Supply Chain Coordination Strategies: From Partnership to Contracts - A Taxonomic Perspective*

Hojung Shin** · Jinmin Kim***

《目 次》

Abstract

The primary objective of this paper is to develop a comprehensive understanding of supply chain coordination issues that connects the theory of inventory coordination and the environmental factors. Although the inventory coordination theory provides a practical foundation for supply chain management and supply chain contracts, the link between the theory and its applications has not been discussed overall. This research is an attempt to explore the opportunities how the inventory coordination theories can contribute to solving the potential management issues in practice, along with their development in the literature.

Key words: Supply Chain Coordination; Quantity Discounts; Supply Chain Contracts

* This research was financially supported by the Institute of Information and Operations Management, Seoul National Universitiy.

** Department of LSOM Korea University Business School(hojung_shin@korea.ac.kr) Corresponding Author

*** Department of LSOM Korea University Business School

Ⅰ. Introduction

Supply Chain Management (SCM) is an integrative management philosophy to control the total flow of materials and resources from the supplier to the ultimate user. It has been known that excellence of Zara in SCM has strengthened its leadership position in the apparel industry. "In Zara stores, customers can always find new products - but they're in limited supply. There is a sense of tantalizing exclusivity since only a few items are on display even though stores are spacious (the average size is around 1,000 square meters). A customer thinks, "This green shirt fits me, and there is one on the rack. If I don't buy it now, I'll lose my chance." Such a retail concept depends on the regular creation and rapid replenishment of small batches of new goods."[1)]

Sometimes management failures in the supply chain may hurt the companies' performance directly. For example, one of the reasons why Apple has demonstrated disappointing results and suffered from the slashed stock price recently is crystal clear. The company has not been able to develop and produce products on time to meet consumer demand while other competitors such as Samsung lures customers with continuation of new products in a timely manner. According to *Wall Street Journal*, "Analysts say the company could sell 10 million or so iPad Minis by the end of the year, if they can make enough. Analysts have blamed supply-chain problems for lower-than-expected initial iPhone 5 sales of five million in the opening weekend."[2)] In particular, the primary target of attack was Foxconn - a Chinese OEM manufacturer for Apple - for its production failures as Apple's products have become more sophisticated and complex to assemble.

In a conventional procurement and distribution channel, an individual company's outstanding inventory performance could have a negative influence on the entire supply chain performance. A manufacturer, for example, can transfer its raw material inventories to the suppliers to minimize its inventory costs, yet increase total in-

1) Source - http://hbswk.hbs.edu/archive/4652.html, Zara's Secret for Fast Fashion.

2) Source - http://www.forbes.com/sites/petercohan/2012/10/26/apple-cant-innovate-or-manage- supply-chain/

ventory costs of the supply chain. Companies under the contemporary SCM, however, attempt to find the systems which optimize the whole supply chain rather than achieve sub-optimization at each stage of supply. Therefore, supply chain coordination is understood as a key element for supply chain efficiency. In this research, we use "Supply Chain Coordination" to describe the outcome of supply chain participants' coordinated efforts to reduce overall inventory costs in the supply chain by determining appropriate ordering policies and/or price.

The objective of the proposed research is twofold. One is to develop a taxonomic framework which can overview the complicated inventory coordination theories. Since the objective of SCM is to have the right merchandise at the right time in the right place at the right price, inventory coordination is essential to achieve this goal of SCM. Therefore, the current needs for building conceptual models that help explain the complex supply chain inventory coordination theories in a practical manner are very strong for both practitioners and researchers. Second, the proposed research attempts to reduce the gap in the inventory coordination theories and the environmental constraints that may affect the effectiveness of management effort to implement the inventory coordination theories into practice. Recent progress of SCM has led to the renaissance of analytical inventory coordination models including multi-echelon inventory models and Quantity Discount Based Inventory Coordination Models, and supply chain contracting models. However, the literature has been built on common assumptions of perfect information and control and/or operating environments without uncertainty. In the proposed research, we explore the impact of implementing the supply chain coordination ideas into practice and identify the challenges that may surface in practice under the relaxation of the assumptions.

Ⅱ. Alternative Practices to Supply Chain Coordination

Inventory coordination in supply chains is not a "Zero Sum Game." The concept of coordination and collaboration in inventory management is taking hold across many industries. The most popular supply chain coordination example was that of P&G

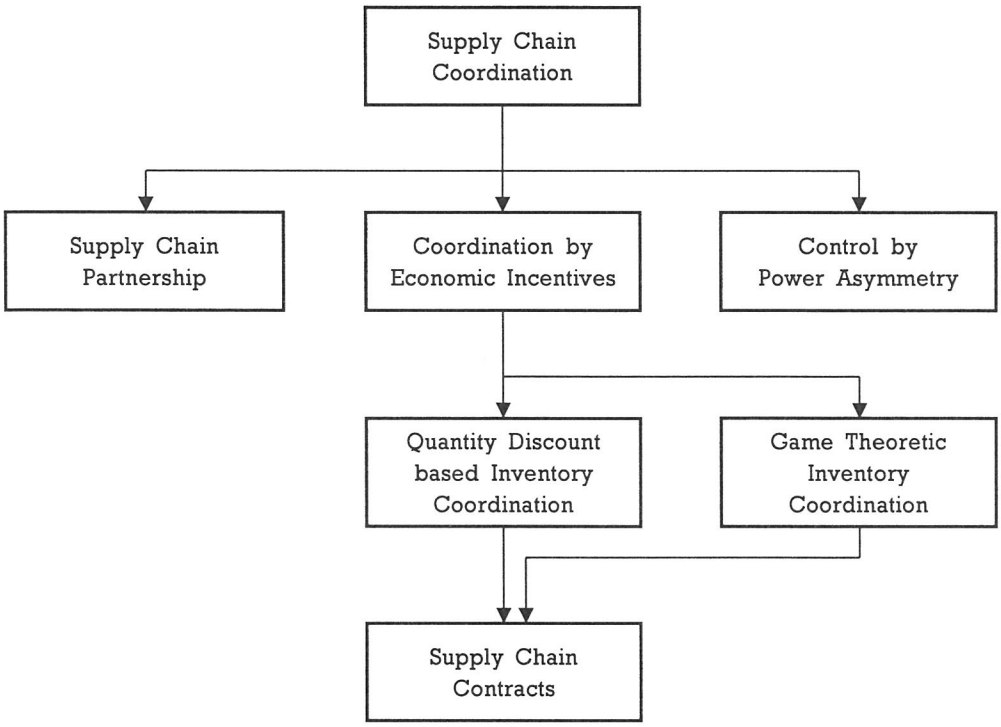
and Wal-Mart, which has been known as Continuous Replenishment Program (CRP). In 1985, P&G initiated a pilot program that linked daily retail sales records and warehouse shipments data to its own product shipments. The objective was to leverage P&G's own production and inventory control, capitalizing on the information nearer to consumers. The successful pilot program generated one of the most popular inventory coordination programs, CRP. Further, using Electronic Data Interchange (EDI) to capture information automatically, P&G has been able to be more responsive to consumers and improved supply chain efficiency. With success stories recognized, the popularity of SCM is stronger than ever.

Nevertheless, how to coordinate inventories and material-flows in the supply chain is one of the biggest challenges for the majority of companies in many supply chains. Many strategic alternatives are available depending on business characteristics and surroundings. In SCM, it appears that there exist three distinct ways to coordinate inter-organizational decisions including inventory decisions. These include 1) sustaining 'Supply Chain Partnerships', 2) gaining 'Control' over the supply chain, and 3) providing "Incentives" such as quantity discounts to other parties.

The taxonomic structure of the present study is illustrated in Figure 1. In the following sections, we provide comprehensive explanations how these concepts and methods are developed and applied.

2.1 Supply chain partnerships

The first approach is to rely on business relationships so called *Supply Chain Partnership*. Influenced by the Japanese business practices, many companies have been emphasizing development of supplier/buyer relationships to coordinate operational decisions. Supply Chain Partnerships, Strategic Alliances, and Integrated Supply Chains have become common terms, reflecting the current management focus on close business relationships among the supply chain participants. Although 'Supply Chain Partnership' is a buzzword ill-defined in the literature, defining the nature of 'Partnership' is beyond the scope of this research.



〈Figure 1〉 Taxonomic Structure of the Proposed Research

Supply chain partnerships appear overemphasized in practice. Although many studies (Ellram, 1990; Cooper and Ellram, 1993; Barney and Hansen, 1994; Choi and Hartley, 1996) praise benefits of Supply Chain Partnerships, there exist empirical evidence that partnership is not a universal way to achieve supply chain coordination. According to Austin and Lee (1998), current SCM practices relying heavily on business relationships are insufficient to provide business solutions. The participating companies display a certain degree of Gamesmanship toward each other instead of seeking cooperation and interactivity based on mutual trust. The Gamesmanship tends to undermine rather than improve the supply chain's efficiency (Austin and Lee, 1998). Mariotti (1999) also points out that "the worst problems at the supply chain nodes stem from either lack of information or lack of trust between people."

The lack of partnership in supply chains must be understood as a natural outcome of competitive economic environments. Behind the lack of partnership, problems exist

associated with economic justification of Supply Chain Integration. In some industries, absolute cost advantages are a core competence of business, and technical expertise cannot be differentiated. In this case, Supply Chain Partnerships may not be a viable alternative to supply chain inventory coordination. Besides, if one understands the evolving nature of business relationships, it becomes clear that Supply Chain Partnerships cannot be a universal remedy. When the supplier and the buyer just initiate their business transactions, supply chain partnership may not exist at all.

2.2 Gaining control over the supply chain

The second strategic alternative is to gain '*Control*' over the entire supply chain. Vertical integration epitomizes obtaining control over the supply chain. In practice, vertical integration has been used to establish stable procurement and/or distribution systems. When companies realize that they do not have all the resources, technologies, facilities, and networks, they use three methods to achieve the objectives: 1) developing the assets and skills internally, 2) seeking cooperative relationships or agreements with other companies, or 3) acquiring the assets and skills. Among them, vertical integration is an alternative to gain control by acquiring the tangible assets and intangible skills.

Once a company gains control and facilitates a central coordination mechanism, it becomes possible to optimize material-flows in the supply chain. In the inventory coordination literature, multi-echelon inventory systems adopt the idea of centralized control with assumptions of perfect information and free flow of materials. A multi-echelon system involves transfer of goods among the locations, distribution stages, and production levels guided by a centralized control. Therefore, inter-regional or inter-organizational flows of materials are coordinated to achieve the optimal inventory policy for the supply chain. Due to the above strong assumptions (perfect information/control and free flow of materials) multi-echelon inventory models had limited applications in the past. However, multi-echelon inventory models have regained their convincing popularity over the last decade since integrated inventory control has become possible in some industries via modern information technology

(Diks and Kok, 1998).

Although multi-echelon inventory models broaden their applications, the models may not reflect exactly the current practice of SCM. Supply chains with multiple echelons often function in a decentralized mode with many companies at the different levels of procurement and distribution. When two or more companies are involved in a supply chain, the assumptions made in multi-echelon inventory models may not be realistic. Since the optimal policy for the entire supply chain does not minimize individual companies' costs, each company may be tempted to deviate from the optimal echelon policy for its own sake.

2.3 Supply chain coordination using economic incentives

The last alternative to supply chain inventory coordination is to provide incentives such as quantity discounts to other parties. This type of mechanism is further developed to supply chain contracts. Recently, supply chain contracts have been a popular and familiar tool in numerous industries to promote products, eliminate excess inventories, and/or to enhance service level and product availability. In fact, the popularity of supply chain contracts originates from the conventional quantity discount based inventory coordination models in which suppliers discount offers can influence buyers' purchasing behavior by providing incentives to buyers. A major benefit of quantity discounts is that both buyer and supplier can reduce their inventory costs simultaneously when the appropriate purchasing discount schedule is available (Crowther, 1964; Monahan, 1984; Rosenblatt and Lee, 1985; Lee and Rosenblatt, 1986; Goyal and Gupta, 1989).

In particular, the properties of quantity discounts and supply chain contracts are suitable for the operating environments, decentralized supply chains. A decentralized supply chain can be defined as the supply chain working in a decentralized mode in which independent companies are willing to coordinate, yet ensure their own profitability at the same time. In fact, many supply chain participants are self-interested independent economic entities whose goal is to maximize their own profit. Supply chain participants display a certain degree of gamesmanship particularly when their

own profitability is not secure. Accordingly, among the strategic alternatives to inventory coordination, supply chain contracts could be one of the most comprehensive devices to coordinate managerial decisions in the supply chain.

Ⅲ. Inventory Coordination in the supply chain

In general, inventory models are decision models. In most traditional inventory models, suppliers' and buyers' inventory problems have been treated in separation. The problem of determining the optimal EOQ policy of a buyer, given a series of price breaks offered by the supplier, is a typical example of independent inventory decision making. In this case, the buyer has to decide how to react to the supplier's discount in order to minimize the buyer's own inventory related costs (purchase cost, setup cost, and inventory holding cost).

Unlike the conventional approach, some inventory models adopt the idea of inventory coordination in the supply chain. These inventory coordination models can be classified into two major categories, integrated inventory system modeling and multi-echelon inventory modeling. The first group, integrated inventory system models, has been studied to provide an inventory coordination mechanism between the buyer and supplier, relaxing several assumptions in the conventional inventory models. For example, the assumption of fixed price or rigid discount schedule is no longer necessary in some of these studies. Goyal and Gupta (1989) classify the integrated inventory system models into the following four categories, and among them the second group became the basis for the supply chain contract studies.

1) Models dealing with joint economic lot sizing policies
2) Models dealing with coordination of inventory by simultaneously determining the order quantity of the buyer and the supplier (*inventory coordination models with buyer-supplier perspectives*).
3. Models dealing with integrated inventory system problems but not determining simultaneously the order quantity of the buyer and supplier.

4) Models dealing with buyer-supplier coordination due to marketing considerations.

The other group, multi-echelon inventory models, deals with inventory coordination at the multiple levels of production or distribution, relaxing the assumption of single stocking point. A multi-echelon system involves various flows of goods among the locations, distribution stages, and production levels. The structure of multi-level (or echelon) production or distribution systems can be analogous to that of supply chain if each echelon represents an independent company. From the modeling perspective, multi-echelon inventory models generate implications of how stochastic nature of demand can be incorporated in the supply chain structure.

A majority of multi-echelon serial inventory models is characterized as a centralized inventory control mechanism adopted in the pioneering work by Clark and Scarf (1960, 1962). In other words, it takes the viewpoint of a central organizer who has perfect information and guarantees free flow of materials throughout the echelons. In practice, however, most problems with the supply chain management come from either lack of information or lack of trust between stocking points and participating companies. Moreover, supply chains with multiple echelons often function in a decentralized mode with multiple economic entities (Lee and Whang, 1999) in which free flow of materials is impeded by the participants own interests and gamesmanship. Since the optimal policy for the entire echelon system does not guarantee minimization of individual companies' costs, each company may be tempted to deviate from the optimal echelon policy for its own sake. For these properties too strict for supply chain coordination, we omit the entire body of multi-echelon literature from the scope of this paper.

In contrast, we will review game theory based inventory coordination models. Many ideas in the game theoretic inventory coordination models come from either integrated inventory system models or multi-echelon inventory models. However, the game-theoretic models adopt competition as a dynamic mechanism in decision-making processes. Competition helps suppliers determine the right price to charge particularly when the buyer's willingness to pay is unknown. Accordingly, the game- theoretic models are useful to investigate certain cases of supply chain coordination or contracts.

3.1 Inventory coordination models using quantity discounts

Inventory coordination models with buyer-supplier perspectives form a subgroup of integrated inventory system models (Goyal and Gupta, 1989). These models have several unique features distinguished from that of the other integrated inventory system models. First, the models have been built on the same assumptions as that of Wilson's Economic Order Quantity (EOQ) Model. Therefore most assumptions related to EOQ such as deterministic-constant demand and no shortages allowed hold in these models. Second, unlike joint lot sizing models, inventory coordination models with buyer/supplier perspectives simultaneously determine the supplier and buyer's lot sizes, which reduce or optimize the total inventory costs of the supply chain. Third, purchasing quantity discounts play an important role in achieving inventory coordination. In the conventional quantity discount models, price breaks (supplier's discount offer) are fixed, and the buyer's decision is to choose the best price and corresponding lot size which will minimize the buyer's own inventory cost. In contrast, inventory coordination models consider the supplier's discount offer flexible rather than fixed. Therefore, price of an item (the amount of discount) is a variable, given different inventory holding and setup costs between the supplier and buyer.

Since purchasing quantity discounts are the primary inventory coordination mechanism in these models, it is important to understand general characteristics of purchasing quantity discounts. The rationale behind purchasing quantity discounts stems from the economic advantages of larger customer orders. Buchanen (1953) provided three major motivations for using quantity discounts. First, quantity discounts are a device to achieve perfect price discrimination against a single customer or a group of homogeneous customers. Second, quantity discounts are a mechanism to achieve partial price discrimination against a set of heterogeneous customers. Finally, quantity discounts can be used to improve channel efficiency by influencing buyer's ordering pattern or policy. 'Inventory coordination models with buyer-supplier perspectives' mainly deal with the third category of motivations.

Crowther (1964) initiated the first purchasing quantity discounts model associated with inventory coordination. Crowther's basic idea is that both buyer and supplier

could reduce their inventory costs simultaneously when purchasing quantity discounts are available. Later, Monahan (1984) suggested a policy for a supplier to motivate its customers to increase the order quantity by a factor of K, where K is a multiple of buyer's initial economic order quantity (EOQ). The essence of Monahan's idea is that supplier's discount offer can be flexible rather than fixed. There are several important assumptions behind Monahan's model in addition to the assumptions of EOQ. First, a lot-for-lot ordering policy of the model assumes that supplier's production frequency is the same as buyer's ordering frequency. Second, the increased lot size due to quantity discounts is independent of the opportunity cost of holding extra inventory for both buyer and supplier. Therefore, changes in buyer's order frequency and size do not affect supplier's inventory carrying costs (Joglekar, 1988). Especially, Joglekar (1988) addressed that the financial impact of Monahan's model has little practical significance, and Monahan's model is applicable only to unrealistic and very rare situation.

The limitations with the Monahan's model created a bandwagon effect by which a group of scholars jumped into the rapid developement of inventory coordination models in a short period of time. These include Rosenblatt and Lee (1985), Lee and Rosenblatt (1986), Banerjee (1986a), Banerjee (1986b), Banerjee (1986c), Goyal (1987a), Goyal (1987b), Kim and Hwang (1989), Chakravarty and Martin (1989) and Weng and Wong (1993).

Weng and Wong (1993) examined for important issues associated with purchasing quantity discounts: 1) single vs. multiple buyers, 2) constant or price-sensitive demand, 3) the relationship between the supplier's production schedule or ordering policy and the buyer's order size, and 4) the supplier's business nature, manufacturing vs. buying and selling. They found that the supplier could gain more benefits from offering quantity discounts especially when the buyer's demand is price elastic because the supplier benefits from both reduced inventory level and increased demand of the buyer. This finding helped Weng (1995) develop a more generalized model with price sensitive demand which later became the basis of supply chain contract models. Weng and Wong (1993) also found that as the supplier's capacity became closer the

buyer's demand, the supplier's profit gained from quantity discounts became less and less. This happened since the supplier's did not have a room to offer quantity discounts. In other words, the supplier's volume flexibility decreases due to the buyer's larger orders. In general, the results support that the supplier's order processing or setup cost becomes higher, the chances the supplier improves his profit by offering quantity discounts becomes greater.

The quantity discount based inventory coordination models are not free from limitations. First, demand for the buyer's item is deterministic and constant. Whereas the constant demand assumption is removed from the supplier's inventory cost function, the buyer's cost function is setup based on the assumption of constant demand. The optimal schedules developed from deterministic and constant demand for the buyer's item presumes inherently that the buyer would always take the quantity discount offer since the new offer at least covers extra inventory holding cost due to lager orders. This assumption of constant demand does not hold true in practice where lead-time and demand quantity change continually. Second, the buyer's current inventory position is ignored in developing the supplier's quantity discount schedule. In fact, inventory position of the buyer is a critical factor to determine the next order amount particularly when the buyer uses a periodic review ordering policy. If the buyer's current inventory is significantly high, the buyer may not take the discount offer in order to reduce its overall inventory level. A simulation study by Shin and Benton (2004) indicated that they often fail to secure the buying firm's cost savings under stochastic demand conditions. Since their modeling objective is often to maximize the supplier's profit, the buyer(s) ends up with zero or marginal cost savings under deterministic conditions or negative cost savings under stochastic conditions. Therefore, the need for more practical supply chain models has risen for a variety of reasons.

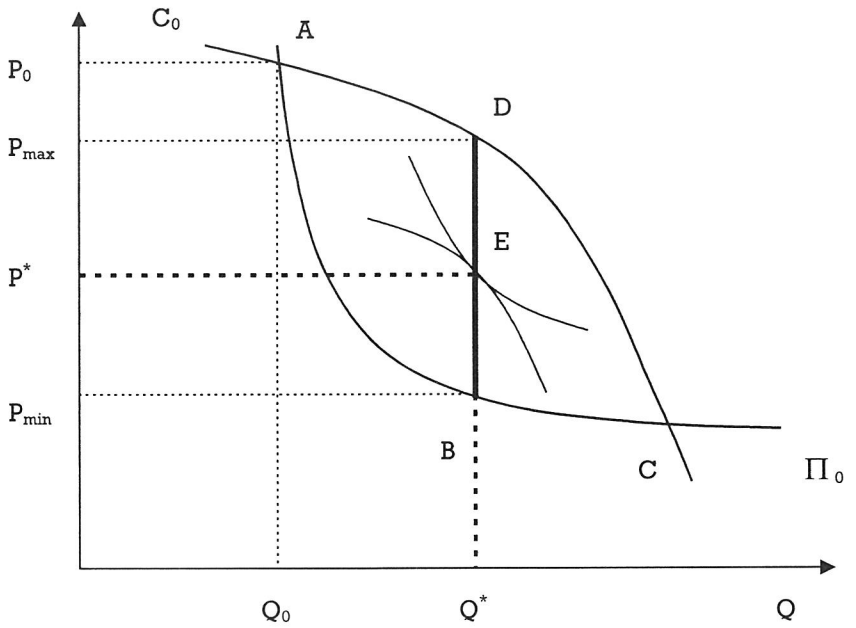
3.2 Game Theory Approach to Inventory Coordination

According to classical micro-economic theories, a competitor in a perfect market neither competes aggressively nor pays attention to what other companies do in the market. Rather, it accepts the market condition and price passively. In contrast,

game-theory models consider competition a process of strategic decision making under uncertainty (McAfee and McMillan, 1996). In addition, game theory regards competition as a dynamic mechanism that helps the competitor to determine the right pricing policies when the buyer's willingness to pay is unknown.

Supply chain coordination between the buyer and supplier is one of the situations that can be modeled by a game theory. For instance, quantity discounts are a bargaining problem in which the buyer and the seller negotiate over the order quantity and the average unit price for a particular time period (Kohli and Park, 1989). Kohli and Park (1989) identified a limitation in the literature, that is, the modeling framework of pricing-inventory literature is only built upon rudimentary micro-economic theories and a simple EOQ model (Dolan, 1978; Lal and Staelin, 1984, and Dada and Srikanth, 1987). The modeling objective is limited to maximizing the supplier's profit, and those models fail to address how the supplier and buyer would split the increased channel profit.

The game theoretic quantity discount models cover this gap, facilitating a dynamic competition mechanism between the buyer and the supplier, as illustrated in Figure 2. As can be seen, the initial ordering quantity (EOQ) of the buyer is Q_0 with a unit price of the item, P_0, when the supplier does not offer any discount. This combination of the price and quantity (A) is equilibrium where the iso-cost curve (C_0) of the buyer and the indifference profit curve (Π_0) of the supplier meet each other. The region 'A-B-C-D-A' is a feasible set of discounts where the supplier does not damage its profit and the buyer may benefit from the supplier's discount offer. The existing models (Dolan, 1978; Lal and Staelin, 1984, and Dada and Srikanth, 1987) suggest that the optimal ordering quantity will be identified when the distance (D - B) between the buyer's iso-cost curve and the supplier's indifferent profit curve is maximized. In other words, at the optimal ordering quantity (Q^*), the supply chain profit reaches the Pareto Efficiency.



〈Figure 2〉 Feasible Quantity Discounts [Adapted from Kohli and Park (1989)]

Any combination of price and quantity that achieves *Pareto Efficiency* provides the buyer and the supplier with cost savings in the following manner. If the item unit price is determined as P_{min}, then the buyer will take all the benefits from the purchasing discount. If the final price is P_{max}, the supplier gains all the profit. In order to determine the bargaining solutions, Kohli and Park (1989) adopt Eliashberg's Model (1986) in which the buyer and the supplier have different tendencies toward risk (risk-neutral or risk-averse). If both the buyer and the supplier are risk neutral, Nash's equilibrium is found when the buyer and the supplier share the equal amount of profit.

Chiang et al. (1994) formulate the quantity discount problem as non-cooperative and cooperative games. For the non-cooperative game, Chiang et al. (1994) use the Stackelberg's equilibrium of the interactive two-stage games, assuming the supplier holds a dominant position over the buyer. The rationale behind this assumption is that without sufficient information and communication the supplier is the active party that offers a fixed price schedule to which the buyer responses. They found that

the largest integer multiple K for the buyer's ordering quantity satisfies the following inequality and the result is quite similar to that of purchasing discount (all-unit discount) models with buyer-supplier perspective (Lee and Rosenblatt, 1986 etc.). For the cooperative game, Chiang et al. (1994) use an optimization technique to maximize the joint profit for both the seller and the buyer. The optimal discount price and order quantity are attained with implicit bargaining power assigned to each of the parties (λ, $1-\lambda$). Chiang et al. (1994) found that the joint profit for the cooperative game is greater than the combined profit for the non-cooperative game. Unlike the model by Kohli and Park (1989), the model of Chiang et al. incorporate the players' dependent strategies affected by the buyers' budget constraints and each player's bargaining power. However, they did not show how to determine the bargaining power either in practice or in their model.

Cachon and Zipkin (1999) investigate a two-stage serial supply chain with stationary stochastic demand with a game theoretic perspective. They also use optimization to investigate the difference of performance between global/competitive and independent/competitive games in the supply chain where the participating companies are using either an echelon stock policy or installation stock policy. They show that each competitive game has a unique Nash Equilibrium, but it differs from the optimal solution. The result implies that competition among the players reduce the channel efficiency.

Unlike the purchasing discount models and multi-echelon inventory models, game theory models deal with two different problems simultaneously, maximization of channel efficiency and allocation of achieved profit among the players. The game theoretic models adopt competition dynamics as a driving force to decide each player's share from total cost savings. For profit allocation, the game theoretic models assume that each player's bargaining power or utility function associated with 'risk' can be identified. Although this assumption may not be realistic, the game theoretic models provide a meaningful insight that total inventory costs of a supply chain or each participant may vary depending on the nature of relationship between the buyer and the supplier.

Ⅳ. Supply Chain Contracts

Supply chain contracts started as a simple coordination problem between a single supplier and a single buyer, using the same idea of quantity discount based inventory coordination models. However, the "rules of engagement" for the supply chain participants vary (more sophisticated in a way) depending on the type of contract (such as buyback or revenue sharing). Unlike the quantity discount models in which EOQ is adopted commonly as a foundation, most of the supply chain contract models use the framework of the newsvendor problem. Accordingly, supply chain contact models may be more suitable for one-time sales environment.

The type of contract ultimately governs how the supply chain participants share the benefits and the risks from uncertain supply or demand. These governing rules are inherently imperfect, and in many cases the supply chain contract mechanism would never achieve the global optima due to various agency problems inhibiting the effectiveness of contract design. Nonetheless, researchers have shown that supply chain contracts are a practical way of resolving some drawbacks of "double marginalization."

4.1 Wholesale price contract

Wholesale price contract is a primitive form of contract and a basis of other supply chain contracts. In general the benefit of coordination and allocation is affected by the wholesale pricing scheme negotiated between the manufacturer and the retailer. Cachon (1999) shows that the retailer and the manufacturer can improve supply chain efficiency by coordinating their wholesale price and supply quantity decisions and that the ratio of the supply chain profit (under the wholesale price contract) to its maximum profit (the global optimum) would improve. Wholesale price contract is the easiest and most general in the newsvendor environment, leading to better product availability in the supply chain. Lariviere and Porteus (2001) study a simple supply-chain contract in a newsvendor problem which there exist a single manufacturer and a single retailer and the contract parameter is only a wholesale price. They show that magnitude of variation in the demand distribution plays an essential role in estab-

lishing wholesale price contract.

4.2 Buyback contract

Buyback is a contract combined with a return policy, an insurance for the retailer. Since the products leftover at the end of sales season would be purchased by the manufacturer (seller), the retailer becomes more aggressive in placing its initial orders to the seller. Technically, product returns work the same as increasing the product salvage value for the retailer. Pasternack (1985) is the first who modeled a coordinated supply chain based on a buyback contract. He used a fixed-price newsvendor model that has a single manufacturer selling to a single retailer. Developing a hierarchical model and examine possible pricing with return policies, Pasternack (1985) proves that return policies reduce the pitfalls of double marginalization, proving supply chain participants with better profitability and product availability. Donohue (2000) creates a supply chain contract mechanism for a two-stage production environment in which the first production stage accounted for a relatively low production cost and a long lead time and the second has accounted for an expensive cost and a short lead time. Donohue (2000) shows that a supply chain contract must capitalize on accurate forecasts and collaborative decisions, particularly for seasonal products. In addition, pricing conditions and the degree of demand forecast accuracy can affect the efficacy of solutions. Song et al. (2008) also study the structural properties of buyback contract in a decentralized supply chain.

4.3 Revenue sharing contract

Revenue sharing contract is a supply chain contract in which the manufacturer charges low wholesale price to the retailer and shares a fraction of revenue generated by the retailer (Chopra and Meindl, 2006). In this arrangement, a retailer pays a supplier a wholesale price for each unit purchased plus a percentage of the revenue the retailer generates afterward. Revenue sharing contracts were once prevalent in the video rental industry (e.g. Blockbuster) compared with the traditional wholesale price contract. However, revenue sharing contracts often created moral hazard issues

driven by the buyers' motivation to hide their sales to reduce the amount of shared revenue.

Revenue sharing contract has been studied by many researchers. Mortimer (2008) developed a structural econometric model that describes the nature of firms' contract choices and shows that both upstream and downstream profits increase by 10% under the revenue-sharing contract for popular titles of DVDs. In three-stage supply chain, Giannoccaro and Pontrandolfo (2004) study supply chain coordination with a revenue sharing mechanism. They propose a revenue sharing scheme that may achieve the optimal system efficiency and the profit improvement for all supply chain participants by adjusting the contract parameters. Wang et al. (2004) show that not only the overall supply chain performance but also individual participants' performance is critically affected by demand price elasticity and allocation of channel cost.

In revenue sharing contract with a supplier and a retailer, Qin and Yang (2008) consider a two-stage Stackelberg game and suggest that the player who keeps less than half of the supply chain's total profit should be the follower of the Stackelberg game. In a standard newsvendor setting with a manufacturer and a retailer, Koulamas (2006) suggest that a revenue sharing contract eliminate double marginalization completely and that the retailer always benefit from a portion of improved total profit. Yao et al. (2008) study supply chain coordination with revenue sharing mechanism between a manufacturer and two competing retailers. In a general supply chain model, Cachon and Lariviere (2005) compare revenue sharing contract with other supply chain contracts. Although revenue sharing contracts appear to have numerous merits, they are prone to some critical limitations. Accordingly, it is impossible for all industries to take advantage of a revenue sharing contract.

4.4 Rebate contract

In many industries, channel rebate is widely used because it gives more profits to both suppliers and buyers. In sales rebate contract, a manufacturer give a retailer a payment based on retailer's sales volume. Taylor (2002) studies two kinds of channel rebate; linear rebates target rebates. In this paper, he shows that a supply chain can

be coordinated and get a win-win outcome by a properly designed target rebate, but a linear rebate is not effective. Krishnan et al. (2004) shows that the sales rebate contract can coordinate a supply chain in a fixed price newsvendor model. Wong et al. (2009) propose a two-echelon supply chain with a single supplier serving multiple retailers in vendor-managed inventory (VMI) partnership. They argue that "VMI facilitates the application of the sales rebate contract since information sharing in VMI partnership allows the supplier to obtain actual sales data in a timely manner and determine the rebate for retailers." Wong et al. (2009) demonstrate that the supplier gains more profit with competing retailers as competition among the retailers lowers the prices and thus induces more demand.

V. Conclusion

The current movement toward SCM has led to development of numerous management policies and conceptual studies that emphasize managerial relationships between suppliers and buyers. Coordination and collaboration in inventory management have become a standard practice for many business sectors. Nonetheless, supply chains often function in a decentralized mode with many companies working for their own profitability. Under these circumstances, the need for connecting analytical models that can provide scientific methods and the practice of supply chain inventory coordination is strong. The proposed research is intended to contribute to the practice of supply chain inventory coordination.

In this paper, we summarized the implications of various supply chain coordination mechanisms, including partnerships, gaining control, proving economic incentives such as quantity discounts, and creating supply chain contracts. Especially, the inventory and profit allocation in the analytical models of supply chain contracts illustrates the win-win possibility among the supply chain participants as prices are adjusted to mitigate the double marginalization problems and achieve better supply chain profitability and product availability for consumers. In a practical sense, the improved product availability and service level is a result of shifting the supplier's

decoupling point closer to end-consumers.

In the end, however, it is noteworthy that all of these problems are centered on the issue of allocating risks and rewards in the supply chain. Therefore, to execute these brilliant ideas in practice, practitioners need to build comprehensive infrastructure for better information acquisition using information technology, reliable and collaborative forecasting, credible supplier-buyer relationship, and collective promotional efforts.

References

1. Austin, T. A. and Lee, H.L., 1998. Unlocking the supply chain's hidden value: a lesson from the PC industry. *Supply Chain Management Review*, 2(2), 24-34.
2. Banerjee, A., 1986a. On 'a quantity discount pricing model to increase vendor's profits.' *Management Science* 32(11), 1513-1517.
3. Banerjee, A., 1986b. A supplier's pricing model under a customer's economic purchasing policy. *OMEGA: International Journal of Management Science* 14(5), 409-414.
4. Banerjee, A., 1986c. A joint economic lot size model for purchaser and vendor. *Decision Sciences* 17(3), 292-311.
5. Barney, J.B. and Hansen, M.H., 1994. Trustworthiness as a source of competitive advantage. *Strategic Management Journal* 15(S1), 175-190.
6. Buchanen, J.M., 1953. The theory of monopolistic quantity discounts. *Review of Economic Studies* 20(3), 199-208.
7. Cachon, G.P. 1999. Competitive supply chain inventory management. *Quantitative Models for Supply Chain Management*, Kluwer Academic Publishers, Boston, 112-146.
8. Cachon, G.P. and Zipkin, P.H., 1999. Competitive and cooperative inventory policies in a two-stage supply chain. *Management Science* 45(7), 936-953.
9. Cachon, G.P. and Lariviere, M. A., 2005. Supply chain coordination with revenue-sharing contracts: strengths and limitations. *Management Science* 51(1) 30-44.

10. Chakravarty A.K. and Martin, G.E., 1989. Discount pricing policies for inventories subject to declining demand. *Naval Research Logistics* 36(1), 89-102.
11. Chiang, W., Fitzsimmons, J., Huang, Z. and Li, S.X., 1994. A game theoretic approach to quantity discount problems. *Decision Sciences* 125(1), 153-168.
12. Choi, T. Y. and Hartley J. L., 1996. An exploration of supplier selection practices across the supply chain. *Journal of Operations Management*. 14(4), 333-343.
13. Chopra, S. and Meindl, P., 2006. *Supply Chain Management: Strategy, Planning, and Operations 3rd Ed.*, Prentice Hall, Upper Saddle River, New Jersey.
14. Clark, A.J. and Scarf, H., 1960. Optimal policies for a multi-echelon inventory problem. *Management Science* 6(4), 475-490.
15. Clark, A.J. and Scarf, H., 1962. Approximate solutions to a simple multi-echelon inventory problem. *Studies in Applied Probability and Management Science*, Stanford University Press, Stanford CA., 88-110.
16. Cooper, M.C. and Ellram, L.M., 1993. Characteristics of supply chain management and the implications for purchasing and logistics strategy. *International Journal of Logistics Management* 4(2), 13-24.
17. Crowther, J.F., 1964. Rationale for quantity discounts. *Harvard Business Review* 42, 121-127.
18. Dada, M. and Srikanth, N.K., 1987. Pricing policies for quantity discounts. *Management Science* 33(10), 1247-1252.
19. Diks, E.B. and De Kok, A.G., 1998. Optimal control of a divergent multi-echelon inventory systems. *European Journal of Operations Research* 111(1), 75-97.
20. Dolan, R.J., 1978. Quantity discounts: managerial issues and research opportunities. *Marketing Science* 6(1), 1-12.
21. Donohue, K. L. 2000. Efficient supply contracts for fashion goods with forecast updating and two production modes. *Management Science* 46(11), 1397-1411.
22. Eliashberg, J., 1986. Arbitrating a dispute: a decision analytic approach. *Management Science* 32(8), 963-974.
23. Ellram, Lisa M., 1990. The supplier selection decision in strategic partnerships. *Journal of Purchasing and Materials Management*. 26(3), 8-14.

24. Giannoccaro, I. and Pontrandolfo, P., 2004. Supply chain coordination by revenue sharing contracts. *International Journal of Production Economics* 89(2), 131-139.
25. Goyal, S.K., 1987a. Comment on: a generalized quantity discount pricing model to increase supplier's profits. *Management Science* 33(12), 1635-1636.
26. Goyal, S.K., 1987b, Determination of a supplier's economic ordering policy. *Journal of Operational Research Society* 38(9), 853-857.
27. Goyal, S.K. and Gupta, Y. P., 1989. Integrated inventory models: the buyer-vendor coordination. *European Journal of Operational Research* 41(3), 261-269.
28. Joglekar, P.N., 1988. Comment on "a quantity discount pricing model to increase vendor profits." *Management Science* 34(11), 1391-1539.
29. Kim, K.H. and Hwang, H., 1989. Simultaneous improvement of supplier's profit and buyer's cost by utilizing quantity discount. *Journal of the Operational Research Society* 40(3), 55-265.
30. Kohli, R. and Park, H.S., 1989. A cooperative game theory model of quantity discounts. *Management Science* 35(6), 693-707.
31. Koulamas, C., 2006. A newsvendor problem with revenue sharing and channel coordination. *Decision Sciences* 37(1) 91-100.
32. Krishnan, H., Kapuscinski, R., and Butz, D.A., 2004. Coordinating contracts for decentralized supply chains with retailer promotional effect. *Management Science* 50(1), 48-63.
33. Lal, R. and Staelin, R., 1984. An approach developing an optimal discount pricing policy. *Management Science* 30(12), 1524-1539.
34. Lariviere, M. A. and Porteus, E. L., 2001. Selling to the newsvendor: an analysis of price-only contracts. *Manufacturing and Service Operations Management* 3(4), 293-305.
35. Lee, H.L. and Rosenblatt, M.J., 1986. A generalized quantity discount pricing model to increase supplier's profits. *Management Science* 32(9), 1177-1185.
36. Lee, H.L. and Whang, S., 1999. Decentralized multi-echelon supply chains: incentives and information. *Management Science* 45(5), 633-640.
37. McAfee, R.P. and McMillan, J., 1996. Competition and game theory. *Journal of*

Marketing Research 33(3) 263-267.

38. Mariotti, J.L., 1999. The trust factor in supply chain management. *Supply Chain Management Review* 3(1), 70-77.
39. Monahan, J.P., 1984. A quantity discount pricing model to increase vendor's profits. *Management Science* 30, 720-776.
40. Mortimer, J.H., 2008. Vertical contracts in the video rental industry. *Review of Economic Studies* 75(1), 165-199.
41. Rosenblatt, M.J. and Lee, H.L., 1985. Improving profitability with quantity discounts under fixed demand. *IIE Transactions* 17(4), 388-395.
42. Pasternack, B.A., 1985. Optimal pricing and return policies for perishable commodities. *Marketing Science* 4(2), 166-176.
43. Qin, Z. and Yang, J., 2008. Analysis of a revenue-sharing contract in supply chain management. *International Journal of Logistics: Research and Applications* 11 (1), 17-29.
44. Shin, H. and Benton, W.C., 2004. Quantity discount-based inventory coordination: effectiveness and critical environmental factors. *Production and Operations Management* 13(1), 63-76.
45. Song, Y., Ray, S. and Li, S., 2008. Structural properties of buyback contracts for price-setting newsvendors. *Manufacturing and Service Operations Management* 10(1), 1-18.
46. Taylor, T.A., 2002. Supply chain coordination under channel rebates with sales effort effects. *Management Science* 48(8) 992-1007.
47. Wang, Y., Jiang, L. and Shen, Z., 2004. Channel performance under consignment contract with revenue sharing. *Management Science* 50(1) 34-47.
48. Weng, Z.K. and Wong, R.T., 1993. General models or the supplier's all-unit quantity discount policy. *Naval Research Logistics* 40(7), 971-991.
49. Weng, Z.K., 1995. Channel coordination and quantity discounts. *Management Science* 41(9), 1509-1522.
50. Wong, W.K., Qi, j. and Leung S.Y.S., 2009. Coordinating supply chains with sales rebate contracts and vendor-managed inventory. *International Journal of*

Production Economics 120(1), 151-161.

51. Yao, Z., Leung, S.C.H. and Lai, K.K., 2008. Manufacturer's revenue-sharing contract and retail competition. *European Journal of Operational Research* 186 (2), 637-651.