

# On eBay's Fee Structure from a Channel Coordination Perspective

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**Abstract.** Can eBay.com's fee structure coordinate the channel? It's a critical strategic problem in e-commerce operations and an interesting research hypothesis as well. eBay's fees include three parts: monthly subscription fee, insertion fee, and final value fee (i.e., a revenue sharing portion), which represent a generic form of revenue sharing fee structure between the retailer and the vendor in a supply chain. This research deals with such a channel consisting of a price-setting vendor who sells products through eBay's marketplace exclusively to the end customers. The up- and down-stream channel relationship is consignment-based revenue sharing. We use a game-theoretic approach with assumption of the retailer (i.e., eBay.com) being a Stackelberg-leader and the vendor being a follower. The Stackelberg-leader decides on the terms of revenue sharing contract (i.e., fee structure), and the follower (vendor) decides on how many units to sell and the items' selling price. This study formulates several profit-maximization models by considering the effects of the retail price on the demand function. Under such settings, we show that eBay's fee structure can improve the channel efficiency; yet it cannot coordinate the channel optimally.

**Keywords:** Channel Coordination, Revenue-sharing, Consignment, Wholesale-price-only, Game Theory

## 1. INTRODUCTION

Can eBay.com's fee structure coordinate the channel effectively and optimally? It's a critical problem in internet commerce and an interesting research hypothesis as well. eBay's marketplace includes auction-style and fixed-price formats, which relies on a large amount of third-party affiliated vendors selling goods through its web-stores. The vendors decide on how many units to list and the items' selling price, and retain ownership of the goods. eBay charges vendors by collecting an up-front, lump-sum side payment and a price-dependent commission fee, i.e., the final value fee. For each item sold, eBay deducts an agree-up percentage from the revenue and remits the balance to the vendor. It is essentially a consignment contract with revenue-sharing, where the R-S percentage is a price-decreasing function. Table

1 summarizes the current final value fee as a percentage of revenue charged by eBay to its affiliated vendors for the book, music, and DVD category, where it collects 15.00% of the initial \$50.00, plus 5.00% of the initial \$50.01-\$1,000.00, plus 2.00% of the remaining closing value balance.

Motivated by such a business model, this paper intends to answer the following questions in eBay's fixed-price trading format or so-called internet catalog sales: can its fee structure coordinate the channel effectively and efficiently? Does the channel conducted by such a contractual arrangement outperform the prevalent wholesale-price-only (W-P-O) arrangement or the fixed R-S ratio practice that is well-adopted in e-retailers like Amazon.com? If not, does it persist in certain decision bias that leads to a lower profit and channel inefficiency? We model the decision-making of the two firms in a verti-

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cally separated channel as a Stackelberg leader-follower game and carry out equilibrium analysis. The downstream retailer, e.g., eBay.com, acts as the leader offering the upstream vendors a take-it-or-leave-it revenue sharing contract, which specifies the percentage allocation of sales revenue between herself and the vendor. The vendor acts as a follower who sets a self-interest retail price as a response. We assume the vendor is a price-setting firm who sells the one-of-a-kind product in the market through the exclusive channel, and the demand is price-sensitive.

**Table 1.** eBay's final value fee for the book, music, and DVD category (Source: eBay.com).

| Price                       | Final Value Fee   |
|-----------------------------|---|
| Item not sold               | No Fee  |
| \$0.01~\$50.00              | 15.00% of the closing value   |
| \$50.01~\$1,000.00          | 15.00% of the initial \$50.00, plus   |
|                             | 5.00% of the remaining closing value balance (\$50.01~1,000.00)   |
| Equal to or Over \$1,000.01 | 15.00% of the initial \$50.00, plus   |
|                             | 5.00% of the initial \$50.01~\$1,000.00, plus 2.00% of the remaining closing value balance (\$1,000.01~closing value) |

While inspired by e-commerce practices, revenue sharing is also widely adopted in a variety of industries, including the video rentals (e.g., Dana and Spier, 2001; Mortimer, 2008; Cachon and Lariviere, 2005) and the retailing with consignment contracting (Coughlan *et al.*, 2001; Turcsik, 2002). Other revenue-sharing examples can be found in the mobile networks with independent content providers (Foros *et al.*, 2009), the assembly systems with vendor-managed inventory (Gerchak and Wang, 2004), and the chain stores with franchising arrangement, e.g., fast-food, hotel, automobile rentals, and gasoline dealerships (Lal, 1990).

In what follows, we provide a review on the revenue-sharing literature, which can be broadly classified as R-S with and without consignment contracting. Under the non-consigned contract, the manufacturer offers the retailer a two-part contract  $(w, r)$  where  $0 < r < 1$ , by charging a lower wholesale price  $w$  in exchange for a  $(1 - r)$  percentage of the retailer's revenue. The retailer then determines a self-interest replenishment quantity (or a stocking factor) and/or retail price (Cachon and Lariviere, 2005; Gerchak *et al.*, 2006; Van der Veen and Venugopal, 2005; Chauhan and Proth, 2005; Koulamas, 2006; Yao *et al.*, 2008a, 2008b). Such setting with somewhat variation is widely applied in the video rentals (Dana and Spier, 2001; Mortimer, 2008; Cachon and Lariviere, 2005; Gerchak *et al.*, 2006; Van der Veen and Venugopal, 2005) and the internet content services (Foros *et al.*, 2009). The non-consigned R-S arrangement is also an effective mechanism for collaborative new product development in intercompany alliances

(Bhaskaran and Krishnan, 2009). Some work in this stream deals with agent-based negotiation systems (Giannoccaro and Pontrandolfo, 2009), three-staged supply chain (Giannoccaro and Pontrandolfo, 2004), two-period newsvendor problem (Linh and Hong, 2009), and the effect of joint adoption of R-S and advanced booking discount programs (Bellantuono *et al.*, 2009).

Under consignment contracting, the retailer offers the manufacturer an R-S percentage, and the manufacturer responds by setting the stocking quantity and/or the retail price (e.g., Gerchak and Wang, 2004; Wang *et al.*, 2004; Li and Hua, 2008; Li *et al.*, 2009; Ha and Tong, 2008; Chen *et al.*, 2009). For the manufacturer dominance setting in Ru and Wang (2010) and Pastermack (2002), the models are mathematically equivalent to the buyback or return policy in a supply chain. However, the aforementioned literature does not consider the contractual design with a price-dependent R-S ratio, which is not only theoretical advanced but more practical in internet commerce and business operation. We consider such an R-S function in the research stream. The price-dependent profit sharing model proposed by Foros *et al.* (2009) is spiritually close to our model. They dealt with the information goods in a mobile network channel with multiple independent content providers, so that the marginal variable production and retailing costs are negligible and the profit function is greatly simplified. We deals with the physical and one-of-a-kind goods, and do consider the unit variable production cost by the vendor and unit variable merchandizing cost by the retailer.

Our contribution to the literature is two folds. Firstly, the problem being studied is unique and probably is the first attempt in the revenue-sharing research. We consider a price-dependent R-S function in a vertically separated channel setting, which is also a generic version of the constant R-S models. Secondly, our analysis provides fertile managerial implications. We found the price-dependent function always underperforms than the constant R-S function, and only outperforms the traditional W-P-O model under certain conditions, e.g., a higher retailer's cost-share ratio in the channel or a lower price-sensitivity coefficient of R-S function. Our finding suggests that the more complex revenue-sharing function does not generate higher channel profit and may be unworthy of adopting.

In the remainder, we describe the problem context and a base model. Next, the mathematical models are formulated and equilibrium analyses are carried out for both the decentralization regimes with wholesale-price-only, price-independent, and price-dependent revenue-sharing contractual arrangements. Based on the analytical results, managerial implications are drawn concerning with the tendencies of decision variables and profit values generated by various channel settings. Numerical study is then carried out to quantify the analytical results. In conclusions, we summarize our research contributions and provide future research directions.

## 2. THE CENTRALIZATION MODEL

eBay's fee structure includes three parts: monthly subscription fee (from \$15.95 to \$299.95), insertion fee (from \$0.03 to \$0.10 per single listing for a 30-day duration), and final value fee (from 15.00% to 1.00% of the closing price per item, i.e., a revenue-sharing portion). The sum of the first two fees is an up-front lump-sum side-payment (transfer price), which is regardless of the transaction quantity, and the third fee is a price-decreasing function of revenue sharing. This research deals with such a channel, in which a price-setting vendor sells multiple, identical, and one-of-a-kind goods through the exclusive channel to the end customers. The up- and down-stream channel relationship is consignment-based revenue sharing.

We assume the vendor produces and distributes the goods at a constant unit variable cost of  $c_v$ , and the retailer incurs a unit variable cost of  $c_e$  for handling and merchandizing the product in the market. Let  $c = c_v + c_e$  be the total channel-wide cost per unit. We assume the function of demand rate (e.g., sales quantity per month) is price sensitive, iso-price-elastic, and multiplicative,  $Q_i(p_i) = \alpha p_i^{-\beta}$ , where  $\alpha$  is a scale parameter,  $\alpha > 0$ ,  $\beta$  is the price elasticity of the demand,  $\beta > 1$ , and the subscript  $i$  for  $i = 0, 1, 2, 3$ , represents the integrated channel ( $i=0$ ), and the decentralizations with W-P-O ( $i=1$ ), with a fixed R-S ratio ( $i=2$ ), and with a price-dependent R-S ratio arrangements ( $i=3$ ). The functional form has the following properties: the elasticity is constant, sale quantity is nonnegative, and is decreasing in price. Before presenting the mathematical models, we define and summarize the necessary notation as follows:

|               |  |
|---------------|--|
| $\alpha$      | Scale parameter of demand function, $\alpha > 0$ ,                                       |
| $\beta$       | Price elasticity of demand function, $\beta > 1$ ,                                       |
| $p_i$         | The retail price for channel strategy $i$ , $i = 0, 1, 2$ , and 3,                       |
| $Q_i$         | The sales quantity (say per month) for channel strategy $i$ , $i = 0, 1, 2$ , and 3,     |
| $w$           | The wholesale price chosen by the vendor, $w > 0$ , for strategy 1,                      |
| $\varphi$     | The revenue-sharing ratio of the retailer, $0 < \varphi < 1$ , for strategy 2,           |
| $1 - \varphi$ | The revenue-sharing ratio of the vendor for strategy 2,                                  |
| $r(p)$        | The price-dependent revenue-sharing ratio of the retailer, $0 < r < 1$ , for strategy 3, |
| $1 - r(p)$    | The price-dependent revenue-sharing ratio of the vendor, for strategy 3,                 |
| $\delta$      | Scale factor of revenue-sharing function chosen by the retailer, $\delta > 0$ ,          |
| $\gamma$      | Price-sensitivity coefficient of revenue-sharing function, $0 \leq \gamma \leq 1$ ,      |
| $\pi_{i,v}$   | Vendor's profit for strategy $i$ , $i = 1, 2, 3$ ,                                       |
| $\pi_{i,e}$   | Retailer's profit for strategy $i$ , $i = 1, 2, 3$ ,                                     |

$\Pi_i$  Channel-wide profit for strategy  $i$ ,  $i = 0, 1, 2, 3$ .

Since the main purpose behind developing various analytic models is to explore the effects of these mechanisms on channel performance, we develop the profit model for the integrated channel (i.e., strategy 0) as a benchmark. For the integrated channel, the profit function can be expressed as follows:

$$\begin{aligned} \max_{p_0} \Pi_0 &= (p_0 - c)\alpha p_0^{-\beta} \\ \text{s.t. } p_0 - c &> 0. \end{aligned} \quad (1)$$

The decision problem facing the integrated company is to determine the retail price  $p_0$  so that the channel-wide profit is maximized. The optimal price, denoted by  $p_0^*$ , can be obtained by taking the first derivative of equation (1) with respect to  $p_0$  and setting the result equal to zero:

$$p_0^* = \frac{\beta c}{\beta - 1}, \quad \text{for } \beta > 1. \quad (2)$$

**Theorem 1:** *The retail price  $p_0^*$  is a unique optimal solution of the integrated profit model.*

**Proof:** To show the optimality of the solution, we shall demonstrate that equation (1) is a unimodal function in  $p_0$ , for  $p_0 > 0$ . The first order derivative of equation (1) with respect to  $p_0$  is as follows:

$$\frac{\partial \Pi_0}{\partial p_0} = \alpha p_0^{-\beta-1} [(1 - \beta)p_0 + \beta c].$$

It is easy to prove by showing  $\partial \Pi_0 / \partial p_0 > 0$  for  $0 < p_0 < \beta c / (\beta - 1)$ , i.e.,  $\Pi_0$  is increasing, and  $\partial \Pi_0 / \partial p_0 < 0$  for  $p_0 > \beta c / (\beta - 1)$ , i.e.,  $\Pi_0$  is decreasing. Since  $\Pi_0$  is concave with respect to  $p_0$  for  $0 < p_0 < (\beta + 1)c / (\beta - 1)$ , and  $p_0^* = \beta c / (\beta - 1)$ ,  $p_0^*$  is the unique optimal solution for the integrated channel under strategy 0.  $\square$

Substituting equation (2) into (1) generates the channel-wide profit:

$$\Pi_0^* = \frac{\alpha(\beta - 1)^{\beta-1}}{\beta^\beta c^{\beta-1}}. \quad (3)$$

## 3. THE DECENTRALIZATION MODEL

We proceed to developing the models for the three decentralizations under the wholesale-price-only, fixed and price-dependent revenue-sharing contractual arrangements.

### 3.1 Strategy 1—The W-P-O Model

In this subsection, we consider a wholesale-price-only channel setting. Under such a setting, the up-stream

vendor offers a wholesale price  $w$  per item of the product to the retailer. If the retailer accepts the offer, she will set a self-interest retail price  $p_1$  to maximize her own profit. Each entity within the channel aims at optimizing its own profit function, without consideration being given to its counterpart's reaction or resulting benefits. So, we first consider the retailer's (i.e., eBay's) sub-problem:

$$\begin{aligned} \max_{p_1} \pi_{1,e} &= (p_1 - w - c_e) \alpha p_1^{-\beta}, \\ \text{s.t. } p_1 - w - c_e &> 0. \end{aligned} \quad (4)$$

The self-interest decision of the retailer, denoted by  $p_1^*$ , can be obtained by differentiating equation (4) with respect to  $p_1$  and setting the result equal to zero:

$$p_1^*(w) = \frac{\beta(w + c_e)}{\beta - 1}. \quad (5)$$

**Theorem 2:** *The retail price  $p_1^*(w)$  is a unique optimal solution of the retailer's profit model under W-P-O setting.*

**Proof:** To show the optimality of the solution, we shall demonstrate that equation (4) is a unimodal function in  $p_1$  for  $p_1 > 0$ . The first order derivative of equation (4) with respect to  $p_1$  is as follows:

$$\frac{\partial \pi_{1,e}}{\partial p_1} = \alpha(1 - \beta)p_1^{-\beta} + \alpha\beta(w + c_e)p_1^{-\beta-1}.$$

It is easy to prove that  $\partial \pi_{1,e} / \partial p_1 > 0$  for  $0 < p_1 < \beta(w + c_e) / (\beta - 1)$ , and  $\partial \pi_{1,e} / \partial p_1 < 0$  for  $p_1 > \beta(w + c_e) / (\beta - 1)$ . Since  $\pi_{1,e}$  is concave with respect to  $p_1$  for  $0 < p_1 < (\beta + 1)(w + c_e) / (\beta - 1)$ ,  $p_1^*(w) = \beta(w + c_e) / (\beta - 1)$  is the unique optimal solution for the retailer under strategy 1.  $\square$

Next, the vendor's sub-problem is given by

$$\begin{aligned} \max_w \pi_{1,v} &= (w - c_v) \alpha p_1^{-\beta}, \\ \text{s.t. } w - c_v &> 0. \end{aligned} \quad (6)$$

Substituting equation (5) into (6), the vendor's problem can be re-expressed as follows:

$$\pi_{1,v}(w) = (w - c_v) \frac{\alpha}{\beta^\beta} \left( \frac{\beta - 1}{w + c_e} \right)^\beta. \quad (7)$$

The self-interest decision of the vendor, denoted by  $w^*$ , can be obtained by differentiating equation (7) with respect to  $w$  and setting the result equal to zero:

$$w^* = \frac{\beta c_v + c_e}{\beta - 1}. \quad (8)$$

**Theorem 3:** *The wholesale price  $w^*$  is a unique opti-*

*mal solution of the vendor's profit model under W-P-O setting.*

**Proof:** To show the optimality of the solution, we shall demonstrate that equation (7) is a unimodal function in  $w$  for  $w > 0$ . The first order derivative of (7) with respect to  $w$  is as follows:

$$\frac{\partial \pi_{1,v}(w)}{\partial w} = \frac{\alpha}{\beta^\beta} \left( \frac{\beta - 1}{w + c_e} \right)^\beta - \frac{\alpha(\beta - 1)^\beta (w - c_v)}{\beta^{\beta-1} (w + c_e)^{\beta+1}}.$$

It is easy to prove that  $\partial \pi_{1,v} / \partial w > 0$  for  $0 < w < (\beta c_v + c_e) / (\beta - 1)$ , and  $\partial \pi_{1,v} / \partial w < 0$  for  $w > (\beta c_v + c_e) / (\beta - 1)$ . Since  $\pi_{1,v}$  is concave with respect to  $w$  for  $0 < w < [(\beta + 1)c_v + 2c_e] / (\beta - 1)$  and therefore  $w^* = (\beta c_v + c_e) / (\beta - 1)$  is the unique optimal solution for the vendor under strategy 1.  $\square$

Substituting equation (8) into (5) generates the optimal retail price:

$$p_1^* = \frac{\beta^2(c_v + c_e)}{(\beta - 1)^2}. \quad (9)$$

Substituting equations (8) and (9) into (6) and (4) obtains the optimal vendor's and retailer's profit, respectively, as follows:

$$\pi_{1,v}^* = \frac{\alpha(\beta - 1)^{2\beta-1}}{\beta^{2\beta}(c_v + c_e)^{\beta-1}}, \text{ and} \quad (10)$$

$$\pi_{1,e}^* = \frac{\alpha(\beta - 1)^{2\beta-2}}{\beta^{2\beta-1}(c_v + c_e)^{\beta-1}}. \quad (11)$$

Summing up equations (10) and (11) generates the channel-wide profit:

$$\Pi_1^* = \frac{\alpha(2\beta - 1)(\beta - 1)^{2\beta-2}}{\beta^{2\beta}(c_v + c_e)^{\beta-1}}. \quad (12)$$

### 3.2 Strategy 2–The Fixed R–S Model

We use a game-theoretical approach to model the decision-making of the two firms. The retailer moves first by offering the vendor a take-it-or-leave-it revenue sharing contract, and the vendor reacts by accepting or declining the offer. If the vendor accepts the offer, she will set a self-interest retail price to maximize her own profit.

The sequence of strategic movements is the retailer first then followed by the vendor. The solution procedure is in a reverse fashion, i.e., solving the vendor's price as a function of  $\phi$ , then the revenue-sharing ratio  $\phi$ . So we first consider the vendor's sub-problem as follows:

$$\begin{aligned} \max_{p_2} \pi_{2,v} &= [(1-\varphi)p_2 - c_v] \alpha p_2^{-\beta}, \\ \text{s.t. } (1-\varphi)p_2 - c_v &> 0. \end{aligned} \quad (13)$$

The self-interest decision of the vendor, denoted by  $p_2^*$ , can be obtained by differentiating equation (13) with respect to  $p_2$  and setting the result equal to zero:

$$p_2^*(\varphi) = \frac{\beta c_v}{(\beta-1)(1-\varphi)}. \quad (14)$$

**Theorem 4:** *The retail price  $p_2^*(\varphi)$  is a unique optimal solution of the vendor's profit model under Fixed R-S setting.*

**Proof:** To show the optimality of the solution, we shall demonstrate that equation (13) is a unimodal function in  $p_2$  for  $p_2 > 0$ . The first order derivative of equation (13) with respect to  $p_2$  is as follows:

$$\frac{\partial \pi_{2,v}}{\partial p_2} = \alpha p_2^{-\beta-1} [(1-\beta)(1-\varphi)p_2 + \beta c_v].$$

It is easy to show that  $\pi_{2,v}(p_2)$  is concave in  $p_2$ , if  $0 < p_2 < (\beta+1)c_v / (\beta-1)(1-\varphi)$ , where  $\pi_{2,v}(p_2)$  is increasing in  $p_2$ , if  $0 < p_2 < \beta c_v / (\beta-1)(1-\varphi)$  and decreasing in  $p_2$ , if  $p_2 > \beta c_v / (\beta-1)(1-\varphi)$ . Since  $p_2^*(\varphi) < (\beta+1)c_v / (\beta-1)(1-\varphi)$  and therefore is the unique optimal solution for the vendor under strategy 2.  $\square$

Next, the retailer's problem can be expressed as follows:

$$\max_{\varphi} \pi_{2,e} = (\varphi p_2 - c_e) \alpha p_2^{-\beta}. \quad (15)$$

Substituting equation (14) into (15), the retailer's problem can be re-expressed as follows:

$$\pi_{2,e}(\varphi) = \frac{\alpha(\beta-1)^{\beta-1}(1-\varphi)^{\beta-1}\varphi}{\beta^{\beta-1}c_v^{\beta-1}} - \frac{\alpha(\beta-1)^{\beta}(1-\varphi)^{\beta}c_e}{\beta^{\beta}c_v^{\beta}}. \quad (16)$$

The self-interest decision of the retailer, denoted by  $\varphi^*$ , can be obtained by differentiating equation (16) with respect to  $\varphi$  and setting the result equal to zero:

$$\varphi^* = \frac{c_v + (\beta-1)c_e}{\beta c_v + (\beta-1)c_e}. \quad (17)$$

**Theorem 5:** *The R-S percentage  $\varphi^*$  is a unique optimal solution of the retailer's profit model under Fixed R-S setting.*

**Proof:** To show the optimality of the solution, we shall demonstrate that equation (16) is a unimodal function in  $\varphi$  for  $\varphi > 0$ . The first and second order derivatives of equation (16) with respect to  $\varphi$  are as follows:

$$\begin{aligned} \frac{\partial \pi_{2,e}(\varphi)}{\partial \varphi} &= \frac{\alpha(\beta-1)^{\beta-1}(1-\varphi)^{\beta-2}[(1-\beta\varphi)c_v + (\beta-1)(1-\varphi)c_e]}{\beta^{\beta-1}c_v^{\beta}}, \text{ and} \\ \frac{\partial^2 \pi_{2,e}(\varphi)}{\partial \varphi^2} &= \frac{\alpha(\beta-1)^{\beta}(1-\varphi)^{\beta-3}[(\beta\varphi-2)c_v - (\beta-1)(1-\varphi)c_e]}{\beta^{\beta-1}c_v^{\beta}}. \end{aligned}$$

After some algebraic manipulations, it is easy to show that  $\pi_{2,e}(\varphi)$  is concave in  $\varphi$ , if  $0 < \varphi < [2c_v + (\beta-1)c_e] / [\beta c_v + (\beta-1)c_e]$ , where  $\pi_{2,e}(\varphi)$  is increasing in  $\varphi$ , if  $0 < \varphi < [c_v + (\beta-1)c_e] / [\beta c_v + (\beta-1)c_e]$  and decreasing in  $\varphi$ , if  $\varphi > [c_v + (\beta-1)c_e] / [\beta c_v + (\beta-1)c_e]$ . Since  $\varphi^* < [2c_v + (\beta-1)c_e] / [\beta c_v + (\beta-1)c_e]$  and therefore is the unique optimal solution for the retailer under strategy 2.  $\square$

Substituting equation (17) into (14) generates the optimal retail price:

$$p_2^* = \frac{\beta[\beta c_v + (\beta-1)c_e]}{(\beta-1)^2}. \quad (18)$$

Substituting equations (17) and (18) into (13) and (15) obtains the optimal vendor's and retailer's profit, respectively, as follows:

$$\pi_{2,v}^* = \frac{\alpha(\beta-1)^{2\beta-1}c_v}{\beta^{\beta}[\beta c_v + (\beta-1)c_e]^{\beta}}, \text{ and} \quad (19)$$

$$\pi_{2,e}^* = \frac{\alpha(\beta-1)^{2\beta-2}}{\beta^{\beta}[\beta c_v + (\beta-1)c_e]^{\beta-1}}. \quad (20)$$

Summing up equations (19) and (20) generates the channel-wide profit:

$$\Pi_2^* = \frac{\alpha(\beta-1)^{2\beta-2}[(2\beta-1)c_v + (\beta-1)c_e]}{\beta^{\beta}[\beta c_v + (\beta-1)c_e]^{\beta}}. \quad (21)$$

### 3.3 Strategy 3-The Price-Dependent R-S Model

In this subsection, we use a game-theoretical approach with assumption of the retailer, e.g., eBay.com, being a channel-leader and the vendor being a follower. The Stackelberg leader decides on the terms of revenue sharing contract (i.e., fee structure), and the follower decides on how many units to sell and the item's selling price. The price-decreasing R-S function can be represented as follows:

$$\begin{aligned} r(\delta, p_3) &= 1 - \delta p_3^{\gamma}, \\ \text{s.t. } 0 < r(\delta, p_3) &< 1, \text{ and } \delta > 0, \end{aligned} \quad (22)$$

where  $\delta > 0$  is the scale parameter, and  $\gamma$  is the price-sensitivity coefficient of revenue-sharing function,  $0 \leq \gamma \leq 1$ . The price-dependent function (22) is a mimic of eBay's final value fee (see Table 1). It is because eBay's step-ladder form is in-differentiable, while our mimic form is differentiable which can facilitate further mathe-

mathematical manipulations and analyses. Therefore, the vendor's R-S percentage is  $1-r(\delta, p_3) = \delta p_3^\gamma$ , and its profit function can be expressed as follows:

$$\begin{aligned} \max_{p_3} \pi_{3,v} &= [(1-r)p_3 - c_v] \alpha p_3^{-\beta}, \\ \text{s.t. } (1-r)p_3 - c_v &> 0, \text{ and sign restrictions.} \end{aligned} \quad (23)$$

Substituting equation (22) into (23), the vendor's problem can be re-expressed as follow:

$$\pi_{3,v} = [\delta p_3^{1+r} - c_v] \alpha p_3^{-\beta}. \quad (24)$$

The self-interest decision of the vendor, denoted by  $p_3^*$ , can be obtained by differentiating equation (24) with respect to  $p_3$  and setting the result equal to zero:

$$p_3^*(\delta) = \left( \frac{\beta c_v}{(\beta - \gamma - 1)\delta} \right)^{1/(1+\gamma)}, \text{ for } \beta - \gamma - 1 > 0. \quad (25)$$

**Theorem 6:** *The retail price  $p_3^*(\delta)$  is a unique optimal solution of the vendor's profit model under price-dependent R-S setting.*

**Proof:** To show the optimality of the solution, we shall demonstrate that equation (24) is a unimodal function in  $p_3$  for  $p_3 > 0$ . The first and second order derivatives of equation (24) with respect to  $p_3$  are as follows:

$$\begin{aligned} \frac{\partial \pi_{3,v}}{\partial p_3} &= -\alpha(\beta - \gamma - 1)\delta p_3^{\gamma-\beta} + \alpha\beta c_v p_3^{-\beta-1}, \text{ and} \\ \frac{\partial^2 \pi_{3,v}}{\partial p_3^2} &= \alpha p_3^{-\beta-2} [(\beta - \gamma)(\beta - \gamma - 1)\delta p_3^{1+\gamma} - \beta(\beta + 1)c_v]. \end{aligned}$$

After some algebraic manipulations, it is easy to show that  $\pi_{3,v}(p_3)$  is concave in  $p_3$ , if  $0 < p_3 < ([\beta(\beta+1)c_v]/[(\beta-\gamma)(\beta-\gamma-1)\delta])^{1/(1+\gamma)}$  where  $\pi_{3,v}(p_3)$  is increasing in  $p_3$  if  $0 < p_3 < ([\beta c_v]/[(\beta-\gamma-1)\delta])^{1/(1+\gamma)}$  and decreasing in  $p_3$  if  $p_3 > ([\beta c_v]/[(\beta-\gamma-1)\delta])^{1/(1+\gamma)}$ . Since  $p_3^*(\delta) < ([\beta(\beta+1)c_v]/[(\beta-\gamma)(\beta-\gamma-1)\delta])^{1/(1+\gamma)}$  and therefore it is the unique optimal solution for the vendor under strategy 3.  $\square$

Next, the retailer's sub-problem is given by

$$\max_r \pi_{3,r} = (rp_3 - c_e) \alpha p_3^{-\beta}, \quad (26)$$

s.t.  $rp_3 - c_e > 0$ , and sign restrictions.

Substituting equations (22) and (25) into (26), the retailer's problem can be re-expressed as follows:

$$\pi_{3,r}(\delta) = \{[1 - \delta(p_3^*(\delta))^\gamma] p_3^*(\delta) - c_e\} \alpha (p_3^*(\delta))^{-\beta}. \quad (27)$$

The self-interest decision of the retailer, denoted by  $\delta^*$ , can be obtained by differentiating equation (27) with respect to  $\delta$  and setting the result equal to zero, which

induces

$$\beta c_e + \left( \frac{\beta c_v}{\delta(\beta - \gamma - 1)} \right)^{1+\gamma} \left[ 1 - \beta + \delta \beta \left( \frac{\beta c_v}{\delta(\beta - \gamma - 1)} \right)^{\frac{\gamma}{1+\gamma}} \right] = 0.$$

Since the second order differentiation of (27) is strictly less than zero, that is,  $\partial^2 \pi_{3,r}(\delta) / \partial \delta^2 < 0$  provided  $\delta > \bar{\delta}$ , where

$$\bar{\delta} = \frac{(\beta - 1)^{1+\gamma} (\beta - \gamma - 2)^{1+\gamma} c_v}{\beta^\gamma [\beta c_v + (\beta - \gamma - 1)c_e]^{1+\gamma}}.$$

After some algebraic manipulations we have

$$\delta^* = \frac{(\beta - 1)^{1+\gamma} (\beta - \gamma - 1)^\gamma c_v}{\beta^\gamma [\beta c_v + (\beta - \gamma - 1)c_e]^{1+\gamma}}. \quad (28)$$

**Theorem 7:** *The R-S scale factor  $\delta^*$  is a unique optimal solution of the retailer's profit model under price-dependent R-S setting.*

**Proof:** To show the optimality of the solution, we shall demonstrate that equation (27) is concave in  $\delta$ , i.e., the second order sufficient condition of (27) is strictly less than zero. After some algebraic manipulations, we can show that  $\pi_{3,r}(\delta)$  is concave in  $\delta$  if it is greater than  $\bar{\delta}$ , where  $\pi_{3,r}(\delta)$  is increasing in  $\delta$  if  $0 < \delta < \delta^*$  and decreasing in  $\delta$  if  $\delta > \delta^*$ . Since  $\delta^* > \bar{\delta}$  and therefore it is the unique optimal solution for the retailer under strategy 3.  $\square$

Substituting equation (28) into (22) and (25) obtains the optimal revenue sharing and retail price respectively:

$$r^* = \frac{c_v + (\beta - \gamma - 1)c_e}{\beta c_v + (\beta - \gamma - 1)c_e}, \text{ and} \quad (29)$$

$$p_3^* = \frac{\beta [\beta c_v + (\beta - \gamma - 1)c_e]}{(\beta - 1)(\beta - \gamma - 1)}. \quad (30)$$

Substituting equations (29) and (30) into (23), and (26) obtains the optimal vendor's and retailer's profit, respectively, as follows:

$$\pi_{3,v}^* = \frac{\alpha(1+\gamma)(\beta-1)^\beta (\beta-\gamma-1)^{\beta-1} c_v}{\beta^\beta [\beta c_v + (\beta-\gamma-1)c_e]^\beta}, \text{ and} \quad (31)$$

$$\pi_{3,e}^* = \frac{\alpha(\beta-1)^{\beta-1} (\beta-\gamma-1)^{\beta-1}}{\beta^\beta [\beta c_v + (\beta-\gamma-1)c_e]^{\beta-1}}. \quad (32)$$

Summing up equations (31) and (32) generates the channel-wide profit:

$$\Pi_3^* = \frac{\alpha(\beta-1)^{\beta-1} (\beta-\gamma-1)^{\beta-1} [(2\beta + \beta\gamma - \gamma - 1)c_v + (\beta - \gamma - 1)c_e]}{\beta^\beta [\beta c_v + (\beta - \gamma - 1)c_e]^\beta} \quad (33)$$

#### 4. ANALYSIS

In what follows, we summarize analytic findings that characterize various properties of the decisions and corresponding optimal profit values generated by the four strategies. Based on the analysis, some managerial implications are addressed.

**Proposition 1:** Assuming that  $\beta > 1$ ,  $0 \leq \gamma \leq 1$ , and  $\beta - \gamma - 1 > 0$ , the optimal decisions generated by the four strategies persist in the following sequence: (i)  $p_0^* < p_2^* < p_3^* < p_1^*$  when  $c_e / c_v > \beta\gamma / (\beta - \gamma - 1)$ , (ii)  $p_0^* < p_2^* < p_1^* < p_3^*$  when  $c_e / c_v < \beta\gamma / (\beta - \gamma - 1)$ , and (iii)  $p_0^* < p_2^* < p_3^* = p_1^*$  when  $c_e / c_v = \beta\gamma / (\beta - \gamma - 1)$ .

**Proof:** To prove part (i), we subtract equation (30) from (9) to verify  $p_1^* - p_3^* > 0$ , for  $\beta > 1$ ,  $0 \leq \gamma \leq 1$ , and  $\beta - \gamma - 1 > 0$ . The equation can be re-expressed as follows:

$$\frac{\beta^2(c_v + c_e)}{(\beta - 1)^2} - \frac{\beta[\beta c_v + (\beta - \gamma - 1)c_e]}{(\beta - 1)(\beta - \gamma - 1)} > 0,$$

only if  $c_e / c_v > \beta\gamma / (\beta - \gamma - 1)$ . Obviously,  $p_2^* - p_0^* > 0$  by comparing equations (2) and (18) and, it is not difficult to show that both  $p_1^*$  and  $p_3^*$  are larger than  $p_2^*$ . So, part (i) is proved. Parts (ii) and (iii) can be proved easily in a similar fashion.  $\square$

The proposition suggests that the pricing decision generated by strategies 1 and 3 are closely related to the values of parameters  $\beta$ ,  $\gamma$ ,  $c_v$ , and  $c_e$ . Given  $c_e / c_v > \beta\gamma / (\beta - \gamma - 1)$ , the retail price generated by strategy 1 is greater than that by strategy 3. Contrarily, the retail price generated by strategy 1 is less given  $c_e / c_v < \beta\gamma / (\beta - \gamma - 1)$ . If  $c_e / c_v = \beta\gamma / (\beta - \gamma - 1)$ , the two strategies will generate identical pricing solutions. In all circumstances, the integrated channel produces the smallest retail price; while the decentralization with a fixed R-S ratio produces the second smallest price.

**Proposition 2:** Assuming that  $\beta > 1$ ,  $0 \leq \gamma \leq 1$ , and  $\beta - \gamma - 1 > 0$ , the optimal channel-wide profits produced by the four strategies persist in the following sequence: (i)  $\Pi_0^* > \Pi_2^* > \Pi_3^* > \Pi_1^*$  when  $c_e / c_v > \beta\gamma / (\beta - \gamma - 1)$ , (ii)  $\Pi_0^* > \Pi_2^* > \Pi_1^* > \Pi_3^*$  when  $c_e / c_v < \beta\gamma / (\beta - \gamma - 1)$ , and (iii)  $\Pi_0^* > \Pi_2^* > \Pi_3^* = \Pi_1^*$  when  $c_e / c_v = \beta\gamma / (\beta - \gamma - 1)$ .

**Proof:** Since we have proved that equation (1) is a unimodal function in  $p_0 > 0$  in Theorem 1, and also have shown that the optimal price for policy  $i$ ,  $i = 0, 1, 2$ , and  $3$ , is ordered by  $p_0^* < p_2^* < p_3^* < p_1^*$  in Proposition 1, the channel-wide profits is ordered by  $\Pi_0^* > \Pi_2^* > \Pi_3^* > \Pi_1^*$  when  $c_e / c_v > \beta\gamma / (\beta - \gamma - 1)$ . So, part (i) is proved. Similar arguments can be applied to parts (ii) and (iii).  $\square$

The profit values produced by the four strategies is a result of Theorem 1 and Proposition 1, in which strategies 1 and 3 will generate identical profit values if the condition  $c_e / c_v = \beta\gamma / (\beta - \gamma - 1)$  is met. It is worthy of noting that our price-dependent R-S model can be simplified into a fixed R-S model by substituting  $\gamma = 0$  into equations (29)–(33). In other words, our R-S model is a generic version of the fixed R-S models.

Based on the analysis given in Propositions 1 and 2, it is clear that the price-dependent R-S model underperforms than that of the fixed R-S model. Therefore, it is unworthy to adopting such a more complex while less efficient model. We summarize the managerial implications into the following two corollaries.

**Corollary 1:** Assuming that  $\beta > 1$ ,  $0 \leq \gamma \leq 1$ , and  $\beta - \gamma - 1 > 0$ , the following sequences of the optimal decisions and channel-wide profits holds:

- (i)  $p_0^* < p_2^* < p_3^*$ , and  $\Pi_0^* > \Pi_2^* > \Pi_3^*$ , and
- (ii)  $p_0^* < p_2^* < p_1^*$ , and  $\Pi_0^* > \Pi_2^* > \Pi_1^*$ .

The corollary suggests that the integrated strategy always outperforms the others, and the decentralization with a fixed R-S percentage is the second best in all circumstances. In what follows, we will characterize the performance between the W-P-O and the price-dependent R-S strategies by comparing the values of  $\gamma$  and  $(\beta - 1)c_e / (\beta c_v + c_e)$ .

**Corollary 2:** Assuming that  $\beta > 1$ ,  $0 \leq \gamma \leq 1$ , and  $\beta - \gamma - 1 > 0$ , the comparisons of the optimal decisions and channel-wide profits of strategies 1 and 3 are dependent on the price-sensitivity coefficient of R-S function,  $\gamma$ :

- (i)  $p_1^* > p_3^*$ , and  $\Pi_1^* < \Pi_3^*$ ,  
when  $\gamma < (\beta - 1)c_e / (\beta c_v + c_e)$ ,
- (ii)  $p_1^* < p_3^*$ , and  $\Pi_1^* > \Pi_3^*$ ,  
when  $\gamma > (\beta - 1)c_e / (\beta c_v + c_e)$ , and
- (iii)  $p_1^* = p_3^*$ , and  $\Pi_1^* = \Pi_3^*$ ,  
when  $\gamma = (\beta - 1)c_e / (\beta c_v + c_e)$ .

#### 5. NUMERICAL STUDY

In this section we report on a numerical study conducted to quantify our analytic findings, and more importantly, to attend managerial insights into the decision tendencies and channel efficiencies associated with the four strategies.

##### 5.1 The Base Case

In the underlying base case, we assume the values of major parameters as follows: the demand parameters  $\alpha = 6,000$  and  $\beta = 2.1$ , the price sensitivity coefficient of R-S ratio  $\gamma = 0.2$ , the cost parameters  $c_v = 5$ , and  $c_e = 3$ , and the channel-wide cost  $c = 8$ . Our setting im-

plies that the maximum potential market magnitude is 6,000, a high price elastic coefficient 2.1, and a larger portion of production variable cost at 0.625. Table 2 summarizes the numerical results generated by the four strategies.

**Table 2.** Numerical results of the base case.

| Strategy 0        | Strategy 1           | Strategy 2           | Strategy 3           |
|-------------------|----------------------|----------------------|----------------------|
| $\Pi_0^* = 142.4$ | $\Pi_1^* = 106.6$    | $\Pi_2^* = 121.4$    | $\Pi_3^* = 109.7$    |
|                   | $\pi_{1,v}^* = 36.6$ | $\pi_{2,v}^* = 34.6$ | $\pi_{3,v}^* = 36.6$ |
|                   | $\pi_{1,e}^* = 70.0$ | $\pi_{2,e}^* = 86.8$ | $\pi_{3,e}^* = 73.1$ |
| $p_0^* = 15.3$    | $p_1^* = 29.2$       | $p_2^* = 24.0$       | $p_3^* = 28.0$       |
| $Q_0^* = 19.6$    | $Q_1^* = 5.0$        | $Q_2^* = 7.6$        | $Q_3^* = 5.5$        |
|                   | $w^* = 12.3$         | $\varphi^* = 0.60$   | $r^* = 0.58$         |

**Table 3a.** Numerical results for  $\beta\gamma / (\beta - \gamma - 1) = 0.4667$ .

| $c_e / c_v$ | $w$  | $\varphi$ | $r$  | $p_0$ | $p_1$ | $p_2$ | $p_3$ |
|-------------|------|-----------|------|-------|-------|-------|-------|
| 0.14        | 14.3 | 0.51      | 0.51 | 15.3  | 29.2  | 27.4  | 33.1  |
| 0.23        | 13.8 | 0.53      | 0.52 | 15.3  | 29.2  | 26.6  | 31.8  |
| 0.33        | 13.3 | 0.55      | 0.54 | 15.3  | 29.2  | 25.7  | 30.5  |
| 0.45        | 12.8 | 0.58      | 0.56 | 15.3  | 29.2  | 24.8  | 29.3  |
| 0.60        | 12.3 | 0.60      | 0.58 | 15.3  | 29.2  | 24.0  | 28.0  |
| 0.78        | 11.8 | 0.63      | 0.61 | 15.3  | 29.2  | 23.1  | 26.7  |
| 1.00        | 11.3 | 0.66      | 0.63 | 15.3  | 29.2  | 22.2  | 25.5  |
| 1.29        | 10.8 | 0.69      | 0.66 | 15.3  | 29.2  | 21.3  | 24.2  |
| 1.67        | 10.3 | 0.72      | 0.69 | 15.3  | 29.2  | 20.5  | 22.9  |

**Table 3b.** Numerical results for  $\beta\gamma / (\beta - \gamma - 1) = 0.4667$ .

| $c_e / c_v$ | $\Pi_0$ | $\Pi_1$ | $\Pi_2$ | $\Pi_3$ |
|-------------|---------|---------|---------|---------|
| 0.14        | 142.4   | 106.6   | 111.3   | 96.9    |
| 0.23        | 142.4   | 106.6   | 113.7   | 99.9    |
| 0.33        | 142.4   | 106.6   | 116.3   | 103.0   |
| 0.45        | 142.4   | 106.6   | 118.8   | 106.3   |
| 0.60        | 142.4   | 106.6   | 121.4   | 109.7   |
| 0.78        | 142.4   | 106.6   | 124.1   | 113.2   |
| 1.00        | 142.4   | 106.6   | 126.7   | 116.9   |
| 1.29        | 142.4   | 106.6   | 129.4   | 120.7   |
| 1.67        | 142.4   | 106.6   | 132.0   | 124.6   |

In the base case, the integrated channel generates, as expected, the lowest price at  $p_0^* = \$15.3$ , the largest sales quantity at  $Q_0^* = 19.6$ , and the highest channel profit at  $\Pi_0^* = \$142.4$ . It represents the maximum profit that can be possibly generated by the channel, and will be used as the benchmark to evaluating the performances of various decentralizations. Among the three decentralizations, the fixed R-S model (i.e., strategy 2) produces

the smallest retail price at  $p_2^* = 24$  and the highest channel-wide profit at  $\Pi_2^* = \$121.4$ . The profit generated by eBay’s price-dependent R-S model barely outperforms that of the W-P-O model:  $\Pi_3^* = \$109.7$  versus  $\Pi_1^* = \$106.6$ . In brief, eBay’s model can only outperform the traditional W-P-O model under our settings, and always underperforms than that of the integrated and the fixed R-S model in all circumstances.

Since the performance of eBay’s model exclusively depends on the magnitudes of  $c_e / c_v$ , and  $\beta\gamma / (\beta - \gamma - 1)$ , we carried out another numerical study to elaborate it by changing the ratio of  $c_e / c_v$ , while keeping the magnitude of  $\beta\gamma / (\beta - \gamma - 1) = 0.4667$  as constant. The numerical results are summarized in Table 3. It reveals that  $p_3^* > p_1^*$  and  $\Pi_3^* < \Pi_1^*$  for  $c_e / c_v < \beta\gamma / (\beta - \gamma - 1) = 0.4667$ , and  $p_3^* < p_1^*$  and  $\Pi_3^* > \Pi_1^*$  for  $c_e / c_v > 0.4667$ .

According to Corollary 2, the performance of eBay’s model depends on the magnitudes of  $\gamma$  and  $(\beta - 1)c_e / (\beta c_v + c_e)$ . In doing so, we compute the values of  $(\beta - 1)c_e / (\beta c_v + c_e)$  from Table 3a and Table 3b, while keeping the magnitude of  $\gamma = 0.2$  as constant, which generates Table 4a and Table 4b. The rearranged table clarifies the performance between the two strategies:  $p_1^* > p_3^*$  and  $\Pi_1^* < \Pi_3^*$  for  $\gamma < (\beta - 1)c_e / (\beta c_v + c_e)$ , and  $p_1^* < p_3^*$  and  $\Pi_1^* > \Pi_3^*$  for  $\gamma > (\beta - 1)c_e / (\beta c_v + c_e)$ .

**Table 4a.** Numerical results.

| $\gamma$ | $(\beta - 1)c_e / (\beta c_v + c_e)$ | $p_1$ | $p_3$ | Result          |
|----------|--------------------------------------|-------|-------|-----------------|
| 0.2      | 0.070                                | 29.2  | 33.1  | $p_1^* < p_3^*$ |
| 0.2      | 0.109                                | 29.2  | 31.8  | $p_1^* < p_3^*$ |
| 0.2      | 0.151                                | 29.2  | 30.5  | $p_1^* < p_3^*$ |
| 0.2      | 0.196                                | 29.2  | 29.3  | $p_1^* < p_3^*$ |
| 0.2      | 0.244                                | 29.2  | 28.0  | $p_1^* > p_3^*$ |
| 0.2      | 0.297                                | 29.2  | 26.7  | $p_1^* > p_3^*$ |
| 0.2      | 0.355                                | 29.2  | 25.5  | $p_1^* > p_3^*$ |
| 0.2      | 0.418                                | 29.2  | 24.2  | $p_1^* > p_3^*$ |
| 0.2      | 0.487                                | 29.2  | 22.9  | $p_1^* > p_3^*$ |

**Table 4b.** Numerical results.

| $\gamma$ | $(\beta - 1)c_e / (\beta c_v + c_e)$ | $\Pi_1$ | $\Pi_3$ | Result              |
|----------|--------------------------------------|---------|---------|---------------------|
| 0.2      | 0.070                                | 106.6   | 96.9    | $\Pi_1^* > \Pi_3^*$ |
| 0.2      | 0.109                                | 106.6   | 99.9    | $\Pi_1^* > \Pi_3^*$ |
| 0.2      | 0.151                                | 106.6   | 103.0   | $\Pi_1^* > \Pi_3^*$ |
| 0.2      | 0.196                                | 106.6   | 106.3   | $\Pi_1^* > \Pi_3^*$ |
| 0.2      | 0.244                                | 106.6   | 109.7   | $\Pi_1^* < \Pi_3^*$ |
| 0.2      | 0.297                                | 106.6   | 113.2   | $\Pi_1^* < \Pi_3^*$ |
| 0.2      | 0.355                                | 106.6   | 116.9   | $\Pi_1^* < \Pi_3^*$ |
| 0.2      | 0.418                                | 106.6   | 120.7   | $\Pi_1^* < \Pi_3^*$ |
| 0.2      | 0.487                                | 106.6   | 124.6   | $\Pi_1^* < \Pi_3^*$ |



## 6. CONCLUSION

This paper deals with an emerging research of managing a vendor-buyer channel with consignment and revenue sharing. We have carried out equilibrium analysis for the centralization and the decentralization regimes with W-P-O and R-S policies. As we have proved that the decentralization with a price-dependent R-S function, e.g., eBay's fee structure, leads to a less profit and lower channel efficiency. It is due to the decision bias set by the vertically separated channel participants; the vendor tends to set a higher price and the retailer tends to sale less quantity. The problem can be rectified significantly by choosing a price-independent R-S function, which leads to a much higher profit and channel efficiency.

Our research contributes to the literature by conducting theoretic research work, and probably being the first work, with a focus on investigating the fix-price trading format of eBay's marketplace from a channel coordination perspective. We believe that our models provide a good starting point in the revenue sharing research. Future direction may be aimed at considering more general demand functions, multiple retailers and/or multiple vendors with competition, information asymmetry, Pareto improvement issue, and maybe the special form of a time-dependent R-S function, which is widely adopted in the movie industry (see Eliashberg *et al.*, 2001 for details).

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## REFERENCES

- Bellantuono, N., Giannoccaro, I., Pontrandolfo, P., and Tang C. S. (2009), The implications of joint adoption of revenue sharing and advance booking discount programs, *International Journal of Production Economics*, **121**(2), 383-394.
- Bhaskaran, S. R. and Krishnan, V. (2009), Effort, revenue, and cost sharing mechanisms for collaborative new product development, *Management Science*, **55**(7), 1152-1169.
- Cachon, G. P. and Lariviere, M. A. (2005), Supply chain coordination with revenue-sharing contracts: strengths and limitations, *Management Science*, **51**(1), 30-44.
- Chauhan, S. S. and Proth, J. M. (2005), Analysis of a supply chain partnership with revenue sharing, *International Journal of Production Economics*, **97**(1), 44-51.
- Chen, J. M., Cheng, H. L., Wang, T. Y., and Chien, M. C. (2009), On channel coordination under revenue sharing contract: can eBay's fee structure coordinate the channel? *Proceedings of the APIEMS Conference, Kitakyushu, Japan*, 10-18.
- Coughlan, A. T., Anderson, E., Stern, L. W. and El-Ansary, A. I. (2001), *Marketing Channels*, sixth edition, Prentice Hall, New Jersey.
- Dana, J. D. and Spier, K. E. (2001), Revenue sharing and vertical control in the video rental industry, *The Journal of Industrial Economics*, **49**(3), 223-245.
- Eliashberg, J., Swami, S., Weinberg, C. B., and Wierenga, B. (2001), Implementing and evaluating silver-screen: a marketing management support system for movie exhibitors, *Interfaces*, **31**(3), 108-127.
- Foros, Ø., Hagen, K. P., and Kind, H. J. (2009), Price-dependent profit sharing as a channel coordination device, *Management Science*, **55**(8), 1280-1291.
- Gerchak, Y., Cho, R. K., and Ray, S. (2006), Coordination of quantity and shelf-retention timing in the video movie rental industry, *IIE Transactions*, **38**(7), 525-536.
- Gerchak, Y. and Wang, Y. (2004), Revenue-sharing vs. wholesale-price contracts in assembly systems with random demand, *Production and Operations Management*, **13**(1), 23-33.
- Giannoccaro, I. and Pontrandolfo, P. (2004), Supply chain coordination by revenue sharing contracts, *International Journal of Production Economics*, **89**(2), 131-139.
- Giannoccaro, I. and Pontrandolfo, P. (2009), Negotiation of the revenue sharing contract: An agent-based systems approach, *International Journal of Production Economics*, **122**(2), 558-566.
- Ha, A. Y. and Tong, S. (2008), Revenue sharing contracts in a supply chain with uncontractible actions, *Naval Research Logistics*, **55**(5), 419-431.
- Koulamas, C. (2006), A newsvendor problem with revenue sharing and channel coordination, *Decision Sciences*, **37**(1), 91-100.
- Lal, R. (1990), Improving channel coordination through franchising, *Marketing Science*, **9**(4), 299-318.
- Li, S. and Hua, Z. (2008), A note on channel performance under consignment contract with revenue sharing, *European Journal of Operational Research*, **184**(2), 793-796.
- Li, S., Zhu, Z. and Huang, L. (2009), Supply chain coordination and decision making under consignment contract with revenue sharing, *International Journal of Production Economics*, **120**(1), 88-99.
- Linh, C. T. and Hong, Y. (2009), Channel coordination through a revenue sharing contract in a two-period newsboy problem, *European Journal of Operational Research*, **198**(3), 822-829.

- Mortimer, J. H. (2008), Vertical contracts in the video rental industry, *Review of Economic Studies*, **75**(1), 165-199.
- Pasternack, B. A. (2002), Using revenue sharing to achieve channel coordination for a newsboy type inventory model. in J Geunes, P. M. Pardalos, and H. E. Romeijn, eds.: *Supply Chain Management: Models, Applications, and Research Directions*, Kluwer Academic Publishers, London, 117-136.
- Ru, J. and Wang, Y. (2010), Consignment contracting: who should control inventory in the supply chain, *European Journal of Operational Research*, **201**(3), 760-769.
- Turcsik, R. (2002), Efficiency on consignment, *Progressive Grocer*, **81**(2), 29-31.
- Van der Veen, J. A. A. and Venugopal, V. (2005), Using revenue sharing to create win-win in the video rental supply chain, *Journal of the Operational Research Society*, **56**(7), 757-762.
- Wang, Y., Jiang, L., and Shen, Z. J. (2004), Channel performance under consignment contract with revenue sharing, *Management Science*, **50**(1), 34-47.
- Yao, Z., Leung, C. H. and Lai, K. K. (2008a), The effectiveness of revenue-sharing contract to coordinate the price-setting newsvendor products' supply chain, *Supply Chain Management*, **13**(4), 263-271.
- Yao, Z., Leung, C. H., and Lai, K. K. (2008b), Manufacturer's revenue-sharing contract and retail competition, *European Journal of Operational Research*, **186**(2), 637-651.