

# Cooperative Supply Chain Management under Asymmetric Information

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## ABSTRACT

This study investigates supply chain cooperative management problem. In this study, based on principal-agent, firstly we analyse cooperative management factors in supply chain including leading enterprise expected utilities, subsidiary enterprise expected incomes and leading enterprise agency cost, then the incentive contract model is constructed; Secondly the model is solved in the case of symmetric information and asymmetric information; At last, in order to make clear of the model, this paper does mathematical analysis of leading enterprise expected utilities, subsidiary enterprise expected incomes and leading enterprise agency cost. Some important conclusions are obtained: subsidiary enterprise ability, cost coefficient, absolute risk aversion factor and output variance has the same influence on leading enterprise expected utilities and subsidiary enterprise expected incomes; subsidiary enterprise ability, cost coefficient has the same influence on leading enterprise expected utilities, subsidiary enterprise expected incomes and leading enterprise agency cost; leading enterprise expected utilities and subsidiary enterprise expected incomes become bigger and bigger, but leading enterprise agency cost becomes smaller and smaller with absolute risk aversion factor and output variance decreased. etc. Leading enterprise can take on incentive measures (improving subsidiary enterprise ability, decreasing subsidiary enterprise cost coefficient.etc) to optimize supply chain management based on the common factors.

Keywords: Asymmetric information, cooperative supply chain, Principal-Agent, incentive.

## 1. Introduction

With the development of information and globalization, supply chain management has become an important factor affecting world's economy development in a sustainable, healthy and rapid way. Studies of supply chain management are more complicated including theories and practices, especially cooperative supply chain management has become the focus in the recent 20 years. Supply chain is related to many industries which are different in departments, functions and operations, and the competition can be formed only by the cooperation between industries, what is more, supply chain activities cannot be achieved until resources of different industries are integrated. Not only it is the significance of supply chain coordination, but it is the way of eliminating the obstacles across industries. Therefore, the problem of cooperative supply chain management needs to be solved urgently. Based on the findings from existing literatures, we found that existing studies discuss the information technology and incentive theory.

Information technology is an important tool in dealing with supply chain management. To verify the importance of information, Prajogo and Olhager put forward supply chain management concept on the background of information, that was, the integration of logistics information resources could drive the integration of logistics resources, and information and information sharing had a significant impact on supply chain performance[1]; Barton and Thomas pointed out that supply chain management had become an increasingly important tool to improve the situation of manufacturing industry, and rapid reaction abilities, intelligent integration system and management capabilities were all the key to create a robust supply chain[2]; Lee emphasized the importance of information resources integration, its contents included: demand, inventory status, production plan, production time, promotion plan, demand forecast and transportation routes sharing[3]. Research also focused on Information tool, such as, Wamba and Chatfield discussed the

application of RF technology in the logistics resources integration [4]. Meanwhile, a dynamic self-assessment of performance on supply chains operating in markets was put forward based on information simulation platform [5][6].

So we can conclude that the quantitative model in the above literatures is information-based.

Incentive theory is another important way of solving cooperative supply chain management problem due to the high cost with information technology. "Cooperation" is one key word of incentive theory, such as, Christopher thought it need cooperation for different supply chain parts in network times[7];With the help of cooperative game theory, Nagarajan and Sos̃ic´ analyzed the integration problem of supply chain, and proposed the theory of 'vision', which provided one new way for cooperative supply chain management [8].

"Trust" is another key word of incentive theory, such as, Handfield, Nichols and Sahay thought the trust mechanism is of great importance for supply chain management, holding that robust supply chain is needed to ensure the mutual trust and responsibilities among the system for a long time, and the sharing of information, risk and revenue was crucial [9][10].

"Agent" is also the key word of incentive theory, such as, on the background of global supply chain manufacture network, Jiao, You and Kumar set up a multi-agent (upstream and downstream enterprises involved in supply chain), multi-contracting negotiations (customer demand) model, which is helpful for dealing with spontaneous or semi-spontaneous problem in supply chain [11]; Brintrup established the supplier selection model of multi-agent, multi-target and multi-role at the aim of reducing transaction time and increasing corporate revenue [12];From the perspective of customer needs, Akanle and Zhang put forward optimizing the configuration for supply chain, and they built a multi-agent model coordinating iterative bidding mechanism based on interactive algorithms, got the optimum based on genetic algorithm in the end[13]. Actually, the incentive theory in the above literatures is an important and new method in dealing with supply chain cooperative management problem.

To sum up, existing literatures mainly focus on resources configuration, supply chain cooperation, trust mechanism and agent model respectively; the problem is that how to coordinate leading enterprise and subsidiary enterprise overall. At present, the problem has not been resolved by related researches. In this paper, based on principal-agent, it analyzes the cooperative management problem in the supply chain, so the incentive contract model is constructed and solved in the case of symmetric information and asymmetric information; Some important conclusions can be obtained by the model. We organize this paper as following: In section 2, we present the incentive contract model, which forms the theoretical foundation of this study. In section 3, we solve the model, which provide the base for analysis. In section 4, we present the analytical model through which we can coordinate leading enterprise and subsidiary enterprise. Finally we conclude the whole study.

## 2. Principal-agent model of cooperative supply chain management

The origin and development of principal-agent theory provides scientific solution for the incentive problem of supply chain, and mechanism design is effective way of tackling with principal-agent problem,by looking for the common parameter related to both the principal and the agent in case of symmetric information and asymmetric information [14].

Leading enterprise and subsidiary enterprise are comprised of Stackelberg model, in which, leading enterprise is the principal (one leading enterprise assumed), subsidiary enterprise is the agent(one subsidiary enterprise assumed). Leading enterprise monitors the activities of subsidiary enterprise while paying agency cost. In the paper, the factors related to the model consist of leading enterprise expected utilities, subsidiary enterprise expected incomes and leading enterprise agency cost.

### 2.1 Mathematical description of model

(1)Subsidiary enterprise expected incomes

(a)The sales model

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