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Research on Coordination Mechanism Model of Launch Vehicle Supply Chain Based on Complex System Theory

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Abstract: The supply chain is a system based on the mechanism of "competition-cooperation-coordination" and coordination is the key to successful implementation of the supply chain. The launch vehicle supply chain is a typical complex system which needs to be coordinated. This paper constructs the coordinated mechanism model of launch vehicle supply chain based on a comprehensive analysis of many domestic and foreign research results, then does the contrast research of price, the sales volume, the system profit and other major variables in coordinated and non-coordinated decision-making's situation, and confirms the coordination mechanism can reduce the prices of products, improve sales volume and increase the system's profits, which was a win-win situation of the supply chain members. Finally, we propose the future research direction.

Keywords: complex system theory, coordination mechanism, launch vehicle, supply chain

1 Introduction

Market competition in 21st century is no longer that among enterprises but that among supply chains. Supply chain is based "Competition-Cooperation-Coordination" mechanism. Coordination is crucial to successful implementation for supply chain.

Research on supply chain coordination mechanism model made by foreign scholar mainly focuses on concrete case. Their research is of partial and microscopic analysis on the base of combination of basic principle of economics and operational research at quantitative mode. Thomas [1] (1996) and other divides supply chain coordination into three types, i.e. Buy—sell coordination, production—distribution coordination and inventory—distribution coordination. Lippman and McCardle [2] (1997) and other utilized existence theorem of Nash equilibrium of Debreu (1952) to study supply chain coordination theory. Lee[3](2001) studied cross-organization coordination issue about inventory, control, goods rejection and clearance sale strategy in distribution channel composed of one supplier, one retailer and discount sales shop. Boya [4] (2002) studied coordination replenishment strategy for supply chain composed of one supplier and more than one retailer. Sebastian [5] (2003) discussed IT and coordination cost at different views. He considered that market mechanism is applicable to downstream of supply chain, but IT-based coordination mechanism is preferred when facing supplier. Wang[6](2004) studied two-stage supply chain model which comprises a supplier and more than one retailer and utilized Nash equilibrium to design optimized model of supply chain coordination mechanism. Ram [7] (2005) studied impact of quality expectation and information sharing on formation and achievement of supply chain coordination mechanism. Chen [8] (2006) and other utilized bilateral goods rejection policy between manufacturer and retailer to coordinate supply chain members. Dimitrios [9] (2007) comprehensively considered supply chain coordination mechanism and established model for verification in aspects of economics and environment and so on. Sarah[10](2008) carried out research on coordination mechanism and credit selection for supply chain composed of one manufacturer and more than one demander. Prasad [11] (2009) utilized Stackelberg feedback mechanism to study advertisement and pricing strategy in supply chain system.

Current domestic study on supply chain coordination mechanism succeeds foreign research fruit and meanwhile has achieved certain innovation and breakthrough. Han Jian [12](1998) and other reviewed current technical situation to current supply chain modeling and management and concluded: it is necessary to fully consider strategic and operational coordination issues no matter model adopts whole model(e.g. MIP) or is based on partial selection. As indicated by Ma Shihua [13] (2000), core enterprise is significant to successful operation of supply chain cooperation relation. Enterprise influence force in its own industry, production development and guide capability, goodwill and cooperation willing, structure of dominant product and operation philosophy and so on all directly influence running of cooperation relation along supply chain. Chen Jian and other [14] (2002) raised general frame for coordination management of supply chain relation based on information platform, coordination mechanism and coordination way. Zhao Tianzhi and Jin Yihui [15](2004) raised dependence relation among three types of supply chains, including resource co-sharing, logistics and time sequence, on the base of coordination theory and utilized optimized model for relevant supply chain to formalize these three types of dependence relations into correlative restriction. Lin Qiang and other [16] (2006) thought about coordination mechanism in supply chain shall adopt mixture mode. Key factor to drive this mode successfully implemented is to formulate logical benefit distribution mechanism. In the course to constitute benefit distribution mechanism, establishment and role of authoritative enterprise is especially important. Wu Bengui and other [17](2007) began from analyzing issue supply chain coordination faces to aim at absence of mutual belief among enterprises along supply chain, target diversification of every enterprise and non effective transfer of information to raise corresponding coordination mechanism respectively in aspects of relation coordination, benefit coordination, information coordination and operation coordination. Hu Longying [18](2008) used game theory and relevant theoretical method for system optimization to establish three-level supply chain operation achievement mathematic model and analyzed contract coordination mechanism for three-level supply chain. In order to solve supply chain coordination against uncertain environment, Yao Ligang [19] (2008) raised method where distributed simulation technology is utilized to analyze and assess supply chain coordination contract scheme. Zhou Changli and other [20](2009) studied supply chain composed of one manufacturer and more than on retailer among which price competition is present and utilized bilevel programming and cooperative game and noncooperative game in game theory to acquire optimized pricing strategy of core enterprise and introduce complete coordination strategy for whole supply chain.

Launch Vehicle Supply Chain is a typical complex system subject to coordination. This article would introduce advanced supply chain management theory into China study of launch Vehicle supply chain system. The research would utilize research method about complex system theory and absorbed own feature of launch Vehicle to constitute coordination mechanism model of launch Vehicle supply chain and, comparison research would be launched to main variables under supply chain coordination and non coordination

2 Modeling

2.1 Assumed condition

(1) About structure: Structure of launch Vehicle supply chain is mainly a network supply chain composed of launch Vehicle spare and accessory parts supplier, technical institute for launch Vehicle and demander. It is an opening but complex system.

(2) About information: In this model, launch Vehicle spare and accessory parts supplier, technical institute for launch Vehicle and demander united to set up a shared coordination center in technical institute for launch Vehicle to be responsible for information communication. Final demand information may be shared.

(3) About demand: Demand features uncertainty and non-linearity. Demand is decreasing function of price. Its price elasticity of demand is high.

(4) About cost: Cost is mainly embodied at launch Vehicle production, raw material, spare and accessory parts cost, inventory and keeping and delayed delivery. Members along launch Vehicle supply chain cooperate close, not considering ordering expense.

(5) About optimization: Besides that launch Vehicle spare and accessory parts supplier and technical institute for launch Vehicle has max. Benefit and max. Demand utility, meanwhile, max. Benefit for whole launch Vehicle supply chain system shall be achieved.

2.2 Variable description

Explanation for concrete parameters and variable setup in model as follows: Price i of spare and accessory parts supplier sold to technical institute for launch vehicle at period t -- $p^1_{i,t}$, price sold by technical institute for launch vehicle to demander j at period t -- $p^2_{j,t}$, utility acquired by demander j buying launch Vehicle in t -- $U_{j,t}$, quantity of spare and accessory parts i delivered by spare and accessory parts supplier to technical institute for launch vehicle at period t -- $d^1_{i,t}$, quantity of launch Vehicle sold by technical institute for launch vehicle to demander j at period t -- $d^2_{j,t}$, unit production cost for spare and accessory parts supplier to manufacture spare and accessory parts i at period t -- $c^1_{i,t}$, unit production cost for technical institute for launch vehicle to manufacture launch Vehicle at period t -- c^2_t , productivity of spare and accessory parts supplier to manufacture spare and accessory parts i at period t -- $Q^1_{i,t}$, productivity of technical institute for launch vehicle to manufacture launch Vehicle at period t -- Q^1_t, quantity of spare and accessory parts i not delivered by spare and accessory parts supplier to technical institute for launch vehicle at period t -- $\Delta d^1_{i,t}$, quantity of launch Vehicle not delivered by technical institute for launch vehicle to demander j launch Vehicle at period t -- $\Delta d^2_{j,t}$, quantity of spare and accessory parts ordered by technical institute for launch vehicle at period t -- $D^1_{i,t}$, quantity of launch vehicle ordered by demander j to technical institute for launch vehicle at period t -- $D^2_{j,t}$, impact of random factor on launch Vehicle demand at period t -- ζ_t, inventory and keeping expense for spare and accessory parts i paid by spare and accessory parts supplier at period t -- $v^1_{i,t}$, inventory level of spare and accessory parts i held by spare and accessory parts supplier at period t -- $g^1_{i,t}$, inventory and keeping expense for spare and accessory parts i paid by technical institute for launch vehicle at period t -- $v^2_{i,t}$, inventory level of spare and accessory parts i held by technical institute for launch vehicle at period t -- $g^2_{i,t}$, fund used by demander j to buy launch Vehicle -- m_j, unit penalty cost implemented by technical institute for launch vehicle to spare and accessory parts supplier who fails to deliver spare and accessory parts on schedule with contracted quantity or its goodwill loss -- $l_{i,1}$, unit penalty cost implemented by demander j to technical institute for launch vehicle who fails to deliver launch Vehicle on schedule with contracted quantity or its goodwill loss -- $l_{j,2}$, Time above contracted delivery deadline required by demander j for technical institute for launch vehicle at period t -- $\Delta s_{j,t}$. Wherein, $t = 1,2,\ldots,T$, $i = 1,2,\ldots,I$, $j = 1,2,\cdots,J$, $\Delta d^1_{i,t}$, $\Delta d^2_{j,t}$, no restriction to ζ_t, other variables all more than 0.

2.3 Models

(1) Profit model of technical institute for launch vehicle. Target function and constraint condition of technical institute for launch vehicle as follows:

$$Z^1 = \sum_{j=1}^{J}\sum_{t=1}^{T} p^2_{j,t} d^2_{j,t} - \sum_{t=1}^{T} c^2_t Q^1_t - \sum_{i=1}^{I}\sum_{t=1}^{T}\left(p^1_{i,t} d^1_{i,t} - l_{i,1}\Delta d^1_{i,t}\right) - \sum_{i=1}^{I}\sum_{t=1}^{T} v^2_{i,t} g^2_{i,t} - \sum_{j=1}^{J}\sum_{t=1}^{T} l_{j,2}\Delta s_{j,t} \quad (1)$$

$$\max Z^1$$

$$s.t.\quad \Delta d^1_{i,1} = D^1_{i,1} - d^1_{i,1} \quad (2)$$

$$\Delta d^1_{i,t+1} - \Delta d^1_{i,t} = D^1_{i,t+1} - d^1_{i,t+1} \quad (3)$$

$$\sum_{t=1}^{T} d^1_{i,t} = \sum_{t=1}^{T} D^1_{i,t} \quad (4)$$

As core member in launch Vehicle supply chain, benefit of technical institute for launch vehicle is product of unit price of launch Vehicle s sold within certain period and its quantity, i.e. $\sum_{j=1}^{J}\sum_{t=1}^{T} p^2_{j,t} d^2_{j,t}$; cost and expense within certain period mainly includes payment to buy launch Vehicle spare and accessory parts $\sum_{i=1}^{I}\sum_{t=1}^{T}\left(p^1_{i,t} d^1_{i,t} - l_{i,1}\Delta d^1_{i,t}\right)$, expense paid during launch Vehicle R&D is $\sum_{t=1}^{T} c^2_t Q^1_t$, and also $\sum_{i=1}^{I}\sum_{t=1}^{T} v^2_{i,t} g^2_{i,t}$ which means expense for inventory and keeping of its spare and accessory parts and $\sum_{j=1}^{J}\sum_{t=1}^{T} l_{j,2}\Delta s_{j,t}$ which means penalty expense implemented by demander.

It is clear in profit equation of technical institute for launch vehicle: Among economic benefit relation among technical institute for launch vehicle, its spare and accessory parts supplier and demander, benefit acquired by technical institute for launch vehicle is expenditure of demander, and its expenditure for spare and accessory parts is exactly benefit resource of its spare and accessory parts supplier. Therefore, "confliction" is existent among three parties in terms of economic benefit; coordination is necessary.

(2) Profit model of launch Vehicle spare and accessory parts supplier. Target function and constraint condition of launch Vehicle spare and accessory parts supplier:

$$Z^2 = \sum_{i=1}^{I}\sum_{t=1}^{T}\left(p^1_{i,t} d^1_{i,t} - c^1_{i,t} D^1_{i,t} - l_{i,1}\Delta d^1_{i,t} - v^1_{i,t} g^1_{i,t}\right) \quad (5)$$

$$\max Z^2$$

$$s.t.\quad \Delta d^1_{i,1} = D^1_{i,1} - d^1_{i,1} \quad (2)$$

$$\Delta d^1_{i,t+1} - \Delta d^1_{i,t} = D^1_{i,t+1} - d^1_{i,t+1} \quad (3)$$

$$\sum_{t=1}^{T} d^1_{i,t} = \sum_{t=1}^{T} D^1_{i,t} \quad (4)$$

$$g^1_{i,t+1} - g^1_{i,t} = Q^1_{i,t} - d^1_{i,t} \quad (6)$$

As important member in launch Vehicle supply chain, launch Vehicle spare and accessory parts supplier is cooperation partner of core member, technical institute for launch vehicle. Its benefit mainly comes from fund $\sum_{i=1}^{I}\sum_{t=1}^{T} p^1_{i,t} d^1_{i,t}$ collected by its selling spare and accessory parts to technical institute for launch vehicle within certain period. And its cost and expense within certain period is mainly $\sum_{i=1}^{I}\sum_{t=1}^{T}\left(c^1_{i,t} D^1_{i,t} + v^1_{i,t} g^1_{i,t}\right)$ which includes expenditure to purchase spare and accessory parts for technical institute for launch vehicle and inventory and keeping expense for spare and accessory parts and penalty cost $\sum_{i=1}^{I}\sum_{t=1}^{T} l_{i,1}\Delta d^1_{i,t}$ implemented by technical institute for launch vehicle

Concluded by this profit equation, relation necessary to be coordinated between spare and accessory parts supplier and technical institute for launch vehicle is mainly its benefit and expenditure paid by technical institute for launch vehicle.

(3) Profit model of demander. Target function and constraint condition of launch Vehicle:

$$Z^3 = \sum_{j=1}^{J}\sum_{t=1}^{T}\left(U_{j,t} - p_{j,t}^2 d_{j,t}^2 + l_{j,2}\Delta s_{j,t}\right) \quad (7)$$

$$\max Z^3$$

$$s.t. \quad \sum_{j=1}^{J}\sum_{t=1}^{T} p_{j,t}^2 d_{j,t}^2 \le \sum_{j=1}^{J} m_j \quad (8)$$

$$d_{j,t+1}^2 - D_{j,t+1}^2 \le \Delta d_{j,t}^2 \quad (9)$$

$$\zeta_t = D_{j,t+1}^2 - D_{j,t}^2 \quad (10)$$

$$\sum_{j=1}^{J}\sum_{t=1}^{T} d_{j,t}^2 = \sum_{j=1}^{J}\sum_{t=1}^{T} D_{j,t}^2 \quad (11)$$

Demand for launch Vehicle, i.e. buyer of launch Vehicle, is a special body. Usually, it means government in China. About its benefit, on one hand, it comes from utility acquired by buying launch Vehicle , mainly including positive effect generated by successful satellite launch, usually expressed with utility function as $\sum_{j=1}^{J}\sum_{t=1}^{T} U_{j,t}$; on the other hand, it comes from reduction of its expected loss, embodied with $\sum_{j=1}^{J}\sum_{t=1}^{T} l_{j,2}\Delta s_{j,t}$; its cost is mainly fund $\sum_{j=1}^{J}\sum_{t=1}^{T} p_{j,t}^2 d_{j,t}^2$ used to buy launch Vehicle .

Economic benefit relation necessary to be coordinated between demand and technical institute for launch vehicle is also embodied in profit model of demander, i.e. coordination between cost of demand and benefit of technical institute for launch vehicle.

(4) Profit model of launch Vehicle supply chain system. Target function and constraint condition of whole launch Vehicle supply chain system:

$$Z^s = \sum_{j=1}^{J}\sum_{t=1}^{T} U_{j,t} - \sum_{t=1}^{T} c_t^2 Q_t^1 - \sum_{t=1}^{T}\sum_{i=1}^{N}\left(c_{i,t}^1 D_{i,t}^1 + v_{i,t}^1 g_{i,t}^1 + v_{i,t}^2 g_{i,t}^2\right) \quad (12)$$

$$\max Z^s$$

$$s.t. \quad \sum_{t=1}^{T} d_{i,t}^1 = \sum_{t=1}^{T} D_{i,t}^1 \quad (4)$$

$$\sum_{j=1}^{J}\sum_{t=1}^{T} d_{j,t}^2 = \sum_{j=1}^{J}\sum_{t=1}^{T} D_{j,t}^2 \quad (11)$$

Profit model of launch Vehicle supply chain system is mainly sum of above three profit models, i.e. $Z^s = Z^1 + Z^2 + Z^3$. Three bodies in supply chain are represented as uniform economic decision making body.

Again coordinative decision making, acquirement of optimal price, quantity and system profit is equal to maximize system profit Z^s with constraint conditions (4) and (11) present. It is analyzed as follows:

Let

$$f = Z^s + \lambda_1\left(\sum_{t=1}^{T} d_{i,t}^1 - \sum_{t=1}^{T} D_{i,t}^1\right) + \lambda_2\left(\sum_{j=1}^{J}\sum_{t=1}^{T} d_{j,t}^2 - \sum_{j=1}^{J}\sum_{t=1}^{T} D_{j,t}^2\right)$$

By

$$\frac{\partial f}{\partial p_{1,t}^2} = 0, \cdots, \frac{\partial f}{\partial p_{j,t}^2} = 0, \cdots, \frac{\partial f}{\partial p_{J,t}^2} = 0, \frac{\partial f}{\partial \lambda_1} = 0, \frac{\partial f}{\partial \lambda_2} = 0 ,$$

it is to acquire optimal price $p_{j,t}^{2*}$ to demander j , and further, it is feasible to acquire optimal order quantity and production quantity and maximized profit of system. Against non coordinative decision making, case is relatively complex. It is needed to use each independent to respectively get maximized profit. In (3-1), optimal price achieved with Lagrange extreme value theory $p_{j,t}^{2'}$ is function about $p_{j,t}^2$ and cost. Optimal price $p_{i,t}^{1'}$ achieved by Lagrange extreme value theory after placing it in (3-5) can lead to that $p_{j,t}^{2'}$ is finally acquired. Further, value other main variable can be achieved.

3 Model analysis

Though launch Vehicle supply chain coordination model formed based on complex system theory can effectively describe actual coordination course and explain necessity of supply chain coordination, it is difficult for quantification. In order to facilitate research, we can supplement several assumptions and variables: (1) Supplier provides single product, with unit production cost or buy cost constant. (2) All costs are all full information. (3) In order for convenient analysis, cost caused by stock out and dull of sale are not considered. (4) Market demand is decreasing function of price. c_1 is unit product cost of launch Vehicle spare and accessory parts supplier; c_2 is unit product cost of technical institute for launch vehicle; v is wholesale price provided by launch Vehicle spare and accessory parts supplier to technical institute for launch vehicle, $v > c_1$; p is price with which technical institute for launch vehicle sells launch Vehicle to demander, $p > c_2 + v$; q is quantity ordered by demander from technical institute for launch vehicle; u is utility achieved by demander for purchase of launch Vehicle , correlative with goods quantity and price, able to be quantitatively expressed as: $u = u(p,q) = \alpha + \beta pq$, wherein $\alpha \geq 0$, and $\beta \geq 1$, which reflects sensitivity in terms of quantity and price generated by demander to launch Vehicle delivered by technical institute for launch vehicle. Research showed price and quantity of launch Vehicle presents such a form as similar to hyperbola, i.e. q is decreasing function of sale price p, expressed as: $q = Ap^{-\eta}$, wherein A is positive constant; η means elasticity of demand price; elasticity of demand price of launch Vehicle is high, i.e. $\eta > 1$.

When information is shared, launch Vehicle spare and accessory parts supplier shall be able to clearly that c_1 and c_2 are both constant and that stock out cost and dull of sale are not existent.

Profit of technical institute for launch vehicle is:

$$Z_S^1 = (p - c_2 - v)q \tag{13}$$

Profit of launch Vehicle spare and accessory parts supplier is:

$$Z_S^2 = (v - c_1)q \tag{14}$$

Profit of demander is:

$$Z_S^3 = \alpha + \beta pq - pq \tag{15}$$

Profit of whole system profit is:

$$Z_S = Z_S^1 + Z_S^2 + Z_S^3 = \alpha + \beta pq - (c_1 + c_2)q \tag{16}$$

3.1 Coordinative decision making for supply chain

Because complete information sharing among members in three-level supply chain system composed of launch Vehicle spare and accessory parts supplier, technical institute for launch vehicle and demander is feasible, and against coordination decision making, every member may be considered as a decision maker. This decision maker may implement uniform management to whole system and utilize all information for uniform decision making in order to maximize whole profit of system. Place $q = Ap^{-\eta}$ in system profit equation (16).

$$\begin{aligned} Z_S &= \alpha + \beta pq - (c_1 + c_2)q \\ &= \alpha + \beta A p^{-\eta+1} - (c_1 + c_2)Ap^{-\eta} \end{aligned}$$

Condition to maximize system profit is its first order derivative to price is zero, i.e.

$$\frac{\partial Z_S}{\partial p} = (1-\eta)A\beta p^{-\eta} + \eta(c_1 + c_2)p^{-\eta-1} = 0$$

Achieved as follows:

$$p_S^* = \frac{\eta}{\beta(\eta-1)}(c_1 + c_2) \tag{17}$$

$$q_S^* = \left[\frac{\beta(\eta-1)}{\eta}\right]^{\eta} \frac{A}{(c_1 + c_2)^{\eta}} \tag{18}$$

Placed into system profit equation (3-16) to acquire:

$$Z_S^* = \alpha + \frac{A}{\eta-1}\left[\frac{\beta(\eta-1)}{\eta}\right]^{\eta} \frac{1}{(c_1 + c_2)^{\eta-1}} \tag{19}$$

3.2 Non coordinative decision making for supply chain

In non coordinative decision making structure, because game relation is present among members, it is impossible to like coordination decision making structure to exist decision maker with absolute decision making right. Members in launch Vehicle supply chain system all consider chasing for max. Own benefit as target with his independent decision making right. Therefore, member would not actively resort to coordination. Only when their own benefit is satisfied, can they consider benefit of other member.

First, technical institute for launch vehicle would depend on given price v to select spare and accessory parts supplier who conforms to requirement, i.e. select optimal price $p_S^{'}$.

Utilize profit equation of technical institute for launch vehicle to acquire its first-order to price, i.e.

$$\frac{\partial Z_S^1}{\partial p} = (-\eta + 1)Ap^{-\eta} + A\eta(c_2 + v)p^{-\eta-1} = 0$$

Acquire:

$$p_S^{'} = \left(\frac{\eta}{\eta-1}\right)(v + c_2) \tag{20}$$

Secondly, place $p_S^{'}$ in profit equation of launch Vehicle spare and accessory parts supplier (2) to acquire price $v_S^{'}$ to maximize its profit. Let $\frac{\partial Z_S^2}{\partial v} = 0$.

Acquire:

$$v_S^{'} = \frac{\eta c_1 + c_2}{\eta - 1} \tag{21}$$

Then acquire:

$$p_S^{'} = \left(\frac{\eta}{\eta-1}\right)^2 (c_1 + c_2) \tag{22}$$

$$q_S^{'} = \left(\frac{\eta-1}{\eta}\right)^{2\eta} \frac{A}{(c_1 + c_2)^{\eta}} \tag{23}$$

At this time, maximum profit of whole system is:

$$Z_S^{'} = \alpha + \left(\frac{\eta-1}{\eta}\right)^{2\eta} \frac{A}{(c_1 + c_2)^{\eta-1}}\left[\beta\left(\frac{\eta}{\eta-1}\right)^2 - 1\right] \tag{24}$$

3.3 Comparison study for above two cases

Against coordinative decision making and non coordinative decision making, main variable is price, sales volume and system profit of launch Vehicle, comparison made as follows:

(1) Price comparison: Because of $\frac{p_S^*}{p_S^{'}} = \frac{\eta-1}{\eta\beta} < 1$, $p_S^* < p_S^{'}$ is achieved, i.e. optimal selling price against

coordinative decision making is less than that against non coordinative decision making.

(2) Quantity comparison: Because of $\frac{q_S^*}{q_S^{'}} = \left(\frac{\eta - 1}{\eta\beta}\right)^{-\eta} > 1$, $q_S^* > q_S^{'}$ is achieved, i.e. optimal sales volume against coordinative decision making is more than that against non coordinative decision making.

(3) Comparison of system profit: Against two cases, no matter system profit acts as differential or quotient, it is impossible to distinctly lock mutual size relation by comparison. Basic analysis as follows: As required by basic theory in economics, when elasticity of demand price is more than 1, price lowers and quantity increases, which can lead to benefit increase. Because cost of above two cases is same, profit comparison would not be interfered.

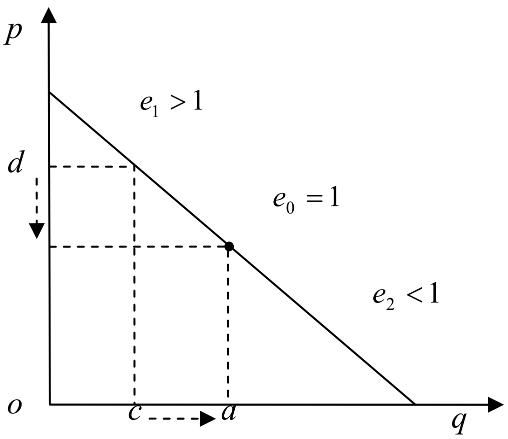

Fig.1 Relation between elasticity and profit

It can be proved with calculus that when elasticity of demand price $e = 1$, benefit pq would be maximized. In Fig.1, area of what encircled by oae_0b is largest. In case of $e > 1$, lowered price means increased benefit.

4 Conclusions

On the base of concluding research fruit of predecessors, this article constituted three-level launch Vehicle supply chain coordination mechanism model. Against that information is shared, comparison between coordinative decision making and non coordinative decision making verified: coordination decision making proved that: when selling price of launch Vehicle lowers, productivity and selling capability would be enhanced to some extent, therefore, competition advantage is existent. And profit of whole system would increase to some extent, win-win is achieved. By coordination decision making, members in launch Vehicle supply chain would unite for common action to lower selling price of launch Vehicle and enhance productivity and selling capability and finally accordingly increase whole profit of system. In order to assure argument clarity and demonstration intuitionism, this research model raised some premises and hypotheses and received better research effect. Facing complex practice, future research would be launched at following two aspects: First, at quantitative research, it is feasible to relax basic hypotheses at aspects, including increasing model variable of launch Vehicle and setting up changeability of cost; secondly, at qualitative research, research may be launched aiming at how to constitute information sharing platform, perfecting profit distribution mechanism of supply chain system and belief mechanism among supply chain members.

References

[1]Thomas DJ, Griffin P M. Coordinated supply chain management[J]. European Journal of Operational Research, 1996(94): 1-15.
[2]Lippman. S. A, McCardle. K. J. The competitive newboy[J]. Operations Research, 1997(45): 54-65.
[3]Lee C H. Coordinated stocking, clearance sales, and return policies for a supply chain[J]. European Journal of Operational Research, 2001, 131(6): 491-513.
[4]Boya T. Gallego G. Coordination pricing and inventory replenishment policies for one whole saler and one or more geographically dispeesed retailers[J]. Int Production Economics, 2002, 77(3): 95-11.
[5]Sebastiaan J Garcia Dastugue, Douglas M Lambert. Internet enabled coordination in the supply chain[J]. Industrial Marketing Management, 2003, 32(3): 251-263.
[6]Wang H, Guo Min, Efstathiou J. A game-theoretical cooperative mechanism design for a two-echelon decentralized supply chain[J]. Production, Manufacturing and Logistics, 2004(157): 372-388.
[7]Ram Narasimhana, Anand Nair. The antecedent role of quality, information sharing and supply chain proximity on strategic alliance formation and performance[J]. International Journal of Production Economics, 2005, 96(3): 301-313.
[8]Chen H, Chen J, Chen YH. A coordination mechanism for a supply chain with demand information updating[J]. International Journal of Production Economics, 2006, 103(1): 347-361.
[9]Dimitrios Vlachos, Patroklos Georgiadis, Eleftherios Iakovou. A system dynamics model for dynamic capacity planning of remanufacturing in closed-loop supply chain [J]. Operations Research, 2007(34): 367-394.
[10]SP Sarmah, D Acharya, SK Goyal. Coordination of a single-manufacturer/multi-buyer supply chain with credit option. International Journal of Production Economics, 2008, 46(1): 38-53.
[11]X He, A Prasad, SP Sethi, G Gutierrez. Cooperative advertising and pricing in a stochastic supply chain: Feedback Stackelberg strategies. Production and Operations Management, 2009(2): 46-59.
[12]Han Jian, Wu Cheng, Fan Yushun. Status and developing trends of supply chain modeling and management technology[J]. Computer Integrated

Manufacturing Systems, 1998(4): 8-13.
[13]Ma Shihua. The influences of core enterprise on the formation of strategic partnership in supply chain[J]. Industrial Engineering and Management, 2000, 5(1): 24-27.
[14]Zhao Chunjun, Chen Jian, Feng Weidong. Studies on virtual enterprise and Its construction[J]. Systems engineering- theory & practice, 2002(10): 49-55.
[15]Zhao Tianzhi, Jin Yihui. Optimized coordination of supply chain based on dependency[J]. Computer Integrated Manufacturing Systems,2004,10(8): 929-933.
[16]Lin Qiang, Yu Han, Gu Peiliang. Research on the coordinative and incentive mechanism facing repetitive cooperation in supply chain[J]. Journal of China University of Geosciences (Social Sciences Edition), 2006, 6(5): 43-46.
[17]Wu Bengui, Chen Zhiya. Resear ch on the coordination mechanism of the supply chain management[J]. Logistics Sci- Tech, 2007(8): 103-105.
[18]Hu Longying, Jiang Zhangsheng, Meng Mei, Qin Jun. Coordination of a three-level supply chain through revenue sharing[J]. Journal of Harbin Engineering University, 2008, 29(2): 198-203.
[19]Yao Ligang, Feng Yuncheng. Architecture of supply chain coordination simulation system based on HLA[J]. Computer Integrated Manufacturing Systems, 2008, 14(10): 2026-2030.
[20]Zhou Changli, Gao Chengxiu, Zhou Weigang, Zhai Jianshou. Optimal pricing under price competition and supply chain coordination method[J]. Journal of Mathematics, 2009, 29(1): 81-86.