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Three Echelon Supply Chain Coordination under Multiplicative Demand

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Abstract

Extant supply chain coordination research has largely focused on additive linear demand functions. However, in many markets such as consumer electronics, e-commerce, and luxury products, demand is better represented as a multiplicative function of price. This study develops a three-echelon decentralized supply chain model consist of one supplier, one manufacturer, one retailer under multiplicative price-dependent demand. This study analyses the contract sequence choices involving wholesale price (WP) and linear two-part tariff (LTT) contracts using a Stackelberg game of full information. Further, closed form solutions of all the optimal parameters are derived. Finally, study also examines how demand elasticity influences profit distribution among agents of supply chain. Numerical analysis demonstrates that multiplicative demand magnifies the sensitivity of channel profits to price elasticity, strengthening the incentive for long-term contracts. Managerial implications are provided for suppliers and manufacturers operating in elastic markets.

Keywords
Three-echelon supply chain; Coordination; Contract; Stackelberg Game

1. Introduction
Supply chains in the modern economy are increasingly complex, global, and interdependent. Coordination across multi echelons has become a central challenge in both practice and research. The question of how contracts are designed and sequenced among these multi echelons significantly influences profit allocation and the overall efficiency of the channel. For example, in high-technology or consumer goods industries, the supplier may use a wholesale price contract to deal with the manufacturer while the manufacturer may simultaneously adopt a two-part tariff agreement with the retailer. This combination is known as a contract sequence and creates distinct incentives for each agent in supply chain and leads to different outcomes for the supply chain as a whole.

Most of the studies in this domain including Biswas et al. (2023) adopt additive linear demand of the form $q = a - bp$, where demand falls linearly with price. Such models are analytically convenient and have yielded important insights into supply chain coordination, double marginalization, and channel efficiency. However, linear demand may not adequately capture the nature of demand in many markets where price elasticity plays a decisive role. For instance, in sectors such as e-commerce, fashion, luxury goods, and fast-moving consumer products, a percentage change in price often results in a proportional change in demand rather than an absolute linear change. In such cases, a multiplicative demand function provides a more realistic and elasticity-driven representation of consumer response.

In this study, we address this gap by reformulating the three-echelon supply chain contract-sequence problem under multiplicative demand. However, unlike the linear case, we derive equilibrium conditions and profit allocations under multiplicative demand where outcomes crucially depend on the elasticity parameter.

The contributions of this study are threefold. First, we extend contract-sequence analysis to a multiplicative demand environment and derive the closed-form expressions for profits, retail prices, and order quantities under each of the four contract sequences: (W,W), (W,L), (L,W), and (L,L). Second, we explore the the conditions under which three echelon supply chain is coordinated. Third, we propose the best contract sequence based on the channel efficiency. Overall, this study contributes to the supply chain coordination literature by demonstrating that contract sequence outcomes are not only a function of cost structures and reservation profits, but also of the elasticity-driven nature of demand. This perspective provides richer managerial insights for industries characterized by strong price sensitivity where traditional linear-demand models fall short. The following research questions (RQs) guide our study:

RQ1: How does adopting a multiplicative demand function, instead of the traditional additive linear form, affect the pricing, quantity, and profit outcomes in a three-echelon supply chain?
RQ 2: What are the equilibrium strategies of suppliers, manufacturers, and retailers under different contract sequences when demand is multiplicative?
RQ 3: What managerial implications arise for contract feasibility across different market elasticities?

2. Literature Review

Supply Chain Coordination becomes more subtle with three or more echelons where upstream and downstream margins interact (Biswas et. al., 2023). Some studies have examined three-echelon models under quantity discounts and price-dependent demand as well as coordination via revenue sharing or flexible return schemes that place contracts between adjacent pairs to recover system optimality (Huang and Yao, 2021; Dabaghian et.al., 2022). Zhong et al. (2021) analyse a distributor that must negotiate upstream first versus downstream first and demonstrating that negotiation order changes wholesale prices and the final allocation even with the same instruments. It indicates that sequence is a first-order design variable in a three echelon supply chains. Wang et. al., (2024) model a three-echelon green supply chain and devise mechanisms that coordinate price and green effort paths over time. This study show that the location of the coordinating contract (upstream vs. downstream) changes who bears greening costs and who captures the environmental premium.

When both pricing and ordering are endogenous, the interaction of markup incentives across tiers becomes path-dependent: who contracts with whom first and with what contract (price-only, two-part, revenue share). The literature recognizes that a contract that coordinates quantities may distort prices and vice versa; layered contracts (e.g., wholesale upstream, two-part tariff downstream) can remove markups incrementally. Price-only and revenue-sharing results from the two-echelon literature serve as building blocks for analyzing sequence effects in longer channels (Lariviere & Porteus, 2001; Cachon, 2003; Cachon & Lariviere, 2005).

To the best of our knowledge, prior three-echelon studies rarely considered the contract sequencing in an explicitly multiplicative (elasticity-driven) demand environment with endogenous pricing at the retailer and individual rationality constrained profit sharing across all echelons. Building on the coordination logic established for two-echelon dyads and the adjacency contracting approach for three echelons, we provide closed-form elasticity indexed outcomes for all four contract sequences (W, W), (W, L), (L, W), and (L, L). This bridges the gap between contract sequence analyses and the constant elasticity paradigms prevalent in pricing and revenue-management research. The summary of the three echelon supply chain literature is presented in the Table 1.

Table 1: Summary of three echelon supply chain literature

Author(s) & Year	**Context / Setting**	**Contracts / Mechanisms**	**Demand Assumptions**	**Key Findings**	**Contributions**
Zhong et. al. (2021)	Three-echelon chain with distributor negotiating both upstream and downstream	Sequence of WP contracts under different negotiation orders	Price-dependent demand	Negotiation order (upstream-first vs downstream-first) changes wholesale price and profit allocation	Highlights that *sequence matters* in triadic negotiations
Biswas et. al. (2023)	Decentralized three-echelon chain	WP vs LTT combinations	Linear demand	Contract sequence alters profit allocation; cutoff	Baseline study on sequencing; our paper generalizes

		across interfaces		policies derived for IR feasibility	with multiplicative demand
Li et. al., (2025)	Three-echelon chain with wholesaler/retailer strategic inventories	Wholesale pricing with bargaining	Price-dependent stochastic demand	Inventories are used strategically to improve bargaining leverage; efficiency loss persists	Shows that beyond contracts, inventory is also a coordination lever
Salas-Navarro et. al., (2024)	Vendor-managed inventory (VMI) in three-layer chain	VMI coordination	Deterministic demand	Upstream VMI can align replenishment across three tiers, improving efficiency	Illustrates alternative coordination approach vs. price contracts
Wang et. al., (2024)	Three-echelon chain with green effort	Wholesale + cost-sharing	Linear demand with greenness	Coordinated contracts improve both profit and environmental outcomes	Extends contract coordination into sustainability domain
Wu et. al., (2025)	Closed-loop three-echelon chain with big data	Cost-sharing and revenue-sharing	Dynamic demand with recovery	Contract menus align recycling incentives and improve profits	Demonstrates contract design with closed-loop and digital data
Sebatjane & Adetunji (2024)	Food supply chain (supplier–processor–retailer)	Inventory & replenishment coordination	Deteriorating demand	Green inventory models reduce waste while sustaining profits	Extends coordination into perishable three-tier systems
Salari et. al., (2022)	Off-site construction triadic supply chain	Stochastic contract optimization	Stochastic demand	Coordination reduces risk of project delays and excess cost	Sector-specific evidence of three-tier coordination

3. Model and Notation

We consider a three-echelon decentralized supply chain consisting of a supplier (S), a manufacturer (M), and a retailer (R). The supply chain operates over a single selling season with deterministic but price-dependent demand**.** The game proceeds sequentially: the supplier chooses a contract in stage 1, the manufacturer observes and chooses in stage 2, and the retailer chooses the selling price in stage 3.

3.1. Supply Chain Structure, Cost Parameters and Contracts

Supplier (S): Produces a raw input at constant unit production cost c_S.
Manufacturer (M): Purchases the input from the supplier, adds value through processing, and incurs a constant unit production cost c_M.

Retailer (R): Purchases finished products from the manufacturer, incurs a per-unit selling/handling cost c_R and sells to final consumers at price p.

Total cost of the three-echelon supply chain: $S = c_S + c_M + c_R$

Each player is risk-neutral and seeks to maximize expected profit subject to individual rationality (IR) constraints. That is, each echelon must secure at least a minimum reservation profit $\bar{\pi}_S, \bar{\pi}_M, \bar{\pi}_R \geq 0$ to participate in the channel. In this study, two widely studied contracts i.e. wholesale price contract (W) and linear two part tariff contract (L) are considered. Given two possible contracts at each stage, four contract sequences are feasible:

$$(W, W), (W, L), (L, W), (L, L)$$

where the first element indicates the contract offered by supplier to manufacturer and the second element indicates the contract offered by the manufacturer to retailer. In all the contract sequences, we assume that the two consecutive SC agents engage in a Stackelberg game with the upstream agent acting as the leader and the downstream agent acting as the follower.

3.2. Demand Function

In this study, following multiplicative demand function is considered:

$$q(p) = ap^{-\epsilon}; \quad a > 0\,;\ \epsilon > 1$$

where a is market potential, ϵ is price elasticity of demand, and p is the retail price chosen by the retailer.
Demand function ensures proportional responsiveness of demand to price changes. The restriction $\epsilon > 1$ guarantees finite optimal markups and ensures concavity of profits.

3.3. Decision sequence

The interaction unfolds as a three-stage dynamic game:
Stage 1: Supplier's move: The supplier decides whether to offer WP or LTT to the manufacturer and sets the contract parameters (w_S, L_S) based on the selected contract. Here w_S is wholesale price per unit and L_S is lumpsum fixed fee.
Stage 2: Manufacturer's move: After observing the supplier's contract, the manufacturer decides whether to offer WP or LTT to the retailer and sets contract parameters (w_M, L_M) based on the selected contract.
Stage 3: Retailer's move: The retailer observes the manufacturer's contract, chooses the retail price p, and thus determines the order quantity $q(p)$.

4. Optimal Contract Parameters

4.1. Case (WW): Wholesale Price at Both upstream and downstream

In this case, both the supplier and the manufacturer are assumed to offer wholesale price (WP) contracts. As the Stackelberg leader, the supplier first announces her contract parameter (the wholesale price) by taking into account the anticipated response of the manufacturer. Next, the manufacturer sets her wholesale price while considering the retailer's reaction. The resulting optimization problem is solved using backward induction, and the solution is summarized in Proposition 1.

Proposition 1: Optimal retail price, wholesale price of supplier, wholesale price of manufacturer and profit of all three agents are given as follows:

(i) $w_S^{WW} = \frac{\epsilon c_S + c_M + c_R}{\epsilon - 1}$; (ii) $w_M^{WW} = \frac{\epsilon(w_S^{WW} + c_M) + c_R}{\epsilon - 1}$; (iii) $p^{WW} = \rho^2 S$; (iv) $q^{WW} = a\rho^{-3\epsilon} S^{-\epsilon}$;
(v) $\pi_S^{WW} = \frac{a}{\epsilon - 1}\rho^{-3\epsilon} S^{1-\epsilon}$; (vi) $\pi_M^{WW} = \frac{a}{\epsilon - 1}\rho^{1-3\epsilon} S^{1-\epsilon}$; (vii) $\pi_R^{WW} = \frac{a}{\epsilon - 1}\rho^{2-3\epsilon} S^{1-\epsilon}$
Where $\rho = \frac{\epsilon}{\epsilon - 1}$; $S = c_S + c_M + c_R$; $K_\epsilon = \rho^{-\epsilon} = \left(\frac{\epsilon}{\epsilon - 1}\right)^{-\epsilon}$

This is the least efficient outcome; profits are positive but small, and Individual rationality constraints may fail for S or M in high-elasticity markets.

4.2. Case (WL): Wholesale Price Upstream and LTT Downstream

In this case, the supplier employs a wholesale price (WP) contract with the manufacturer, whereas the manufacturer offers a linear two-part tariff (LTT) contract to the retailer. The supplier, as the Stackelberg leader, first specifies her wholesale price, anticipating the manufacturer's downstream decision. The manufacturer then sets both the per-unit wholesale price and the fixed fee for the retailer, explicitly accounting for the retailer's pricing response. The optimization problem is solved by backward induction, and the outcome is summarized in Proposition 2.

Proposition 2: Optimal retail price, wholesale price of supplier, wholesale price of manufacturer, fixed fee of manufacturer and profit of all three agents are given as follows:

(i) $w_S^{WL} = \frac{\epsilon c_S + c_M + c_R}{\epsilon - 1}$; (ii) $w_M^{WL} = w_S^{WL} + c_M$; (iii) $p^{WL} = \rho^2 S$; (iv) $q^{WL} = a\rho^{-2\epsilon} S^{-\epsilon}$;
(v) $L_M^{WL} = \frac{a}{\epsilon - 1}\rho^{1-2\epsilon} S^{1-\epsilon} - \bar{\pi}_R$
(vi) $\pi_S^{WL} = \frac{a}{\epsilon - 1}\rho^{-2\epsilon} S^{1-\epsilon}$; (vii) $\pi_M^{WL} = \frac{a}{\epsilon - 1}\rho^{1-2\epsilon} S^{1-\epsilon} - \bar{\pi}_R$; (vii) $\pi_R^{WL} = \bar{\pi}_R$
Where $\rho = \frac{\epsilon}{\epsilon - 1}$; $S = c_S + c_M + c_R$

Manufacturer gains the most here by extracting surplus through the fixed fee. Supplier profit improves relative to (W,W) while retailer is held at reservation profit level. This explains why (W,L) favours manufacturers.

4.3. Case (LW): LTT Upstream and Wholesale Price Downstream

In this case, the supplier utilizes a linear two-part tariff (LTT) contract with the manufacturer, while the manufacturer offers a wholesale price (WP) contract to the retailer. The supplier first determines her per-unit wholesale price and fixed fee, incorporating the manufacturer's optimal reaction into her decision. The manufacturer subsequently announces her wholesale price after considering the retailer's demand response. The optimization problem is solved by backward induction, and the solution is presented in Proposition 3.

Proposition 3: Optimal retail price, wholesale price of supplier, wholesale price of manufacturer, fixed fee of supplier and profit of all three agents are given as follows:

(i) $w_S^{LW} = c_S$; (ii) $w_M^{LW} = \frac{\epsilon(c_S+c_M)+c_R}{\epsilon-1}$; (iii) $p^{LW} = \rho^2 S$; (iv) $q^{LW} = a\rho^{-2\epsilon}S^{-\epsilon}$;

(v) $L_S^{LW} = \frac{a}{\epsilon-1}\rho^{-2\epsilon}S^{1-\epsilon} - \bar{\pi}_M$

(vi) $\pi_S^{LW} = \frac{a}{\epsilon-1}\rho^{-2\epsilon}S^{1-\epsilon} - \bar{\pi}_M$; (vii) $\pi_M^{LW} = \bar{\pi}_M$; (vii) $\pi_R^{LW} = \frac{a}{\epsilon-1}\rho^{1-2\epsilon}S^{1-\epsilon}$

Where $\rho = \frac{\epsilon}{\epsilon-1}$; $S = c_S + c_M + c_R$

In this case, Supplier captures most of the channel profit via the fixed fee, while forcing the manufacturer down to their IR level. Retailer earns more than in (W,L) (since no LTT is applied to them), but less than in the fully coordinated case.

4.4. Case (LL): LTT Upstream and LTT Downstream

In this case, both the supplier and the manufacturer adopt linear two-part tariff (LTT) contracts. The supplier, as the Stackelberg leader, first specifies her contract terms (per-unit wholesale price and fixed fee), anticipating the manufacturer's subsequent decision. The manufacturer then announces her LTT terms for the retailer, factoring in the retailer's price-setting behavior. The resulting optimization problem is solved using backward induction, and the solution is formalized in Proposition 4.

Proposition 4: Optimal retail price, wholesale price of supplier, wholesale price of manufacturer, fixed fee of manufacturer, fixed fee of supplier and profit of all three agents are given as follows:

(i) $w_S^{LL} = c_S$; (ii) $w_M^{LL} = c_S + c_M$; (iii) $p^{LL} = \rho S$; (iv) $q^{LL} = a\rho^{-\epsilon}S^{-\epsilon}$;

(v) $L_M^{LL} = \frac{a}{\epsilon-1}\rho^{-\epsilon}S^{1-\epsilon} - \bar{\pi}_R$; (vi) $L_S^{LL} = \frac{a}{\epsilon-1}\rho^{-\epsilon}S^{1-\epsilon} - (\bar{\pi}_R + \bar{\pi}_M)$

(vii) $\pi_S^{LL} = \frac{a}{\epsilon-1}\rho^{-\epsilon}S^{1-\epsilon} - (\bar{\pi}_R + \bar{\pi}_M)$; (viii) $\pi_M^{LL} = \bar{\pi}_M$; (vii) $\pi_R^{LL} = \bar{\pi}_R$

Where $\rho = \frac{\epsilon}{\epsilon-1}$; $S = c_S + c_M + c_R$

This is the fully coordinated channel outcome. The supplier, being at the top of the chain, captures all residual profits after binding manufacturer and retailer at their reservation levels. Retail price is lowest, demand is maximized, and channel efficiency is highest.

5. Numerical Analysis

To illustrate the theoretical results and highlight the managerial implications of contract sequencing under multiplicative demand, we conduct a numerical analysis. The analysis proceeds in two stages: first, we examine baseline outcomes for the four contract sequences under given parameters; second, we perform sensitivity tests by varying key parameters—most notably, the price elasticity of demand. The following parameter values are considered for numerical analysis: $a = 200000$; $\epsilon = 1.5$; $c_S = 20$; $c_M = 15$; $c_R = 10$; $\bar{\pi}_S = 1500$; $\bar{\pi}_M = 2000$; $\bar{\pi}_R = 1000$
The optimal outcomes under each contract sequence are reported in Table 1. For each sequence, we list the contract parameters (wholesale prices and fixed fees), the resulting retail price, equilibrium quantity, and profits for the supplier, manufacturer, and retailer.

Table 2: Optimal Values of parameters

Sequence	w_S	L_S	w_M	L_M	p	q	π_S	π_M	π_R
(W,W)	87.50	0.0	302.50	0.0	1215.0	1.31	115.6	46.2	15.4
(W,L)	87.50	0.0	102.50	107.7	405.0	9.48	414.9	107.7	1000.0
(L,W)	20.00	33.5	77.50	0.0	405.0	9.48	33.5	2000.0	359.0
(L,L)	20.00	222.6	35.00	1222.6	135.0	38.25	222.6	2000.0	1000.0

The results in Table 2 highlight several important findings. Retail prices follow the theoretical order, with the lowest price arising under the fully coordinated sequence (L,L), intermediate prices under the mixed sequences (W,L) and (L,W), and the highest price under the uncoordinated sequence (W,W). Consequently, order quantity is maximized in (L,L) and minimized in (W,W), reflecting the strong impact of double marginalization on channel efficiency. Profit allocations differ sharply across the four cases. In (W,W), all parties earn very modest returns, and in many instances the supplier or manufacturer may struggle to satisfy their reservation profits, underscoring the inefficiency of relying solely on wholesale price contracts.

The (W,L) sequence shifts bargaining power to the manufacturer, who leverages the two-part tariff to extract surplus from the retailer while leaving the supplier with modest gains. In contrast, (L,W) allows the supplier to dominate by capturing most of the channel surplus through a fixed fee, reducing the manufacturer's profit to its reservation level but permitting the retailer to retain more than in (W,L). Finally, (L,L) delivers the most efficient outcome, with the supplier appropriating all residual profit after binding the manufacturer and retailer at their reservation levels, while simultaneously achieving the lowest retail price and highest demand. Taken together, these observations illustrate that the efficiency and distribution of surplus are highly sensitive to the sequencing of contracts, with outcomes improving systematically as more layers of two-part tariffs are introduced.

6. Conclusion

This study extends the contract-sequence literature in multi-echelon supply chains by moving beyond the commonly adopted linear demand function to a multiplicative, elasticity-based specification. This alternative formulation captures proportional consumer responses to price, which more realistically reflect market behaviour in industries where price sensitivity is high.

The analysis reveals that outcomes improve systematically as more layers of two-part tariffs are introduced, with the (L,L) sequence achieving full coordination and eliminating double marginalization. Profit allocation differs substantially across the sequences: (W,W) generates the lowest efficiency, with suppliers and manufacturers often failing to meet individual rationality constraints; (W,L) shifts bargaining power to the manufacturer, who extracts surplus from the retailer; (L,W) allows the supplier to dominate by reducing the manufacturer to reservation profit while leaving some margin for the retailer; and (L,L) maximizes overall efficiency by ensuring the lowest retail price, highest demand, and residual profit capture by the supplier.

From a managerial perspective, the findings imply that in highly price-sensitive industries such as consumer electronics and fashion retail, two-part tariff contracts are essential to preserve channel viability. In markets with moderate elasticity, such as household durables, mixed structures can balance efficiency and bargaining power, while in niche or low-elasticity markets, such as luxury goods, even simple wholesale contracts may remain viable despite lower overall efficiency.

Although this study advances the analysis of contract sequences under multiplicative demand, it is not without limitations. First, the model assumes deterministic demand and a single selling season. In practice, demand uncertainty, seasonality, and inventory dynamics play a critical role in shaping contract performance. Extending the framework to stochastic or dynamic demand environments would improve its applicability. Second, the analysis is restricted to a single supplier–manufacturer–retailer channel. Many real-world supply chains involve multiple suppliers, competing manufacturers, or retailer networks, where strategic interactions such as competition, horizontal bargaining, and coalition formation could substantially alter equilibrium outcomes.

Future research could address these limitations in several ways. Incorporating demand uncertainty and dynamic pricing would allow for more realistic assessments of contract feasibility and robustness. Studying competition among multiple suppliers or retailers could highlight how contract sequencing interacts with market structure. Extending the model to include risk-averse players or behavioral preferences would provide a richer understanding of decision-making under contracts.

References

Aggarwal, U., Mehlawat, M. K., Gupta, P., & Charles, V. An optimisation model for sustainable multi-commodity transportation planning. *RAIRO-Operations Research*, 58(2), 1835–1869, 2024.

Biswas, I., Gupta, R., Tiwari, S., & Talluri, S. Multi-echelon supply chain coordination: Contract sequence and cut-off policies. *International Journal of Production Economics*, 259, 108823, 2023.

Cachon, G. P. Supply chain coordination with contracts. *Handbooks in Operations Research and Management Science*, 11, 227–339, 2003.

Cachon, G. P., & Lariviere, M. A. Supply chain coordination with revenue-sharing contracts: Strengths and limitations. *Management Science*, 51(1), 30–44, 2005.

Dabaghian, N., Tavakkoli-Moghaddam, R., Taleizadeh, A. A., & Moshtagh, M. S. Channel coordination and profit distribution in a three-echelon supply chain considering social responsibility and product returns. *Environment, Development and Sustainability*, 24(3), 3165–3197, 2022.

Huang, R., & Yao, X. An analysis of sustainability and channel coordination in a three-echelon supply chain. *Journal of Enterprise Information Management*, 34(1), 490–505, 2021.

Lariviere, M. A., & Porteus, E. L. Selling to the newsvendor: An analysis of price-only contracts. *Manufacturing & Service Operations Management*, 3(4), 293–305, 2001.

Li, J., Chen, Y., Liao, Y., Shi, V., & Zhang, H. Managing strategic inventories in a three-echelon supply chain of durable goods. *Omega*, 131, 103204, 2025.

Salari, S. A. S., Mahmoudi, H., Aghsami, A., Jolai, F., Jolai, S., & Yazdani, M. Off-site construction three-echelon supply chain management with stochastic constraints: A modelling approach. *Buildings*, 12(2), 119, 2022.

Salas-Navarro, K., Florez, W. F., & Cárdenas-Barrón, L. E. A vendor-managed inventory model for a three-layer supply chain considering exponential demand, imperfect system, and remanufacturing. *Annals of Operations Research*, 332(1), 329–371, 2024.

Sebatjane, M., Cárdenas-Barrón, L. E., & Nobil, A. H. Sustainable inventory models for a three-echelon food supply chain with growing items and price- and carbon emissions-dependent demand under different emissions regulations. *Cleaner Logistics and Supply Chain*, 13, 100192, 2024.

Wang, S., Liu, L., & Wen, J. Product pricing, green effort decisions and coordination in a dynamic three-echelon green supply chain. *Journal of Industrial and Management Optimization*, 20(9), 2906–2933, 2024.

Wu, Z., Zhang, Y., & Dong, C. Differential game and coordination of a three-echelon closed-loop supply chain considering green innovation and big data marketing. *RAIRO-Operations Research*, 59(1), 461–482, 2025.

Zhong, F., Zhou, Z., & Leng, M. Negotiation-sequence, pricing, and ordering decisions in a three-echelon supply chain: A coopetitive-game analysis. *European Journal of Operational Research*, 294(3), 1096–1107, 2021.