

Abstract of thesis of Indrani Modak (14/22/ Maths./27)

Title of the Thesis: Developing efficient pricing strategies for deterministic and stochastic inventory and supply chain models

Abstract:

Pricing is one of the most influential levers in supply chain and inventory management, significantly impacting profitability, customer satisfaction, and operational efficiency. This thesis investigates a variety of pricing strategies under both deterministic and stochastic settings in modern inventory systems and supply chains, emphasizing the integration of real-world complexities such as perishability, learning effects, preservation investment, greening initiatives, uncertain demand, and supply disruptions.

The research presents a comprehensive framework for optimal pricing decisions across a range of scenarios—from single-echelon inventory systems to multi-period and two-echelon supply chains. It addresses how pricing interacts with other strategic factors like lead time, preservation and greening investment, customer service level, and revenue-sharing contracts. A consistent theme throughout the work is the development of dynamic pricing models that align with quality-conscious and environmentally aware consumer behavior, while also managing deterioration, shortages, and return logistics.

In perishable inventory models, the thesis explores the role of time-dependent demand, where price, service quality, and freshness directly affect consumer decisions. Strategies such as planned stock-outs, preservation efforts, and price discounting during shortages are examined to minimize wastage and enhance service. Analytical and numerical results provide guidance for retailers on optimal ordering cycles, pricing schedules, and investment in preservation technologies.

The research also delves into integrated supply chain models where pricing decisions are coordinated between manufacturers and retailers. In a two-echelon system, a revenue-sharing contract is analyzed to balance interests across the chain. Here, dynamic adjustment of prices and revenue fractions helps both parties achieve higher profitability, especially under rising operational costs and preservation constraints.

Further, the thesis incorporates randomness in pricing, production yield, and demand into closed-loop supply chain settings, where products are remanufactured or refurbished. Government regulations on emissions and carbon trading are embedded into these models, and their interaction with green investment strategies is thoroughly explored. These models highlight the advantages of buyback and remanufacturing contracts in improving coordination, reducing environmental impact, and enhancing long-term profitability.

Methodologically, the research employs differential calculus, Pontryagin's Maximum Principle, and sensitivity analyses to derive optimal pricing and investment strategies. Several of the developed models are supported by real-world inspired numerical experiments and have been published in peer-reviewed journals. Across different models, findings consistently suggest that investment in preservation and greening, along with flexible pricing mechanisms, can jointly enhance customer satisfaction, reduce waste, and ensure sustainability in supply chain operations.

This thesis contributes significantly to the literature on pricing in supply chains by offering a unified yet versatile set of models that account for various operational realities. It provides actionable insights for managers and policy-makers aiming to implement adaptive pricing.

investment, and replenishment strategies in an increasingly complex and sustainability-driven marketplace.

Date: 25/06/ 2025

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