Management in the Post-Crisis Era: Diverse World and Diversified Management

后危机时代的管理：多元化的世界，多元化的管理

Proceedings of 2010 International Conference on Management

2010管理国际大会论文集

Editor-in-chief : Department of Management Sciences,
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国家自然科学基金委员会管理科学部　编

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国家自然科学基金委员会管理科学部 编　　　　责任编辑 汤礼广

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序　言

改革开放三十多年来，中国经济与社会持续地高速发展。尤其在金融危机之后，中国经济为世界经济的复苏做出了无可比拟的贡献。与此同时，中国的宏观管理、工商管理实践，以及管理学研究，也正悄然地影响着世界管理学理论与实践。

国家自然科学基金委员会管理科学部定期举办管理国际大会，其宗旨就是为了促进中国管理学研究走向世界，在提高自身研究水平的同时，为世界管理理论与实践做出贡献。

次贷危机爆发后，许多西方主流的管理学理论和观点受到挑战与质疑，人们开始认识到，管理理论只有多极化地发展，才能使管理学研究的生态更加健康。正因如此，此次在上海召开的第七届管理国际大会将大会主题定为："后危机时代的管理——多元化的世界、多元化的管理"。

这次会议是一次高水平的会议。为保证会议的质量，大会组委会采取了严格的论文评审制度，通过专业委员会的层层筛选，从收到的 250 余篇论文中，最终确定了 104 篇论文入选本次会议论文集。本论文集涵盖了管理学领域的诸多方面，包括"运作管理与物流"、"最优化方法与模型"、"决策理论与应用"、"信息管理与电子商务"、"金融工程与风险管理"、"营销学与服务管理"、"组织与行为学"、"经营战略与全球化"、"技术创新与创业"、"中国特色的管理"、"经济与政策模型"、"环境、能源与自然资源管理"、"财务管理"、"人力资源管理"，及"管理科学的其他问题"等 15 个专题，可以说，这是对我国管理学研究水平的一次全面检验。我们高兴地看到，我国管理学研究水平已经有了长

足的进步，尤其是许多年青的学者，他们的研究成果让人感到后生可畏，他们代表了中国管理学界的未来与希望。

更让人欣喜的是，中国管理学界已经完成了从追求数量到追求质量的嬗变。可以相信，中国的管理学研究开始走向良性发展的道路，如果真的是这样，则中国幸甚，世界幸甚。

是为序。

国家自然科学基金委员会管理科学部主任
中国工程院院士、工程管理学部副主任　**郭重庆**

2010年11月12日于上海

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A Study On Outsourcing Decision-making Strategy For OEM And CM

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Abstract

Recently the contract manufacturing industry has grown rapidly, as original equipment manufacturers (OEM) in a wide range of industries have increasingly preferred buying finished products from contract manufacturers (CM). And new technologies are being constantly introduced to CMs for upgrading the products. This paper focuses on the outsourcing strategy on technology introduction in a supply chain with one OEM and one CM. This study investigates the impact of inducing new technology to the CM for increasing the products' value. Through the development of analytical models that maximize the profits, the optimal outsourcing decisions for OEM and CM are explored under both competition and cooperation scenarios.

Key words

outsourcing, OEM, CM, Game theory

1 Introduction

Outsourcing has received considerable attention in the popular and business press over the last two decades. Within economics there exist numerous studies that have used alternative theoretical frameworks to study outsourcing issues. These studies have relied on contract theory, transaction cost theory, industrial general equilibrium and so on. Quelin, B. and F. Duhamel (2003) analyzed the outsourcing motives and risks, then pointed out that bringing together strategic outsourcing and corporate strategy is preferable. Sang, Chung and Joseph (2010) studied outsourcing with quality competition by developing a three-stage game theoretic model. There are several researches on the effect of contract manufacturing, concerning the effect of OEM totally home-made, partly outsourcing or totally outsourcing. Plambeck and Taylor (2005) explored the impact of contract manufacturing on innovation, capacity, and profitability. They found that outsourcing could be detrimental to innovation and profit, especially if the OEMs are weak relatively to the CM. Gilbert (2006) investigated strategic outsourcing for competing OEMs that faced cost reduction opportunities. John, Brian and Aleda (2009) studied outsourcing to a powerful contract manufacturer with the consideration of the effect of learning-by-doing.

Along with the emergence of contract manufacturers in many industries such as automotive, electronics and pharmaceuticals, many original equipment manufacturers prefer to outsource the entire manufacturing of products for reducing costs of labor or raw materials. Traditional brand owners, now named OEMs, focus on the things that most enhance products' value, such as R&D, design and marketing (Benito, 2006).

In this paper, we assume there is an OEM and a CM. Initially, OEM outsources all products to the CM. Later, OEM needs to upgrade its products to gain more profit or market shares. When OEM and CM make the centralized decision for maximizing profits of both sides, this situation is called cooperation. On the other hand, if OEM and CM make the decentralized decision to maximize their individual profit, this situation is called competition. And in the case of competition, CM might use the technology to produce and sell its own brand products.

2 Problem Description and Assumptions

Suppose, firstly, that the quantity of current products ordered by OEM from CM is q_o, and the variable cost is C_o. Assuming the market model is a perfect competitive market, so the demand function becomes $P_o(q_o)=x$, which means, with given price x, q_o current products could be sold.

Consider, later on, OEM will develop a new product with the quality level denoted by v, the investment in product innovation is denoted by $I_n(v)$, the new demand function is assumed to be $P_n(q_n)=a+bv-zqn(a, b, z>0)$. The price of a new product purchased by OEM from CM is denoted as w. Besides producing q_{OEM} for OEM, CM might use the technology to produce and sell its own brand products to the market, the quantity is q_{CM}. We suppose these two kinds of productions are not substitutable. The demand function of CM own brand production is $P_n(q_n)=a'+b'v-z'q_n(a', b', z'>0)$.

We introduce the parameter δ to adjust the ratio of $I_n(v)$ between OEM and CM ($0\leqslant\delta\leqslant1$). Suppose that the OEM and CM share the investment with the ratio of δ and $1-\delta$ respectively.

3 The Model

3.1 Case of current products

Firstly, we discuss the case of OEM outsourcing the current products with quantity of q_o to CM, the unit price is w_o. The variable cost is

$$C_o(q_o) = \frac{1}{2}m_o q_o^2, m_o > 0 \tag{1}$$

The profit of the entire supply chain (both OEM and CM) can be given as

$$\pi_o = xq_o - \frac{1}{2}j_o q_o^2 \tag{2}$$

The profits of OEM and CM can be obtained as

$$\pi_{OEM} = (x - w_o)q_o \tag{3}$$

$$\pi_{CM} = w_o q_o - \frac{1}{2}m_o q_o^2 \tag{4}$$

The profit maximization problem can be solved by taking the first derivative of Eq. (2) with respect to q_o and let the first derivative equal 0, we then have

$$\frac{\partial \pi_o}{\partial q_o} = x - m_o q_o = 0 \tag{5}$$

The equilibrium quantity (q_o^*) and profit (π^*) can be derived as

$$q_o^* = \frac{x}{m_o} \tag{6}$$

$$\pi^* = \frac{x^2}{2m_o} \tag{7}$$

In a game with perfect information, the OEM and CM will share the net profit, and then we have

$$\pi_{OEM}^* = \pi_{CM}^* = \frac{x^2}{4m_o} \tag{8}$$

$$w_o^* = \frac{3}{4}x \tag{9}$$

3.2 Case of new products

In the situation that the OEM plans to invest in new technology for developing new products, the CM is required for cooperation.

The demand function now is

$$P_n(q_n) = a + bc - zq_n \tag{10}$$

The variable cost is

$$C_n(q_n) = \frac{1}{2}m_n q_n^2 \tag{11}$$

The investment in new product development is

$$I_n(v) = \beta v^2 \tag{12}$$

So the objective profit of the supply chain can be expressed as

$$\pi_n(q_n, v) = (a + bv - zq_n)q_n - \frac{1}{2}m_n q_n^2 - \beta v^2 \tag{13}$$

3.2.1 Cooperation scenario

In this scenario, the OEM and CM will cooperate for maximizing the sum of both individual profits. Taking partial derivatives of Eq. (13) with respect to q_n and v, respectively, we have

$$\frac{\partial \pi_n}{\partial q_n} = a + bv - (2z + m_n)q_n \tag{14}$$

$$\frac{\partial \pi_n}{\partial v} = bq_n - 2\beta v \tag{15}$$

The equilibrium quantity (q_n^*), quality level (v^*) and profit (π_n^*) can be derived as

$$q_n^* = \frac{a + bv}{2z + m_n} \tag{16}$$

$$v^* = \frac{bq_n}{2\beta} \tag{17}$$

$$\pi_n^* = \frac{(a + bv)^2}{2(2z + m_n)} - \beta v^2 = aq_n + \frac{b^2 - 4\beta z - 2\beta n_n}{4\beta} q_n^2 \tag{18}$$

Since both OEM and CM will share the net profit, then we have

$$\pi_{OEM}^* = \pi_{CM}^* = \frac{1}{2}\pi_n^* = \frac{(a + bv)^2}{4(2z + m_n)} - \frac{1}{2}\beta v^2 = \frac{1}{2}aq_n + \frac{b^2 - 4\beta z - 2\beta n_n}{8\beta} q_n^2 \tag{19}$$

From Eq. (19), it can be seen that if $\beta \leqslant \frac{b^2}{4z+2m_n}$, the profits of both OEM and CM are the convex function of quality level v and quantity q_n. This means if the investment on new product development is lower than a specific level $\beta\_ = \frac{b^2}{4z+2m_n}$, then both OEM and CM will prefer a higher quality level v.

3.2.2 Competition scenario

Under the competition scenario, the outsourcing policy for both OEM and CM can be found through a two-stage game model as follows:

Stage 1: OEM chooses the purchasing quantity q_{OEM} and technology level v.

Stage 2: CM chooses the quantity q_{CM} of the products to produce with its own brand.

Assuming the unit price that the OEM pays to CM is

$$w(v) = w_o + \alpha v, \ (\alpha > 0) \tag{20}$$

The profit function of OEM consists of three terms: sales revenue, outsourcing cost, and new product development investment share. Then the objective function can be expressed as

$$\pi_{OEM}(q_{OEM}, v) = (a + bv - zq_{OEM})q_{OEM} - (w_o + \alpha v)q_{OEM} - \delta\beta v^2 \tag{21}$$

Let the partial derivation of Equation (21) with respect to q_{OEM} and v respectively equal 0, we have

$$\frac{\partial \pi_{OEM}}{\partial q_{OEM}} = a - w_o + (b - \alpha)v - 2zq_{OEM} = 0 \tag{22}$$

$$\frac{\partial \pi_{OEM}}{\partial v} = (b - \alpha)q_{OEM} - 2\delta\beta v = 0 \tag{23}$$

Then the equilibrium quantity (q_{OEM}^*) and quality level (v^*) can be derived as

$$q_{OEM}^* = \frac{a - w_o + (b - \alpha)v}{2z} = \frac{2\delta\beta(a - w_o)}{4z\delta\beta - (b - \alpha)^2} \tag{24}$$

$$v^* = \frac{(b - \alpha)q_{OEM}}{2\delta\beta} = \frac{(a - w_o)(b - \alpha)}{4z\delta\beta - (b - \alpha)^2} \tag{25}$$

$$\pi_{OEM}^* = \frac{\delta\beta(a - w_o)^2}{4z\delta\beta - (b - \alpha)^2} + \frac{2\delta\beta(b - \alpha)^2(a - w_o)^2}{[4z\beta - (b - \alpha)^2]^2} \tag{26}$$

As the demand function of CM own brand production is supposed to be $P_n(q_n) = a' + b'v - z'q_n$, the profit function of the CM consists of four terms: outsourcing revenue, own brand production revenue, manufacturing cost and new product development investment share. Then the objective function $\pi_{CM}(q_{CM})$ becomes

$$\pi_{CM}(q_{CM}) = (w_o + \alpha v)q_{OEM} + (a' + b'v - z'q_{CM}) - \frac{1}{2}m_n(q_{CM} + q_{OEM})^2 - (1 - \delta)\beta v^2 \tag{27}$$

Let the partial derivation of Eq. (27) with respect to q_{CM} equal 0, we have

$$\frac{\partial \pi_{CM}}{\partial q_{CM}} = a' + b'v - 2z'q_{CM} - m_n q_{OEM} - m_n q_{CM} = 0 \tag{28}$$

Then the equilibrium quantity (q_{CM}^*) can be obtained as

$$q_{CM}^* = \frac{a' + b'v - m_n q_{OEM}}{m_n q_{OEM} + 2z'} \tag{29}$$

Inserting the Equations (24) and (25), we can get the q_{CM}^{*} as

$$q_{CM}^{*}=\frac{a'[4z\delta\beta-(b-\alpha)^{2}]+b'(a-w_{0})(b-\alpha)-2m_{n}\delta\beta(a-w_{o})}{2m_{n}\delta\beta(a-w_{o})+2z'[4z\delta\beta-(b-\alpha)^{2}]} \tag{30}$$

Taking Eq. (31) into Eq. (27), we can get the π_{CM}^{*} as

$$\begin{aligned}\pi_{CM}^{*}=&\left[w_{o}+\frac{\alpha(a-w_{n})(b-\alpha)}{4z\delta\beta-(b-\alpha)^{2}}\right]\cdot\frac{2\delta\beta(a-w_{o})}{4z\delta\beta-(b-\alpha)^{2}}+\left[a'+\frac{b'(a-w_{o})(b-\alpha)}{4z\delta\beta-(b-\alpha)^{2}}\right]\cdot\\&\frac{a'[4z\delta\beta-(b-\alpha)^{2}]+b'(a-w_{n})(b-\alpha)-2m_{n}\delta\beta(a-w_{o})}{2m_{n}\delta\beta(a-w_{o})+2z'[4z\delta\beta-(b-\alpha)^{2}]}-\\&z'\left\{\frac{a'[4z\delta\beta-(b-\alpha)^{2}]+b'(a-w_{n})(b-\alpha)-2m_{n}\delta\beta(a-w_{o})}{2m_{n}\delta\beta(a-w_{o})+2z'[4z\delta\beta-(b-\alpha)^{2}]}\right\}^{2}-\\&\frac{1}{2}m_{n}\left\{\frac{a'[4z\delta\beta-(b-\alpha)^{2}]+b'(a-w_{n})(b-\alpha)-2m_{n}\delta\beta(a-w_{o})}{2m_{n}\delta\beta(a-w_{o})+2z'\delta\beta-(b-\alpha)^{2}}+\right.\\&\left.\frac{2\delta\beta(a-w_{o})}{4z\delta\beta-(b-\alpha^{2})}\right\}^{2}-(1-\delta)\beta\left[\frac{(a-w_{n})(b-\alpha)}{4z\delta\beta-(b-\alpha)^{2}}\right]^{2}\end{aligned} \tag{31}$$

In competition scenario, the total profit π_t could be obtained by adding up Eqs. (26) and (31),

$$\pi_{t}^{*}=\pi_{CM}^{*}+\pi_{OEM}^{*}$$

According to Eqs. (19), (26) and (31), the OEM and CM could make the outsourcing decision in either cooperation or competition scenario to maximize their profits.

3.3 Numerical experiments

In the following, numerical examples are presented for sensitivity study. Considering a system with the following parameters:

$$a=100,\ b=5,\ z=1,\ \alpha=3,\ a'=60,\ b'=4,\ z'=2,\ w_{o}=50,\ m_{n}=1 \text{ and } \beta=9.$$

Now in cooperation scenario, the total profit π_{n}^{*} is a concave function of quality level v and outsourcing quantity q_n (see Figures 1 and 2). In practice, OEM can choose the proper quality level v^{*} and then invest in the new product development to maximize the profit.

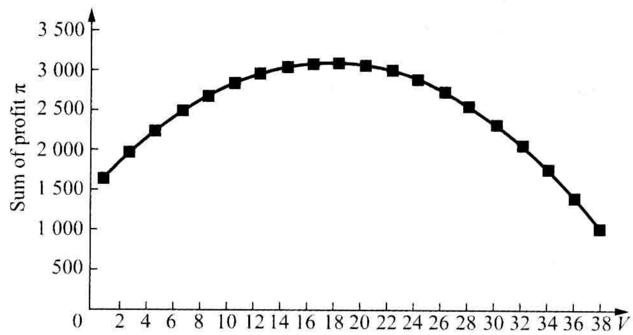

Figure 1 Sum of profit when v varies

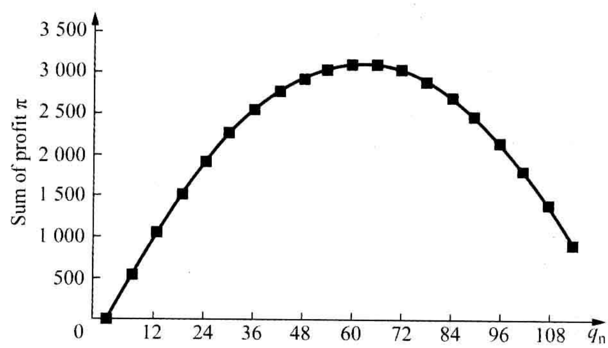

Figure 2 Sum of profit when q_n varies