

On some issues of supply chain coordination under various uncertainties

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Abstract

The primary goal of this doctoral thesis is to investigate the EOQ (economic order quantity) in the context of the newsvendor problem and examine this in various supply chain models with a focus on supply chain coordination. The thesis consists of eight chapters. Chapter 1 is the introductory part which explains the purpose and scope of our work. It explains the fundamental concepts of supply chain as well as their various characteristics. Some major concerns in supply chain coordination are examined, including the newsboy framework, the nature of demand, the best coordination technique, CSR activities, and remanufacturing. In Chapter 2, a brief literature survey is provided so that one can link the problems described in the following chapters.

Chapter 3 demonstrates a two-tier SC comprising of a manufacturer and a retailer where only the manufacturer exhibits corporate social responsibility (CSR) to increase company's goodwill. The retailer sells a single kind of seasonal product to satisfy price and CSR dependent stochastic market demand in a single period. The production process of the manufacturer is subject to random yield. Depending on existence of a secondary market, two possible centralized models are provided: one by considering no secondary market, and other one by incorporating a secondary market. We also analyze a centralized scenario where CSR activities are not exhibited, as a benchmark model. It is shown that the SC's estimated benefit with CSR is persuaded to be greater than the SC without CSR in terms of profit. In the risk sharing decentralized scenario, we show that a simple revenue-sharing contract fails to coordinate such a supply chain. However, a composite contract combining revenue-sharing, and cost-sharing is shown to coordinate the supply chain and allow arbitrary allocation of total channel profit to ensure that both the retailer and the manufacturer are benefited.

Chapter 4 investigates coordination issue in a three-level supply chain with one raw material supplier, one manufacturer, and one retailer. The retailer exerts effort to promote the product as well as his retail shop locally. The customer demand is assumed to be stochastic and dependent on both retail price and sales-effort. Both the supplier and the manufacturer face random yield in production, and the manufacturer cannot access a secondary market due to its brand image and specific configuration or feature. Both centralized and decentralized model of the supply chain are analyzed as the benchmark case for comparison. Then two different composite contract mechanisms are implemented to outperform the base case in terms of chain's total profit as well as individual profits. We find that a composite contract having two components a contingent buyback with target sales rebate and penalty between the retailer and the manufacturer, and a revenue-sharing contract between the manufacturer and the supplier achieves supply chain coordination and allows arbitrary allocation of total channel profit among all the chain members.


In Chapter 5, we consider a single period three-echelon supply chain with three possible uncertainties, in

which a retailer faces an uncertain market demand for a short shelf-life product and sources it from a manufacturer under voluntary regimes. The manufacturer sources the raw materials from two unreliable suppliers without any emergency resource. The manufacturer's main supplier who delivers the order quantity at a cheaper wholesale price is prone to disruption and, therefore, can deliver full order quantity if not disrupted, but it delivers nothing, if disrupted, while the backup supplier who provides similar quality product at a comparatively higher wholesale price is prone to random yield and, therefore, can only fulfill a random fraction of the manufacturer's order. We analyze the integrated model as the centralized benchmark case and the decentralized model with wholesale price-only contract as decentralized benchmark case. Then aiming at how the risk of uncertainties in both supply and demand can be distributed, we introduce a spanning revenue sharing contract into the decentralized system. We explore coordination conditions and elaborate the circumstance under which the contract is desirable to each of the individual members as well as the entire supply chain.

Chapter 6 examines a supply chain in which a manufacturer produces a product with yield uncertainty and sells it to a retailer who offers a full refund return policy to the customers in which the consumers can return the purchased products if the products do not fit their individual needs or tastes. In order to improve the product, the manufacturer invests in product quality improvement according to customers' likes and preferences. We investigate both the centralized and decentralized models in order to shed light on how to spread the two uncertainties (demand and yield), We present two contract mechanisms to coordinate the decentralized supply chain. For a manufacturer-led contract, we combine a buy-back contract in which retailer credits only for unsold product, with a revenue-sharing contract. For a manufacturer-retailer-led contract, we combine a differentiated buyback policy with two buy-back prices - one for unsold product and another for product returned by the customer with a revenue-sharing cost-sharing scheme. We find that the buy-back with revenue sharing contract is unable to coordinate the supply chain, whereas the differentiated buy-back policy with revenue-sharing cost-sharing scheme is able to do so. Apart from SC coordination, we also demonstrate how the manufacturer can motivate the retailer to collect and send customer feedbacks regarding their product expectations and tastes by applying extra rewards for returned products to reduce customer returns rate.

Chapter 7 demonstrates a two-tiered close-loop supply chain which consists of two members - one manufacturer and one retailer. In forward logistics, the manufacturer produces a product under production yield and sells to the retailer. Consumers can purchase this item from the retailer with the manufacturer's free-repair warranty as a safeguard from premature failures. In reverse logistics, two types of products are returned from consumers. The first one is the return of premature failure products due to functioning issues. The other type is the returned waste products that have reached the end of their useful life (EOL). The retailer is responsible for collecting waste products from customers and returning them to the manufacturer for recycling. To coordinate the system, we first propose a buy-back pay-back contract in which buy-back contract is offered by the manufacturer to the retailer and pay-back contract is offered by the retailer to the manufacturer. It is shown that the proposed contract cannot coordinate the supply chain. Then the contract is modified to a buy-back with pay-back-cost sharing contract in which the retailer promises not only to compensate for the manufacturer's excessive output above his order but also to share a portion of the quality improvement expenditure with the manufacturer. We demonstrate that this contract can accomplish coordination and allocate supply chain profit to the manufacturer and retailer in a number of different ways.

In Chapter 8, an overview of the overall conclusion of the study done in this thesis is provided, as well as some future research areas are suggested.


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Professor
Department of Mathematics
Jadavpur University
Kolkata-700032

Jayanta km Majhi
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