南京航空航天大学

论文集

（二〇〇七年） 第33册

经济与管理学院

（第4分册）

南京航空航天大学科技部编

二〇〇八年三月

经济与管理学院

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Value Chain Coordination with Contracts for Virtual R&D Alliance towards Service

Bin Liu
College of Economics and Management
Nanjing University of Aeronautics and Astronautics
Nanjing, China
Email: liubhnau@163.com

Sifeng Liu
College of Economics and Management
Nanjing University of Aeronautics and Astronautics
Nanjing, China
Email: sfliu@nuaa.edu.cn

***Abstract*-Value chain of virtual R&D alliance (VR&DA) towards service has taken on more and more important role in present manufacturing era. This paper considers the coordination problem of value chain of VR&DA towards service with contracts. Firstly, key concepts on value chain of VR&DA towards service are introduced. Then, the framework for coordinating the value chain of VR&DA towards service with contract is developed, and the preliminary model to depict the contract relationship between the agents of VR&DA is presented. Finally, future study suggestions are advanced.**

Key Words-Virtual R&D alliance; Value Chain; towards Service; Contract; Model.

I. INTRODUCTION

With the shortening of product's life cycle, the innovation for products has been paid attention by scholars. So, the virtual R&D alliance has already become the most important factor in supply chain[1]. Unfortunately, virtual R&D alliance is confronting some risks under nowadays setting that people's live standard is improved rapidly and that new technologies are developed incessantly. For the lower costs in R&D, some firms start to seek the outsourcing of R&D tasks from the agents who can develop some new products according to specifically requirement, but firms take on all risks of future product and future market[2]. It is undoubted that these risks will restrain the performance of whole value chain of R&D alliance towards service. Now, service has taken on the more and more important role in economic growth, and service science and service engineering, as a novel interdisciplinary, starts to attract some international scholars. In this background, Value chain of R&D alliance towards service is endowed to new meaning and wider signification. On September 12, 2005 the international workshop on Service Management and Service Engineering hold by Peking University started to arouse more scholars' interest for service. Under the framework of the generalized service, how to seek the optimal mechanism to coordinate the virtual Value chain of R&D alliance towards service in case to deal with risks from future market has become a focus paid by scholars and managers. This paper will have a try to study this problem with the view of mathematics modeling.

The rest of this paper is organized as follows. Some key concepts on virtual Value chain of R&D alliance towards service are introduced in section 2, and the study framework for coordinating the virtual Value chain of R&D alliance towards service with contracts is developed in section 3. Then, section 4 presents the primary model to depict the contact for virtual Value chain of R&D alliance towards service, and the last is our conclusion.

II. KEY CONCEPTS

A. Service

The service concept may be modeled from different perspectives. A fair general definition looks at a service like "an activity performed by one organization (provider) on behalf of another (consumer)". While in the past services were usually provided through human interaction, such as face to face, by telephone, et al., the Internet growth is nowadays leading to an amplification of communication capabilities, thus giving new market opportunities. However, exploitation of a network infrastructure requires several components to manage the entire service provisioning process, from subscription to delivery. The complex relationships existing among the various parties involved in the service negotiations and activation process impose new constraints on architecture design. When considering a service built over a virtual R&D alliance, many aspects have to be accounted for. Among them, service availability and customization are gaining more and more relevance. Service availability considers the assurance of service deployment to the largest number of people with the smallest number of failures. Service customization is a new emerging requirement due to the different situations a dynamic market can produce. While the world wide web(WWW) provides a way to guarantee wide availability of a service, and it can be considered as a consolidated technology for creation of electronic business scenarios, current mechanisms for customizing services based on end users' needs are quite inadequate[3].

Bin Liu is a Post-PhD at College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing, China, and also with department of Management Science, Henan Agricultural University, Zhengzhou, China. E-mail: liubin@nuaa.edu.cn.

Sifeng Liu is with college of economics and management, Nanjing University of Aeronautics and Astronautics, Nanjing, China, and also the dean and the endowed professor of the college. E-mail: sfliu@nuaa.edu.cn.

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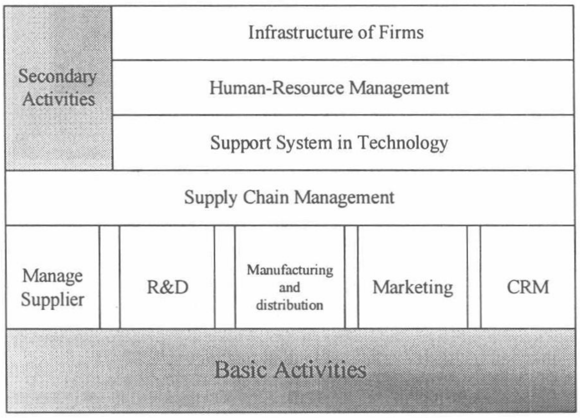

Figure 1. Value Chain towards Service

A service provisioning life cycle starts with a service description, which then requires a proper degree of formalization. Emphasis is on the different types of information that need to be defined, as well as on the ability to model relationships between them. When the service is defined, a contract containing formal specifications is prepared and subscription to it represents resourced are limited in nature, so it is mandatory the introduction of policy-based mechanisms able to alert in case of breaches of contract.

B. Value Chain towards Service

Value Chain towards service aims to achieve the optimal customer value, and is the set consisted of some valuable activities, which can provide kinds of services for customers. For the value chain towards services, some meanings are included. Firstly, to ensure the value for customers is the key and the start in the value chain towards services, and this objective can ensure to operate the firms well. Secondly, the measures to attain the customer value are to provide the services required by customers. Certainly, these services are omni-directional, and the time range for services should be a process from ordering to washing out product. When a customer selects a new product, this process will be run in a new cycle. Some traditional service, such as the service before sale, on sale and after sale, are included the service, which should be a service system. Finally, the value chain towards services is a set of valuable activities in order, and the orderliness is depicted as an integrated management for activities[4]. The value chain towards service is shown as follows.

C. Virtual R&D Alliance

Virtual R&D alliance is a new alliance mode, and it integrates the virtual organization to R&D team. In nature, virtual R&D alliance is operated based on the interaction between information and communication techniques (ICT), and it is an R&D network consisted by relative firms for a special task. Furthermore, virtual R&D alliance can break up the limit in time and space for firms, and strengthens the coordination each other. By this effective mode, firms can ensure the integration in information, technology, and human resources, and at the same time they can share in profits and risks. Virtual R&D alliance can be the alliance between the government and the firm, the firms, and the academic research centers, and they can cooperate with a formal mode, and also with an informal one, such as friendship networks among experts. Differing from other cooperation mode, there are four characteristics in virtual R&D alliance, ICT-based, Agreement, project-orient and flexibility[4].

1).ICT-based.

"*Virtual*" is defined with "Because of some inherent factor, it takes on its role though it could not exist in present setting". We think the inherent factor in virtual R&D alliance is the application of information and communication technologies. Virtual R&D alliance takes full of modern information and communication technologies to break up the restriction in firms, industries and terrains, and then to achieve the share with global

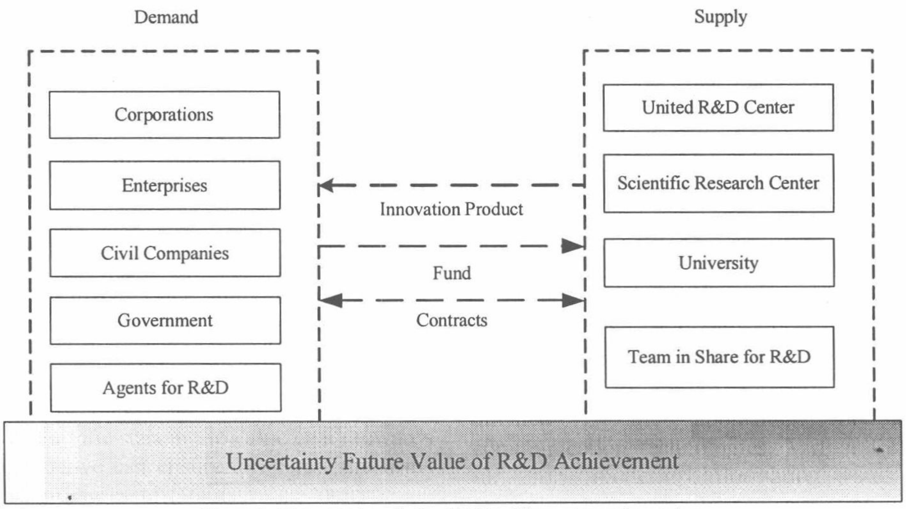

Figure 2. Virtual Value chain of R&D alliance towards services

information, techno-talent well[5].

2) Agreement

Differing from the cooperative company or the special R&D group, there is none practical R&D organization or group in the virtual R&D alliance, and there is not leadership in its interior. The cooperation is built on the relationship of equality and trusting based on the agreement[6]. In some extent, agreement takes on some tasks of the contract paid by this paper.

3) Project-Orient.

Because of the non-constrain in territory, virtual R&D alliance provides some cooperation opportunity for the customer-orient R&D. Differing from traditional R&D organization, virtual R&D alliance pays more attention to the project, which can be regard as the direct of the virtual alliance, also the precondition to construct this alliance[7].

4) Flexibility

It is known that virtual R&D alliance is a dynamic alliance. I.e., this cooperation can come into being because of certain chance, and then the alliance will wind up when the life cycle of cooperative product ends. So, virtual R&D alliance does not need large numbers of investment in capital asserts, and it can select partner befittingly to strengthen the flexibility of alliance[4].

D. Virtual Value chain of R&D alliance towards Services

Based on the above analysis on service, value chain towards service, and virtual R&D alliance, we can design the virtual Value chain of R&D alliance towards service as fig.2. In this value chain, some agents, such as the R&D customer (corporations, enterprises, civil companies, et al.), the R&D suppliers (United R&D center, Scientific research center, and universities, et al.), are included. They take on different tasks in this alliance to deal with the uncertainty future value of products. Certainty, contact, as a key mechanism, will encourage them to the consistent object. According to contracts, they can share with the performance and risks of cooperative product, which differs from others cooperation modes adopted by traditional R&D alliance. With the wider application of supply chain management (as a modern thoughts), more and more corporations will adopt outsourcing for R&D widely, and virtual Value chain of R&D alliance towards service will take on more important role. Additionally, in this alliance, contract can be regards as one kind of service, which trades off the relationship between risks and performances.

III. Study Frameworks for Coordinating Virtual R&D Value Chain towards Service with Contracts

Contract is a cooperation mechanism among firms, and it can ensure that the cooperation between firms cannot depend only on the moralities and must be normalized by the feasible mechanism, which will affect directly the decision actions of companies and decide the allocation of the coordination profits and risk[8]. In the study on the coordination of supply chain/value chain, contracts are often regards as a mechanism to share with risks from uncertainty market. Certainly, there are many uncertain factors in virtual Value chain of R&D alliance towards service as others supply chain. Among these uncertain factors, some are controllable, such as the change of new technology, and others are uncontrollable, such as the time of coming-into-the-market.

By the contract, we can adjust the contract parameters, such as, ordering price, and lead-time, to inspirit effectively suppliers and demanders and allocate arbitrarily the coordination profit. Among pricing contracts, there are the option, and the revenue sharing, which all aim to control the controllable risks or to alleviate the uncontrollable risks. The principle of contracts among firms is listed as follows.

From the contact, demander for R&D services will pay transferring price to the suppliers for R&D services, and correspondingly the suppliers will take on some risks from uncertainty factors. Through the share with risks among demanders and suppliers, the expected performance of whole system will have an improvement, and demanders for R&D services will seek the R&D service from suppliers.

IV. Modeling Coordination of Virtual R&D Service Value Chain towards Service

In this paper, the model framework is introduced, which can help readers understand the coordination problem of virtual Value chain of R&D alliance towards service well. Some assumptions for modeling are listed as follows.

EPD is for the expected profit of demander for R&D service;

EPS is for the expected profit of supplier for R&D service;

X is for the future technology level of the same kind of R&D product, and it is a random variable; $X \sim F(\cdot)$.

P is for the bargaining price between the demander and supplier for R&D service, and it is a decision variable;

I is the scheming technology level in the commitment subscribed by demander and supplier, and it is a decision variable. Generally, I is concave on P, which implies that the higher the scheming technology level is, the more the bargaining price is, at the same time, when the bargaining price is very high, the scheming technology level will get to a steady limit. I.e., $\frac{d^2 I(P)}{dP^2} < 0$, and $\lim_{p \to \infty} I(P) = A$, where A is a real number.

In the model as follows, the "N" in the subscript is for the R&D system without the coordination mechanism, and the "C" is for the R&D system with the cooperation mechanism.

So, the decision problem under without contract is

$$\underset{X \sim F(\cdot)}{Max}\ EPD_N(I_N, P_N) \qquad (1)$$

When the contract is subscribed, the decision problem with contract is

$$\underset{X \sim F(\cdot)}{Max}\ EPD_C(I_C, P_C) \qquad (2)$$

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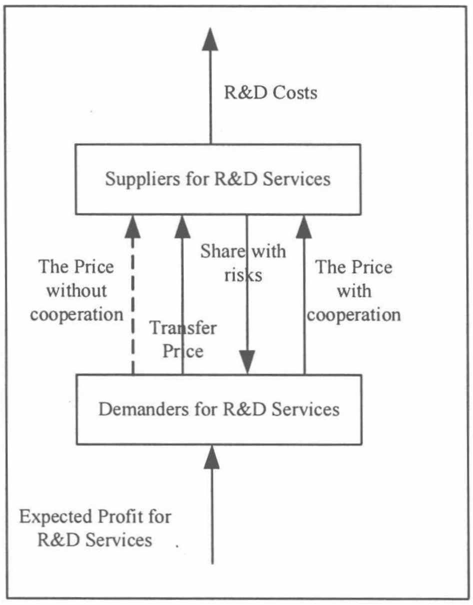

Virtual R&D Alliance Value Chain towards Service
Figure3. Contract

$$\underset{X\sim F(.)}{EPS_C}(I_C, P_C) \geq \underset{X\sim F(.)}{EPS_N}(I_D, P_D) \quad (3)$$

$$\underset{X\sim F(.)}{EPD_C}(I_C, P_C) \geq \underset{X\sim F(.)}{EPD_N}(I_D, P_D) \quad (4)$$

The formula (3 and 4) imply that the Pareto improvement of two agents can achieve, but subject to the conditions, the Incentive Compliancy and the Individual Rationality, with the contract. Certainly, this optimal problem for R&D service is only a conceptual model, and the factual model should be established by practical cases.

V. CONCLUSION

Based on the analysis on several key concepts, the virtual Value chain of R&D alliance towards service with contract is developed, and its coordination problem is also presented. For this value chain, how to coordinate the agents on R&D value chain is our focus of this paper. A conceptual coordination mechanism, contract, is advanced, and when two constrained condition are satisfied, the win-win will get easily. Certainly, the R&D service can give better performance the demander and supplier with the contract than these without the contract.

In future research, we will investigate a virtual Value chain of R&D alliance towards service, and exam the efficient of our model and study frameworks.

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A Review on Quantity Discounts for Supply Chain Coordination

Liu Bin[1,2], *Zhang Rong*[1,2], *Robin G.Qiu*[1,3] *,Sifeng Liu1*

[1]College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing, 210016,China

[2]Department of Management Science, Henan Agricultural University, Zhengzhou, 450002, China

[3]Department of Information Science, Pennsylvanian State University, 19355,USA

liubhnau@163.com, zr.mis@163.com, sfliu@nuaa.edu.cn, gxq102@gv.psu.edu

Abstract: Confronting severe competitions, more and more companies and scholars have started to pay their attentions to supply chain management, especially in supply chains channel coordination, which can improve the performance of supply chains by the relevant information and inspirited policy to achieve coordination between buyers and vendors. In this paper, we start with the basic definition of supply chains, and expatiate the objective of supply chain management and the status quo in channel coordination of supply chains. Then, we expounded synthetically literatures on channel coordination with discounts policies mainly, and sum up several kinds of discount policies and its decision problems on channel coordination with quantity discount. Last, we discuss some possible further researches for channel coordination with discount policies in supply chain management.

Keywords: supply chain management, channel coordination, quantity discount, pricing policy, model

1. INTRODUCTION

Supply chain is defined as the network consisted of manufacturers, who provide raw materials, accessories, products and services, supplier and retailers. Supply chain management (SCM) has gained significance as one of the 21st century manufacturing paradigms for improving organizational competitiveness. SCM has been considered as a competitive strategy for integrating suppliers and customers with the objective of improving responsiveness and flexibility of manufacturing organizations. For example, Japanese have achieved competitive advantages in automobile industry by implementing just-in time (JIT), which focuses on decentralization of various operations. Furthermore, SCM has contributed to development of all agents on supply-chain with the aim of reducing congestion along supply chain and hence enhance productivity and performance of whole system and every agent.

There exists not only cooperation but also competitive relation among agents on supply chain. On one hand, as "rational economic person", agents on supply chain are self-governed and they view the optimal profit as their exclusive objective. On the other hand, for heightening the performance of whole system, they often need consanguineous cooperation each other. So, with the viewpoint, how to unite all agents on supply chain to the objective, the most profit or the least cost of supply-chain system, with a suitable coordination mechanism, which can ensure the win-win in the whole profit and the individual profit and strengthen the performance of whole system, is the focus issue and the hotspot question of present research for supply-chain management.

The rest of this paper is organized as following. Section 2 the coordination mechanism of supply-chain channel is introduced, and its study status in supply chain coordination with quantity discounts are reviewed in section 3. The class of quantity discounts by decision variable and by the discounts types are developed in section 4, and at last further research suggestions are brought forward.

2. SUPPLY CHAIN COORDINATION AND ITS MECHANISMS

The objective of supply-chain management is to achieve the perfect coordination, which means to get the performance of centralized system under decentralized system with optimal prompting measure and optimize the performance of selling channel. In fact, even if the optimal scheme cannot exist, Pareto optimal scheme should be gotten, which ensure every agent to get more performance than before. The perfect coordination mainly achieves by cooperation between agents, inspiration and game, such as quantity discounts, to encourage the ordering behavior of purchasers and then to reduce the cost of supplier, even whole system[1].

There are many mechanisms to ensure the channel coordination of supply-chain system with contract, such as quantity discounts, vendor management inventory (VMI), return policy, backup agreement, revenue sharing, quantity flexibility and so on. With quantity discounts, obviously, supplier can reduce the inventory and the retailer can take lower wholesale price, on the other hand, the marginal profit of supplier will decrease because of the lower wholesale price and the inventory cost of retailer will increase. So, confronted these contradictions, how to put forward the suitable pricing and ordering policy to get rid of these conflict according to different market setting, and let agents on supply-chain get more satisfied profit is the core of quantity discounts. VMI is an operation or coordination policy of efficient customer response (ECR), and with it manufacturers make the order or complement the inventory of retailer according to the real selling and the safety inventory. The real selling demand are generally estimated in advance by dynamic inventory and selling data, and with VMI operation mode manufacturers can improve the response time more. At the same time, manufacturers and suppliers can reduce the unnecessary inventory due to changed market, and then velocity rate of capitals will heighten and the unsold products will reduce. Return policy should also class into an inspirited mechanism for retailers. With return policy supplier will buy back the unsold products of retailer in some price at the end of selling period, and retailer and supplier will take on the market risks commonly. Backup agreement is alike return policy, and with backup agreement supplier only need deliver the part ordering quantity to retailer at the beginning of selling period, and others ordering will be stored into the inventory of supplier. At the same time, retailer only needs pay for unsold products in the part wholesale price at the end of selling period. With revenue sharing, supplier will provide a wholesale price w to retailer, which is lower than the marginal cost of supplier, and at the same time, suppler will share with the part revenue of retailer.

Supply chain coordination with quantity discounts is addressed in this paper.

3. SUPPLY CHAIN COORDINATIN WITH QUANTITY DISCOUNTS

Starr et al. firstly studied quantity discounts (QD) question, namely, the buyers how to determinate the optimal ordering problem if seller provide a price discounts for them. Since 1984 quantity discounts problem with the view of sellers has attracted more and more scholars. As the most familiar coordination mechanism and inspired measure, quantity discounts has also been the focus, which theories lagged badly its practices though this policy almost has existed in present market setting[2].

Under determinate demand, literatures[3-10] addressed into the quantity discounts problem of supply-chain system consisted of one supplier and one retailer or multiple homogeneity retailer, while literatures[11-14] dealt with quantity discounts problem with one supplier and multiple heterogeneity retailers. Furthermore, under the stochastic and price elasticity demand, literatures[1,14] considered the quantity discounts problem of supply-chain system consisted of one supplier and one retailer, and literatures[15-17] paid attentions to the QD problem with single supplier and multiple retailers. More practically, literature[18] considered the QD policy of three-hierarchy channel system consisted of manufacturer, supplier and retailer.

Materially, Monahan[4], as the inaugurator, firstly considered the optimal discounts pricing problem of channel system consisted of single supplier and single retailer with the view of supplier, and its objective aimed to maximize the supplier's profit under no increase the purchasing cost of buyer. It is recognized that Monahan had inaugurated a new field of supply-chain coordination management, and he developed the decision factor of optimal ordering quantity, $K^* = \sqrt{s_2 / s_1 + 1}$, where s_1 and s_2 is for the ordering cost of seller and buyer, respectively.

Based on the achievement of Monahan, Lee et al.[6] and Joglerar[17] extended his pricing model respectively, and they released the original assumption of Order-to-Order, where Lee et al[6] assumed that seller might order products with arbitrary quantity. Lee et al developed the corresponding model to find the increase factor of the optimal ordering quantity of retailer, *K,* and the optimal ordering quantity of seller, which is *k* times of the ordering quantity *K*. Furthermore, they designed an optimal arithmetic to find the optimal ordering quantities under single product and single buyer. Joglerar[17] thought there were two irrationalities in the key assumptions in Monahan model, and he improved them through redefined variable S_2, at the same time, assumed that the ordering quantity of supplier is integer times of that one of retailers, and extended this optimal pricing model.

Lal et al.[10] almost simultaneity considered the quantity discounts problem with the view of seller, while he paid more attention to the channel coordination. He addressed into the supplier "*why*" to provide a quantity discounts policy to improve the system performance of whole supply-chain, and provided a "*what type*" quantity discounts to induce buyer to heighten his EOQ from $Q^* = \sqrt{2A_b D / H_b}$ to $Q^{**} = \sqrt{2(A_b + A_s)D/(H_b - H_s)}$, which is the EOQ of whole system. In this paper, it was assumed that buyer's ordering quantity was Q^{**} and seller would provide prices with form $p = p_0 \cdot e^{-a(Q-Q^*)}$, where a is the quantity discounts size factor. He firstly advanced and applied a unite price-quantity relation to inspirit buyer to increase responding optimal ordering quantity, which could reduce the ordering cost and holding cost of whole system. Furthermore, he established the responding mathematics model, and extended this model to the case of multiple heterogeneity buyers. And at the same time, the continuous iterative search arithmetic was designed to determinate the optimal pricing scheme with multiple breaking points.

Banerjee[19] extended the quantity discounts pricing model established by Monahan too, and got rid of the limitation, which the buyer maybe get products from other sellers. At the same time, he also considered quantity discounts pricing model with transportation fee and viewed the manufacturer as the seller.

Goyal[9] reviewed the quantity discounts pricing model developed by literature[4], and advanced a more simple and convenient arithmetic to find the optimal ordering quantity factor of retailer, *K*, the optimal ordering factor of supplier, *k*, and the optimal pricing discounts provided by supplier, d_k. Subsequently, Dad et al[7] considered the quantity discounts pricing decision based on the literature[4], and he annotated the pricing policy of literature[4] with geometry graphics. With this method, the range of discounts prices and ordering sizes were depicted, and designed a mechanism, paying the year amount management fees to supplier, to commonly share in the coordination profit, which ensured the maximization of whole system.

Weng[1] considered the channel coordination of supply-chain consisted of one supplier and multiple homogeneity retailers. Firstly, he considered the optimal question under two cases, one is non-coordination, under which agents all sought the maximization of profit themselves, and the other is coordination, under which the aim is to optimize the jointed profit. It was shown that under non-coordination and $s_s/s_b = h_s/h_b$ supplier would get the maximization of profit if supplier adopted the optimal ordering quantity of retailer, $Q_b(p)$. Furthermore, EOQ of whole system is the exclusive quantity to balance the ordering cost and holding cost, and at the same time, he also considered the increase of coordination profit under the demand function, $D(x) = d \cdot x^{-2k}$ and $D(x) = a - bx$. It was interested that he developed and applied a control mechanism to promote system coordination, and let ordering quantity equal to the jointed ordering quantity discounts. Furthermore, he introduced the coordination mechanism combined with discounts and franchise to coordinate the channel system, and distinctly pointed out single quantity discounts couldn't ensure the channel coordination. Additionally, he also compared the coordination effect between two quantity-discounts policy, all-unit quantity discounts and incremental quantity discounts.

Chen et al.[20] studied the distribution system of supply-chain consisted of one supplier and multiple heterogeneous retailers with single product under determine demand. He developed the perfect coordination was the goal of channel coordination, and depicted the optimal policy to maximize the centralization channel system. Furthermore, he pointed out the same channel profit as centralization system should be achieved by the fixed-time complement, fixed fees and quantity discounts provided by seller under decentralization system. Generally, there were three kinds of quantity discounts to be applied, year-amount discounts, ordering frequency discounts and ordering quantity discounts. It was interested that he also considered the necessary condition to ensure system coordination, and concluded that single quantity discounts couldn't ensure the system coordination, but the perfect coordination of system might be achieved by the integrating quantity discounts and franchise.

Wang et al.[2] addressed into the pricing and inventory decision problem for the single product supply chain system consisted of one supplier and n heterogeneous retailers, and assumed that seller is the leader of Stackelberg game. In this paper, a new discounts mode, the price discounts sprung by the increase rate of ordering quantity, was developed, and discrete all quantity discounts(AQD) policy with multiple price breaking also was advanced. It was shown that the price discounts sprung by the increase rate of ordering quantity is better than the classic quantity discounts.

Klastorin, et al.[21] considered the ordering coordination problem of multiple-tier distribution system consisted of single supplier and multiple retailers under decentralization system, and developed a new coordination mode, fixed time ordering, with which retailer would get price discounts when retailer makes synchronous order with wholesaler. It was shown that the fixed time ordering could better the system performance. He also advanced the optimal arithmetic to find the optimal price. In the context, he assumed that retailer wasn't price-sensitivity, and lead-time of ordering could be omitted, at the same time, all demand should be met.

Kohil et al.[22] studied the cooperation-game model of quantity discounts based on present literatures, and considered the pricing problem by uniting price-quantity relation with two kinds of prompting methods. It was shown that AQD was equivalence to increase quantity discounts(IQD) in pricing and the rationality of efficiency, and Pareto effect should be a condition of pricing. Furthermore, he concluded that the coordination profit was gotten from the pricing game, and the optimal state was situate in the optimal ordering point and in this point discounts came into being.

Corbett et al. [23], as a pioneer, considered the quantity discounts policy under asymmetry information with the assumption of Lot-for-Lot and compared it to the same policy under the pull information. It was shown that the system could achieve the optimal performance under the full information.

Viswanathan et al.[24] studied supply chain channel coordination with quantity discounts, and evaluated the efficiency of AQD and year amount quantity discounts respectively. They assumed that retailer and supplier all individual and rational, and only maximized themselves profits. This paper considered the optimal ordering policy with combining quantity discounts and year amount discounts, and for the first time developed a new coordination mechanism, combining the AQD with Year amount discounts, to achieve the channel coordination. Furthermore, effects of quantity discounts on channel profits were discussed with examples. It was shown that when demand elasticity was high the year amount discounts was effective very much, and demand elasticity was low all quantity discounts was more effective, furthermore, perfect coordination was always achieved with the combined discounts.

Weng[14] discussed the optimal ordering problem with AQD or IQD under price-elasticity demand, and aimed to the consistent between the individual optimum and the system optimum. Furthermore, he developed the relationship of optimal decisions under AQD and IQD.

Munson et al.[18] considered the three-tier supply chain system consisted of supplier, manufacturer and retailer. Under determinate demand, supplier would provide quantity discounts policy for manufacturer, and manufacturer would give quantity discounts to retailer. This paper addressed into the case where two terminal agents accepted quantity discounts to reduce the ordering cost and then to ensure the system channel coordination. It was shown that quantity discounts accepted by two terminal agents could reduce more costs than that one only accepted by downriver agent, furthermore, manufacture would lost potential saving in costs if ignored the upriver agent.

Under the newsboy setting, Khouja [25-28] combined the gradual multi-discounts policy to disposal the overstock with the quantity discounts, which the supplier gave to the retailer, and ensured the system coordination.

Burnetas et al.[29] addressed into the pricing problem of channel coordination with quantity discount that the supplier gave to the retailer under asymmetry information, and set up a bridge to link the channel coordination with quantity discounts under the EOQ framework and under the newsboy framework.

Under stochastic demand, Cheung[30] considered the effect of time discounts for the first time, and he established an inventory model with time discounts to encourage buyer to accept the delayed products. He developed the control policy, (R_1,Q,R_2,T), where R_1, Q is the complement point and ordering quantity under normal time respectively, and R_2 and T is the trigger to time discounts. It was shown that the amount costs with the time discounts is lower than before, and the performance of supply-chain was improved. In the context, it was assumed customer demand was stochastic, buyer accepted the delayed products with probability mode, the lead-time, L, was constant, and supplier adopted the inventory policy of continuous review.