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Contract Analysis and Design for Supply Chains with Stochastic Demand

 Springer

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Abstract

This book is devoted to the analysis and design of supply chain contracts with stochastic demand. The book contains eight chapters, and each chapter is summarized as follows: Chap. 1 provides a comprehensive review of the classical development of supply chain contracts. Chapter 2 examines the effects of demand uncertainty on the applicability of buyback contracts. Chapter 3 conducts a mean-risk analysis for wholesale price contracts, taking into account contracting value risk and risk preferences. Chapter 4 studies the optimization of product service system by franchise fee contracts in the service-oriented manufacturing supply chain with demand information asymmetry. Chapter 5 develops a bidirectional option contract model and explores the optimal contracting decisions and supply chain coordination issue with the bidirectional option. Chapter 6 addresses supply chain options pricing issue, and a value-based pricing scheme is developed for the supply chain options. With a cooperative game theory approach, Chap. 7 explores the issues concerning supply chain contract selection/implementation with the option contract under consideration. Chapter 8 concludes the book and suggests worthy directions for future research.

Keywords: Supply chain management, Supply chain contract, Supply chain coordination, Stochastic demand, Buyback contract, Demand uncertainty, Risk preference, Contract value risk, Wholesale price contract, Product service system, Information asymmetry, Option contract, Spot market, Supply chain options pricing, Option value, Bidirectional option contract, Contract implementation, Game theory

Preface

A supply chain consists of multiple decision-makers who have different risk preferences and incentives. As a result, the optimal supply chain efficiency requires coordination of the actions adopted by the respective supply chain participants. However, it is often difficult to reach supply chain coordination owing to various reasons; typically the actions that are system-wide optimal for the supply chain are often not in the best interests of the individuals, which leads them to have no incentive to do so. To make coordination in supply chains, contracts have to be designed to align the incentives of supply chain members so as to make the individual interest compatible with that of the supply chain system, so that the optimal supply chain efficiency can be achieved. In addition to their employment for channel performance improvement, contracts also serve as important instruments for supply chain members to share risks arising from various uncertainties inherent in the supply chain, such as demand uncertainty, price uncertainty, etc. With the proper assignment of risk among supply chain participants, contracts help to facilitate the supply chain operations in different business environments.

Given the extensive utilization of contracts in supply chains, the issues concerning contract analysis and design are extremely important for supply chain management, and substantial research has been conducted to address the relevant issues over the past years. Despite the abundance of classical research, new research needs to be made in response to new issues emerging with the recent changing business environments, such as the fast-shortening life cycle of product and the increasing globalization of supply chain. Only in this way can we gain a more comprehensive and profound understanding of this important topic.

This book is devoted to addressing issues concerning the analysis and design of supply chain contracts under stochastic demand, with the intention to present new research results on how to apply contracts to improve supply chain management. The book consists of eight chapters, and each chapter is summarized as follows:

In Chap. 1 a comprehensive review is provided for the classical development of supply chain contracts. Given that the literature on supply chain contracts is vast and any categorization of research streams may not be enough to cover all, the review begins with the research under the classical newsvendor model and

then covers various extensions. Particular attention is paid to the wholesale price contract, buyback contract, revenue-sharing contract, sales-rebate contract, quantity discount contract, and various flexible supply contracts. Such an organization of the contents aims to make the review follow a clear pattern and better capture the most important features of the past development on supply chain contracts. Besides, the main innovations for the research presented in this book are also summarized in this chapter.

Chapter 2 examines buyback contracts in a supplier-retailer supply chain where the retailer faces a price-dependent downward-sloping demand curve subject to uncertainty. Compared with classical research, a fundamental difference of this research lies in its analytical examination of the effects of demand uncertainty on the applicability of buyback contracts. To this end, the research seeks to characterize the buyback contract model in terms of only demand uncertainty level. With such a new research perspective, some new and interesting findings are obtained for such issues as how demand uncertainty level affects the applicability of buyback practice and how to apply this practice to improve supply chain members' own interests or the supply chain system's efficiency. The research in this chapter demonstrates that the uncertainty level inherent in market demand can be a critical factor influencing the applicability of supply chain contracts, as well as the contract's administrative cost (Cachon 2003) and the uncertainty type (Marvel and Peck 1995).¹

Given that risk is a pertinent issue in designing supply chain contracts with stochastic demand, Chap. 3 is devoted to developing a mean-risk analysis for the commonly adopted wholesale price contract. The research incorporates contract value risk into the wholesale price contract model. Regarding the contract value risk, it actually relates to the uncertainty in the true value of the contract and arises from various uncertainty sources inherent in the supply chain, such as demand uncertainty, price uncertainty, etc. In addition, given that the supply chain agents with different risk preferences will have different risk attitudes towards the contract value risk, which in turn affects their contracting decisions, the research also considers the degree of supply chain agents' risk-aversion towards the contract value risk. This chapter makes the first attempt to assess the efficiency of wholesale price contracts, incorporating contract value risk and risk preferences attached to it; thereby some interesting managerial and academic insights are generated for supply chain contracts.

Chapter 4 examines franchise fee contracts in the product service system with demand information asymmetry. In this chapter, three types of contracts are devel-

¹Marvel and Peck (1995) incorporated two types of uncertainties in their model, namely, the uncertainty with respect to product valuation and the uncertainty with respect to the number of customer arrivals. Their studies showed that *only* the valuation uncertainty makes the supplier prefer the wholesale price-only contract, whereas *only* the arrivals uncertainty induces the supplier to offer buyback in its contracts. Their studies reveal that the type of uncertainty can be a significant factor affecting the applicability of supply chain contracts. Cachon (2003) pointed out that the contract's administrative cost may be another critical factor for the applicability of supply chain contracts.

oped to optimize the operations of product service system in the service-oriented manufacturing supply chain. The first is the franchise fee contract under which a two-part tariff including a wholesale price and a franchise fee is provided. The second is the franchise fee with service requirement (FFS) contract under which a service level is specified in addition to a two-part tariff. The third is the franchise fee with centralized service requirement contract which is similar to the FFS contract but that the service level specified is the system-wide optimal solution. This chapter mainly addresses the issues of how to design the contracts by which to assure a credible information sharing across the supply chain and how different these three forms of contracts affect the supply chain. The research can provide managerial insights for optimizing product service system by franchise fee contracts in the service-oriented manufacturing supply chain with demand information asymmetry.

Chapter 5 extends the concept of single directional option to develop a supply contract for a two-echelon manufacturer-retailer supply chain with a bidirectional option for which it may be exercised as either a call option or a put option. With a general demand distribution, the research derives closed-form expressions for the retailer's optimal order strategies under the bidirectional option contract, including the optimal initial order strategy and the optimal option purchasing strategy. The research also analytically examines the feedback effects of the bidirectional option on the retailer's initial order strategy. In addition, a chain-wide perspective is taken to explore how the bidirectional option contract can be designed for supply chain coordination.

Chapter 6 explores the pricing issue for supply chain options. In classical research, this issue is generally considered in the Stackelberg game framework. Such a pricing scheme, however, is usually unacceptable to the follower since the leader always captures all the surplus derived from the options. Being different from the existing literature, this chapter develops a value-based pricing scheme for supply chain options with two modeling scenarios including a single retailer and multiple retailers. The intuition behind such a pricing scheme is to price the option based on the value inherent in the "option right". As shown in the research, such a pricing scheme can assure that each of the contracting partners captures a share of the surplus derived from the options. As a result, the pricing schemes developed in this chapter are more objective and fair and consequently are more likely to be accepted by the contracting partners as compared with those that follow the Stackelberg game approach.

Chapter 7 focuses on exploring issues concerning supply chain contract selection/implementation with the option contracts under consideration. From existing research it is known that various contracts have been developed to attain supply chain coordination and ensure arbitrary allocation of the resulting coordinating profit. However, since the extents to which the individuals involved improve their profits are different with different coordinating contracts, an important issue that remains to be resolved is how to select a coordinating contract that is acceptable for all the contracting partners. In Chap. 7 an effort to address this issue is made with the consideration of option contracts. In this research, the cooperative game approach is taken to consider the supply chain coordination issue with option contracts and to

develop the contract negotiation model, taking into account supply chain members' risk preferences and negotiating powers. The negotiation models developed with the option contract can be easily extended to other types of contracts such as the buyback contract, the revenue-sharing contract, the sales-rebate contract, etc. In this sense the research of this chapter presents a theoretical modeling framework for the selection/implementation issue of supply chain contracts.

Finally, as the end, Chap. 8 concludes the book and suggests some worthy directions for future research.

This book is intended for researchers (including graduate students) in supply chain management who have an interest in conducting in-depth studies on supply chain contracts. This book is also intended for business practitioners who would like to seek a better understanding towards supply chain contracts and look for guidance and decision support for the practice of supply chain contracts. To summarize, this book can be useful for both researchers and practitioners in operations management, management science, and business administration.

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