CHAPTER 2
RELATED WORK

The choice of the optimal contract is of great importance to most manufacturers, especially when supply chains change rapidly these years. Recent studies indicated that the distribution system is currently undergoing dramatic changes, which include the introduction of gradual abolition of a return policy. (cf. Kandel 1996). However, few studies have developed analytic models to construct return contract from manufacturer's view. This study discusses the related problems and develops mathematical models that can fulfill this demand.

2.1 Problems of supply chain decentralized

Recently, many researchers have modeled the decentralized scenario. Fisher and Raman (1996) analyzed a quick response (QR) environment and demonstrated a two-stage ordering process, which could reduce both stockout and markdown costs by reducing the lead time sufficiently to allow a portion of production to be committed after observation of the initial demand. Iyer and Bergen (1997) considered a similar environment. They demonstrated that after QR, a retailer's order could decrease, whereas, under the same conditions, a manufacturer might be negatively influenced. Thus, to compensate the manufacturer, three tools are employed, including requirement for better service to customers, increase in wholesale price, and volume commitment. Tsay (1999) modeled the decentralized situation by "quantity flexibility" coupled with the customer's commitment to purchase no less than a certain percentage and the supplier's guarantee to deliver up to a certain percentage. The decentralized models mentioned above attempt to remedy the problems underlying decentralized control. However, they emphasize the retailer's interests and disregard those of the manufacturer.

Duenyas *et al.* (1993) illustrated the relationship between production quota and card setting. They proposed an algorithm to calculate card counts as well as the optimal quota for a constant work in process (CONWIP) system. Duenyas *et al.* (1997) determined the production quota by assuming that both demand and production are uncertain. Also, they considered overtime production. The costs included in their model are regular time production, fixed cost of overtime, variable overtime costs, and holding cost. By optimizing the manufacturer's position, these studies determined production quota. However, they neglect to consider the system decentralization that would result.

Padmanabhan and Png (1997) studied the strategic effect of the return policy on retailers competition and highlighted its profitability implications to manufacturers. Eppen and Iyer (1997) investigated the backup in which a vendor agrees to retain a predetermined percentage of the retailer's forecasted quantity. Based on the agreement, the retailer is allowed to buy the backup items with no additional premium but must pay a penalty for the items not taken from backup. Emmons and Gilbert (1998) developed a model incorporating the retailer's interests with the policy decisions of the manufacturer. This confirmed that both the manufacturer and the retailer could benefit from a return policy under specific conditions. The above investigations provide a profound insight into understanding of the return policy. Furthermore, most of them conclude that due to the return policy, a retailer will order a greater quantity, thus benefiting the manufacturer. However, this should assume that the manufacturer has an unlimited supply capacity. In fact, a profit-maximizing manufacturer will not expect unlimited production, as it occurs with the risk of overproduction.

There are many ways to solve demand uncertain problem. Tzeng and Tsaur (1995) try to forecast Energy demand via dynamic intergional input-output model. Gurnani and Tang (1999) analyzed the demand forecast updating scenario with a retailer who, prior to a single selling season, had two instants to order seasonal products from a manufacturer. To determine the profit-maximizing ordering strategy of both instants, the retailer had to evaluate the tradeoff between a more accurate forecast and a potentially higher unit cost. Parlar and Weng (1997) considered a model of joint coordination between a firm's manufacturing and supply departments with two runs. The result confirmed that a supply department would procure additional reserved material for the second production, for which a higher price would be charged, if the cooperation were optimal. Otherwise, a supply department should only order the amount of requested material for an initial production run. Weng (1997) considered a manufacturer-distributor supply chain, which encountered price sensitive stochastic demand. The decision variables in this instance were the distributor's order quantity (which equaled the manufacturer's production since the production was make-to-order), retail sale price, as well as the manufacturer's wholesale price. Notably, the model presumed that any excessive demand must be satisfied completely through a second, more costly production run. The above studies provide the same scenario in which a retailer, with an additional fee, can take advantage of backup when the demand exceeds the order quantity. Additionally, a second run is available only if the manufacturer's production lead time is sufficiently short. However, in many industries, the lead time is often over one year. Hence, the setting of the manufacturer's production quantity is rather important.

2.2 Manufacturer's returns-quantity discount strategy

Quantity discount problems have been studied from the point of view of the buyer initially. These studies focus on determining the economic order quantities for the buyer given a quantity discount scheme set by the supplier (cf. Rubin *et al.* 1983, Sethi 1984, and Jucker and Rosenblatt 1985). Several later studies proposed supplier-side pricing discount schedules and developed models where the supplier offers quantity discounts to increase profit without increasing the buyer's cost. Monahan (1984) presented a quantity discount schedule in which the supplier offers a price discount to induce the retailer to increase the lot size. Lee and Rosenblatt (1986) altered Monohan's discount pricing model to include explicit constrains and exclude the lot-for-lot assumption. Dada and Srikanth (1987) attempted to service the entire system by developing quantity discount models that minimize the system cost (the joint cost of the seller and buyer). Sellers can reduce their costs without increasing the buyers' costs since these models utilized quantity discounts to achieve channel efficiency, which optimize the channel overall profit. These studies confirmed that quantity discount schemes produce an efficient supply chain by providing an incentive to the buyer to order in quantities greater than the economic order quantity (EOQ). Restated, the objective of these studies is to induce the buyer to alter his ordering schedule to achieve system efficiency as in traditional quantity discount models. Other researchers such as Lal and Staelin (1984), Banerjee (1986) and Chiang *et al.* (1994) proposed two-person game quantity discount model because quantity discount problems are usually solved via buyer-seller negotiation. Corbett and De Grotte (2000) dropped the full information assumption in the traditional quantity discount scenario and derived an optimal quantity discount policy under asymmetric information. Although the studies reviewed above provide valuable insights into how and when quantity discount schemes can be used to achieve jointly optimal outcomes, they do not consider return contracts which is a major disadvantage considering that they are widely implemented in many industries.

Pasternack (1985) developed a return policy with channel coordination. A key result is that coordination can be achieved by allowing the retailer to return all surpluses at a partial refund. Lau and Lau (1999) designed a pricing and return-credit strategy for a monopolistic manufacturer of a single-period commodity that proved that a return policy could often be manipulated by a shrewd manufacturer aiming to increase profit instead of losing his profit share to the retailer. Padmanabhan and Png (1997) verified the strategic effect of a return policy on retailer competition by highlighting its profitability implications for a manufacturer. Kandel (1996) investigated when and how to use return contracts by analyzing the behavior of three different scenarios including vertical integration, a monopolistic manufacturer, and a monopolistic retailer. Padmanabhan and Png (1995) presented a framework that explains when and how to adopt a return policy. They proposed a menu of alternative return policies since manufacturers might have difficulties implementing a particular return policy with a mix of retailers that differ in risk aversion, competitiveness, and skepticism. Although the menu includes options with more generous return privileges coupled with higher wholesale prices, no analytic model is proposed to verify the alternatives.

2.3 Integrated returns-quantity discount contract

The earliest studies of quantity discount models were conducted from the perspective of the buyer. These studies focused on determining the optimal order quantities for the buyer, given a quantity discount scheme as set by the supplier (cf. Ladany and Sternlieb 1974, Rubin *et al.* 1983, and Sethi 1984). Later studies developed the model from the supplier's standpoint, and proposed that the supplier offer quantity discounts to earn some reasonable profit without increasing the buyer's cost. Monahan (1984) presented a quantity discount schedule such that the manufacturer offers a price discount to induce the retailer to increase lot size. Lal and Staelin (1984) and Dada and Srikanth (1987) developed a quantity discount model by minimizing the system cost (the joint cost) of the seller and buyer. They took quantity discount as a tool for achieving channel efficiency. As a result, the seller is able to reduce his or her costs without increasing any buyer's cost. More recently, Corbett and De Groote (2000) derived an optimal quantity discount scheme for the joint economic lot-sizing problem in the case of asymmetric information, rather than full information being available to the supplier. The models mentioned above provided valuable insights into how and when quantity discount schemes can be used to achieve jointly optimal outcomes. However, they emphasized the manufacturer's interests, and disregarded those of the retailer. In other words, they did not consider return contracts—which is a major disadvantage considering that they are so widely implemented in many industries.

Kandel (1996) investigated the allocation of responsibility for unsold goods. He concluded that monopolistic manufacturers prefer a return contract whereas monopolistic retailers prefer a no-return arrangement, and then identified six main factors affecting the behavior. Emmons and Gilbert (1998) modelled the relationship between a manufacturer and a retailer in a single period setting with price-dependent demand uncertainty. Using a multiplicative model of demand uncertainty, they demonstrated that uncertainty tends to increase the retailer's price. Lau and Lau (1999) designed both the pricing and the return-for-credit strategies of a single-period commodity. They demonstrated that an optimal return policy could range from 'no returns' to 'unlimited returns', depending on the risk attitudes of the manufacturer and the retailer. Both these papers presented returns frameworks that were specifically limited to a monopolistic manufacturer or retailer.

This study is concerned with developing contracts to ensure channel cooperation. The recent article which touched on this issue is Padmanabhan and Png (1997). They studied the strategic effect of return policy on retailers' competition and highlighted its profitability implications for manufacturers. They concluded that the wholesale price when returns are acceptable should include an insurance premium. Prices would therefore be higher than those when returns are not honored. Padmanabhan and Png (1997) specifically assumed that the manufacturer would accept returns only when the profit after returns was no different from no-returns scenario. However, they ignored the fact that the manufacturer might have no incentive to accept returns because the profit after returns is not increased despite their needing to take a demand risk.