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Research on Stimulation Effect of Two Government's Subsidy Modes on Enterprise and Consumer

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Abstract
Games models of manufacturer and retailer are established based on two modes of government's subsidy to manufacturer and consumer, analyzing influence of subsidy modes on manufacturer and retailer's decision and their performance, and comparing stimulated effects on demand. Results indicate that consumer's expenses, demand, profit of enterprise under pattern of government's subsidy to consumer are smaller than those under pattern of government's subsidy to manufacturer. Respectively; when influence on demand by subsidy is smaller than influence on demand by price; consumer's expense, demand, profit of enterprise under pattern of government's subsidy to consumer are larger than those under pattern of government's subsidy to manufacturer. Respectively, when influence on demand by subsidy is larger than influence on demand by price.

Key words: Government's subsidy mode; Games models; Enterprise; Consumer

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INTRODUCTION
Chinese government has made a series of positive policies in recent years in order to stimulate consumer demand and protect the ecological environment such as the policy of the home-appliance replacement which is introduced by the Ministry of Finance, the Ministry of Commerce and other five ministries of China on June 28, 2009. Since June 1, 2010, China has begun to implement the project of energy-saving products and populating fuel-efficient cars (passenger car 1.6 liters and below) has been included. In this paper, the environment which upstream and downstream enterprises in the supply chain face to and the enterprises' decision-making behavior have changed greatly. The problems how to decide the member enterprises could reach the most profits, how government's subsidy for the member enterprises impacts game relation, product price, market demand and enterprise performance is deserves to be studied deeply.

Scholars make a lot of research on the supply chain enterprises and vertical game, for example, Esmaeili *et al.* establish the buyer-seller Stackelberg non-cooperative game model[1], as well as buyer-seller cooperative game model and get a Pareto optimal solution. Leng *et al.* establish a composed of manufacturers, distributors, retailers third-echelon supply chain cooperative game model based on demand information sharing, and obtain the only cost-allocation scheme[2]. Cai *et al.* evaluate the impact of the price discount contract and pricing strategies on the competition between supplier and retailer[3], and the results show that the impact of the price discount contract is better than no contract, fixed pricing strategy which can bring more benefits to retailer could reduce conflict, and game dominant is not necessarily guaranteed to have an advantage. Zhu *et al.* studies game problem

of the decentralized and centralized ordering of retailer to supplier in uncertain environment[4], and get the conclusion that the sharing of demand information can improve supply chain performance. Chiang argue how the substitutability of products affects the efficiency of supply chain[5], the results show that alternative products may increase or decrease the efficiency of centralized supply chain, suppliers and retailers can get more benefits by cooperation, but competition makes the supply chain achieve system optimal difficultly. Zhou *et al.* establish the Stackelberg game model when retailer is the dominant party and manufacturer is the subsidiary party[6], and they certificate that manufacturer's production strategy exists a unique optimal solution, and analyses effects of contract parameter and product's substitutability on supply chain performance. Ge *et al.* study strategies and effects of bargaining power and knowledge spillovers at firm level when R&D cooperation and competition exist within supply chain[7]. Differently with the main results about horizontal collaboration, a higher level of R&D investment and production can be achieved by supply chain R&D cooperation although spillovers are low, compared with non-cooperative R&D. For a firm in the chain, it is optimal to collaborate with such firms whose bargaining power is close to his own. However, not all members have incentives to enhance their spillovers over to others, because conflicts always exist. Thus, this paper show the alliance can enhance technological share only when it has high ability to coordinate its members. Wu *et al.* constructed optimal compensate contract under double-marginal moral hazard from the supplier. In this contract, the optimal rate of both sides marginal profit is the rate of each effort efficiency[8]. Wang *et al.* analyze non-cooperative behavior in a two-echelon decentralized supply chain, composed of one supplier and n retailers [9], build the approximate decision model of their base stock level, and Nash equilibrium contracts are designed. Yao *et al.* investigate the role of the returns policy in the co-ordination of supply chain[10], and investigates how the competing factor influences the decision-making of supply chain members in response to uncertain demand and profit variability, conclude that returns policy depend on demand variability. Cachon *et al.* design the supply chain model under a revenue-sharing contract [11], and conclude that the supply chain performance can be improved when the wholesale price is low under a revenue-sharing contract. Lau *et al.* build game model of manufacturer and retailer based on assuming that the information of manufacturer's cost is asymmetric[12]. They find that under a linear demand curve a manufacturer should overstate the manufacturer's cost, which is an intuitively expected result, under an elastic demand curve she benefits herself and the entire system by understating the manufacturer's cost, which is counter-intuitive.

From the existing literature, studies on vertical game of supply chain enterprises in the context of government subsidies. In particular, there are few studies on the effect of different government subsidies mode on the relation of enterprise vertical game. The paper studies deeply the game relation between the manufacturer and retailer under the mode of subsidies of government to the manufacturer and to the consumer, evaluates the impact of different government subsidies model on the product price, demand, enterprise performance, and provides decision support to the government subsidy policy and strategy of the company, consumer under government subsidy policy.

1. GOVERNMENT'S SUBSIDY TO MANUFACTURER

This section analyzes the game between manufacturers and retailers under mode of government's subsidy to manufacturer. Assume the product market demand influenced by the product price, and the market demand function is:

$$Q = a - bP \ (a > 0, b > 0) \tag{1}$$

In the above model, Q is the product demand in the market, a is basic demand, b is the impact factor of the retail price on demand, and P is retail price.

The retailer's profit function is:

$$\Pi_r = (P-W)Q = (P-W)(a-bP) \tag{2}$$

Where Π_r is retail's profit, and W is manufacturer's wholesale price.

Assume government subsidies for manufacturer, then the profit function of manufacturer is:

$$\Pi_m = (W+X-C_m)Q = (W+X-C_m)(a-bP) \tag{3}$$

Where Π_m is manufacturer's profit, X is government's subsidy, and C_m is manufacturer's cost of unit product.

Assume manufacturer at first determines the wholesale price W, then retailer determines the retail price P, the two parties form a Stackelberg games relation. Thus, the equilibrium solution can be solved according to backward induction.

Take derivative of equation (2) with respect to P:

$$\frac{\partial \Pi_r}{\partial P} = a + b(-2P + W)$$

Let $\frac{\partial \Pi_r}{\partial P} = 0$, get the optimal retail price of retailer:

$$P_1^* = \frac{a+bW}{2b} \tag{4}$$

Substitute equation (4) into equation (3), obtain manufacturer's profit function:

$$\Pi_m = \frac{1}{2}(a-bW)(W+X-C_m) \tag{5}$$

Take derivative of equation (5) with respect to W:

$$\frac{\partial \Pi_m}{\partial W} = \frac{1}{2}(a - 2bW - bX + bC_m)$$

Let $\frac{\partial \Pi_m}{\partial W} = 0$, solve the manufacturer's optimal

wholesale price:

$$W_1^* = \frac{a - bX + bC_m}{2b} \tag{6}$$

Substitute equation (6) into equation (4), obtain the retailer's optimal retail price:

$$P_1^* = \frac{3a - bX + bC_m}{4b} \tag{7}$$

Actual consumer expenditure price is equal to the retail price under government's subsidy to manufacturer, so actual consumer expenditure price is:

$$P_1^{**} = P_1^* = \frac{3a - bX + bC_m}{4b} \tag{8}$$

Substitute equation (7) into equation (1), can get demand for products:

$$Q_1^* = \frac{1}{4}(a + bX - bC_m) \tag{9}$$

Substituting equation (6), (7) into equation (2), (3), retailer's and manufacturer's profit under government's subsidy to manufacturer can be solved:

$$\Pi_{r1}^* = \frac{(a + bX - bC_m)^2}{16b} \tag{10}$$

$$\Pi_{m1}^* = \frac{(a + bX - bC_m)^2}{8b} \tag{11}$$

2. GOVERNMENT'S SUBSIDY TO CONSUMER

Under government's subsidies to consumers, product demand is influenced by product prices and government's subsidy, the demand function is:

$$Q = a - bP + cX \ (a > 0, b > 0, c > 0) \tag{12}$$

Where c is the impact factor of government's subsidy on demand.

The following discuss the influence of government's subsidy and price on demand. Consumer acquires government's subsidy where they have to: (i) hold details invoices; and (ii) register relevant procedures. Whereas, consumer obtains benefits without any registering procedure if retail price is reduced. So lower retail price stimulates consumer's behavior more effectively than equal government's subsidy. In other word, price affects demand more greatly than government's subsidy, that is $b > c$.

Retailer's profit function is:

$$\begin{aligned}\Pi_r &= (P - W)Q \\ &= (P - W)(a - bP + cX)\end{aligned} \tag{13}$$

Manufacturer's profit function is:

$$\begin{aligned}\Pi_m &= (W - C_m)Q \\ &= (W - C_m)(a - bP + cX)\end{aligned} \tag{14}$$

Assume manufacturer at first determines the wholesale price W, then retailer determines the retail price P, the two sides form a Stackelberg games relation. Thus, the equilibrium solution can be solved according to backward induction.

Take derivative of equation (13) with respect to P:

$$\frac{\partial \Pi_r}{\partial P} = a + b(-2P + W) + cX$$

Let $\frac{\partial \Pi_r}{\partial P} = 0$, get the optimal retail price of retailer:

$$P_2^* = \frac{a + bW + cX}{2b} \tag{15}$$

Substitute equation (15) into equation (14) the manufacturer's profit function is:

$$\Pi_m = \frac{1}{2}(a - bW + cX)(W - C_m) \tag{16}$$

Take derivative of equation (16) with respect to W:

$$\frac{\partial \Pi_m}{\partial W} = \frac{1}{2}(a - 2bW + cX + bC_m)$$

Let $\frac{\partial \Pi_m}{\partial W} = 0$, obtain the optimal wholesale price under government's subsidy to consumer:

$$W_2^* = \frac{a + cX + bC_m}{2b} \tag{17}$$

Substitute equation (17) into equation (15), get retailer's optimal retail price under government's subsidy to consumer:

$$P_2^* = \frac{3a + 3cX + bC_m}{4b} \tag{18}$$

As government's subsidy is distributed directly to consumer, then consumer's real expenditure price is:

$$\begin{aligned}P_2^{**} &= P_2^* - X \\ &= \frac{3a + (3c - 4b)X + bC_m}{4b}\end{aligned} \tag{19}$$

Substitute equation (18) into equation (12), get demand for product under government's subsidy to consumer:

$$Q_2^* = \frac{1}{4}(a + cX - bC_m) \tag{20}$$

Substitute equation (17), (18) into equation (13), (14), the retailer's and the manufacturer's profit under government's subsidy to consumer can be solved:

$$\Pi_{r2}^* = \frac{(a + cX - bC_m)^2}{16b} \tag{21}$$

$$\Pi_{m2}^* = \frac{(a + cX - bC_m)^2}{8b} \tag{22}$$

3. EVALUATING DIFFERENT GOVERNMENT'S SUBSIDY MODE

Proposition 1 Consumer's expenditure price decreases with government's subsidy increasing under both pattern of government's subsidy to manufacturer and consumer; the consumer's expenditure price under pattern of government's subsidy to consumer is less than expenditure price under pattern of government's subsidy for manufacturer.

Proof: Take derivative of equation (8) with respect to X and get:

$$\frac{\partial P_1^{**}}{\partial X} = -\frac{1}{4} < 0 \quad (22)$$

Equation (22) shows that consumer's expenditure price under pattern of government's subsidy to manufacturer decreases with government's subsidy increasing.

Take derivative of equation (19) with respect to X and get: $\frac{\partial P_2^{**}}{\partial X} = \frac{3c}{4b} - 1$

$\frac{\partial P_2^{**}}{\partial X} < 0$, as $c<b$, which shows consumer's expenditure price decreases with government's subsidy increasing.

By equation (8) and (19), can get:

$$\Delta P = P_2^{**} - P_1^{**} = \frac{3(c-b)X}{4b}$$

$\Delta P < 0$ as $c < b$; so the consumer's expenditure price under pattern of government's subsidy to consumer is less than the price under pattern of government's subsidy to manufacturer.

Proposition 1 shows that consumer's expenditure cost can be reduced and consumer can benefit from government's subsidy under the two patterns from the view of consumer, and that government's subsidy to consumer is more beneficial to consumer than subsidy to manufacturer.

Proposition 2 Demand under pattern of government's subsidy to consumer is less than that under pattern of government's subsidy to manufacturer.

Proof: Equation (9) and (20) can be resolved:

$$\Delta Q = Q_2^* - Q_1^* = \frac{1}{4}(c-b)X,$$

Because $c<b$, $\Delta Q < 0$, so demand under pattern of government's subsidy to consumer is less than that under pattern of government's subsidy to manufacturer; when $c>b$, demand under pattern of government's subsidy to consumer is more than that under pattern of government's subsidy to manufacturer.

Proposition 2 shows that demand increases more greatly under pattern of government's subsidy to manufacturer than under pattern of government's subsidy to consumer. Government is willing to use the pattern of government's subsidy to manufacturer. Thus, most countries subsidize manufacturer.

Proposition 3 Manufacturer's profit and retailer's profit under pattern of government's subsidy to consumer are less than those under pattern of government's subsidy to manufacturer.

Proof: From equation (10), (11), (21) and (22) get:

$$\Delta\Pi_r = \Pi_{r2}^* - \Pi_{r1}^* = \frac{(c-b)(2a+bX+cX-2bC_m)X}{16b}$$

$$\Delta\Pi_m = \Pi_{m2}^* - \Pi_{m1}^* = \frac{(c-b)(2a+bX+cX-2bC_m)X}{8b}$$

$\Delta\Pi_r < 0$, $\Delta\Pi_m < 0$, so manufacturer's profit and retailer's profit under pattern of government's subsidy to consumer are less than those under pattern of government's subsidy to manufacturer.

Proposition 3 shows that company more benefit from pattern of government's subsidy to manufacturer than pattern of government's subsidy to consumer.

CONCLUSIONS

Considering the mode of government's subsidy to manufacturer and consumer, the games model between manufacturer and retailer is built under government subsidy. Through mathematical analysis and numerical example analysis, we get the following main conclusions: From the view of the consumer, consumer's expenditure reduce under government subsidies to manufacturer or to consumer, consumer can benefit from government subsidies, and government subsidies to consumers is more beneficial to consumer than subsidies to manufacturer. From the view of the government, the effect of government subsidies to manufacturers is better compared with government subsidies to consumer; the government is more willing to use mode of government subsidies to manufacturer. In the perspective of the company, comparing with government subsidies to consumer, government subsidy to manufacturer is more favorable to the company. So, the government and enterprise are more inclined to the government's subsidy to manufacturer, and consumers prefer the government's subsidy to consumer.

REFERENCES

[1] Esmaeili, M., Aryanezhad, M.B., & Zeephongsekul, P. (2009). A Game Theory Approach in Seller-Buyer Supply Chain. *European Journal of Operational Research, 195*(2), 442-448.

[2] Leng, M.M., & Parlar, M. (2009). Allocation of Cost Savings in a Three-Level Supply Chain with Demand Information Sharing: A Cooperative Game Approach. *Operations Research, 57*(1), 200-213.

[3] Cai, G.S., Zhang, Z.G., & Zhang, M. (2009). Game Theoretical Perspectives on Dual-Channel Supply Chain Competition with Price Discounts and Pricing Schemes. *International Journal of Production Economics, 117*(1), 80-96.

[4] Zhu, W.S., Gavirneni, S., & Kapuscinski, R. (2010). Periodic Flexibility, Information Sharing, and Supply Chain Performance. *IIE Transactions, 42*(3), 173-187.

[5] Chiang, W.Y. (2010). Product Availability in Competitive and Cooperative Dual-Channel Distribution with Stock-out Based Substitution. *European Journal of Operational Research, 200*(1), 111-126.

[6] Zhou, X.M., Zhu, Y.L., Zhu, Z., & Shen, H. (2009). Production Decision Based on Retailer-Driven Revenue-Sharing Contracts Under Many-to-One Supply Chain Structure. *24*(9), 1361-1366.

[7] Ge, Z.H., & Hu, Y.Q. (2010). Collaborative R&D and Competitive Production in a Supply Chain. *Journal of Industrial Engineering and Engineering Management, 13*(4), 12-22.

[8] Wu, G., Li, C.Z., & Wu, B.S. (2010). Compensate Contract Design of Supplier-Retailer's Coordinative Sale Promotion. *Journal of Industrial Engineering and Engineering Management, 24*(3), 132-135.

[9] Wang, H.W., Guo, M., & Efstathiou, J. (2004). A Game-Theoretical Cooperative Mechanism Design for a Two-Echelon Decentralized Supply Chain. *European Journal of Operational Research, 157*(2), 372-388.

[10] Yao, Z., Wu, Y., & Lai, K.K. (2005). Demand Uncertainty and Manufacturer Returns Policies for Style-Good Retailing Competition. *Production Planning & Control, 16*(7), 691-700.

[11] Cachon, G.P., & Lariviere, M.A. (2005). Supply Chain Coordination with Revenue-Sharing Contracts: Strengths and Limitations. *Management Science, 51*(1), 30-44.

[12] Lau, H.L., Lau, H.S., & Zhou, Y.W. (2006). Considering Asymmetrical Manufacturing Cost Information in a Two-Echelon System that Uses Price-Only Contracts. *IIE Transactions, 38*(3), 253-271.