

Research on telecommunication resale service supply chain coordination with revenue-sharing contract

Zheng Huili^{1,2} Da Qingli¹ Cao Aihong²

(¹ College of Economics and Management, Southeast University, Nanjing 210096, China)

(² Department of Management Engineering, Nanjing University of Posts and Telecommunications, Nanjing 210003, China)

Abstract: The competition and cooperation between traditional telecom operators and resale operators in the supply chain are discussed, when the telecom industry developed telecommunication resale service. Supply chain contract is an effective way to coordinate the supply chain. This paper analyzes the revenue-sharing contract between telecom operators and resale operators. The study shows that by setting up a rational revenue-sharing ratio and wholesale price, a revenue-sharing contract can coordinate this supply chain, and telecom operators and resale operators can achieve a “win-win” solution.

Key words: telecommunication resale service; supply chain coordination; revenue-sharing contract

“Telecommunication resale service” means that competitors get service with a discount or wholesale price from the original telecom operators and resell the service to the competitors’ customers. In western countries, the telecommunication resell service has developed over about ten years and now it is very popular. *Telecommunications Regulation of the People’s Republic of China*, which was published in September, 2000, has already permitted the resale of basic telecom service.

As the telecom market becomes more open and the competition becomes more intense, telecommunication resale service will be an irreversible trend in the future^[1]. Because of the low barriers to entry to the service sector, many telecom operators would make it the first choice. Therefore the competition between the supply chain and the supply chain will play an important role in the future telecom market.

The most important aspect of supply chain management (SCM) is cooperation and coordination among firms. Theory and practice prove that, in a decentralized control structure, if every part of the supply chain pursues its own benefit, the performance of SCM will be poor. The reasons are asymmetric information among firms and double marginalization^[2].

The supply chain contract^[3] is an effective way to coordinate the supply chain. Utilizing the information in contract and incentives, we can coordinate the buyer and the seller, optimize the

selling channel and improve the whole supply chain’s performance. Even if there is no optimal solution, there always exists a contract in which Pareto dominates a non-coordinating contract^[4], i.e., each firm’s profit is no worse off. By establishing the supply chain, firms can share the risks, improve the efficiency of system performance, build long term partnerships, and so on. Therefore, doing research on the supply chain model of telecommunication resale service is very significant to telecom operators, resale operators and the whole telecom market.

A wholesale price contract is the simplest and the easiest to implement. There are many research papers on wholesale price contracts for practical supply chain model^[5-7]. But wholesale price contracts generally can’t coordinate the supply chain^[8].

The distinctive characteristic of a revenue-sharing contract is that it thoroughly evaluates the market’s selling risk and is based on risk-sharing, to maximize the supply-chain profit. Revenue-sharing contracts succeeded mostly in the video cassette rental industry^[9-12]. As the competition became more intense, both telecom operators and resale operators face large market risk. Revenue-sharing contracts will be a good choice. This idea has been successfully applied in China mobile MMS (multimedia messaging service). Nowadays telecom resale services still prefer wholesale sales to revenue-sharing. In this paper, we first build a telecom resale supply chain, and then study the revenue-sharing contract. The conclusion shows that a revenue-sharing contract can coordinate the supply chain by setting up a rational revenue-sharing ratio and wholesale price, telecom operators and resale operators can achieve a “win-win” solution.

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Biographies: Zheng Huili (1964—), female, graduate; Da Qingli (corresponding author), male, professor, dql@public1.ppt.js.cn.

1 Telecom Resale Service Supply Chain Model

Only one telecom service, one telecom operator and one resale operator are considered. Also we take into account two means of selling and serving: one is that the telecom operator provides sales and service to the customer directly, another is that the resale operator provides sales and service to the customer. Apparently the resale operator needs the basic network platform provided by the telecom operator. So, the relationship between the telecom operator and resale operator is not generally a supplier-customer relationship. Actually their relationship is not only the supply relationship between upstream party and downstream party, but also a competitive relationship in the same layer. The telecom resale service supply chain model defined in this paper is shown in Fig.1.

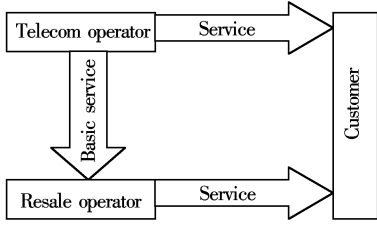


Fig.1 Telecom resale supply chain model

For the model, at first we define a one-period problem. In this period, let q be the telecom operator's total capacity of the service. Let q_1 be the portfolio provided to the customer by the telecom operator, and let q_2 be portfolio resold to the resale operator.

In the given period, let random variables X and Y be demands of the telecom operator and the resale operator; usually, X and Y are relative, so let the two dimensional random variable (X, Y) be the customer's total demand; let $F(x, y) (x \geq 0, y \geq 0)$ be the distribution function of demand; $F(x, y)$ is differentiable about x and y , and $f(x, y)$ is its density function; marginal density function and marginal distribution function about X are $f_x(x)$ and $F_X(x)$; correspondingly, the functions about Y are $f_y(y)$ and $F_Y(y)$.

Let c_0 be the telecom operator's per unit service cost, if the telecom operator provides service directly, cost of sales and service per unit is c_1 , selling price per unit is p_1 ; if the resale operator provides sales and service, cost of sales and service per unit is c_2 , selling price per unit is p_2 .

Other symbols are defined as follows: T is the payment from resale operator to telecom operator; μ_x is the average value of the telecom operator's service demand, $\mu_x = \int_0^\infty x f_x(x) dx$; μ_y is the average value of the

resale operator's service demand, $\mu_y = \int_0^\infty y f_y(y) dy$; $S_1(q_1)$ is the average value of telecom operator's sales, $S_1(q_1) = E(\min(q_1, X)) = q_1 - \int_0^{q_1} F_X(x) dx$; $S_2(q_2)$ is the average value of resale operator's sales, $S_2(q_2) = E(\min(q_2, Y)) = q_2 - \int_0^{q_2} F_Y(y) dy$; $\Omega_1(q_1, q_2)$ is the telecom operator's profit function; $\Omega_2(q_1, q_2)$ is the resale operator's profit function; $\Omega(q_1, q_2)$ is the telecom resale service supply chain's profit function.

The telecom operator's profit function is

$$\Omega_1(q_1, q_2) = T + p_1 S_1(q_1) - c_0(q_1 + q_2) - c_1 q_1 \quad (1)$$

where the first two items are telecom operator's revenues, the last two are telecom operator's costs. The first revenue is telecom operator's resale profit and the second one is his own profit. The first cost is telecom operator's total production cost and the second one is his sales and service cost.

The resale operator's profit function is

$$\Omega_2(q_1, q_2) = p_2 S_2(q_2) - T - c_2 q_2 \quad (2)$$

So the telecom resale service supply chain's profit function is

$$\Omega(q_1, q_2) = p_1 S_1(q_1) + p_2 S_2(q_2) - c_0(q_1 + q_2) - c_1 q_1 - c_2 q_2 \quad (3)$$

2 Revenue-Sharing Contract

Let the telecom operator's fixed resale wholesale price per unit be $w (w > 0)$, $(1 - \varphi)$ is the fraction of revenue which the resale operator pays to the telecom operator. Then $T = w q_2 + (1 - \varphi) p_2 S_2(q_2)$.

From Eqs.(1) and (2), the telecom operator's and resale operator's profit functions are

$$\Omega_1(q_1, q_2) = w q_2 + (1 - \varphi) p_2 S_2(q_2) + p_1 S_1(q_1) - c_0(q_1 + q_2) - c_1 q_1 \quad (4)$$

$$\Omega_2(q_2) = \varphi p_2 S_2(q_2) - w q_2 - c_2 q_2 \quad (5)$$

2.1 Decision of supply chain's maximal profit

$F(x, y)$ is differentiable about x and y , and from Eq.(3), $\Omega(q_1, q_2)$ is strictly concave about q_1 and q_2 , so there must exist a unique (q_1^*, q_2^*) that maximizes the supply chain's profit.

Let

$$\frac{\partial \Omega(q_1^*, q_2)}{\partial q_1} = p_1 [1 - F_X(q_1^*)] - c_0 - c_1 = 0$$

Therefore

$$q_1^* = F_X^{-1} \left(1 - \frac{c_0 + c_1}{p_1} \right) \quad (6)$$

Let

$$\frac{\partial \Omega(q_1, q_2^*)}{\partial q_2} = p_2 [1 - F_Y(q_2^*)] - c_0 - c_2 = 0$$

Therefore

$$q_2^* = F_Y^{-1} \left(1 - \frac{c_0 + c_2}{p_2} \right) \quad (7)$$

The above shows that when the telecom operator holds service quantity q_1^* and the resale operator holds service quantity q_2^* , the supply chain can be **coordinated and the profit maximized**.

2.2 Decision of resale operator's maximal profit

$F(x, y)$ is differentiable about x and y , and from Eq.(5), $\Omega_2(q_2)$ is strictly concave about q_2 , so there must exist a unique q_2^* that maximizes the resale operator's profit.

Let

$$\frac{\partial \Omega_2(q_2^*)}{\partial q_2} = \varphi p_2 [1 - F_Y(q_2^*)] - w - c_2 = 0$$

Therefore

$$q_2^* = F_Y^{-1} \left(1 - \frac{w + c_2}{\varphi p_2} \right) \quad (8)$$

where q_2^* is the optimal quantity which the resale operator hopes to buy.

2.3 Decision of telecom operator's maximal profit

$F(x, y)$ is differentiable about x and y , and from Eq.(4), $\Omega_1(q_1, q_2)$ is strictly concave about q_1 and q_2 , so there must exist a unique (q_1^*, q_2^*) that maximizes the telecom operator's profit.

Let

$$\frac{\partial \Omega_1(q_1^*, q_2)}{\partial q_1} = p_1 [1 - F_X(q_1^*)] - c_0 - c_1 = 0$$

Therefore

$$q_1^* = F_X^{-1} \left(1 - \frac{c_0 + c_1}{p_1} \right) \quad (9)$$

Let

$$\frac{\partial \Omega_1(q_1, q_2^*)}{\partial q_2} = w + (1 - \varphi) p_2 \cdot [1 - F_Y(q_2^*)] - c_0 = 0$$

Therefore

$$q_2^* = F_Y^{-1} \left[1 - \frac{c_0 - w}{(1 - \varphi) p_2} \right] \quad (10)$$

where (q_1^*, q_2^*) are the optimal quantities which **the telecom operator hopes to sell and resell**.

2.4 Analysis of the revenue-sharing contract coordination

Clearly, if $q_2^* = q_2^{1*} = q_2^{2*}$, then the telecom operator, resale operator and the supply chain can all get optimal profit. This contract can coordinate the supply chain. From Eqs. (7), (8), and (10), to coordinate the supply chain the contract's two parameters must satisfy

$$w = \varphi c_0 - (1 - \varphi) c_2 \quad w > 0 \quad (11)$$

From Eq.(11),

1) When $w = c_0$, $\varphi = 1$, and from Eqs.(4) and (5),

$$\Omega_1(q_1^*, q_2^*) = p_1 S_1(q_1^*) - (c_0 + c_1) q_1^* \quad (12)$$

$$\Omega_2(q_2^*) = p_2 S_2(q_2^*) - (c_0 + c_2) q_2^* \quad (13)$$

Now, the revenue-sharing contract reverts to the easiest wholesale price contract; the telecom operator resells service to the resale operator only at the wholesale price; the resale operator earns all his income; the supply chain cannot be coordinated.

2) When $w = 0$, $\varphi = c_2 / (c_0 + c_2)$ is the smallest possible value.

Hence, to coordinate the supply chain, the revenue-sharing contract's parameters must satisfy:

$$w \in [0, c_0], \varphi \in [c_2 / (c_0 + c_2), 1)$$

Meanwhile, the telecom operator and resale operator's profits are:

$$\begin{aligned} \Omega_1(q_1^*, q_2^*) &= w q_2^* + (1 - \varphi) p_2 S_2(q_2^*) + \\ & p_1 S_1(q_1^*) - c_0(q_1^* + q_2^*) - c_1 q_1^* = \\ & (1 - \varphi) [p_2 S_2(q_2^*) - (c_0 + c_2) q_2^*] + \\ & [p_1 S_1(q_1^*) - (c_0 + c_1) q_1^*] \end{aligned} \quad (14)$$

$$\Omega_2(q_2^*) = \varphi [p_2 S_2(q_2^*) - (c_0 + c_2) q_2^*] \quad (15)$$

From Eqs.(14) and (15), telecom operator's profit is composed of two parts; the first part comes from resale profit $(1 - \varphi)$, the rate of profit is the same as that of revenue; the second one is the total profit from running his own business.

Hence, when the telecom operator's service quantity is q_1^* , with a wholesale price $w = \varphi c_0 - (1 - \varphi) c_2$, let the resale operator provide service quantity q_2^* , so the supply chain gets maximal profit. Meanwhile telecom operator and resale operator also get maximal profit, and the revenue-sharing contract coordinates the supply chain.

Even through $0 < w < c_0$, which means that the telecom operator's resale profit is negative, but through setting a rational revenue-sharing ratio $(1 - \varphi)$, the telecom operator can obtain compensative revenue from resale profit and ultimately maximize profit through resale service. Furthermore, the bigger φ is, the smaller proportion the telecom operator earns by reselling service. And the bigger the wholesale price w is, the more risk the resale operator shares. Whereas, the smaller φ is, the bigger proportion the telecom operator earns by reselling service. And the smaller the wholesale price w is, the more risk the **resale operator shares**.

3 Conclusion

This paper discusses competition and cooperation between traditional telecom operators and resale operators in the supply chain, when the telecom

industry has developed telecommunication resale service. With a revenue-sharing contract, through a rational revenue-sharing ratio and wholesale price, the supply chain can be coordinated, and a “win-win” solution for telecom operators and resale operators can be achieved.

In the 21st century, the interior and exterior environments of the telecom industry’s development has great change. Hence the future telecom market will become more complex. More and more new service models will appear other than virtual operation, telecom resale and so on. So if telecom operators only act as a service provider in the telecom service’s industrial chains, the problem of cooperation and competition will emerge. Although this paper only investigates a revenue-sharing contract for the telecom resale supply chain, the concept can be used in more telecom services. Of course with a new service model, the model’s parameters will become more complex; accordingly, the model of this paper must be modulated and modified.

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电信业务转售收入共享合同研究

郑惠莉^{1,2} 达庆利¹ 曹爱红²

(¹ 东南大学经济管理学院, 南京 210096)
(² 南京邮电学院管理工程系, 南京 210003)

摘要: 从供应链的角度, 研究了电信业在开展转售电信业务时, 传统运营商与转售商之间的竞争与合作问题.供应链合同(契约)是实现供应链协调的一种有效方法, 本文通过对运营商与转售商之间建立收入共享合同的分析研究得到:通过收入共享比例和批发价的合理设置, 收入共享合同可以协调电信业务转售供应链, 实现运营商与转售商的“双赢”.

关键词: 电信业务转售; 供应链协调; 收入共享合同

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