Production Planning & Control: The Management of Operations

Improving supply chain efficiency via option premium incentive

Chi-Sheng Shi & Chao-Ton Su
Published online: 15 Nov 2010.

PLEASE SCROLL DOWN FOR ARTICLE

Improving supply chain efficiency via option premium incentive

CHI-SHENG SHI and CHAO-TON SU

Abstract. This study considers a supply chain, including one manufacturer and one retailer, in which stochastic demand and return policy is focused upon. When each site aims to maximize its individual profitability, decentralized control may arise in the system. From the overall system's point of view, the decentralized supply chain will not be as efficient as the centralized one. Various studies have attempted to resolve the inefficiency of supply chains. However, such studies have focused on the optimization from retailer's perspective only and thus ignored manufacturer's interest. This study emphasizes manufacture's self-interested situation and determines optimal production quantity. Furthermore, it will contribute to decentralized control with the retailer offering option premium. It is also demonstrated that the Pareto efficiency can be attained in the supply chain by employing the option premium incentive.

1. Introduction

Consider a supply chain including one manufacturer and one retailer. The system serves an uncertain market demand that is the general experience in the competitive environment. That is, the actual demand at a specific due date is unpredictable. Therefore, the manufacturer's quantity setting at the outset of production is quite important. If the determined quantity is too large, the deterioration cost might be enormous. However, shortage will occur if the determined quantity is insufficient. On the other hand, due to the benefit from the manufacturer's overproduction at no immediate cost, the retailer has the incentive to initially over forecast but eventually purchase smaller quantity. The manufacturer must in turn anticipate

Authors: Chi-Sheng Shi, and Chao-Ton Su, Department of Industrial Engineering and Management, National Chiao Tung University, 1001 Ta Hsueh Road, Hoinchu, Taiwan, E-mail: ctsu@cc.nctu.

Chi-Sheng Shi is currently a doctoral candidate in industrial engineering at National Chiao Tung University, Taiwan. His present research interests are in the field of production/inventory control and production management.

Chao-Ton Su is Professor of the Deparment of Industrial Engineering and Management, National Chiao Tung University, Taiwan. He received his PhD from University of Missouri-Columbia, USA. His current research activities include quality engineering, production management and neural networks in industrial applications. Dr Su has published articles in *Computers and Industrial Engineering, Computers in Industry, International Journal of Industrial Engineering, Internaitonal Journal of Production Research, International Journal of Operations & Production Management, International Journal of Production Economics, Production Planning & Control, Integrated Manufacturing Systems, Opsearch, Quality Engineering, Quality and Reliability Engineering International, International Journal of Quality and Reliability Management, International Journal of Quality Science, International Journal of Systems Science, IEEE Transactions on Components, Packaging, and Manufacturing Technology, European Journal of Operational Research, IIE Transactions, Total Quality Management, Industrial Management and Data Systems.*

the outcome, particularly when a return policy is in place. If the manufacturer and the retailer make decisions independently, a rational manufacturer will determine the production quantity by maximizing his profit within both production cost and wholesale price. Thus, the market often suffers the shortage. If the manufacturing lead time is sufficiently short, the retailer can match the demand by employing backup but at an extra premium to compensate for overtime production cost. If the lead time fails to permit backup, then the retailer and manufacturer should absorb the market loss. In this study, the lead time is assumed to be insufficient for backup to occur. This results in an inefficient supply chain and is referred to as decentralized control (cf. Iyer and Bergen 1997, Lee and Whang 1999, Tsay 1999). Tsay (1999) proposed an efficiency benchmark deemed central control, where the retailer and manufacturer are coordinated by a single entity and therefore the system is able to deliver the maximum expected profit.

Various studies have attempted to remedy inefficient supply chains, as will be noted in Section 2. In this study, the manufacturer's self-interest is emphasized and the production quantity optimized. Furthermore, it is demonstrated that in comparison to centralized model, decentralized control causes an insufficient supply chain. That is, implementation of a centralized model results in extra profit and Pareto efficiency. However, in the centralized model, production quantity must be increased, which in turn decreases the manufacturer's profit. Hence, without compensation, a manufacturer will have no incentive to accept such a contract. As a result, it is proposed that a retailer should offer an option premium to induce a manufacturer to increase the production quantity. This, while not affecting the manufacturer, will increase the retailer's profit, and thus result in extra profit as a whole. Restated, an option premium incentive is proposed to resolve the dilemma of a decentralized supply chain. This study also demonstrates that when the option premium incentive is applied to a decentralized supply chain, the Pareto efficiency obtained will equal that of a centralized model.

The rest of this paper is organized as follows: section 2 reviews relevant literature. In section 3, a brief description of the decentralized model is provided. Section 4 characterizes the centralized scenario with conjoining of the retailer and the manufacturer by a single entity. In section 5, the option premium incentive is proposed to improve the efficiency of a supply chain. In section 6, a numerical example is presented to illustrate the effectiveness of the proposed approach. Section 7 summarizes the conclusions of this study.

2. Literature review

Recently, many researchers have modelled the decentralized scenario. Fisher and Raman (1996) analysed 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) modelled 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.

Gurnani and Tang (1999) analysed 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 co-operation 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 equalled 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.

3. Problem description

The problem is described as follows. In response to a given wholesale price and production cost, the manufacturer determines the production quantity by realizing the company's best interest (i.e. maximizing profit). During the selling season, the retailer sells the items in the market at a constant retail price. At the end of the season, the retailer returns unsold items to the manufacturer for full credit.

The relevant assumptions are twofold. (a) The distribution of market demand is available. Although this is a simplification, it is known that the distribution can be found by analysing history data. (b) Under the circum-

stance with return policy, prior to the selling season, the retailer makes commitment in terms of order quantity and wholesale price, and at the end of the season, is allowed to return unsold items. Pasternack (1985) assumed two forms of return policy, which include partial credit to the retailer for all unsold items and full credit for the return of a certain portion of the original order. To simplify it, the retailer is assumed to have received full credit for all unsold items in this study. Thus, it is possible to focus on the model to be described, which deals with a profit-oriented manufacturer.

To construct the model, the relevant notation is stated as follows:

w wholesale price per item

w_0 baseline wholesale price per item, that is, the price when no option premium is offered

Δw option premium, the difference between w and w_0, defined as $(w - w_0)$

m production cost per item

p retail price per item

u salvage value per item

s shortage cost per item

D market demand, stochastic variable

Q production quantity of manufacturer

Q_d production quantity of decentralized model

Q_c production quantity of centralized model

$F(\cdot)$ distribution function of the market demand

$f(\cdot)$ density function of the market demand

To assure internal consistency, the cost parameters follow some straightforward assumptions:

(a) $p > w_0 > m > 0$,   (b) $u < m$,   (c) $s > 0$.

2.1. *Manufacturer's profit function*

The manufacturer's profit can be expressed as wholesale revenue minus production costs plus salvage value. Notably, wholesale revenue only counts sold items because unsold items are returned with full credit.

$$\pi_m = w_0 \operatorname{Min}(Q, D) - mQ + u(Q - D)^+ \qquad (1)$$

Take expectation for all possible demand, then the manufacturer's average profit can be written as:

$$E(\pi_m) = w_0 E\{\operatorname{Min}(Q, D)\} - mQ + uE(Q - D)^+ \quad (2)$$

Differentiation of equation (2) yields the following first-order condition:

$$\frac{\partial}{\partial Q} E(\pi_m) = w_0 \frac{\partial}{\partial Q} \{E(D) - E(D - Q)^+\}$$

$$- m + u \frac{\partial}{\partial Q} E(Q - D)^+$$

$$= w_0(1 - F(Q)) - m + uF(Q)$$

$$= (w_0 - m) + (w_0 - u)F(Q) = 0 \qquad (3)$$

or it can be rewritten as

$$F(Q) = (w_0 - m)/(w_0 - u) \qquad (4)$$

Differentiating equation (3) yields the second-order condition.

$$-(w_0 - u)f(Q) \leq 0 \qquad (5)$$

Hence, the second-order condition is satisfied and $Q_d = F^{-1}\{(w_0 - m)/(w_0 - u)\}$ is the manufacturer's optimal production quantity.

2.2. Retailer's profit function

The retailer's profit can be expressed as revenue minus wholesale cost and goodwill loss. Notably, wholesale cost only counts sold items because unsold items can be returned for full credit.

$$\pi_r = (p - w_0) \operatorname{Min}(Q, D) - s(D - Q)^+ \qquad (6)$$

Take expectation for all possible demand, then the retailer's average profit becomes:

$$E(\pi_r) = (p - w_0)E\{\operatorname{Min}(Q, D)\} - sE(D - Q)^+ \qquad (7)$$

Differentiation of equation (7) yields the following first-order condition:

$$(p + s - w_0)(1 - F(Q)) = 0 \qquad (8)$$

It concludes that the retailer's optimal ordering quantity is infinite. Restated, the retailer hopes the manufacturer produces as many as possible so that shortage costs can be reduced significantly. Furthermore, the retailer does not need to worry about ordering too much because unsold items can be returned for full credit.

If the manufacturer and the retailer make decisions independently, a rational manufacturer will determine the optimal production quantity by maximizing the profit. Since backup is prohibited in this study, once the production quantity is determined, regardless of shortage during a selling season, the retailer cannot acquire any extra quantity. Explicitly the shortage does not affect the manufacturer but only matters to the retailer. Thus, the retailer encounters a great potential risk that is a shortage might destroy business viability. The situation mentioned above is also referred to as decentralized dilemma. If the profits of the manufacturer and the retailer are considered together, the quota ascertained in the model will not allow for too much shortage to occur. This is called a centralized scenario. The next section attempts to model the centralized scenario.

4. Centralized model

Let $\pi_{\mathcal{J}}$ be the joint profit of the manufacturer and the retailer, which can be written as

$$\pi_{\mathcal{J}} = \pi_r + \pi_m,$$

or

$$\pi_{\mathcal{J}} = p \operatorname{Min}(Q, D) - mQ + u(D - Q)^+ - s(D - Q)^+ \qquad (9)$$

Take expectation for all possible demand, the manufacturer average profit is:

$$E(\pi_{\mathcal{J}}) = p \operatorname{Min} E(Q, D) - mQ + uE(D - Q)^+ - sE(D - Q)^+ \qquad (10)$$

Differentiation of equation (10) yields the following first-order condition:

$$(p + s - m) - (p + s - u)F(Q) = 0 \qquad (11)$$

or rewritten as

$$F(Q) = (p + s - m)/(p + s - u) \qquad (12)$$

The second-order condition is produced by differentiating equation (11).

$$-(p + s - u)f(Q) \leq 0 \qquad (13)$$

Therefore, the second-order condition is satisfied and $Q_c = F^{-1}\{(p + s - m)/(p + s - u)\}$ is the system's optimal production quantity.

Proposition 1

Joint profit of the centralized model is higher than that of the decentralized model.

As the objective of the centralized model is to maximize the joint profit, this proposition is self-explanatory. Therefore, the optimal joint profit of the centralized model is always higher than or equivalent to that of the decentralized model. Furthermore, once the optimal quota within the decentralized model is ascertained to be different from that within the centralized one, the centralized model dominates the decentralized model. Compare equations (12) and (4), the difference of their optimal quota is apparent. So the centralized model dominates the decentralized model, or restated, extra profit results in the centralized model.

Proposition 2

The manufacturer's profit of the centralized model is less than that of the decentralized one.

The objective of the decentralized model is to maximize the manufacturer's profit, so that when optimum, the manufacturer's profit of the decentralized model is always higher than or equivalent to that of the centralized model. Furthermore, once the optimal quota within the centralized model differs from that within the decentralized one, the decentralized model dominates the centralized model. Proposition 1 confirms that the optimal quota between two models is distinct, therefore, when the centralized model is implemented, the manufacturer's profit decreases.

Proposition 3

The retailer's profit of the centralized model is higher than that of the decentralized one.

From proposition 1, when optimum the joint profit of the centralized model is higher than that of the decentralized one. In addition, from proposition 2, the manufacturer's cost of the centralized model is less than that of the decentralized model. Thus, it is explicit that the retailer's profit of the centralized model is higher than that of the decentralized one.

Proposition 4

The manufacturer's production quantity of the centralized model is greater than that of the decentralized situation.

This proposition is proven by comparing $Q_d = F^{-1}\{(w_0 - m)/(w_0 - u)\}$ and $Q_c = F^{-1}\{(p + s - m)/(p + s - u)\}$. Since $p > w_0$ based on the assumption, and $F^{-1}(\cdot)$ is a monotonous increasing function, then $Q_c > Q_d$ can be concluded.

Proposition 5

Pareto efficiency is attained in the centralized model.

A feasible allocation x is a Pareto efficient allocation if there is no feasible allocation x^t such that all agents prefer x^t to x (cf. Varian 1984). There is no feasible production quantity where the manufacturer and the retailer are at least both well off and at least one of them is strictly better off. That is, if such a quantity exists, then the joint profit of the centralized model can be improved. However, the joint profit of the centralized model is maximized in the supply chain. As a result, it can be concluded that Pareto efficiency is attained in the centralized model.

The above propositions verify that when the centralized model is implemented, the manufacturer's profit decreases, while both the retailer's profit and the joint profit increase. Notably, the retailer's profit increases more than the manufacturer's profit decreases, therefore, the manufacturer-retailer system will yield extra overall profit. Furthermore, it is demonstrated that implementation of the centralized model results in Pareto efficiency.

However, problems still exist. If the manufacturer accepts a centralized model contract, it means that he must produce more but earn less. It is clear that unless compensated by the retailer, the manufacturer will not accept such a contract. This will be considered in the next section.

5. Cooperative model employing option premium as an incentive

In this section, it is proposed that the retailer employ an option premium as an incentive, so that the manufacturer is motivated to accept the contract. Furthermore, it will determine the amount of the option premium that the retailer should offer. Also, production quantity in such a situation will be determined.

Let the option premium be Δw that is defined as $(w - w_0)$, and $\pi_m(Q_d)$ be the profit function before the option premium. After the option premium, the manufacturer's profit function can be expressed as $\pi_m(Q)$. If the manufacturer's profit after option premium is not less than that of the decentralized model, the motivation to accept the contract of the centralized model will exist. Equation (14) expresses such a situation, where Q_d is the optimal production quantity of the decentralized model.

$$\pi_m(w, Q) - \pi_m(w_0, Q_d) \geq 0 \qquad (14)$$

For simplicity, let equation (14) equal zero, which implies that after option premium, the manufacturer's profit is equal to that of the decentralized model. After solving equation (14), the reaction function of the manufacturer is as follows:

$$w = \frac{\{\pi_m(Q_d) + mQ - uE(Q - D)^+\}}{E(\text{Min}(Q, D))} \qquad (15)$$

Furthermore, to determine the ordering quantity, the retailer will maximize profit under the reaction function, which is expressed in the following:

$$\text{Max } E(\pi_r) = (p - w)E\{\text{Min}(Q, D)\} - sE(D - Q)^+$$

$$\text{s.t.} \quad w = \frac{\{\pi_m(Q_d) + mQ - uE(Q - D)^+\}}{E\{\text{Min}(Q, D)\}} \quad (16)$$

Differentiation of equation (16) yields the following first-order condition:

$$(p + s - m) - (p + s - u)F(Q) = 0 \quad (17)$$

It is evident that equation (17) is equivalent to equation (11). Thus, the ordering quantity determined herein is equal to that of the centralized model (i.e. Q_c). Substitute Q_c into equation (15), the optimal wholesale price w can be ascertained and option premium Δw is obtained by $(w - w_0)$.

Proposition 6

Through the employment of option premium as an incentive, the manufacturer's profit will not decrease compared with that of the decentralized model, whereas will increase compared with that of the centralized model. Meanwhile, the retailer's profit will increase compared with that of the decentralized model, whereas will decrease compared with that of the centralized model. Furthermore, Pareto efficiency is also attained herein.

Based on equation (14), the manufacturer's profit is equivalent to that of the decentralized model. From proposition 2, the manufacturer's profit of the decentralized model is higher than that of the centralized one. Therefore, it can be concluded that the manufacturer's profit herein is larger than that of the centralized model. Since option premium paid by the retailer is equivalent to the amount received by the manufacturer, therefore the joint profit of the manufacturer and the retailer will be also equivalent both before and after option premium. Thus, proposition 1 is also correct here. From proposition 1, extra profit exists within the centralized model. When the manufacturer's profit equals that of the decentralized situation, it is explicit that the retailer's profit will increase in comparison with that of the decentralized model. However, since the manufacturer's profit herein is larger than that of the centralized model, the retailer's profit will decrease in comparison with that of the centralized model. Finally, Pareto efficiency is attained, because the joint profit after option premium is equivalent to that of the centralized model.

6. Numerical illustration

To illustrate the effectiveness of the co-operative model, the decentralized control from previous literature is solved by the proposed approach. This problem origi-

nates from Tsay (1999). Tsay assumed that market demand is uniformly distributed within [0, 100]. He also assumed $p = 15$, $w_0 = 10$, $m = 6$, $u = 3$. Here, it is assumed $s = 3$ in the retailer's parameters.

First, the decentralized model is solved. The optimal quota which manufacturer produces is 57.14. Notably, every individual cost and the total profit are computed when the optimal quota is substituted into the manufacturer's profit function. Furthermore, with this quota, the retailer's cost is also computed. Table 1 illustrates the results.

Then, the centralized model is solved. The optimal quota is 80. Notably, it is greater than that of the decentralized model (i.e. 57.14). When the option quota is substituted into the profit function of both the retailer and the manufacturer, every individual cost and the total profit are again computed. Table 2 illustrates the results. It shows that the retailer's shortage cost decreases, but the manufacturer's production and salvage costs increase here. As a result, the retailer's profit increases, but here the manufacturer's profit decreases in comparison with that of the decentralized model. Moreover, the joint profit is 322.35, which increases by about 12.7% in comparison with that of the decentralized model.

Finally, the co-operative model is solved. The optimal quota of 80 is the same as it is in the centralized model. When the optimal quota is substituted into the profit function of both the retailer and the manufacturer, every individual cost and the total profit are computed. The wholesale price can be solved as 10.41, thus option premium Δw, 0.41, is obtained. That is, the retailer should offer an option premium, 0.41 per item to induce the manufacturer to increase the production quantity

Table 1. Results obtained from the decentralized model.

Manufacturer		Retailer	
Revenue	402.57	Revenue	201.28
Production cost	(342.84)	Shortage cost	(25.67)
Salvage cost	50.64		
Profit	110.37	Profit	175.61
Joint profit		285.98	

Table 2. Results obtained from the centralized model.

Manufacturer		Retailer	
Revenue	472.53	Revenue	236.26
Production cost	(480)	Shortage cost	(4.68)
Salvage cost	98.24		
Profit	90.77	Profit	231.58
Joint profit		322.35	

Table 3. Results obtained from the co-operative model.

Manufacturer		Retailer	
Revenue	492.13	Revenues	216.66
Production cost	(480)	Shortage cost	(4.68)
Salvage cost	98.24		
Profit	110.37	Profit	212.98
Joint profit		322.35	

from 57.14 to 80. The results are illustrated in table 3, which shows that due to the option premium, the manufacturer's profit, 110.37, equals that of the decentralized model. However, the retailer's profit, 212.98, is higher than that of the decentralized model. Restated, it is increased by approximately 21.3%. In addition, the joint profit, 322.35, is equivalent to that of the centralized model.

7. Conclusions

The decentralized dilemma within a supply chain has been discussed. Stochastic demand and return policy are included in the model. Furthermore, the decentralized effect within a supply chain has been revealed, as well as the decision policies of the retailer and the manufacturer modelled. The retailer hopes the manufacturer produce as many as possible, thereby reducing the cost of shortage due to the return policy. However, if the manufacturer and the retailer make decisions independently, a rational manufacturer will determine the optimal production quantity by maximizing profit.

It has been proven that when a retailer and a manufacturer are conjoined by a single entity, the system can attain the Pareto efficiency or centralization. Within the centralized model, the manufacturer must produce a greater amount, but earn less. Therefore, unless compensated, the manufacturer will not have the incentive to accept this type of contract. It is therefore proposed that the retailer should offer an option premium to induce the manufacturer to increase production quantity.

It has been demonstrated that when the retailer offers the manufacturer an option premium, the system can be Pareto efficient, and thus remedy the inefficiencies caused by decentralized control within a the system.

References

Duenyas, I., Hopp, W. J., and Spearman, M. L., 1993, Characterizing the output process of a CONWIP line with deterministic processing and random outages. *Management Science*, **39**(8), 975–988.

Duenyas, I., Hopp, W. J., and Bassok, Y., 1997, Production quotas as bounds on interplant JIT contracts. *Management Science*, **43**(10), 1372–1386.

Emmons, H., and Gilbert, S. M., 1998, Note: the role of returns policies in pricing and inventory decisions for catalogue goods. *Management Science*, **44**(2), 276–283.

Eppen, G. D., and Iyer, A. V., 1997, Backup agreements in fashion buying – the value of upstream flexibility. *Management Science*, **43**(11), 1469–1484.

Fisher, M., and Raman, A., 1996, Reducing the cost of demand uncertainty through accurate response to early sales. *Operations Research*, **44**(1), 87–99.

Gurnani, H., and Tang, C. S., 1999, Note: optimal ordering decisions with uncertain cost and demand forecast updating. *Management Science*, **45**(10), 1456–1462.

Iyer, A. V., and Bergen, M. E., 1997, Quick response in manufacturer-retailer channels. *Management Science*, **43**(4), 559–570.

Lee, H., and Whang, S., 1999, Decentralized multi-echelon supply chain: incentives and information. *Management Science*, **45**(5), 633–640.

Palar, M., and Weng, Z. K., 1997, Designing a firm's coordinated manufacturing and supply decisions with short product life cycles. *Management Science*, **43**(10), 1329–1344.

Padmanabhan, V., and Png, I. P., 1997, Manufacturer's returns policies and retail competition. *Management Science*, **16**(1), 81–94.

Pasternack, B. A., 1985, Optimal pricing and returns policies for perishable commodities. *Marketing Science*, **4**, 166–176.

Tsay, A. A., 1999, The quantity flexibility contract and supplier-customer incentives. *Management Science*, **45**(10), 1339–1358.

Varian, H. R., 1984, *Microeconomic Analysis*, 2nd edn. (New York: W. W. Norton).

Weng, Z. K., 1997, Pricing and ordering strategies in manufacturing and distribution alliances. *IIE Transactions*, **29**(8), 681–692.