Journal of Southeast University (English Edition) Vol. 23, No. 4, pp. 620 – 625 Dec. 2007 ISSN 1003—7985

Supply chain coordination mechanisms under asymmetric information with retailer cost disruptions

Zhuang Pin[1,2] Zhao Lindu[1]

([1] Institute of Systems and Engineering, Southeast University, Nanjing 210096, China)

([2] College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China)

Abstract: A two-level supply chain model involving one supplier and one retailer with linear demand is developed, and supply chain coordination mechanisms under asymmetric information (the retailer's cost structure is asymmetric information) are proposed by employing game theory in two scenarios: coordination mechanisms under asymmetric information in a regular scenario (without disruption); and coordination mechanisms under asymmetric information in an irregular scenario (with retailer cost disruptions). It is optimal for the supply chain to maintain the original production plan and to guarantee a steadily running system if variations of retailer costs are sufficiently low and do not exceed an upper bound. This shows that the original production plan has certain robustness under disruptions. Decisions must be re-made if a retailer's cost change is greater and exceeds an upper bound. Impacts of retailer cost disruptions on the order quantity, the retail price, the wholesale price and each party's as well as the system's expected profits are investigated through numerical analyses.

Key words: disruption management; supply chain coordination mechanism; asymmetry information; game theory; cost disruption

Supply chain management (SCM) is primarily concerned with efficient integration of suppliers, manufacturers, warehouses, retailers, and ultimately customers, so merchandise is purchased, produced and distributed at the right quantities, to the right locations, and at the right time. The challenge for the supply chain is to create an appropriate coordination mechanism, i. e., to structure the costs and rewards of all of its members so as to align their individual objectives with an aggregate system-wide objective.

When we have an optimal operational plan that was obtained by using certain models and solution schemes, the environment is often disrupted by some contingencies such as natural disasters, labor strikes, machine breakdowns, supplier bankruptcies and inclement environmental conditions. Therefore, we may want to change the original plan in order to be better adapted in the disrupted environment. Disruption management is concerned with how to make optimal reaction decisions when a system faces disruptions, so as to minimize the loss caused by disruptions. Successful applications of disruption management range from flight operations[1], telecommunications[2], to project management[3] and production scheduling[4].

Supply chain disruption management has recently received extensive attention from practitioners and researchers. Qi et al.[5] investigated a one-supplier one-retailer supply chain that experiences a disruption in demand during the planning phase. They showed that changes to the original plan induced by a disruption may impose considerable deviation costs throughout the system. Xu et al.[6] studied the problem of how to handle demand disruptions in a one-supplier-one-retailer supply chain, where production cost is a convex function of production quantity. Tomlin[7] explored strategies for coping with disruptions, including inventory, dual sourcing, and acceptance. Xiao et al.[8] developed an indirect evolutionary game model with two-vertically integrated channels and analyzed the effects of the demand and raw material supply disruptions on retailer strategies.

In contrast to the previous literature assuming that information is symmetrical between the supplier and the retailer, we study optimal decisions of supply chain disruption management when the retailer has private information about her own cost structure. In related works on supply chain coordination mechanisms under asymmetric information, Yue et al.[9] presented a profit maximization model following a simultaneously-played Bertrand type game to obtain optimal strategies for a firm making decisions under information asymmetry.

Received 2007-03-08.

Foundation items: The National Natural Science Foundation of China (No. 70671021), Jiangsu Postdoctoral Foundation (No. 0601015C).

Biography: Zhuang Pin (1967—), female, doctor, associate professor, zpnuaa@163. com.

Corbett et al. [10] developed the supplier's optimal contracts and profits for all six scenarios: three increasingly general contracts, each under full and incomplete information about the buyer's cost structure. Sucky[11] analyzed the typical case of a buyer-supplier relationship with a strong buyer, providing a bargaining model with asymmetric information about the buyer's cost structure. Lau et al. [12] studied supply chain contract models using stochastic and asymmetric-information instead of the deterministic and symmetric-information framework.

1 Basic Model: Full Information in a Centralized Setting

We consider the standard setting with a single supplier and a single retailer who sells the supplier's product to the final market. The retailer orders from the supplier according to market demand D. The situation is described as follows. The market demand function for representing a downward-sloping price versus demand relationship is given by the linear demand function $D(p) = a - bp$, where $a > 0$ and $b > 0$ are known parameters. The supplier's variable costs are s, the retailer's internal variable costs are c, the wholesale price is w, and the retail price selling to the customer is p. The retailer's order quantity is Q, without loss of generality, we assume that the supplier follows a lot-for-lot policy, i. e., the supplier's production lot size is equal to the lot size shipped to the retailer.

We first investigate the centralized situation where one central decision maker seeks to maximize total system profits. Then the supply chain system profit can be written as $\Pi^{C}(p) = (a - bp)(p - s - c)$. It is easy to see that $\Pi^{C}(p)$ is strictly concave over p, so there must be a unique optimal point p^{C} to maximize the supply chain system profit. By the first-order condition $\frac{\partial \Pi^{C}(p)}{\partial p} = 0$, we have the optimal retail price $p^{C} = (a + bs + bc)/(2b)$, and the optimal order quantity $Q^{C} = (a - bs - bc)/2$. Then the optimal supply chain profit is $\Pi^{C} = (a - bs - bc)^2/(4b)$. From this formula, we know that the supply chain profit is decreasing non-linearly with the supplier's cost s and the retailer's cost c.

2 Supply Chain Coordination Mechanisms under Asymmetric Information without Disruptions

The preceding analysis is based on full information and a centralized situation. In general, the supplier does not know the retailer's cost c; we assume the supplier holds a prior distribution function $F(c)$ with a continuous density function $f(c)$, and mean value of μ_A. $F(c)$ is differentiable, strictly increasing and is defined on $[\underline{c}, \bar{c}]$, where $0 \leqslant \underline{c} \leqslant \bar{c} \leqslant \infty$. Let $F(0) = 0$ and $\bar{F}(c) = 1 - F(c)$. All parameters except c are common knowledge.

The supplier initiates to propose contracts but the retailer may refuse them. This corresponds to a principal-agent framework with supplier as principal and retailer as agent. The game is as follows: the supplier makes a take-it-or-leave-it-offer, i. e., in the first stage, the supplier makes a contract, and then in the second stage, the retailer can either accept or reject. If the retailer rejects the contract, then the game is immediately terminated; if the retailer accepts the contract, she/he will select the optimal quantity and retail price that maximizes his/her expected profits.

The optimization problem of the supplier is to maximize his expected profits; that is

$$S_A \quad \max_{w} E[\Pi_s^{A}(w)] = \max_{w} \int_{\underline{c}}^{\bar{c}} \Pi_s^{A}(w) f(c)\,\mathrm{d}c \quad (1)$$

$$\text{s. t.} \quad \text{IC:} \quad Q = \arg\max_{Q} \Pi_r^{A}(p, Q) \quad (2)$$

The supplier's expected profits in Eq. (1) depend on the quantity Q ordered by the retailer through the definitional constraint (2). Eq. (2) is the retailer's incentive compatibility (IC) constraint, which will ensure the retailer's selection of a lot size that maximizes his/her expected profits.

The retailer's expert profit function can be written as $\Pi_r^{A}(p) = (a - bp)(p - w - c)$. From the first optimality condition $\frac{\partial \Pi_r^{A}(p)}{\partial p} = 0$, we obtain the optimal retail price $p^{A}(w) = [a + b(w + c)]/(2b)$, and the optimal order quantity is $Q^{A}(w) = [a - b(w + c)]/2$.

The supplier's optimization problem becomes $\max_{w} E[\Pi_s^{A}(w)] = E[Q^{A}(w)(w - s)]$. Solving the first-order condition $\frac{\partial E[\Pi_s^{A}(w)]}{\partial w} = 0$, we can derive the following lemma 1.

Lemma 1 The supply chain coordination mechanisms under asymmetric information without disruptions are as follows:

The optimal wholesale price is

$$w^{A} = \frac{a + b(s - \mu_A)}{2b} \quad (3)$$

The optimal retailer price is

$$p^{A} = \frac{3a + b(s + \mu_A)}{4b} \quad (4)$$

The optimal order quantity is

$$Q^{A}=\frac{a-b(s+\mu_{A})}{4} \tag{5}$$

The corresponding retailer's expected profit is

$$\Pi_{r}^{A}=\frac{[a-b(s+\mu_{A})]^{2}}{16b} \tag{6}$$

The supplier's expected profit is

$$\Pi_{s}^{A}=\frac{[a-b(s+\mu_{A})]^{2}}{8b} \tag{7}$$

The supply chain system's expected profit is

$$\Pi^{A}=\frac{3[a-b(s+\mu_{A})]^{2}}{16b} \tag{8}$$

3 Supply Chain Coordination Mechanisms under Asymmetric Information with Disruptions

This section considers the optimal emergency strategy for coordinating the supply chain under asymmetric information to handle disruptions. We assume that there are only retailer cost disruptions and other settings are unchanged. The situation is as follows: after the supplier's production plan is made and before the selling season arrives, an unforeseeable event takes place, and it makes the retailer's cost disruption; i. e., the cost distribution changes from F to G (Its density function is assumed to be g). The same as with the distribution function F, we assume the distribution function of demand G is differentiable and strictly increasing and $G(0)=0$. Let $\bar{G}(c)=1-G(c)$ and denote the mean value as μ_{D}.

The supplier's optimal problem under asymmetric information with disruption can be written as

$$S_{D} \quad \max_{w} E[\Pi_{s}^{D}(w)] = \max_{w}\int_{\underline{c}}^{\bar{c}} \Pi_{s}^{D}(w)g(c)\mathrm{d}c \tag{9}$$

$$\text{s.t.} \quad \text{IC:} \quad Q=\arg\max_{Q}\Pi_{r}^{D}(p,Q) \tag{10}$$

When an original plan is revised, there will be some deviation cost associated with the adjustment. By considering the deviation costs, the supplier's profit function under disruption can be written as

$$\Pi_{s}^{D}(w)=Q(w-s)-\lambda_{1}(Q-Q^{A})^{+}-\lambda_{2}(Q^{A}-Q)^{+} \tag{11}$$

where the parameters λ_1 and λ_2 are the marginal extra costs associated with the adjustment of the production plan from the original plan, respectively, and $(x)^{+}=\max(0,x)$. More precisely, λ_1 is the unit-extra production cost greater than that which has been planned; and λ_2 is the unit cost of handing the leftover inventory less than that which has been planned. We assume $\lambda_1<(\mu_{A}-\mu_{D})^{+}$ and $\lambda_2<(\mu_{D}-\mu_{A})^{+}$, respectively.

The disruptions may make the cost scale greater or smaller; i. e., $\bar{G}(c)\geqslant\bar{F}(c)$, for all $c\geqslant0$; or $\bar{G}(c)\leqslant\bar{F}(c)$, for all $c\geqslant0$[13].

Under the disruptions, we assume the optimal emergency production quantity is Q^{D}. Then, we derive the following theorem 1.

Theorem 1 If the disruptions make the retailer's costs greater, i. e., $\bar{G}(c)\geqslant\bar{F}(c)$, for all $c\geqslant0$, then $Q^{D}\leqslant Q^{A}$; otherwise, if the cost is smaller, i. e., $\bar{G}(c)\leqslant\bar{F}(c)$, for all $c\geqslant0$, then $Q^{D}\geqslant Q^{A}$.

Proof Under the condition that the retailer's cost is greater, i. e., $\bar{G}(c)\geqslant\bar{F}(c)$, assume $Q^{D}>Q^{A}$, for all $c\geqslant0$. The supplier's expected profit function is $\Pi_{s}^{D}(w)=Q(w-s)-\lambda_{1}(Q-Q^{A})$. The supplier's optimal function is $\max_{w}E[\Pi_{s}^{D}(w)] = \max_{w}\int_{\underline{c}}^{\bar{c}}\Pi_{s}^{D}(w)g(c)\mathrm{d}c$, which is maximized at $Q^{D}=[a-b(s+\lambda_{1}+\mu_{D})]/4$. It can be shown that $Q^{D}<Q^{A}$, which is contradictive inequality. So when the disruptions make the retailer's cost greater, then $Q^{D}\leqslant Q^{A}$. A similar proof can confirm the other result of this theorem; i. e., if the cost is less, then $Q^{D}\geqslant Q^{A}$.

We develop optimal decisions of supply chain under asymmetric information with disruptions in the following two cases, respectively.

Case 1 The cost is less, i. e., $\bar{G}(c)\leqslant\bar{F}(c)$, for all $c\geqslant0$. If this is true, then $Q^{D}\geqslant Q^{A}$.

The supplier's profit function under case 1 can be written as $\Pi_{s1}^{D}(w)=Q(w-s)-\lambda_{1}(Q-Q^{A})$, and the supplier's optimal problem can be written as $\max_{w}E[\Pi_{s1}^{D}(w)] = \max_{w}\int_{\underline{c}}^{\bar{c}}\Pi_{s1}^{D}(w)g(c)\mathrm{d}c$. From the first optimality condition $\frac{\partial E[\Pi_{s1}^{D}(w)]}{\partial w}=0$, we have the following lemma 2.

Lemma 2 In case 1, the supply chain coordination mechanisms under asymmetry information with disruptions are as follows:

The optimal wholesale price is

$$w_{1}^{D}=\frac{a+b(s+\lambda_{1}-\mu_{D})}{2b} \tag{12}$$

The optimal retail price is

$$p_{1}^{D}=\frac{3a+b(s+\lambda_{1}+\mu_{D})}{4b} \tag{13}$$

The optimal order quantity is

$$Q_{1}^{D}=\frac{a-b(s+\lambda_{1}+\mu_{D})}{4} \tag{14}$$

The retailer's expected profit is

$$\Pi_{r1}^{D}=\frac{[a-b(s+\lambda_{1}+\mu_{D})]^{2}}{16b} \tag{15}$$

The supplier's expected profit is

$$\Pi_{s1}^{D}=\frac{(a-bs-b\mu_{D})^{2}-(b\lambda_{1})^{2}}{8b}-\frac{b\lambda_{1}(\mu_{A}-\lambda_{1}-\mu_{D})}{4} \tag{16}$$

The supply chain expected profit is

$$\Pi_{1}^{D}=\frac{[a-b(s+\lambda_{1}+\mu_{D})][3a-b(3s-\lambda_{1}+3\mu_{D})]}{16b}-\frac{b\lambda_{1}(\mu_{A}-\lambda_{1}-\mu_{D})}{4} \tag{17}$$

Case 2 The retailer's cost is greater; i. e., $\overline{G}(c)\geqslant\overline{F}(c)$, for all $c\geqslant0$. If this is true, then $Q^{D}\leqslant Q^{A}$.

The supplier's profit function under case 2 can be written as $\Pi_{s2}^{D}(w)=Q(w-s)-\lambda_{2}(Q^{A}-Q)$, then the supplier's optimal problem can be written as $\max_{w}E[\Pi_{s2}^{D}(w)]=\max_{w}\int_{\underline{c}}^{\bar{c}}\Pi_{s2}^{D}(w)g(c)\,\mathrm{d}c$. From the first optimality condition, we have the following lemma 3.

Lemma 3 In case 2, the supply chain coordination mechanisms under asymmetric information with disruptions are as follows:

The optimal wholesale price is

$$w_{2}^{D}=\frac{a+b(s-\lambda_{2}-\mu_{D})}{2b} \tag{18}$$

The optimal retail price is

$$p_{2}^{D}=\frac{3a+b(s-\lambda_{2}+\mu_{D})}{4b} \tag{19}$$

The optimal order quantity is

$$Q_{2}^{D}=\frac{a-b(s-\lambda_{2}+\mu_{D})}{4} \tag{20}$$

The retailer's expected profit is

$$\Pi_{r2}^{D}=\frac{[a-b(s-\lambda_{2}+\mu_{D})]^{2}}{16b} \tag{21}$$

The supplier's expected profit is

$$\Pi_{s2}^{D}=\frac{(a-bs-b\mu_{D})^{2}-(b\lambda_{2})^{2}}{8b}-\frac{b\lambda_{2}(\mu_{D}-\lambda_{2}-\mu_{A})}{4} \tag{22}$$

The supply chain expected profit is

$$\Pi_{2}^{D}=\frac{[a-b(s-\lambda_{2}+\mu_{D})][3a-b(3s+\lambda_{2}+3\mu_{D})]}{16b}-\frac{b\lambda_{2}(\mu_{D}-\lambda_{2}-\mu_{A})}{4} \tag{23}$$

Summarizing the above results, we have

Lemma 4 The supply chain coordination mechanisms under asymmetric information with disruptions are as follows:

The optimal order quantities are

$$Q^{D}=\begin{cases}Q_{1}^{D} & \text{if } \mu_{D}<\mu_{A}-\lambda_{1}\\ Q^{A} & \text{if } \mu_{A}-\lambda_{1}\leqslant\mu_{D}\leqslant\mu_{A}+\lambda_{2}\\ Q_{2}^{D} & \text{if } \mu_{D}>\mu_{A}+\lambda_{2}\end{cases}$$

The corresponding retail prices are

$$p^{D}=\begin{cases}p_{1}^{D} & \text{if } \mu_{D}<\mu_{A}-\lambda_{1}\\ p^{A} & \text{if } \mu_{A}-\lambda_{1}\leqslant\mu_{D}\leqslant\mu_{A}+\lambda_{2}\\ p_{2}^{D} & \text{if } \mu_{D}>\mu_{A}+\lambda_{2}\end{cases}$$

The wholesale prices are

$$w^{D}=\begin{cases}w_{1}^{D} & \text{if } \mu_{D}<\mu_{A}-\lambda_{1}\\ w^{A} & \text{if } \mu_{A}-\lambda_{1}\leqslant\mu_{D}\leqslant\mu_{A}+\lambda_{2}\\ w_{2}^{D} & \text{if } \mu_{D}>\mu_{A}+\lambda_{2}\end{cases}$$

The retailer's expected profits are

$$\Pi_{r}^{D}=\begin{cases}\Pi_{r1}^{D} & \text{if } \mu_{D}<\mu_{A}-\lambda_{1}\\ \Pi_{r}^{A} & \text{if } \mu_{A}-\lambda_{1}\leqslant\mu_{D}\leqslant\mu_{A}+\lambda_{2}\\ \Pi_{r2}^{D} & \text{if } \mu_{D}>\mu_{A}+\lambda_{2}\end{cases}$$

The supplier's expected profits are

$$\Pi_{s}^{D}=\begin{cases}\Pi_{s1}^{D} & \text{if } \mu_{D}<\mu_{A}-\lambda_{1}\\ \Pi_{s}^{A} & \text{if } \mu_{A}-\lambda_{1}\leqslant\mu_{D}\leqslant\mu_{A}+\lambda_{2}\\ \Pi_{s2}^{D} & \text{if } \mu_{D}>\mu_{A}+\lambda_{2}\end{cases}$$

The supply chain system's expected profits are

$$\Pi^{D}=\begin{cases}\Pi_{1}^{D} & \text{if } \mu_{D}<\mu_{A}-\lambda_{1}\\ \Pi^{A} & \text{if } \mu_{A}-\lambda_{1}\leqslant\mu_{D}\leqslant\mu_{A}+\lambda_{2}\\ \Pi_{2}^{D} & \text{if } \mu_{D}>\mu_{A}+\lambda_{2}\end{cases}$$

Hence, we can derive the following theorem 2.

Theorem 2 It is optimal for the supply chain to maintain the original production plan and guarantee the system running steadily if variations of the retailer's cost is sufficiently small and does not exceed an upper bound ($\mu_{A}-\lambda_{1}\leqslant\mu_{D}\leqslant\mu_{A}+\lambda_{2}$). This shows that the original production plan has certain robustness under disruptions; decisions must be adjusted if the retailer's cost change is greater and exceeds an upper bound ($\mu_{D}<\mu_{A}-\lambda_{1}$ or $\mu_{D}>\mu_{A}+\lambda_{2}$).

Proof of theorem 2 is omitted.

4 Numerical Analysis

In this section, we give several numerical examples to analyze the effects of the retailer's cost disruption on the wholesale price, the retail price, the order quantity, the retailer's expected profit, the supplier's expected profit, and the supply chain system's expected profit. Let $a=200$, $b=5$, $s=10$, $\lambda_{1}=2$, $\lambda_{2}=2$. The retailer's cost prior distribution function $F(c)$ is uniform with mean value $\mu_{A}=10$. Disruptions might cause the increase or the decrease of the retailer's costs. We assume that the value of μ_{D} varies from 2 to 18 (see Fig. 1).

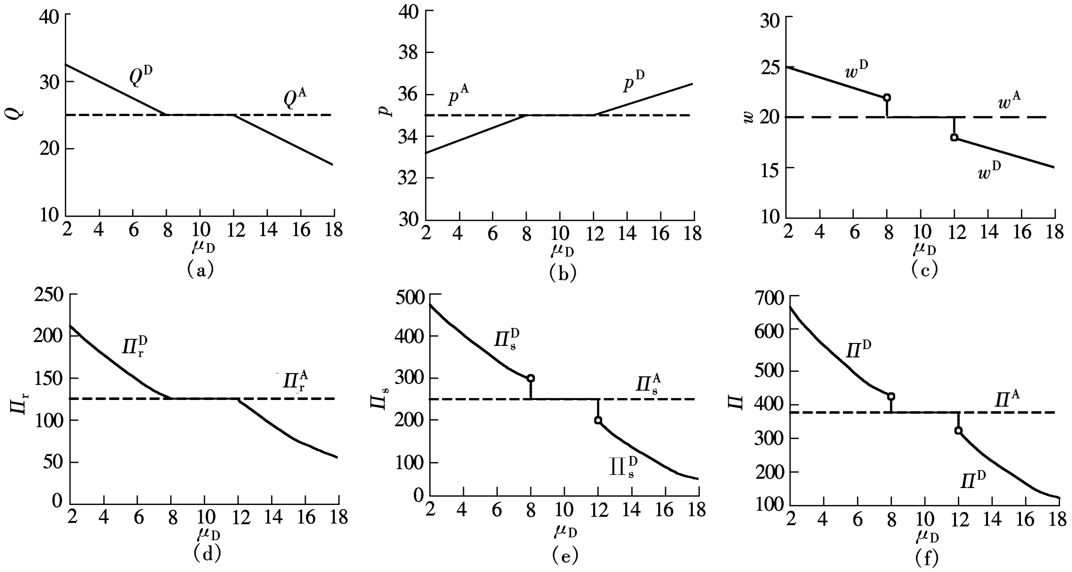

Fig. 1 Supply chain coordination mechanism with respect to μ_D. (a) μ_D vs. the order quantity; (b) μ_D vs. the retail price; (c) μ_D vs. the wholesale price; (d) μ_D vs. the retailer's expected profit; (e) μ_D vs. the supplier's expected profit; (f) μ_D vs. the system's expected profit

From Fig. 1 we can find that: The retail price is a linear increasing function of μ_D, and the order quantity and the wholesale price are linearly decreasing functions of μ_D, while the retailer's expected profit, the supplier's expected profit and the supply chain system's expected profit are found decreasing non-linearly with μ_D.

The details are as follows:

① If $\mu_D < \mu_A - \lambda_1$, retail price with disruption is less than that without disruption, i. e., $p^D < p^A$; order quantity, wholesale price, retailer's expected profit, supplier's expected profit and supply chain system's expected profit with disruption are greater than those without disruption; i. e., $Q^D > Q^A$, $w^D > w^A$, $\Pi_r^D > \Pi_r^A$, $\Pi_s^D > \Pi_s^A$, $\Pi^D > \Pi^A$;

② If $\mu_A - \lambda_1 \leqslant \mu_D \leqslant \mu_A + \lambda_2$, retail price, order quantity, wholesale price, retailer's expected profit, supplier's expected profit as well as supply chain system's expected profit do not change; i. e., $p^D = p^A$, $Q^D = Q^A$, $w^D = w^A$, $\Pi_r^D = \Pi_r^A$, $\Pi_s^D = \Pi_s^A$, $\Pi^D = \Pi^A$;

③ If $\mu_D > \mu_A + \lambda_2$, retail price with disruption is more than that without disruption, i. e., $p^D > p^A$; order quantity, wholesale price, retailer's expected profit, supplier's expected profit and supply chain system's expected profit with disruption are less than those without disruption, i. e., $Q^D < Q^A$, $w^D < w^A$, $\Pi_r^D < \Pi_r^A$, $\Pi_s^D < \Pi_s^A$, $\Pi^D < \Pi^A$.

5 Conclusion

Supply chain coordination mechanisms under disruption has become an important management paradigm. In this paper, we have investigated supply chain coordination mechanisms under asymmetric information with retailer cost disruption. Based on the analysis above, we can draw a conclusion that it is optimal for the supply chain to keep the original production plan and to guarantee that the system run steadily if variation of retailer's cost is sufficiently small and does not exceed an upper bound; otherwise decisions must be adjusted.

Although our work focuses on a two-echelon system with one supplier and one retailer, it will be interesting to extend this supply chain coordination mechanism to multiple heterogeneous retailers or to a multi-echelon environment. The case of nonlinear demand functions and other supply chain coordination mechanisms such as quantity discount contracts, buy back contracts and revenue sharing contracts under asymmetric information with disruptions are important problems to be studied in the future.

References

[1] Abdi M R, Sharma Sanjay. Strategic/tactical information management of flight operations in abnormal conditions through network control centre [J]. *International Journal of Information Management*, 2007, **27**(2): 119 − 138.

[2] Clausen J, Hansen J, Larsen J, et al. Disruption management [J]. *ORMS Today*, 2001, **28**: 40 − 43.

[3] Willians T, Ackermann F, Eden C. Structuring a delay and disruption claim: an application of cause-mapping and system dynamics [J]. *European Journal of Operation Research*, 2003, **148**(1): 192 − 204.

[4] Petrovic D, Duenas A. A fuzzy logic based production

scheduling/rescheduling in the presence of uncertain disruptions [J]. *Fuzzy Sets and Systems*, 2006, **157**(16): 2273 - 2285.

[5] Qi X T, Bard J F J, Yu G. Supply chain coordination with demand disruptions [J]. *Omega*, 2004, **32**(4): 301 - 312.

[6] Xu M H, Gao C X. Supply chain coordination with demand disruption under convex production cost function [J]. *Wuhan University Journal of Natural Sciences*, 2005, **10**(3): 493 - 498.

[7] Tomlin B. On the value of mitigation and contingency strategies for managing supply chain disruption risks [J]. *Management Science*, 2006, **52**(5): 639 - 657.

[8] Xiao T J, Yu G. Supply chain disruption management and evolutionarily stable strategies of retailers in the quantity-setting duopoly situation with homogeneous goods [J]. *Production, Manufacturing and Logistics*, 2006, **173**(2): 648 - 668.

[9] Yue X, Mukhopadhyay S K, Zhu X. A Bertrand model of pricing of complementary goods under information asymmetry [J]. *Journal of Business Research*, 2006, **59**(10/11): 1182 - 1192.

[10] Corbett C J, Zhou D, Tang C S. Designing supply contracts: contract type and information asymmetry [J]. *Management Science*, 2004, **50**(4): 550 - 559.

[11] Sucky E. A bargaining model with asymmetric information for a single supplier-single buyer problem [J]. *European Journal of Operational Research*, 2006, **171**(2): 516 - 535.

[12] Lau A H, Lau H, Zhou Y. A stochastic and asymmetry-information framework for a dominant-manufacturer supply chain [J]. *European Journal of Operational Research*, 2007, **176**(1): 295 - 316.

[13] Ross S M. *Stochastic processes*[M]. John Wiley & Sons, 1996.

非对称信息下零售商成本扰动时供应链协调机制

庄 品[1,2] 赵林度[1]

([1] 东南大学系统工程研究所, 南京 210096)

([2] 南京航空航天大学经济与管理学院, 南京 210016)

摘要:建立市场需求为线性需求,包含一个供应商和一个零售商的供应链模型,当零售商成本信息为非对称信息时,研究2种情形的非对称信息供应链协调机制:正常情形下非对称信息供应链协调机制和零售商成本发生扰动情形下非对称信息供应链协调机制. 研究表明,当零售商成本扰动小于一个阈值时,供应链系统利用原生产计划可以保证系统稳定运行,说明原有的协调机制具有一定的鲁棒性;当零售商成本扰动大于一个阈值时,要对原来的计划进行调整. 最后,通过数值分析研究了零售商成本扰动对订单数量、零售价格、批发价格以及供应链成员和系统期望利润的影响.

关键词:应急管理;供应链协调机制;非对称信息;博弈论;成本扰动

中图分类号:F406. 2