

Study on two-echelon supply chain models with variable demand under different shipment policies

Anamika Dash

Department of Mathematics, Jadavpur University

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Abstract

We are in a time of unprecedented globalization of trade and businesses. While there are radical innovations of new and advanced technologies, on the other hand, customer expectations are also changing rapidly. To survive and thrive, organizations need to adapt to today's market volatility and technology dependence, which rely on efficient management of the supply chain. In this context, this doctoral study aims to explore several important issues in two-level supply chain models such as imperfect production, lead time, batch shipment, green initiatives, advertising or promotional activities, defect management, cost reduction, and so on.

The thesis includes nine chapters. **Chapter 1** is the introductory chapter which gives a succinct summary of supply chain management covering several terminologies and fundamental concepts of supply chain management pertinent to the thesis. **Chapter 2** presents a concise review of the existing literature spanning across the research domains relevant to our work.

Chapter 3 presents a single-manufacturer single-retailer supply chain model with an imperfect production system under unequal-sized shipment policy. The inspection process at the retailer is erroneous and results in misclassification errors (Type-I and Type-II errors). Defective items are returned to the manufacturer, who conducts a rigorous screening to classify the defective items into repairable, design-flawed and non-repairable ones. The manufacturer incurs carbon emissions cost due to transportation and disposal of scrap items to get one step closer to sustainability. Customer demand is influenced by retail price and sales effort. Optimal shipment policy, pricing and inventory decisions are determined in both the decentralized (based on the Stackelberg leader-follower gaming approach) and the centralized scenarios. A trade credit mechanism and wholesale price discount contract are employed and a fair profit-sharing strategy is implemented based on the supply chain member's bargaining power. The conditions for participating in these coordination mechanisms are examined from the point of view of each supply chain member. Finally, a numerical experiment along with sensitivity analysis is carried out to illustrate the applicability of the proposed coordination mechanisms and defect management policy.

Chapter 4 considers a two-stage supply chain model consisting of a single manufacturer and a single retailer with a combination of equal and unequal sized batch shipment policy. Consumer's demand is sensitive to the retail price and greening improvement level of the product. At the retailer, planned shortage is allowed in each shipment cycle and is completely backlogged. Assuming that the retailer has higher power than the manufacturer, we develop non-coordinated decentralized model and coordinated model with cost sharing contract, and the integrated centralized model. The numerical results show that the cost sharing contract gives an impressive increment in the profits of both the manufacturer and the retailer over their profits in the non-coordinated model. A sensitivity analysis is performed to explore the impacts of key model-parameters on the optimal decisions and profitability of each member as well as the entire supply chain.

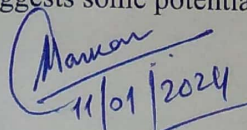
Chapter 5 considers an imperfect production-inventory system which consists of a single manufacturer and a single retailer. The manufacturer delivers the order quantity to the retailer in some unequal-sized batches. To separate the defective items, the retailer performs an error-free screening process after receiving each delivery from the manufacturer. Shortage in retailer inventory is allowed and completely backlogged. The customer demand is dependent on the retail price, advertisement frequency and greening level of the product. The centralized model and the decentralized model (based on a Stackelberg gaming approach) are developed to determine optimal pricing, advertising and inventory decisions. A cost sharing contract between the manufacturer and the retailer is implemented, which enhances the environmental performance, advertisement frequency and profitability of the supply chain significantly. The proposed model is illustrated with a numerical example followed by a sensitivity analysis. Several managerial insights are also highlighted.

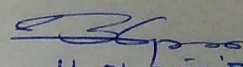
Chapter 6 studies a single-manufacturer single-retailer green supply chain model with an unequal sized batch shipment policy. Upon arrival of each shipment, the retailer conducts a sample inspection on a few randomly selected items. The manufacturer adopts a set-up cost reduction strategy. Consumer demand is influenced by retail price and retailer's promotional and greening efforts. Mathematical models are developed and investigated under both decentralized and centralized structures. Thereafter, two incentive coordination schemes, namely, a trade credit contract and a wholesale price contract are proposed. The necessary conditions for involvement in these coordination mechanisms are derived from each member's perspective. Numerical examples demonstrate that the proposed coordination mechanisms efficiently improve the economic as well as environmental performance of the entire supply chain. Sensitivity of some key model parameters is also analyzed.

Chapter 7 considers a two-level supply chain which is composed of a single manufacturer and multiple retailers. The ordered quantities of the retailers are delivered in some equal sized batches from the manufacturer. Customer demand is linearly dependent on the retail price of the product. Lead time is random and it follows a normal distribution. The proposed models are developed for both the centralized and the decentralized scenarios. Numerical results illustrate that integration of the supply chain players gives an impressive increment in profit of the whole supply chain. Sensitivity analysis is also carried out to explore the impacts of key parameters on the profitability of the supply chain system.

Chapter 8 investigates a two-level supply chain comprising a single manufacturer and multiple retailers in which the manufacturer produces a single product and delivers it to the retailers in equal-sized batches. Each retailer faces a price and green-sensitive market demand. The lead time is assumed to be a random variable that follows a normal distribution. Shortages for retailer inventory are allowed to occur and are completely backlogged. The centralized model and a decentralized model based on the leader-follower Stackelberg gaming approach are developed. A price discount coordination mechanism between the manufacturer and retailers is proposed. Numerical outcomes exhibit that the price discount mechanism effectively coordinates the supply chain and enhances both environmental and economical performances. A sensitivity analysis with respect to some key parameters is performed, and certain managerial insights are emphasized.

Chapter 9 provides a brief outline of the key findings from the study conducted for this doctoral research, and suggests some potential areas for further investigation.


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Professor
Department of Mathematics
Jadavpur University
Kolkata - 700032


11.01.2024
Professor
Department of Mathematics
Jadavpur University
Kolkata - 700032

Anamika Dash
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