

Mitigating the bullwhip effect of Xiaomi Auto's supply chain: an integrated supply chain coordination perspective via revenue-sharing and buy-back Contracts

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Abstract. Against the background of the booming new-energy vehicle industry in China, competition among automobile enterprises has shifted from individual-product competition to supply-chain competition. New-energy carmakers adopting pre-order sales modes face prominent risks of demand distortion, which easily triggers the bullwhip effect and damages supply-chain stability. This paper focuses on the bullwhip effect in Xiaomi Auto's supply chain under its pre-order sales model. Adopting literature analysis and case-study approaches, this paper sorts out relevant theories of the bullwhip effect, revenue-sharing contracts and buy-back contracts, identifies the major factors contributing to the bullwhip effect at Xiaomi Auto, and discusses feasible coordination strategies. The study finds that although VMI and JIT inventory systems optimize material circulation, they cannot fundamentally eliminate the bullwhip effect caused by shortage gaming. Introducing properly-designed revenue-sharing and buy-back contracts can help mitigate demand amplification and stabilise cooperative relationships between upstream and downstream participants.

Keywords: bullwhip effect, supply chain coordination, revenue-sharing contract, buy-back contract, Xiaomi Auto

1. Introduction

With the rapid development of China's new-energy vehicle industry, market demand is changing rapidly. Emerging automobile brands rely on intelligent manufacturing and innovative marketing strategies to expand market share. Industry competition has gradually shifted from product competition to supply chain competition. As a newly established automobile manufacturer, Xiaomi Auto quickly attracted substantial market attention through large-scale pre-order sales, resulting in rapid order growth and continued capacity expansion.

The new energy vehicle industry is characterized by complex component structures, long production cycles, component shortages and unstable market demand. During pre-sales and production planning, vehicle manufacturers frequently face demand forecasting errors, information asymmetry and dramatic inventory fluctuations, which easily generate the supply chain bullwhip effect. The bullwhip effect causes greater order

volatility among upstream suppliers, inventory backlogs, idle production capacity, and higher operating costs, seriously undermining supply chain stability [1].

Existing studies have formed a relatively mature theoretical system regarding the causes, impacts and mitigation strategies of the bullwhip effect. However, few studies have specifically examined new-energy vehicle manufacturers operating under pre-order sales models. This research applies classic contract theories to Xiaomi Auto's supply chain scenario, thereby extending the practical application of bullwhip effect theory and providing theoretical support for future research in this area.

This paper adopts two main research methods: literature analysis and case study. This paper mainly includes three parts. First, it systematically sorts out theoretical foundations concerning the bullwhip effect, revenue-sharing contracts and buy-back contracts. Second, it analyzes existing problems and bullwhip effect incentives within Xiaomi Auto's supply chain. Third, it proposes targeted optimization suggestions based on supply chain coordination theories to reduce demand distortion, weaken the bullwhip effect, and improve supply chain collaborative performance. This paper takes the pre-sale model of emerging new energy vehicle manufacturers as a unique research scenario. By combining a dual coordination mechanism consisting of revenue-sharing agreements and buyback agreements, it specifically analyzes and addresses the issue of amplified supply chain volatility among these new-energy vehicle manufacturers, thereby adapting traditional supply chain theory to the new operational models of the current new energy vehicle industry. The research conclusions demonstrate strong adaptability to specific scenarios and practical applicability.

2. Theoretical basis

2.1. Bullwhip effect theory

The bullwhip effect is a typical demand distortion phenomenon in supply chain operations. It refers to the phenomenon whereby small fluctuations in terminal consumer demand are gradually amplified during transmission to upstream suppliers, resulting in severe order volatility in upper-level enterprises [1].

In multi-level supply chains, upstream and downstream enterprises make independent decisions based on self-interest, causing information isolation and distorted demand signals. According to classic research, the bullwhip effect has four major causes: demand signal processing distortion, shortage gaming, batch ordering, and price fluctuation [1].

First, demand signal distortion occurs because downstream enterprises forecast demand based on historical data, while upstream enterprises conduct secondary forecasting based on downstream orders, accumulating prediction errors. In the automotive industry, car dealers predict vehicle sales from past retail data and submit procurement orders to automakers; automakers then generate component procurement forecasts purely from dealer orders rather than real end-customer sales. Minor swings in retail sales get magnified when passed to tier-one and tier-two auto-parts suppliers. Second, shortage gaming encourages downstream firms to over-order to avoid stock-out losses during component shortages. When core auto parts such as automotive chips are in short supply, vehicle manufacturers will deliberately place excess orders with chip suppliers to secure sufficient supply, even though actual vehicle assembly demand is lower, artificially inflating component demand signals. Third, batch ordering leads to concentrated and intermittent orders, creating false demand peaks. Automakers often place large-volume, periodic batch orders for metal raw materials and interior trim parts instead of continuous small orders. This generates spike-like order volumes for upstream material suppliers, which do not match the steady real-world consumption of finished automobiles. Fourth, market promotions and price volatility encourage inventory hoarding, further destabilizing supply chains.

The bullwhip effect causes severe negative impacts, including excessive upstream inventory, idle production capacity, increased logistics costs and low supply chain response efficiency.

2.2. Supply chain coordination contract theory

In decentralized supply chains, independent profit-oriented decisions lead to double marginalization problems, reducing overall supply chain efficiency and exacerbating demand distortion. Supply chain contracts are effective coordination tools for risk sharing and bullwhip effect mitigation [2]. This paper mainly applies revenue-sharing contracts and buy-back contracts.

2.2.1. Revenue-sharing contract

Under this contract, upstream suppliers provide products at a discounted wholesale price, and downstream retailers share a certain proportion of their sales revenue with suppliers after the products are sold [3].

In traditional decentralized supply chains, inconsistent profit targets cause downstream enterprises to over-order or under-order based on risk aversion, distorting real market demand and amplifying the bullwhip effect. By reconstructing profit distribution mechanisms, revenue-sharing contracts align the interests of upstream and downstream participants, reduce irrational ordering behavior, improve information transparency, and effectively suppress demand fluctuation amplification [4]. Revenue-sharing contracts can mitigate double marginalization, improve overall supply chain profitability, and are particularly suitable for industries characterized by uncertain market demand.

However, there are significant practical obstacles to the implementation of revenue-sharing contracts in the automotive supply chain scenario. Automotive parts span a wide range of categories and vary substantially in cost and value. Negotiating profit-sharing ratios for each type of component will greatly raise transaction costs for contract formulation and signing. Therefore, revenue-sharing contracts are more suitable for long-term in-depth cooperation between vehicle manufacturers and Tier 1 suppliers, especially for high-value core components such as batteries and chassis. Such contracts are not appropriate for universal application across all component suppliers.

2.2.2. Buy-back contract

A buy-back contract, also known as a return policy contract, is a crucial risk-sharing mechanism for uncertain demand environments [2]. The contract stipulates that upstream suppliers repurchase unsold products at a predetermined buy-back price at the end of the sales period, thereby transferring part of the inventory risk from downstream retailers to upstream suppliers.

In the automobile manufacturing industry, high product value, strong component specificity and long production cycles lead to widespread stock-out aversion psychology. Vehicle manufacturers tend to over-order components during capacity tension periods, which intensifies shortage gaming and the bullwhip effect. Buy-back contracts reduce downstream concerns about inventory risk, discourage excessive ordering, promote more rational ordering decisions, and mitigate demand signal distortion as information moves through the supply chain.

Nevertheless, buy-back contracts have distinct limitations in the automotive context compared with conventional consumer-goods applications. Unlike general fast-moving consumer goods, automotive components feature high specificity and dedicated production lines. Returned specialized automobile parts can hardly be reused or resold to other clients, making reverse logistics and processing costs far higher than those for ordinary products. Inappropriate parameter settings may also induce irrational ordering. Overall, revenue-sharing contracts and buy-back contracts coordinate supply chains through profit distribution and risk sharing respectively, effectively alleviating volatility problems in new energy vehicle supply chains.

This chapter systematically examines the definition, causes, and negative impacts of the bullwhip effect; explains the operational mechanisms, coordination logic, and role in mitigating the bullwhip effect of profit-sharing agreements and buyback agreements; and establishes a comprehensive theoretical analytical framework for this paper, providing a solid theoretical foundation for the subsequent case study analysis and optimization strategies regarding Xiaomi's automotive supply chain.

3. Case study of Xiaomi Auto supply chain

3.1. Overview of Xiaomi Auto's supply chain

As a new participant in the new energy vehicle industry, Xiaomi Auto adopts the pre-order sales model for its SU7 series and achieves rapid growth in deliveries. Xiaomi built a VMI central warehouse system at the Yizhuang plant and implemented a 72-hour JIT delivery system, lifting annual inventory turnover to 16 times. Combined with the 72-hour JIT delivery rule, suppliers must replenish warehouse stocks within 72 hours according to real-time assembly scheduling. The 72-hour JIT system shortens material replenishment cycles, aligns component arrival closely with actual production schedules, lowers on-site overstock risks, and improves the responsiveness of material supply for frequent production-plan adjustments. In short, VMI and 72-hour JIT optimise physical material flow, on-site inventory levels and order execution efficiency, effectively mitigating inventory waste caused by untimely replenishment and long lead-time procurement. Through consignment inventory and short-cycle delivery, Xiaomi realizes inventory collaboration between the automaker and Tier 1 suppliers [5].

Nevertheless, VMI and 72-hour JIT are primarily operational tools for inventory and logistics execution, and they possess inherent limitations. They cannot fundamentally eliminate demand-signal distortion across multi-tier suppliers. VMI only governs inventory held inside Xiaomi's Yizhuang warehouse; it does not force Tier 1 suppliers to share genuine downstream demand data with their own upstream Tier 2 and Tier 3 component and raw-material vendors. The 72-hour replenishment window targets logistics speed, yet it does not correct forecast bias, speculative over-ordering, batch-order behaviour or price-driven hoarding along the supply chain.

The automotive supply chain consists of multiple tiers and involves highly specialized components. Combined with demand uncertainty under pre-order sales, even though Xiaomi has adopted VMI and JIT to improve material flow, this system mainly focuses on material delivery and inventory management. Without formal risk-sharing contracts, its supply chain still has typical conditions to trigger the bullwhip effect.

3.2. Inducing factors of the bullwhip effect in Xiaomi Auto's supply chain

Based on established bullwhip effect theory, three major factors contribute to the bullwhip effect in Xiaomi Auto's supply chain [1]. First, the pre-order model causes distortion in demand signal processing. Rapidly rising SU7 orders and revised sales targets create short-term demand surges. Both the automaker and upstream suppliers forecast component demand based on short-term sales goals. Accumulated forecasting errors across supply chain tiers deviate from real terminal demand.

Second, capacity constraints on core components lead to shortage gaming. Key parts such as power batteries and intelligent driving chips have limited production capacity. When components are tight during capacity ramp-up, Xiaomi may place excessive component orders to avoid production shutdown, artificially inflating demand signals and worsening the bullwhip effect.

Third, batch ordering for vehicle scheduling and component delivery creates intermittent orders and amplifies volatility for upstream manufacturers.

Taken together, these factors can cause upstream order fluctuations to exceed real consumer demand, potentially leading to excess inventory, idle capacity, and higher supply-chain costs. It should be emphasized that VMI and JIT improve material circulation but only optimize inventory coordination. They cannot resolve conflicts of interest and insufficient risk-sharing under sharp demand fluctuation, so they cannot fundamentally eliminate shortage gaming and demand amplification.

3.3. Optimization suggestions based on revenue-sharing and buy-back contracts

At present, Xiaomi Auto relies primarily on its VMI central warehouse, 72-hour JIT delivery system, strategic investments in upstream suppliers and capacity reservation to stabilize component supply. Nevertheless, formal risk-sharing mechanisms such as revenue-sharing and buy-back contracts have not yet been implemented within its supply chain. Drawing on the aforementioned supply-chain coordination theories, this paper puts forward two targeted optimization proposals.

(1) Revenue-sharing contracts can be introduced for core-component suppliers. The automaker purchases components at a discounted wholesale price and shares a fixed proportion of vehicle sales revenue with suppliers after delivery. Aligned interests enable joint risk-sharing and reduce shortage gaming and overstocking, mitigating demand distortion.

(2) Second, buy-back contracts may be adopted to mitigate downstream inventory risks. The contract can specify that suppliers repurchase unused specialized components at an agreed discount after each production cycle. The contract would stipulate that suppliers repurchase unused specific-purpose components at a pre-negotiated discount upon the completion of each production cycle. This measure lowers Xiaomi Auto's exposure to inventory losses and discourages excessive component ordering triggered by fear of production stockouts, which in turn weakens the bullwhip effect. However, implementation faces practical limitations: component buy-backs incur additional costs for reverse logistics, warehousing and administration. Therefore, contract parameters need to be carefully calibrated to prevent new resource waste across the whole supply-chain system.

Using the Xiaomi SU7 supply chain as a case study, this chapter identifies factors that trigger the bullwhip effect, such as demand forecasting errors and shortage gaming. It examines real-world characteristics including the company's VMI central warehouse, 72-hour JIT delivery, rapid production ramp-up, pre-sale model, and constraints on the supply of core components. To address the shortcoming of the existing supply chain, namely the lack of risk-sharing agreements, this chapter proposes a coordinated optimization approach based on revenue-sharing and buy-back agreements. It provides a reference for Xiaomi and other emerging new-energy vehicle manufacturers to stabilize their supply chains and mitigate the bullwhip effect.

4. Conclusion

This paper uses the supply chain of Xiaomi Auto's SU7 as a case study of a new-energy vehicle manufacturer. Using literature review and case study methods, this paper investigates the bullwhip effect, revenue-sharing contracts and buy-back contracts. The main conclusions are as follows:

Firstly, the combination of pre-order sales, capacity constraints of core components and batch ordering tends to trigger the bullwhip effect. Even if firms implement VMI and JIT inventory coordination, these measures can improve material flow but cannot address the underlying causes of shortage gaming and insufficient risk sharing during periods of sharp demand fluctuations.

Secondly, revenue-sharing contracts and buy-back contracts are effective supply chain coordination tools. Revenue-sharing contracts align profits to share risks; buy-back contracts reduce automakers' fear of

stock-outs by repurchasing idle specialized components. Both mechanisms curb irrational over-ordering, ease demand signal distortion and weaken the bullwhip effect.

Thirdly, for Xiaomi Auto, suitable revenue-sharing or buy-back contracts can be introduced on the basis of existing VMI, JIT and upstream strategic investment to complete the risk-sharing system. Additional costs such as reverse logistics and warehousing must be evaluated in contract design to ensure practicality.

This research has limitations. It is a qualitative case study without quantitative modeling or numerical simulation. Therefore, it cannot quantitatively measure the exact magnitude by which revenue-sharing and buy-back contracts suppress the bullwhip effect, nor can it obtain the optimal contract parameter values under different operational scenarios. Future research can collect empirical order data, component inventory records and production-capacity data from new-energy vehicle supply chains. On such bases, quantitative analytical models can be established to simulate different contract-parameter combinations.

References

- [1] Lee, H. L., Padmanabhan, V., & Whang, S. (1997). Information distortion in a supply chain: The bullwhip effect. *Management Science*, 43(4), 546–558. <https://doi.org/10.1287/mnsc.43.4.546>
- [2] Pasternack, B. A. (1985). Optimal pricing and returns policies for perishable commodities. *Marketing Science*, 4(2), 166–176. <https://doi.org/10.1287/mksc.4.2.166>
- [3] Cachon, G. P., & Lariviere, M. A. (2005). Supply chain coordination with revenue-sharing contracts: Strengths and limitations. *Management Science*, 51(1), 30–44. <https://doi.org/10.1287/mnsc.1040.0215>
- [4] Özelkan, E. (2020). Bullwhip effect in pricing under the revenue-sharing contract. *Computers & Industrial Engineering*, 147, Article 106637. <https://doi.org/10.1016/j.cie.2020.106637>
- [5] Zhang, Q., Da, Q. L., & Shen, H. C. (2001). Evaluation of bullwhip effect and information sharing under ARIMA(0, 1, 1) demand. *Chinese Journal of Management Science*, 9(6), 1–6.