* at the inner point, there is $\frac{dp_b^*}{d\gamma} < 0, \frac{dp_a^*}{d\gamma} > 0$.

Inference 1.3 demonstrates an inverse correlation between product failure rates and retail pricing, accompanied by a positive association with replacement service costs. Elevated product failure rates necessitate platform implementation of risk-hedging strategies, characterized by regulated retail price reductions coupled with compensatory increases in replacement service charges.

4.2. Pricing strategy two: focus on the pricing of products and services in the common consumer market

The pricing strategy targeting the product-service co-consumption market restricts product demand exclusively to Segmented Market 2, where the specified condition is satisfied $(1-\gamma)q_b+\gamma q_c \le p_b \le q_b$. Manufacturer and platform profit functions are derivable from the following expressions:

$$\pi_m^{**}=(1-\alpha)\cdot p_b\cdot\beta(1-\frac{p_b+p_a}{q_b})$$

$$\pi_p^{**}=\alpha\cdot p_b\cdot\beta(1-\frac{p_b+p_a}{q_b})+(p_a-\gamma\cdot p_b)\cdot\beta(1-\frac{p_b+p_a}{q_b})$$

The equilibrium solution is derived through inverse solution as follows:

Lemma 2. Under Pricing Strategy 2 (the co-consumption market-focused pricing strategy for products and services), equilibrium solutions for product demand, replacement service demand, product price, and service price are $d_a^{**}=0$,$d_b^{**}=\frac{\beta}{4}$,$p_b^{**}=\frac{q_b}{2+2\gamma-2\alpha}$and $p_a^{**}=\frac{q_b(-3\alpha+3\gamma+1)}{4+4\gamma-4\alpha}$respectively. Furthermore, under this pricing strategy, the equilibrium profits for the brand manufacturer and the platform are $\pi_m^{**}=\frac{(\alpha-1)q_b\beta}{8\alpha-8\gamma-8}$,$\pi_p^{**}=\frac{q_b\beta}{16}$, respectively.

Proposition 2. If the retail price of the product is satisfied $(1-\gamma)q_b+\gamma q_c\le p_b\le q_b$, the equilibrium solution between the retail price of the product and the price of the replacement service is:

(1) When $1+\gamma-\alpha\ge 1/2$ and $\rho\ge 2(1+\gamma-\alpha)$,$[p_b^{**},p_a^{**}]$ is the pricing equilibrium solution;

(2) When $1+\gamma-\alpha\ge 1/2$ and $\rho\le 2(1+\gamma-\alpha)$, $[p_b^c,p_a^{**}]$ is the pricing equilibrium solution, among $p_b^c=\gamma q_b+(1-\gamma)q_c$where is the corner solution.

Proposition 2 holds only if the commission rate and product failure rate jointly satisfy $1+\gamma-\alpha\ge\frac{1}{2}$. Under these conditions, the above proposition is obtained, indicating that the utility ratio between purchasing and not purchasing the replacement service ρ (driven by an increase in γ) increases and platform charges a higher commission, the manufacturer's revenue increasingly relies on the co-consumption market, where both the product and replacement service are purchased. If ρ is too low and γ is too small and α is too big, no interior solution exists. When α and γ meet $1+\gamma-\alpha\le\frac{1}{2}$, consumers opt out of purchasing the replacement service, and the platform ceases to offer it.

Inference 2.1. When given $(1-\gamma)q_b+\gamma q_c\le p_b\le q_b$, that is, when the retail price of the product p_b is solved p_b^{**} at the inner point, there is (1)$\frac{dp_b^{**}}{d\alpha}>0,\frac{dp_a^{**}}{d\alpha}<0$; (2)$\frac{dp_b^{**}}{d\gamma}<0,\frac{dp_a^{**}}{d\gamma}>0$.

Corollary 2.1 establishes that: (1) A positive correlation exists between platform commission ratios and product retail prices, whereas an inverse relationship is observed with replacement service pricing. Elevated platform commissions necessitate increased fee expenditures by manufacturers, leading to compensatory retail price adjustments to maintain profit margins. (2) Rising product failure rates exhibit negative correlation with retail pricing but positive association with replacement service costs.

4.3. Comparative strategy analysis

Within the platform's replacement service pricing framework, equilibrium solutions for both product retail prices and replacement service prices are determined by two distinct scenarios, contingent upon critical thresholds of market parameters. By synthesizing the values of the equilibrium solution in the above two different situations, the following propositions can be obtained.

Proposition 3: When $0\le p_b\le q_b$, the equilibrium pricing of the retail price of the product and the price of the replacement service meets:

DOI: 10.54254/2754-1169/2026.31210

(1) When $\rho \leq \frac{2\beta(1+\gamma-\alpha)}{3\beta-2}$, the pricing equilibrium solution is: $[p_b^*, p_a^*]$;

(2) When $1+\gamma-\alpha \geq \frac{1}{2}$ and $\rho \geq 2(1+\gamma-\alpha)$, the pricing equilibrium solution is: $[p_b^{**}, p_a^{**}]$;

(3)When $2(1+\gamma-\alpha) \leq \rho \leq \frac{2\beta(1+\gamma-\alpha)}{3\beta-2}$ and $1+\gamma-\alpha \geq \frac{1}{2}$, $[p_b^*, p_a^*]$ and $[p_b^{**}, p_a^{**}]$ simultaneously satisfy the pricing equilibrium solution.

Proposition 4. Within the interval $2(1+\gamma-\alpha) \leq \rho \leq \frac{2\beta(1+\gamma-\alpha)}{3\beta-2}$, the equilibrium pricing strategy for the product's retail price and replacement service price depends on the relative magnitude of the retail price p_b.

Make $\triangle\pi_m = \pi_m^* - \pi_m^{**} = \frac{(\alpha-1)(\gamma q_b+(1-\gamma)q_c)(\beta-2)^2 q_b}{[(8\alpha-8\gamma-8)(\gamma q_b+(1-\gamma)q_c)+16q_b]\beta-16q_b} - \frac{(\alpha-1)q_b\beta}{8\alpha-8\gamma-8}$. The equilibrium pricing of products and trade-in services in the supply chain can be determined by comparing the manufacturer's profits under two scenarios. Solving the equations reveals that when $u_2/u_1 \geq 2(1+\gamma-\alpha)/\beta$, $\triangle\pi_m < 0$. Therefore, the manufacturer will adopt Pricing Strategy 2 if $u_2/u_1 \geq 2(1+\gamma-\alpha)/\beta$. Otherwise, it will choose Pricing Strategy 1.

5. Conclusions

This study examines three primary research questions. First, we analyze how the magnitude of utility enhancement from full coverage replacement services, together with commission rates, affects retail pricing and service fees. Second, we explore how profitability varies for supply chain participants depending on utility increments and consumer adoption rates. Third, we identify the conditions under which manufacturers adjust sales strategies and associated pricing mechanisms. To address these questions, a two-echelon supply chain model is developed. Two equilibrium conditions are derived. Equilibrium pricing depends on the post-replacement-to-standalone utility ratio and is significantly influenced by product failure probabilities, commission rates, and full coverage replacement service adoption. Equilibrium 1 occurs under high-failure-rate scenarios with strong platform trust, requiring manufacturer premium pricing and elevated commission rates for targeting Segment 2 consumers. Equilibrium 2 requires continuous monitoring of failure-rate-to-commission differentials, with full coverage replacement service termination triggered when thresholds are exceeded.

These findings offer practical insights for digital platforms and manufacturers. Platforms can optimize profitability by designing tiered full coverage replacement service packages and differentiated commission rates. Manufacturers can adjust pricing and product-service bundling strategies based on consumer segments and observed service adoption patterns.

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