International Journal of u- and e- Service, Science and Technology
Vol.8, No.2 (2015), pp.299-312
http://dx.doi.org/10.14257/ijunesst.2015.8.2.29

Manufacturers' Emergency Procurement Strategies under Supply Disruption and Competition Based on Scenario Analysis

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Abstract

Emergency procurement strategies have attracted significant attention from academicians and practitioners with the increase of supply disruptions in the past two decades. We study a manufacturer's contingent sourcing strategies under supply disruption and competition using Stackelberg game. We investigate a two-stage supply chain consisting of two competing manufacturers and two suppliers, where the wholesale prices offered by the two suppliers are different. Supplier 1 is unreliable and cheap, while supplier 2 is reliable and expensive, and moreover, supplier 2 has capacity limits. Manufacturer A uses a dual-sourcing, manufacturer B uses a single-sourcing. According to two manufacturers' order sequence, we established two manufacturers' expected profit function under three scenarios. We obtain the optimal order quantities and expected profits of the two manufacturers in different scenarios, and show that supply disruption and procurement time have effect on the manufacturer's purchasing decisions.

Keywords: *Supply disruptions; Emergency procurement; Scenario analysis; Stackelberg game; dual sourcing; Competition; Resource allocation*

1. Introduction

With the development of lean production and economic globalization, supply chains become more and more complexity and vulnerable. Manufacturers tend to reduce the number of suppliers so as to increase economies of scale to achieve cost reduction and convenient management. Under this circumstance, once one of suppliers cannot delivery for disruption, it is possible bring the huge loss to downstream manufacturers or distributors and the entire supply chain. Facing with the supply disruption of the fire on March 2000 at the Philips plant in Albuquerque, NM, Nokia seek proactively other emergency suppliers, gaining great market share, and Ericsson waited passively, losing huge market share. On October 2011, Apple MacBook Air's main supplier of metal chassis was ordered to suspend production for rectification by the local government because of environment destruction. These cases illustrate the necessary of contingent sourcing.

There has been a growing stream of literature on supply disruptions. C. Blome[1]study a review of the literature about supply disruption management ,and list a detailed qualitative analysis. O. Tang [2] provides supplier faces detailed presentation risk factors and give some contingent sourcing. G. Burke and J. Carrillo [3] shows unless the supplier's capacity is greater than the product demand and buyer unable to obtain the differential benefit, single-sourcing is better than dual-souring. Wang et al.[4] hypothesis two suppliers are unstable, they have different cost structure and

ISSN: 2005-4246 IJUNESST

respectively independent. Supply chain is divided into four scenarios, and then he establishes the expected profit function, using the approximation method to obtain the optimal ordering quantity. H.Yu and Amy Z. Zeng [4] study that supplier homogeneity degree is higher, the dual sourcing in response to supply disruptions in terms of the effect more obvious, and the traditional multi-sourcing is conducive to promoting competition among suppliers, to obtain the lowest purchase price. K. Chen [6] study the buyers adjust the wholesale price retailers or give allowance for suppliers to cope with supply Disruptions. Fabian et al.[7] analysis the effect of correlation between supply and demand uncertainty on the optimal sourcing strategy. X. Li et al. [8] divide disruptions into common cause failure and supplier-specific incident, and explore dual-sourcing strategies to mitigate supply disruption risk. J. Hou[9] comparative advantages and disadvantages of the backup supplier strategy and dual-sourcing. Tomlin [10] through the newsboy model to study the dual sourcing flexibility and reliability, and analyzed the influence factors of second suppliers use. W. Zhang [11] compare the risk of dual source and dual mixed source, analyze the dual sourcing strategy under the different disruption probability how to affect buyers expected profits. X. Li et al. [12] present optimal ordering mechanisms based on options contracts for a triadic supply chain. J. Chen [13] research an unreliable supplier and a backup supplier of capacity constraints, the buyer how to choose the order strategy. V. Babich[14] research how to select backup supplier when supplier face disruption risk.

Our study is also related to the literature on competing manufacturers exposed to supply disruptions. B. Shou et al.[15] study two competing supply chains face uncertainties supply chain, retailers with cournot competition to determine the optimal number ordered from suppliers, they make decisions from three different aspects: operational, design, and strategic. Supply chain coordination may not be favorable for the growth of the supply chain, which mainly depends on the degree of the supply risk. X. Zhou [16] study multiple competing manufacturers and a multi-retailer supply chain, firstly retailers to determine each manufacturer according to the contract from each manufacturer and its retention of profits the number of products procured, then analyzed as a leading manufacturer Stackelberg game party game balance. Li et al. [17] analysis retailers procurement strategy and vendor pricing strategy when supply risk, where the spot market as a completely reliable suppliers, retailers take sourcing in both centralized and decentralized procurement strategy. V. Babich[18]research suppliers exist in the period ahead of supply risk, as the passive side of Stackelberg game retailers how to develop supply strategies based on problems affecting the relationship between suppliers to buyers. Tang and Kouvelis[19] study supplier diversification benefits for two competing buyers, the authors conclude that buyers should never choose the same supplier, because the increased correlation between the delivered quantities leads to a decrease in the buyers' profits.

Most of these documents focus on procurement strategy under supply chain disruption, but few literatures involve the study of procurement strategy under competition and supply-side disruption, and literatures considering the capacity constrained factors are less and less. Some literatures about the dual sourcing strategy are better than the single sourcing and safety stock, but this strategy is always have a cost advantage has yet to be considered.

In this paper, we investigate contingent sourcing under supply disruption and competition using the Stackelberg game mode. We model the manufacturers to engage in a quantity competition. Firstly, we examine the manufacturer the optimal order quantity and their expected profit in different scenarios. Then we explore the impact of supply disruption and procurement time on optimal order quantity and manufacturers' expected profit. Finally, we analyze how to obtain the optimal cost advantage by dual sourcing strategy.

2. Model Assumptions and Symbol Description

2.1 Model Assumptions

In a single-period model, we consider the manufacturers' procurement strategy under supply disruption and competition as shown in Figure 1. There are two manufacturers A and B that procure critical components from two suppliers represented by 1 and 2. Both A and B process these components into substitutable products, then sell them at the same price in the market. Supplier 1 is unreliable and cheap, supplier 2 is reliable and expensive, and supplier 2 has capacity limits. Manufacturer A applies a dual-sourcing strategy, mainly buys products at a unit cost of c_1 from supplier 1 at normal, but with supply disruption of supplier 1, manufacturer A enables emergency order from supplier 2 at a unit cost of c_3. Manufacturer B uses a single-sourcing strategy, and therefore he only buys components at a unit cost of c_2 from supplier 2. We assume $c_3 > c_2 > c_1$.

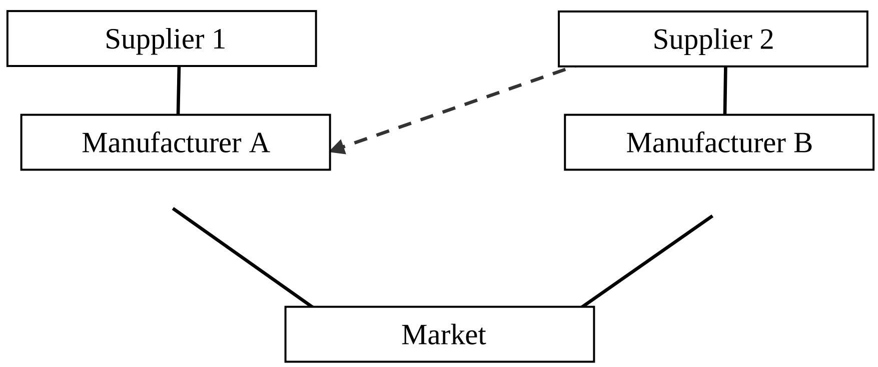

Figure1. Sourcing Model of Two Manufacturers

If supplier 1 defaults, A orders Q_E from supplier 2. Supplier 2 cannot fully meet the delivery subject to capacity constraints. Due to capacity constraints, the proportion that supplier 2 can be provided quantity accounts for β of the total emergency order quantity that A need purchase. That is to say, emergency procurement quantity that the supplier 2 offers A is βQ_E.

2.2 Symbol Description

Model symbols are described in Table 1.

Table1. Symbol Description

Parameters	Definition	Parameters	Definition
c_1	supplier 1's unit wholesale price	Q_1	A's order quantity from supplier 1
c_2	supplier2's unit wholesale price	Q_2	B's order quantity from supplier 2
c_3	supplier2's unit wholesale price in disrupted state	a	maximum market scale
Q_E	A's emergency order quantity from	s	the total product quantity delivered to A and B in disrupted state
γ	supplier 2 reliability of the supplier1	$p(s)$	unit sales price of final product
$E(\pi_A^i)$	A's expected profit in case *I*	$E(\pi_B^i)$	B's expected profit in case i ,i=1,2,3
β	supplier 2 provided to A order quantity accounted for the proportion of emergency order quantity, $0 \le \beta \le 1$		

3. Analysis of the Sourcing Strategy under Supply Disruption and Competition

According to the occurrence of these event, there can be divided into three kinds of situation: A and B order at the same time, A orders first, or A orders last.

3.1 Case 1

The sequence of event in this case is shown in Figure 2.

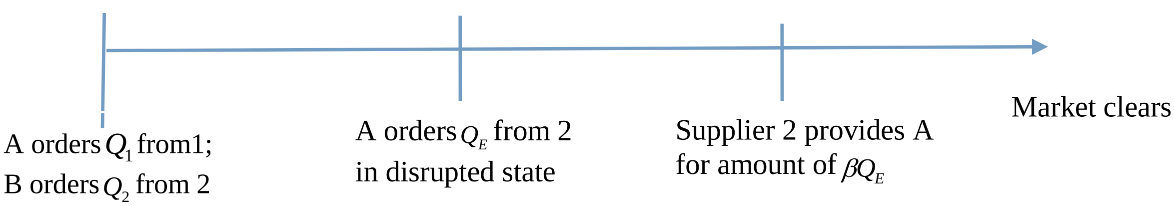

Figure2. Procurement Flow Chart in Case 1

As shown in Figure 2, A and B at the same time order Q_1 and Q_2 from suppliers 1 and 2, respectively. When supplier 1 defaults, A places an emergency order Q_E from supplier 2. Supplier 2 has capacity limits, so only provides A for βQ_E.

According to the Stackelberg equilibrium, A and B simultaneously order Q_1 and Q_2, A and B both acting as the leaders. After supplier 1 defaults, A determines the emergency order quantity Q_E based on the order quantity Q_1 and Q_2, this makes A as the follower. We use backward induction to obtain the equilibrium solution. We use the feedback function $q_E(Q_1, Q_2)$ to represent A's emergency order quantity Q_E.

When supplier 1 defaults, A's maximize profit is as follows,

$$\max_{q_E} [(a - Q_2 - Q_e - c_3)Q_e] \tag{1}$$

By solving this, we obtain the best response function of A

$$q_E(Q_1, Q_2) = \frac{a - Q_2 - c_3}{2} \tag{2}$$

We acquire A's emergency order quantity reaction function. Next we solve the Nash game between A and B. As A and B order Q_1 and Q_2 simultaneously, we obtain A and B's expected profits maximization problems.

$$\max_{Q_1} [\gamma(a - Q_1 - Q_2 - c_1)Q_1 + (1-\gamma)(a - Q_2 - \beta \cdot \frac{a - Q_2 - c_3}{2} - c_3)\beta \frac{a - Q_2 - c_3}{2}] \tag{3}$$

$$\max_{Q_2} [\gamma(a - Q_1 - Q_2 - c_2)Q_2 + (1-\gamma)(a - \beta \cdot \frac{a - Q_2 - c_3}{2} - Q_2 - c_2)Q_2] \tag{4}$$

By solving this, we obtain the optimal order quantity Q_1 and Q_2.

$$Q_1^1 = \frac{-2a - 2c_2 + \beta a(1-\gamma) + \beta c_3(1-\gamma) + 2(\gamma - 1)\beta c_1 + 4c_1}{2[2\beta(1-\gamma) + \gamma - 4]} \tag{5}$$

$$Q_2^1 = \frac{ar + a\beta - 2a - c_1 r + 2c_1 - ra\beta - (1-\gamma)\beta c_3}{2\beta(1-\gamma) + \gamma - 4} \tag{6}$$

Inserting (6) into the objective function (2) yields the emergency order quantity.

$$Q_E^1 = \frac{a\beta - a\beta\gamma - 2a - c_3\beta + c_3\beta\gamma - c_3\gamma + 4c_3 + c_1\gamma - 2c_2}{2[2\beta(1-\gamma) + \gamma - 4]} \tag{7}$$

Then we obtain A and B's expected profits.

$$E(\pi_A^1) = [\gamma(a - Q_1^1 - Q_2^1 - c_1)Q_1^1 + (1-\gamma)(a - Q_2^1 - \beta \cdot \frac{a - Q_2^1 - c_3}{2} - c_3)\beta \frac{a - Q_2^1 - c_3}{2}] \tag{8}$$

$$E(\pi_B^1) = [\gamma(a - Q_1^1 - Q_2^1 - c_2)Q_2^1 + (1-\gamma)(a - \beta \cdot \frac{a - Q_2^1 - c_3}{2} - Q_2^1 - c_2)Q_2^1] \tag{9}$$

Proposition 1: Q_1^1 increases in γ, β and c_2, decreases in c_1 and c_3. Q_2^1 increases in c_1 and c_3, decreases in γ, β and c_2. Q_E^1 increases in γ, decreases in c_1, c_2 and c_3.

Proof: Solving the first-order of formula (5) and (6) yields

$$\frac{\partial Q_1^1}{\partial c_1} = \frac{(\gamma-1)\beta + 2}{2\beta(1-\gamma) + \gamma - 4} < 0, \quad \frac{\partial Q_1^1}{\partial c_2} = \frac{-2}{2\beta(1-\gamma) + \gamma - 4} > 0, \quad \frac{\partial Q_1^1}{\partial c_3} = \frac{\beta(1-\gamma)}{2[2\beta(1-\gamma) + \gamma - 4]} < 0,$$

$$\frac{\partial Q_1^1}{\partial \gamma} = \frac{-\beta a - \beta c_3 + 2\beta c_1}{2[2\beta(1-\gamma) + \gamma - 4]} > 0, \quad \frac{\partial Q_1^1}{\partial \beta} = \frac{(1-\gamma)[\gamma(a + c_3 - 2c_1) + 4c_2 - 4c_3}{2[2\beta(1-\gamma) + \gamma - 4]^2} > 0.$$

Similarly, we can lead to the results for Q_2^1 and Q_E^1.

That is to say, when the cost of supplier 2 increases, supplier 1 has a higher cost advantage over supplier 2, so A from the supplier 1 order quantity will increase. When the cost of supplier 1 increase, manufacturer A has to bear the procurement cost will increase, it will also reduce the order quantity. To increase the reliability of supplier 1, means that A is more advantage than B, with the increase of reliability, A purchases more and B buy less.

3.2 Case 2

The sequence of event in this case is shown in Figure 3.

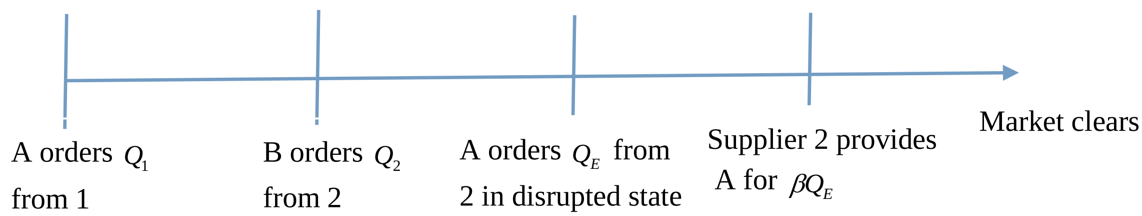

Figure 3. Procurement Flow Chart in Case 2

As shown in Figure 3, A first orders Q_1 from supplier 1, then B orders Q_2 from supplier 2. When supplier 1 defaults, A places an emergency order Q_E from supplier 2. Supplier 2 has capacity limits, so provides A for βQ_E.

The case consists of two Stackelberg games. In the first Stackelberg game, A as the leader first orders, B as the follower then orders after the observation of A's behavior. In the second Stackelberg game, B first orders, and then A orders emergency quantity after observing B's behavior. Therefore, A's response order quantity is the feedback function $q_E(Q_1, Q_2)$. Thus, B's problem is

$$\max_{Q_2}[\gamma(a-Q_1-Q_2-c_1)Q_2+(1-\gamma)(a-Q_2-\beta\cdot\frac{a-Q_2-c_3}{2}-c_3)Q_2] \tag{10}$$

By solving this, we obtain the best response of B

$$q_2(Q_1)=\frac{a(2-\beta+\gamma\beta)+c_3(\beta-\gamma\beta)-2c_2-2\gamma Q_1}{2(\gamma\beta+2-\beta)} \tag{11}$$

Using the first Stackelberg game yields A's maximizes expected profit

$$\max_{Q_1}[\gamma(a-Q_1-q_2(Q_1)-c_1)Q_1+(1-\gamma)(a-\beta\cdot\frac{a-q_2(Q_1)-c_3}{2}-q_2(Q_1)-c_3)\beta\cdot\frac{a-q_2(Q_1)-c_3}{2}] \tag{12}$$

By solving this, we obtain the optimal order quantity Q_1.

$$Q_1^2=\frac{(a-2c_1)(\gamma\beta+2-\beta)+c_3(\beta-\gamma\beta)-2c_1}{2[3(\gamma\beta+2-\beta)-\gamma]} \tag{13}$$

Inserting (13) into the objective functions (11) leads to the optimal order quantity Q_2.

$$Q_2^2=\frac{[3(\gamma\beta+2-\beta)-\gamma][c_3(\beta-\gamma\beta)-2c_1+a(\gamma\beta+2-\beta)]-4\gamma c_1(\gamma\beta+2-\beta)}{2(\gamma\beta+2-\beta)[3(\gamma\beta+2-\beta)-\gamma]} \tag{14}$$

Inserting function (14) into the objective functions (2), then we obtain the emergency order quantity.

$$Q_E^2=\frac{a-c_3}{2}-\frac{[3(\gamma\beta+2-\beta)-\gamma][c_3(\beta-\gamma\beta)-2c_1+a(\gamma\beta+2-\beta)]-4\gamma c_1(\gamma\beta+2-\beta)}{4(\gamma\beta+2-\beta)[3(\gamma\beta+2-\beta)-\gamma]} \tag{15}$$

Then A and B's expected profits are as follows.

$$E(\pi_A^2)=[\gamma(a-Q_1^2-q_2(Q_1)-c_1)Q_1^2+(1-\gamma)(a-\beta\cdot\frac{a-q_2(Q_1)-c_3}{2}-q_2(Q_1)-c_3)\beta\cdot\frac{a-q_2(Q_1)-c_3}{2}] \quad (16)$$

$$E(\pi_B^2)=[\gamma(a-Q_1^2-Q_2^2-c_1)Q_2^2+(1-\gamma)(a-Q_2^2-\beta\cdot\frac{a-Q_2^2-c_3}{2}-c_3)Q_2^2] \quad (17)$$

Proposition 2: Q_1^2 increases in γ, β and c_2, decreases in c_1 and c_3. Q_2^2 increases in c_1 and c_3, decreases in γ, β and c_2. Q_E^2 increases in γ, decreases in c_1, c_2 and c_3.

3.3 Case 3

The sequence of event in this case is shown in Figure 4.

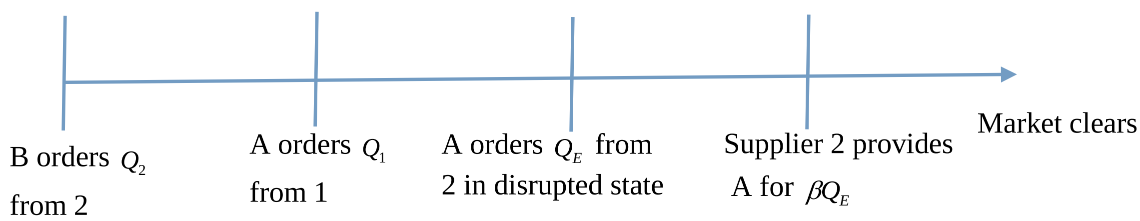

Figure 4. Procurement Flow Chart in Case 3

As shown in Figure 4, B first orders Q_2 from supplier 2, then A orders Q_1 from supplier 1. This is the first Stackelberg game. When supplier 1 defaults, A places an emergency order Q_E from supplier 2. This is the second Stackelberg game. Supplier 2 has capacity limits, so provides A for βQ_E. Therefore, A's response order quantity is the feedback function $q_E(Q_1,Q_2)$ as given in (2). Thus, A's problem is

$$\max_{Q_1}[\gamma(a-Q_1-Q_2-c_1)Q_1+(1-\gamma)(a-Q_2-\beta\cdot\frac{a-Q_2-c_3}{2}-c_3)\beta\frac{a-Q_2-c_3}{2}] \quad (18)$$

By solving this, we obtain the best response of A.

$$q_1(Q_2)=\frac{a-Q_2-c_1}{2} \quad (19)$$

In the first stage of Stackelberg game, B is the leader order Q_2 from suppliers 2, and A orders Q_1 and Q_E according to B's behavior. Therefore, according to (19) and (2) we obtain B's expected profit maximization problem.

$$\max_{Q_2}[\gamma\frac{a-Q_2-c_1-2c_2}{2}Q_2+(1-\gamma)(a-\beta\cdot\frac{a-Q_2-c_3}{2}-Q_2-c_3)Q_2] \quad (20)$$

By solving this, we obtain the optimal order quantity Q_2.

$$Q_2^3=\frac{-\gamma a+\gamma c_1+2a-2c_2-\beta(1-\gamma)(a-c_3)}{2-2(1-\gamma)(\beta-1)} \quad (21)$$

Inserting (21) into the objective functions (19), then we obtains the optimal order quantity Q_1.

$$Q_1^3 = \frac{2(a-c_1)-2(1-\gamma)(\beta-1)(a-c_1)+\beta(1-\gamma)(a-c_3)+\gamma a-\gamma c_1-2a+2c_2}{4-4(1-\gamma)(\beta-1)} \quad (22)$$

We insert (21) into the objective functions (2) to obtain

$$Q_e^3 = \frac{\gamma a-\gamma c_1+2c_2-2c_3+(1-\gamma)(a-c_3)(2-\beta)}{4-4(1-\gamma)(\beta-1)} \quad (23)$$

Then we obtain A and B's expected profits.

$$E(\pi_A) = [\gamma(a-Q_1^3-Q_2^3-c_1)Q_1^3+(1-\gamma)(a-Q_2^3-\beta\cdot\frac{a-Q_2^3-c_3}{2}-c_3)\beta\frac{a-Q_2^3-c_3}{2}] \quad (24)$$

$$E(\pi_B) = [\gamma\frac{a-Q_2^3-c_1-2c_2}{2}Q_2^3+(1-\gamma)(a-\beta\cdot\frac{a-Q_2^3-c_3}{2}-Q_2^3-c_3)Q_2^3] \quad (25)$$

Proposition 3: Q_1^3 increases in β and c_2, decreases in c_1, γ and c_3. Q_2^3 Increases in c_1, γ and c_3, decreases in β and c_2. Q_E^3 Decreases in c_1, c_2, γ and c_3.

Proposition 4: Priority ordering manufacturers have higher profits. A's expected profits satisfy $E(\pi_A^2) > E(\pi_A^1) > E(\pi_A^3)$. B's expected profits satisfy $E(\pi_B^2) < E(\pi_B^1) < E(\pi_B^3)$.

4. Analysis of Numerical Example

In this section, we analyze the impact of different parameters on the procurement strategy in three scenarios. We explore the effects of supplier costs, stability, and capacity constraints and other factors change on A and B's expected profit. Parameter assignments are shown in Table 2.

Table 2. Parameter Assignments

Parameter	c_1	c_2	c_3	a	γ	β
Values	3	4	5	100	0.2	0.7

4.1 Impact of Supplier Costs, Capacity Limits and Reliability on Profit of A

(1) Capacity limits β

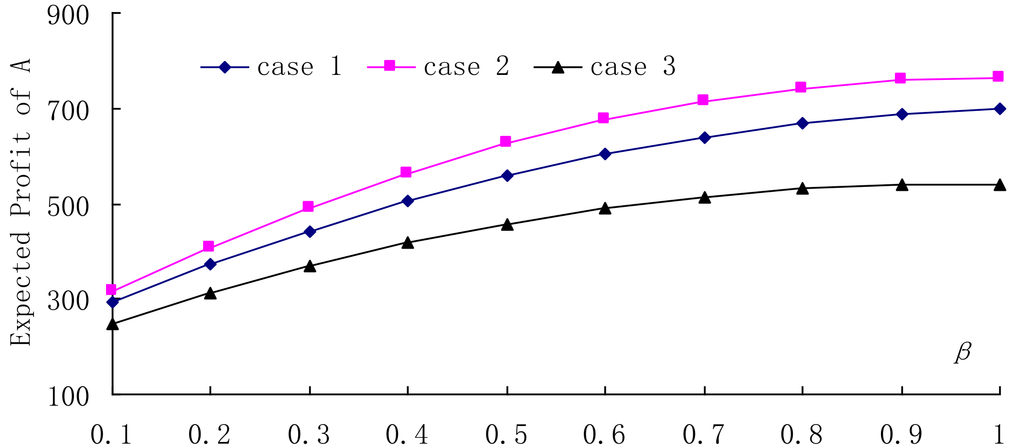

Figure 5. Variation of $E(\pi_A)$ with Respect to β in Three Scenarios

As shown in Figure 5, with the increase of supplier 2's capacity limits β, manufacturer A's expected profit increases in three scenarios. When β is increasing, the emergency order quantity βQ_E is more close to optimal emergency order quantity Q_E, which makes A's expected profit maximization.

(2) Supplier cost c_1

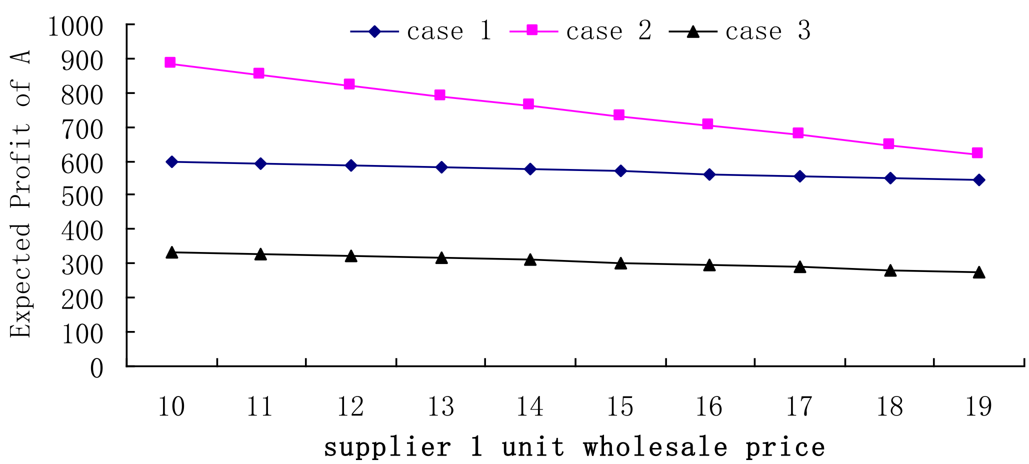

Figure 6. Variation of $E(\pi_A)$ with Respect to c_1 in Three Scenarios

As shown in Figure 6, the $E(\pi_A)$ decreases with an increase of c_1. This is because supplier 1 is the main supplier for A, when c_1 increases, the cost of supplier 1 will increase, which makes A's expected profit decrease.

(3)Supplier reliability

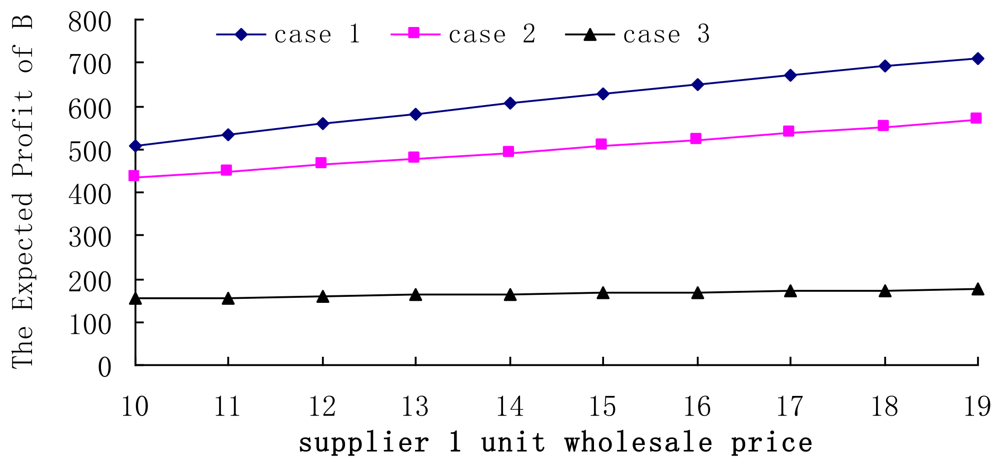

Figure 7. Variation of $E(\pi_A)$ with Respect to γ in Three Scenarios

As shown in Figure 7, the $E(\pi_A)$ increases with an increase of supplier 1's reliability γ. This is because A has a cost advantage over B as supplier 1 is cheaper than 2. Then the expected profit of A's increases with γ.

4.2 Impact of Supplier Costs, Capacity Limits and Reliability on Profit of B

(1) Capacity limits β

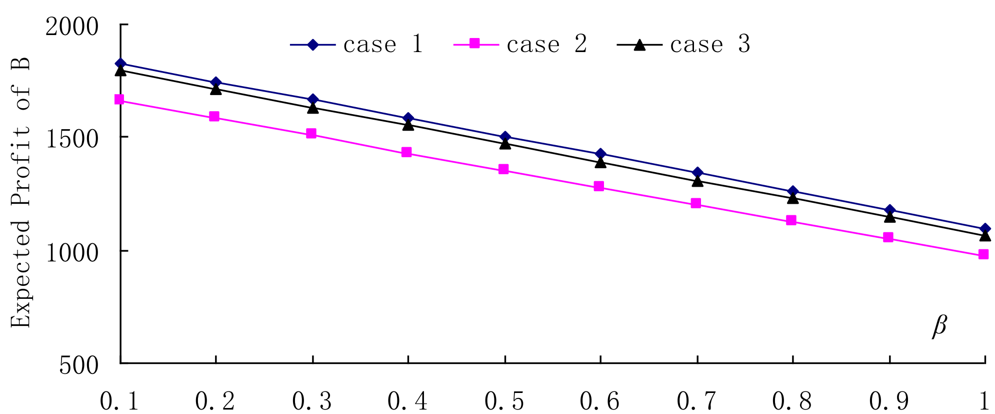

Figure 8. Variation of $E(\pi_B)$ with Respect to β in Three Scenarios

As shown in Figure 7, the $E(\pi_B)$ decreases with an increase of supplier 2's capacity limit β. When β increases, the emergency order quantity βQ_E is more close to optimal emergency order quantity Q_E. According to $Q_E = \frac{a - Q_2 - c_3}{2}$, βQ_E and Q_2 is negative correlation, then manufacturers B's expected profit decreases with an increase of β.

(2)Supplier cost c_2

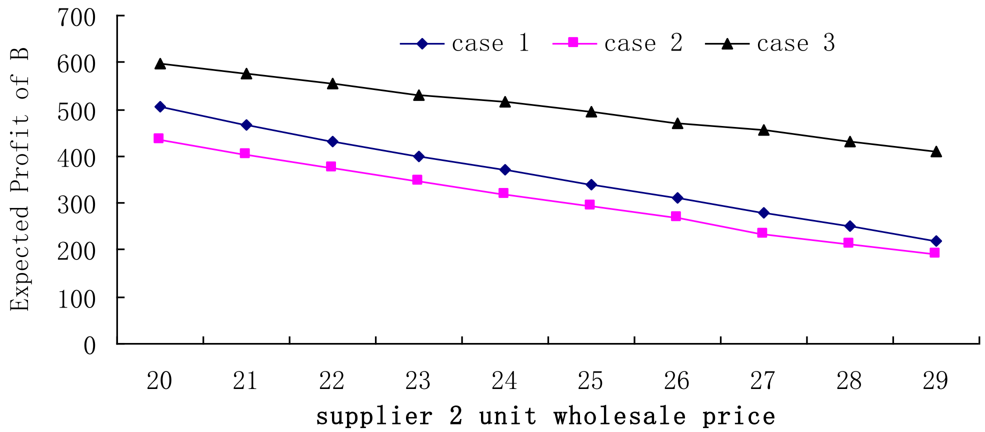

Figure 9. Variation of $E(\pi_B)$ with Respect to c_2 in Three Scenarios

As shown in Figure 9, the $E(\pi_B)$ decreases with an increase in c_2. This is because supplier 2 is the only supplier of B, when c_2 increases, the cost of supplier 2 increases, which makes B's, expected profit decrease.

(3)Supplier Reliability γ

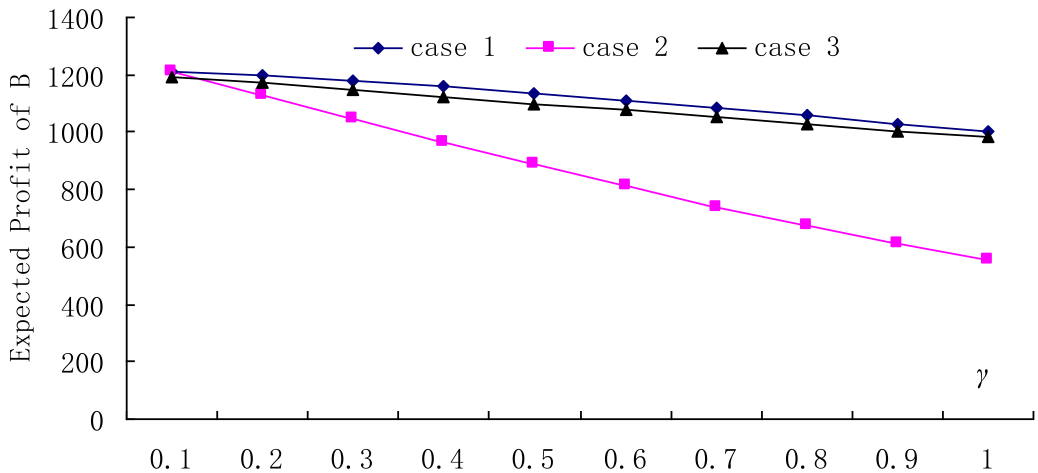

Figure10. Variation of $E(\pi_B)$ with Respect to γ in Three Scenarios

As shown in Figure 10, $E(\pi_B)$ decreases with an increase of supplier 1's reliability γ. Due to $c_1 < c_2$, when supplier 1's disruption risk is small, A has a cost advantage over B, and then the expected profit of B decreases with γ.

4.3 Expected Profits of A and B under Different Disruption Probability

This section compares the expected profit value of manufacturer A and B. In comparison of expected profits, we adopt the profits difference between A and B values $E(\pi_A) - E(\pi_B)$ for analysis

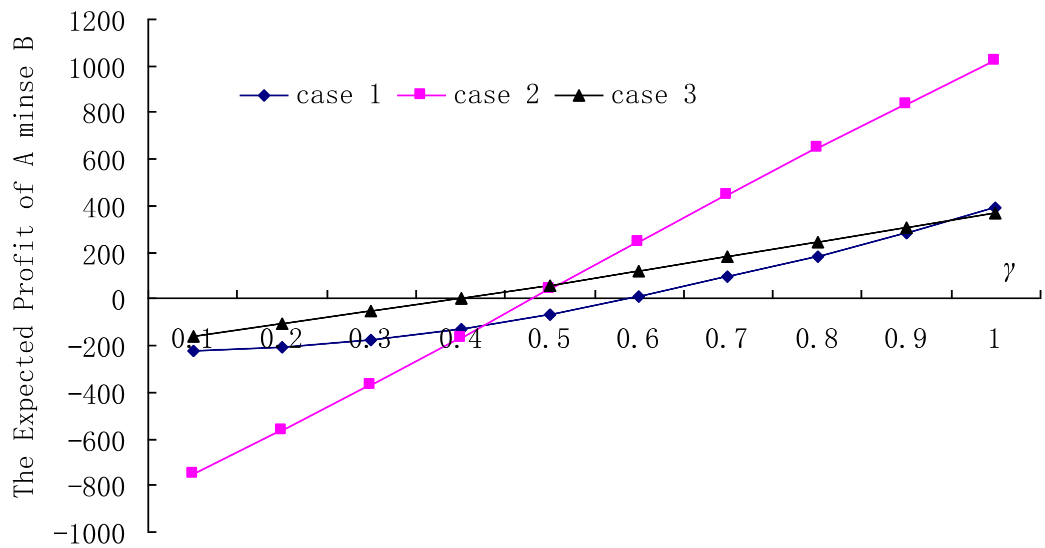

Figure11. Variation of $E(\pi_A) - E(\pi_B)$ with Respect to γ in Three Scenarios

As shown in Figure 11, $E(\pi_A) - E(\pi_B)$ increases with an increase in supplier 1 reliability γ. That is to say when the supplier 1 reliability is high, $E(\pi_A) - E(\pi_B)$ is larger, dual-sourcing is better than single-sourcing. And when the supplier 1's reliability is lower, $E(\pi_A) - E(\pi_B)$ is negative, that is single-sourcing is better than dual-sourcing.

5. Conclusions

This paper mainly investigates single sourcing and dual sourcing strategy based on the market competition and supply disruption. We obtain that the manufacturer the optimal order quantity and their expected profit in different scenarios. Further studies show supply disruption and procurement time affect the manufacturer's purchasing decisions. Since the manufacturers cannot control the supply disruption, manufacturers should choose the proper order strategies to mitigate the losses caused by the interruption of supply.

(1) The dual sourcing strategy has a cost advantage over single source procurement, but studies show that dual-souring is not completely superior to single-sourcing. Dual

sourcing cost advantage depends on cheaper supplier's reliability. When the stability of supplier 1 is higher, the cost advantage will be significant, the dual sourcing strategy is better than the single source strategy.

(2) Priority ordering manufacturers have higher profits. Manufacturer B using single-sourcing obtain the maximum profit when he places the order before his competitor. In the same way, using dual sourcing, the profit of manufacturer A is maximal when he places the order before his competitor.

(3) There are other avenues to extend this article. First, based on the manufacturer's profit, we can examine the entire supply chain profits. Second, we can investigate limited supplier 1's capacity. Finally, our framework can be extended to consider more qualified suppliers.

Acknowledgements

This work is supported by the National Social Science Fund of China under Grant No. 12CGL042, the National Natural Science Fund of China under Grant No. 71372122, 71402158 and 71272122. The authors also gratefully acknowledge the helpful comments and suggestions of the reviewers, which have improved the presentation.

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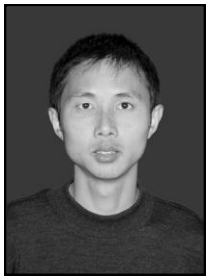

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