Signalling Effect of Daily Deal Promotion for a Start-Up Service Provider

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In this paper, we consider a start-up service provider that decides whether to advertise its service product by offering temporary daily deal promotion. Based on the repeat purchase mechanism, we show that both the commission rate (that is, the revenue-sharing ratio) charged by the daily deal site and the discount level offered by the service provider play important roles in signalling the initially unobservable quality level of the service provider. A high commission rate can facilitate the signalling of the daily deal promotion, and in equilibrium only the high-quality service provider would do daily deal promotion. We find that if the daily deal site adopts a two-part tariff charging scheme, the high-quality service provider can always signal its quality by offering daily deals. And the two-part tariff leads to a lower signalling cost but a higher repeat purchase rate than those under the revenue-sharing if the variable cost of the low-quality service provider is not too large.

Keywords: Signalling, quality, daily deal promotion, repeat customer, advertising

1 Introduction

Everyday, hundreds of daily deal sites offer discount vouchers to customers all over the world, among which the best known ones are Groupon and LivingSocial. Since their advent, the daily deal promotion has covered numerous service industries such as restaurant and health care. When selling service goods, almost all the daily deal sites adopt the following business model: Merchants in a city offer steep discounts ranging from around 50% to 90% off the regular price on products that would appeal to local customers; the deal site adopts the revenue-sharing mechanism with the merchants and takes a portion of the revenue generated by a deal as a commission.

Daily deal sites provide a new channel for start-up service providers to advertise their products. As Groupon states on its website, "We designed the Groupon model to be an alternative to traditional advertising. Whereas most marketing methods (i.e. print advertisements, radio spots, and TV commercials) require upfront payment without providing any guarantee that your campaign will be successful, Groupon costs you nothing out-of-pocket.

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$\cdots$ We can help your business grow and thrive with a customized campaign that guarantees new customers and keeps them coming back time after time." As those daily deal sites like Groupon often position themselves as alternatives to traditional advertising, then an interesting research question arises: Will the daily deal promotion posit the signalling effect of advertising? And how effective it is as a means of advertising?

Dholakia (2011b) finds that the exposure value of Groupon promotion is approximately 140% of the merchant's baseline sales and that approximately 4% of Groupon customers repurchase at least once at the regular price in the first two weeks after redemption of their Groupon promotion. When they repurchase, their spending is well over the average spending level of a regular customer. In a survey study, Dholakia (2011c) finds that merchants view daily deals as effective replacements for traditional advertising to gain exposure to consumers within their local markets. According to a study of daily deal performance over three time periods by Dholakia (2012), almost 80% of the daily deal customers are new customers and 20% of them will repurchase. All aforementioned studies show that daily deal promotion can increase the merchants' exposure and attract repeat customers.

Compared with the advertising through traditional media such as newspaper, magazine, television commercials, radio or direct mail (called *traditional advertising* in this paper), daily deal promotion exhibits some new features that are beneficial to start-up service providers. *First*, daily deal promotion is performance-based advertising in which total advertising expenditure is determined by the realization of the demand, that is, the purchase amount of daily deal promotions (Feng and Xie, 2012). *Second*, there is no upfront lump-sum cost in daily deal promotion. However, in traditional advertising such as television advertisement, there is a minimum expenditure requirement at which a merchant can place an advertisement. For example, the minimum that any TV station will accept to begin advertising for a client is $1,500.00 per month (Goldman, 2008). Thus, daily deal sites provide a new marketing channel for small-size firms such as a nail salon or a coffee shop around the corner as well as start-up firms which cannot afford the expenditure in traditional advertising to advertise their products. Besides, from the viewpoint of consumers, dail deal sites provide them with more choices of merchants which they cannot find by other ways. According to Neary (2011), daily deal sites change how customers shop. Searching deals on daily deal sites and sharing them with friends are regarded as cool things. *Third*, the effectiveness of daily deal promotion can be easily identified because a customer coming from the daily deal promotion shall present his/her redemption code upon arrival. However, in other advertising means such as television and newspaper advertising, it is hard for service providers to identify whether a customer arrives because of the exposure to the advertisement. *Fourth*, daily deal promotion belongs to advance selling while traditional advertising does not. In traditional advertising, customers first observe the advertisement and then decide whether to purchase products on spot. From the timing of observing the advertisement to that of purchasing products, it may take a long time such that some customers who initially want to try the product may forget to do so. In contrast, in daily deal promotion, customers need pay upfront through daily deal sites and then redeem the voucher on spot. Therefore, daily deal customers have strong incentives to try the service provider's product as otherwise, their upfront payment may be sunk. *And last*, the voucher in daily deal promotion is transferable and thus the service provider can capture the positive externality of customers' interaction. Daily deal customers buy the product before their redemption costs (e.g. their opportunity cost of time) (Lu and Moorthy, 2007) are realized. Therefore, when their redemption costs are so high that they are unavailable for redemption, they can transfer their vouchers to their friends and recommend them to redeem. However, in traditional advertising, in case of high redemption cost, the customers will just not try the product. Although daily deal promotion can provide aforementioned benefits, it remains unclear whether it can perform the following basic function of advertising: *Signalling the quality of promoted service products*, an important requirement for the business model of daily deal promotion to sustain.

In a daily deal transaction, a daily deal site like Groupon normally extracts 50% of the revenue generated by a deal, leaving no more than 25% of regular revenue to the service provider (Smith, 2011). However, 25% of regular revenue is not possible for a considerable portion of service providers to make a profit per transaction. For example, the variable costs of restaurants are normally about 25% to 30% (Kimes and Dholakia, 2011). In another example, in the salon and spa industry, service providers adopt the base plus commission pay structure under which employees receive a percentage of the revenue they generate for the firm. According to a report by InSPAration Management, the average employee commission rate in the SPA industry typically ranges from 35% to 60%. When the service provider cannot make a profit from daily deal transactions, the loss from those daily deal promotions shall be regarded as the advertising expenditure. Then the main purpose of carrying out daily deal promotion shall be to *win repeat customers*.

Unlike traditional coupons and promotions that mainly attract price-sensitive and low-value customers (e.g. Lewis, 2006 and Narasimhan, 1984), daily deal users are normally affluent and not very careful with the personal finances (Dholakia and Kimes, 2011). According to a survey conducted by Freed (2011), daily deal users tend to be between 25 and 44 years old, and have an annual income between \$50,000 and \$100,000. Also, Dholakia and Kimes (2011) report that daily deal consumers may be less sensitive to the depth of daily deal discount than is conventionally believed. They are interested in trying new products such as new restaurants so as to have experience to talk about and influence others. Undoubtedly, a deep discount is definitely one motivation for customers to try a new product. But this motivation alone might not be strong enough for customers to eventually purchase the deep discount deals if they perceive the quality of service product to be low. The perception of the product quality shall also play a very important role in consumer's purchasing decision. However, many service products listed on daily deal sites are *experience goods* (Nelson, 1974), whose quality is impossible to observe in advance and can only be ascertained upon consumption.

In this paper, we aim to examine the signalling effect of daily deal promotion. We first consider the commission rate– the *revenue-sharing ratio*– charged by the daily deal site as exogenously given and then construct the model based on the repeat purchase mechanism. Because a high-quality product is more likely to attract repeat purchases, an initial sale is, ceteris paribus, more valuable to a high-quality service provider. Thus, such a service provider would be more willing to offer a deep discount to attract an initial sale. Similar to Milgrom and Roberts (1986), this relationship would then provide a basis for correlation of quality with the net benefits of signalling. We show that if the low-quality service provider cannot make a positive profit when its quality level is common knowledge, there exists a separating equilibrium in which only the high-quality service provider would participate in the daily deal promotion and customers infer that products offered in the promotion are of high quality. Next, we show that the commission rate charged by the site plays an important role in signalling quality. If the penalty cost from an unsatisfied customer is relatively large, the daily deal site shall charge a commission rate that deters the low-quality service provider from making money when its true quality level is revealed, to facilitate the signalling of the high-quality service provider. Last, we show that if the contract between the daily deal site and the service provider is a two-part tariff composed of a transaction-independent fixed fee and a transaction-dependent commission rate rather than the revenue sharing with a transaction-dependent commission rate, the high-quality service provider can always signal its quality by offering daily deals. Moreover, if the variable cost of the low-quality service provider is not too large, signalling under the two-part tariff leads to a lower signalling cost but a higher repeat purchase rate than those under the revenue sharing. Finally, it is worth noting that although our paper aims at the startup service provider, our setting can also be applied to those service providers launching a new product. And it is common that the service provider only promotes a specific item (Dholakia, 2011a).

The remainder of this paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the model setting and examines the signalling effect of daily deal promotion. Section 4 extends the model by considering the commission rate as an endogenous decision variable. We then study the signalling game by considering the two-part tariff contract between the deal site and the service provider in section 5. Concluding remarks are provided in section 6. All the proofs are relegated to the appendix.

2 Literature Review

Our work is closely related to the following streams of research. First, it is related to the growing daily deal promotion literature. Dholakia (2011a, 2011b, 2012) conducts several survey-based work to investigate the performance of daily deal promotion. Dholakia and Kimes (2011), and Kimes and Dholakia (2011) find that both daily deal users and non-users may exhibit similar loyalty patterns. Byers (2011) examines the influence of groupon promotion on Yelp ratings. Ye et al. (2011) study the group purchasing behavior of daily deals listed on Groupon and LivingSocial and construct a predictive dynamic model of collective attention for group buying behavior. Kim et al. (2012) study the competition between Groupon and Livingsocial. Kumar and Rajan (2012) analyze the profitability of social coupons. They show that daily deal promotion does not necessarily yield profits for the businesses. Subramanian (2012) studies when and why firms set the tipping point that should be reached for the deal to be on. Li and Wu (2012) collect the data from Groupon and explore how the social-network word-of-mouth and existing sales affect customers' shopping behavior as well as the merchant's sales. Liang et al. (2013) consider the strategic customer behavior in grouping-buying. They show that information updating on the number of participating customers can increase the deal success rate as well as consumer surplus. Our study is mostly closely related to Edelman et al. (2011) in which they examine two mechanisms by which a discount voucher service can benefit affiliated merchants: price discrimination and advertising. However, they focus on the daily deal promotion' role of informing customers about the existence of the merchants. Instead, we consider the signalling effect of daily deal promotion by adopting the repeat purchase mechanism.

Next, our work is related to the existing literature on signalling unobservable product quality. Much of the work in this research stream investigates how a merchant can provide signals of its quality when its quality is unknown to consumers. Several signalling mechanisms have been identified by previous literature such as price (e.g. Bagwell and Riordan, 1991 and Desai and Srinivasan, 1995), advertising (e.g. Nelson, 1974 and Milgrom and Roberts, 1986) and money back guarantees (Moorthy and Srinivasan, 1995). The work most closely related to ours is Tirole (1989). Tirole (1989) assumes that customers are homogeneous and shows that an introductory price that is lower than the production cost can serve as a signal of product quality. We depart from his work in the following three aspects. First, we study heterogeneous customers with a general distribution. Second, a firm signals its quality by retail pricing in Tirole (1989) while in our paper, the service provider signals its quality through offering promotional deals on the daily deal site. As a result, the service provider under our setting has to pay a transaction-based commission to the daily deal site. We find that the charged commission can facilitate signalling the quality level of the service provider. Third, we also consider a situation under which the commission rate is endogenous. In such a case we extend our basic model into a two-stage game which consists of a first-stage screening game and a second-stage signalling game. For other related work, see the review work of Kirmani and Rao (2000) and the references therein. Our paper contributes to this stream of literature by showing that a service provider may signal its good quality through another way: offering deep discounts.

Our work is also related to the stream of research on performance-based advertising. Much of the existing work in this stream focuses on bidding strategy (e.g. Brint, 2003, Jerath et al., 2009, Zhang and Feng, 2011, Laffey et al., 2009 and Malaga et al., 2010) or bid-weighting mechanism (e.g. Feng, 2008 and Chen et al., 2009) in the sponsored search advertising. Besides, Dellarocas (2012) studies the double marginalization effect in the performance-based advertising channel and proposes two mechanisms to restore efficient pricing. Srinivasan and Kwon (2012) investigate the option contracts between an online advertiser and a publisher. We note that both Animesh et al. (2010) and Feng and Xie (2012) consider the signalling function of performance-based advertising. Using data from keywords search auctions, Animesh et al. (2010) examine the relationship between search ranking and quality. They find that the high ranking firms are not always of high quality.

Feng and Xie (2012) compare the signalling effects between performance-based advertising and impression-based advertising and show that if customers are unaware of the change in advertising scheme or they are unable to infer expenditure of performance-based advertising, the performance-based advertising may fail to signal quality. In our work, the daily deal promotion is also performance-based. The signal in daily deal promotion is the magnitude of discount while the signal in Feng and Xie (2012) is the advertising expenditure. And in equilibrium, the low-quality service provider will not do daily deal promotion in our case but the low-quality one will still advertise in Feng and Xie (2012). Furthermore, we also consider the scenario where the advertising fee (the commission rate in our case) is endogenous but Feng and Xie (2012) do not.

The study on the advance selling mechanism is also related. Much of the previous work on advance selling focuses on its role of homogenizing heterogenous customers and mitigating the seller's information disadvantage (e.g. Xie and Shugan, 2001; Fay and Xie, 2010; Nasiry and Popescu, 2012). In the field of operations management, there is a growing literature that considers the impact of advance selling on the seller's inventory decisions (e.g. Cachon and Swinney, 2009; Prasad et al., 2011; Swinney, 2011; Li and Zhang, 2013). In contrast, here we consider a new advance selling channel, daily deal promotion and its signalling effect.

3 Model Setting

Consider a start-up service provider who plans to attract new customers by offering discount promotion on a daily deal site in the first promotional period with an objective of maximizing the net present value of its expected payoffs up to a finite T time periods, where T denote the time gap between two consecutive promotions. The service provider does not offer the discount promotions in the remaining $T-1$ periods. In this paper, we define the length of a time period as the average time between two *consecutive* purchases of a customer, say, the average time length between two consecutive hair cuts or restaurant visits. Denote δ as the discount factor per time period. The regular retail price of the product, denoted by p_0, is the price charged by the service provider in the non-promotional periods. The service provider needs to determine the discount level β at which the promotional price is set at $(1-\beta)p_0$. Note that the discount level on daily deal sites such as Groupon and LivingSocial is usually more than 50% (Edelman et al., 2011), a level much higher than that offered by a traditional coupon. Therefore, we impose a lower bound $\bar{\beta}$ on β, that is, $\bar{\beta} \leq \beta \leq 1$.

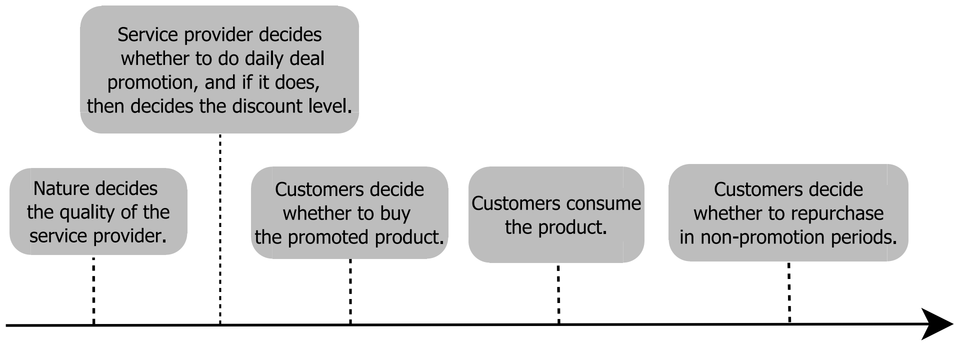

Figure 1: Sequence of Events

The product is of either high (H) or low (L) quality with a corresponding quality level of q_H or q_L. We assume that the start-up service provider knows the realized product quality but potential customers do not. For ease of exposition, we assume that customers on the daily deal site have no previous purchase experience about the service provider's product. And the service provider cannot credibly reveal its quality information to new customers before they make initial purchase decision. We model this problem as a signalling game. The sequence of events is depicted in Figure 1. First, nature chooses the product quality of the service provider: $j \in \{H, L\}$. Quality j is known by the service provider but unobservable by customers. Next, the service provider decides whether to carry out daily deal promotion and if it conducts daily deal promotion, it then decides the price discount level β, $\bar{\beta} \leq \beta \leq 1$. Then customers observe the discount and decide whether to purchase the deal. By consuming the product, customers then gain the information about the product quality and decide whether to repurchase the product in the following non-promotional periods in which the regular price is charged. We assume that customers who do not purchase the deals in the first period will not purchase the product in the non-promotional periods.

There is a unit mass of customers who are heterogenous in a parameter r, which represents customer type and is continuously distributed over the interval [0, 1] with a cumulative distribution $F(\cdot)$ and a probability density $f(\cdot)$. Let $\bar{F}(\cdot) = 1 - F(\cdot)$. Each customer type r values the low-quality product at rq_L and the high-quality product at rq_H. Through direct consumption of the service product, the customer gains information about the quality, and then, if her valuation about the product is greater than the regular price, she will buy the product in each of the non-promotional periods. Thus, when the quality level of a service provider is q_j, $j = H, L$, customer r will receive a total utility of

$$\underbrace{rq_j - (1-\beta)p_0}_{(1)} + \underbrace{\frac{\delta(1-\delta^{T-1})}{1-\delta}\max\{rq_j - p_0,\, 0\}}_{(2)}, j \in \{H,\, L\}\,,$$

where the first term is the utility she receives by purchasing the product through the daily deal promotion and the second term is her net discounted utility if she repurchases the product through the regular price afterwards.

Let the unit production cost of type j service provider be c_j, $j = L, H$. We assume that the high-quality service provider incurs a higher unit cost than that of the low-quality service provider, that is $c_H \geq c_L$. For every unit of sold products, the service provider needs to pay α proportion ($0 \leq \alpha \leq 1$) of its revenue as a commission to the daily deal site. Thus, the net profit margin of the service provider is $(1-\alpha)(1-\beta)p_0 - c_j$ in the promotional period and $p_0 - c_j$ in non-promotional periods. Let $\pi_j(\beta,\, J)$ denote the total expected profit of a service provider with a discount level β and a quality level j that is initially perceived to be of quality J, $j, J \in \{H,\, L\}$. Furthermore, we define β_J^j as the optimal discount level that maximizes $\pi_j(\beta, J)$. In the symmetric information case, J equals to j. However, in the asymmetric information case, J may differ from j.

If customer r knows the product quality, she will buy it on the daily deal site as long as $rq_j-(1-\beta)p_0 > 0$, that is, $r > (1-\beta)p_0/q_j$. Then the initial demand for the service provider's product can be derived as $\bar{F}((1-\beta)p_0/q_j)$, $j \in \{H,\, L\}$. We assume that $q_H > p_0 > q_L$ under which the value of service delivered by the low-quality service provider is not worth the regular price. Consequently, only the high-quality service provider may attract repeat purchases at the regular price when the quality information is common knowledge. This assumption is realistic as through reading the consumer reviews on Yelp and TripAdvisor, we find that customers do compare the value of the service they received with the price they paid when judging the product quality. Examples of such kind of reviews include "$\cdots$ Most of it didn't seem very high quality relative to the price. Ended up paying $7.11 for some mediocre sushi. $\cdots$"(http://www.yelp.com/biz/qfc-quality-food-center-seattle-17), "Good food but incredibly overpriced relative to quality $\cdots$"(http://www.tripadvisor.co.uk), "$\cdots$ I would say it's good for the price $\cdots$"(http://www.yelp.com.sg/biz/saveur-singapore). These reviews imply that customers assess the service quality based on whether it is commensurate with the price. Then in the non-promotional periods, customers repurchase only if the product turns out to be of high quality: $rq_H - p_0 > 0$. Thus, the demand size of repeat customers can be derived as $\bar{F}(p_0/q_H)$. Because the size of repeat customers (i.e. $\bar{F}(p_0/q_H)$) is smaller than that of the initial demand (i.e. $\bar{F}((1-\beta)p_0/q_H)$), the deal offered by the high-quality service provider always attracts some deal-seekers who only purchase the product in the promotional period (i.e. $\bar{F}((1-\beta)p_0/q_H) - \bar{F}(p_0/q_H)$). Note that the initial demand is increasing in the discount level while the size of repeat customers is independent of it, therefore, the higher the discount rate the service provider offers, the more deal-seekers it will attract. Then the expected profits of the high- and low-quality service providers are

$$\begin{aligned}
\pi_H(\beta,\, H) &= [(1-\alpha)(1-\beta)p_0 - c_H]\bar{F}\left(\frac{(1-\beta)p_0}{q_H}\right) + \bar{\delta}(p_0 - c_H)\bar{F}\left(\frac{p_0}{q_H}\right), \text{ where } \bar{\beta} \le \beta \le 1 \\
\pi_L(\beta,\, L) &= \begin{cases} [(1-\alpha)(1-\beta)p_0 - c_L]\bar{F}\left(\frac{(1-\beta)p_0}{q_L}\right) & if \ \max\left\{\bar{\beta},\, 1-\frac{q_L}{p_0}\right\} \le \beta \le 1 \\ 0 & otherwise, \end{cases}
\end{aligned} \tag{1}$$

respectively, where $\bar{\delta} = \delta(1-\delta^{T-1})/(1-\delta)$. Note that $\beta = 1$ corresponds to the case of free product/service. We assume that $\pi_H(1,\, H) > 0$. That is, the long-term profit of the high-quality service provider is large enough to compensate any possible monetary loss in the promotional period.

4 Quality Signalling with Exogenous Commission Rate

In this section, we study the quality signalling via the discount level by assuming that the commission rate is exogenously given. Let $\lambda(\beta)$ denote the customers' belief that a service provider with a discount level β is of high quality. As the low-quality service provider makes a negative profit when $\beta > 1 - [c_L/\left((1-\alpha)p_0\right)]$ (see (1)), the sequential elimination of dominated strategies (Milgrom and Roberts, 1986) requires that customers believe that only the high-quality service provider will offer $\beta > 1 - [c_L/\left((1-\alpha)p_0\right)]$, that is, $\lambda(\beta) = 1$ for all $\beta > 1 - [c_L/\left((1-\alpha)p_0\right)]$. Thus we have the following lemma.

Lemma 1. *In any separating equilibrium surviving the sequential elimination of dominated strategies,* $\lambda(\beta) = 1$ *for all* $\beta > 1 - [c_L/\left((1-\alpha)p_0\right)]$.

Let $\pi_j^+(\beta,\, J) = \max\{\pi_j(\beta,\, J),\, 0\}$. To signal its quality, the high-quality service provider needs to solve the following optimal problem:

$$
\begin{aligned}
(\mathcal{HQ}) \quad \max_{\beta} \quad & \pi_H(\beta,\, H) \\
s.t. \quad & \pi_L(\beta,\, H) \le \pi_L^+(\beta_L^L,\, L), && (2)\\
& \pi_H(\beta,\, H) \ge \pi_H^+(\beta_L^H,\, L), && (3)\\
& \bar{\beta} \le \beta \le 1.
\end{aligned}
$$

Below we will study the above quality-signalling problem $(\mathcal{HQ})$ under the following three possible production cost scenarios.

4.1 Case 1: $c_L \ge (1-\alpha)(1-\bar{\beta})p_0$

In this case, the low-quality service provider cannot make any profit per promotional transaction regardless of whether it mimics the high-quality service provider, that is, $\max_{\beta \in [\bar{\beta},\, 1]} \pi_L(\beta,\, J) \le 0,\, J = H, L$. Thus, the sequential elimination of dominated strategies requires that customers believe that only the high quality service provider will offer daily deals, that is, $\lambda(\beta) = 1$ for all $\beta \in [\bar{\beta},\, 1]$. Then the quality-signalling problem $(\mathcal{HQ})$ is reduced to

$$
\begin{aligned}
(\mathcal{HQ}1) \quad \max_{\beta} \quad & \pi_H(\beta,\, H) \\
s.t. \quad & \pi_H(\beta,\, H) \ge 0, && (4)\\
& \bar{\beta} \le \beta \le 1.
\end{aligned}
$$

Proposition 1. *When $c_L \ge (1-\alpha)(1-\bar{\beta})p_0$, there exists a unique separating equilibrium at which the high-quality service provider offers a daily deal promotion with a discount level $\beta^* = \bar{\beta}$ and the low-quality service provider will not conduct daily deal promotion. Customers' belief is $\lambda(\beta) = 1$ for all $\beta \in [\bar{\beta},\, 1]$.*

As the low-quality service provider cannot make money per promotional transaction, it has no incentives to conduct daily deal promotion. And because of the cost disadvantage $((1-\alpha)(1-\bar{\beta})p_0 \le c_L < c_H)$, the high-quality service provider also cannot make any profit per promotional transaction. Thus, the optimal discount level offered by the high-quality service provider is $\bar{\beta}$, the minimum discount level required by the daily deal sites. The *signalling cost*, that is, the monetary loss incurred by the high-quality service provider in the promotional period and the average repeat-customer acquisition cost are then respectively,

$$
[c_H - (1-\alpha)(1-\bar{\beta})p_0]\bar{F}\left(\frac{(1-\bar{\beta})p_0}{q_H}\right) \quad \text{and} \quad \frac{[c_H - (1-\alpha)(1-\bar{\beta})p_0]\bar{F}\left(\frac{(1-\bar{\beta})p_0}{q_H}\right)}{\bar{F}\left(\frac{p_0}{q_H}\right)}.
$$

Corollary 1. *When* $c_L \geq (1-\alpha)(1-\bar{\beta})p_0$*, both the signalling cost and the average repeat-customer acquisition cost are increasing in* α*.*

Undoubtedly, the higher the commission rate the service provider pays to the deal promotion site, the higher signalling cost it incurs and the higher the average repeat-customer acquisition cost.

4.2 Case 2: $(1-\alpha)q_L \leq c_L < (1-\alpha)(1-\bar{\beta})p_0$

To facilitate the analysis of this scenario, we first provide the following lemma.

Lemma 2. *When* $(1-\alpha)q_L \leq c_L < (1-\alpha)(1-\bar{\beta})p_0$*, the low-quality service provider cannot make a profit by revealing its true quality, that is,* $\max\limits_{\beta \in [\bar{\beta},\, 1]} \pi_L(\beta,\, L) \leq 0$*.*

However, the low-quality service provider could make a profit by mimicking, which can be expressed as

$$\pi_L(\beta,\, H) \;=\; [(1-\alpha)(1-\beta)p_0 - c_L]\bar{F}\left(\frac{(1-\beta)p_0}{q_H}\right), \text{ where } \bar{\beta} \leq \beta \leq 1. \tag{5}$$

As to the high-quality service provider, according to Lemma 1, only when $\beta \leq 1 - [c_L/\left((1-\alpha)p_0\right)]$, customers may perceive the high-quality service provider to be the low-quality one. Then, we have the following corollary.

Corollary 2. *When* $(1-\alpha)q_L \leq c_L < (1-\alpha)(1-\bar{\beta})p_0$*, if the high-quality service provider is perceived to be of low quality, it cannot make money by conducting daily deal promotion, that is,* $\pi_H(\beta,\, L) = 0$*.*

According to Corollary 2 and Lemma 2, the quality-signalling problem $(\mathcal{HQ})$ now is reduced to

$$\begin{aligned}
(\mathcal{HQ}2) \quad \max_{\beta} \quad & \pi_H(\beta,\, H) \\
s.t. \quad & \pi_H(\beta,\, H) \geq 0, && (6)\\
& \pi_L(\beta,\, H) \leqslant 0, && (7)\\
& \bar{\beta} \leq \beta \leq 1.
\end{aligned}$$

The first constraint assures that the high-quality service provider will participate in a daily deal promotion and the second constraint assures that the low-quality service provider will not mimic.

Proposition 2. *When* $(1-\alpha)q_L \le c_L < (1-\alpha)(1-\bar{\beta})p_0$*, there exists a unique separating equilibrium at which the high-quality service provider offers* $\beta^* = 1-[c_L/((1-\alpha)p_0)]$ *and the low-quality service provider will not do daily deal promotion. Customers' belief is* $\lambda(\beta)=1$ *for all* $\beta \in \left[1-[c_L/((1-\alpha)p_0)], 1\right]$ *and* $\lambda(\beta)=0$ *for all* $\beta \in \left[\bar{\beta}, 1-[c_L/((1-\alpha)p_0)]\right)$.

Proposition 2 implies that in equilibrium the low-quality service provider makes zero profit by mimicking, and thus will not do daily deal promotion. Although the high-quality service provider makes a negative profit over the promotional deal, it earns profits via the repeat customers. As to the optimal discount level, we have the following corollary.

Corollary 3. *When* $(1-\alpha)q_L \le c_L < (1-\alpha)(1-\bar{\beta})p_0$*,* β^* *is decreasing in* c_L *and* α.

Corollary 3 implies that as α decreases, the commission paid by the service provider to the deal site decreases and thus it is more likely that the low-quality service provider can make money by mimicking. Thus, to prevent the low-quality service provider from mimicking, the high-quality service provider need offer a deeper discount. Although people criticize that the discount on daily deal sites is too deep to be profitable for service providers (Brown, 2011), Corollary 3 shows that when the low-quality service provider has a low variable cost, a steep discount is necessary to signal quality.

Next, we derive the signalling cost incurred by the high-quality service provider in the promotional period, the average repeat customer acquisition cost and the repeat purchase rate respectively as follows:

$$(c_H - c_L)\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right), \quad \frac{(c_H - c_L)\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right)}{\bar{F}\left(\frac{p_0}{q_H}\right)} \quad \text{and} \quad \frac{\bar{F}\left(\frac{p_0}{q_H}\right)}{\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right)}.$$

Corollary 4. *When* $(1-\alpha)q_L \le c_L < (1-\alpha)(1-\bar{\beta})p_0$*, both the signalling cost of the high-quality service provider and the average repeat customer acquisition cost are decreasing in* α *whereas the repeat purchase rate is increasing in* α.

Interestingly, Corollary 4 shows that a higher commission rate actually helps the high-quality service provider as it incurs less signalling cost. The customer acquisition cost is also reduced. It is worth noting that the above results are opposite to that of Corollary 1 due to the fact that the optimal discount level is a function of the commission rate α here in case 2 but is independent of α there in case 1.

4.3 Case 3: $c_L < \min\left\{(1-\alpha)q_L, (1-\alpha)(1-\bar{\beta})p_0\right\}$

When $c_L < \min\left\{(1-\alpha)q_L, (1-\alpha)(1-\bar{\beta})p_0\right\}$, the low-quality service provider can make a profit per promotional transaction even by revealing its true quality, that is, $\max_{\beta\in[\bar{\beta},\,1]} \pi_L(\beta,\, L) > 0$. Hence, the low-quality service provider will always participate in a daily deal promotion. Then the quality-signalling problem $(\mathcal{HQ})$ is reduced to

$$
\begin{aligned}
(\mathcal{HQ}3) \quad \max_{\beta} \quad & \pi_H(\beta,\, H) \\
s.t. \quad & \pi_L(\beta,\, H) \leq \pi_L(\beta_L^L,\, L), \\
& \pi_H(\beta,\, H) \geq \pi_H(\beta_L^H,\, L), \\
& \bar{\beta} \leq \beta \leq 1.
\end{aligned}
$$

Here the quality signalling problem $(\mathcal{HQ}3)$ is similar to the classic price-quality signalling problem in which price is served as a signal of quality (e.g. Milgrom and Roberts, 1986) except that the discount level here falls within a specified range. According to Milgrom and Roberts (1986), the existence of separating equilibrium in case 3 depends on the shape of the customer distribution $F(\cdot)$ and often it may not exist. As here both types of service providers can do daily deal promotion, daily deal promotion may not be a good tool to signal product quality. Under such a scenario, the service provider may not aim to attract repeat purchases but rather to fill its idle capacities or serve a different group of customers, which is beyond the scope of this paper. Actually, in next section, we will consider the case of commission rate as an endogenous decision variable and show that in such a scenario, it is in the deal site's self-interest to avoid case 3 to facilitate the signalling of the high-quality service provider.

5 Quality Signalling with Endogenous Commission Rate

So far we have demonstrated that a daily deal promotion can serve as a signal of high quality for a start-up service provider by assuming that the commission rate charged by the site is exogenously given. However, in reality, a daily deal site may charge different commission rates for different types of service providers. In this section, we consider such a scenario and investigate how the daily deal site's commission rate decision affects the signalling effect of daily deal promotion.

Consider a two stage game in which the daily deal site acts as the Stackelberg leader and decides the commission rate α first. Next, the service provider decides whether to do daily deal promotion. If it chooses to do daily deal promotion, it then decides the discount level. The site then decides whether to accept the service provider's offer. After that the signalling game is the same as that in §4. Both the daily deal site and the customers do not know the quality level of the service provider. Denote the prior beliefs of the site and the customers that the service provider is of high-quality by λ_s and λ_c, $0 \leq \lambda_s, \lambda_c \leq 1$, respectively.

We impose an upper bound $\bar{\alpha}$ on the commission rate as the outside option under which the service provider will switch to other daily deal sites to conduct the daily deal promotion. Thus $\alpha \in [0, \bar{\alpha}]$. Notice that the daily deal customers are normally affluent and care more about the quality rather than the price, and some of them may even unsubscribe to the site when the product quality is low (Dholakia and Kimes, 2011). Even for the deal-seekers, if the service quality does not match their expectations, they are also disappointed and complain. For example, in 2011, a Japanese restaurant offered a Groupon deal which attracted many customers, some of whom may never come without the discount vouchers. However, because the food quality was much lower than the average standard, the customers were so disappointed that the CEO of Groupon had to issue an apology for this unqualified deal (Koh, 2011). This example shows that in case the service quality of the deal provider turns out to be low, the daily deal site does incur a loss of goodwill. We thus assume that if the service provider is of low quality, the site will incur a penalty cost γ per customer for its loss of goodwill. Below we will study the aforementioned two-stage game under the following two possible penalty cost scenarios.

Case 1: $(1-\bar{\beta})p_0 \leq (1-\lambda_s)\gamma$

In this case, the deal site's expected penalty cost from an unsatisfied customer (who purchases from the low-quality service provider) cannot be compensated by its potential gain from that daily deal transaction. Therefore, when quality information is common knowledge, the deal site will accept a service provider's offer if and only if (iff) it is of high quality and the corresponding profit of the daily deal site, denoted by π_s^H is

$$\pi_s^H(\alpha) = \alpha(1-\beta)p_0\bar{F}\left(\frac{(1-\beta)p_0}{q_H}\right).$$

But when quality information is asymmetric, the deal site then bears the risk of accepting a low-quality service provider and its expected profit can be written as

$$\pi_s(\alpha) = [\alpha(1-\beta)p_0 - (1-\lambda_s)\gamma]\bar{F}\left(\frac{(1-\beta)p_0}{q(\lambda_c)}\right), \tag{8}$$

where $q(\lambda_c) = (1-\lambda_c)q_L + \lambda_c q_H$. Note that $\pi_s(\alpha) < 0$ as $(1-\bar{\beta})p_0 < (1-\lambda_s)\gamma$. Therefore, the daily deal site shall not accept any offer if it is uncertain about the service provider's quality. Then the daily deal site's optimization problem becomes

$$\begin{aligned}
(\mathcal{S}) \quad \max_{\alpha\in[0,\,\bar{\alpha}]} \quad & \pi_s^H(\alpha) \\
s.t. \quad & \pi_L(\beta_L(\alpha),\, H) \leqslant\, 0, \qquad (9) \\
& \pi_H(\beta_H(\alpha),\, H) >\, 0, \qquad (10)
\end{aligned}$$

where $\beta_j(\alpha)$ is the optimal discount level of the j quality service provider given the commission rate α, $j = L, H$.

Here the site uses the commission rate to screen the service providers so as to ensure that only the high-quality one can afford daily deal promotion. Then the two-stage game reduces to the one with a screening game at the first stage and a signalling game at the second stage. We will solve this game via the backward induction. Below we first solve the second stage signalling game. According to Tirole (1989), the signalling effect of a low introductory price depends crucially on the assumption that the low-quality service provider cannot make money by revealing its true quality. Thus we have the following proposition.

Proposition 3. *When $(1-\bar{\beta})p_0 \leq (1-\lambda_s)\gamma$, the commission rate charged by the deal site shall be no less than α_0, where $\alpha_0 = \min\left\{1 - \left[c_L/\left((1-\bar{\beta})p_0\right)\right], 1-(c_L/q_L)\right\}$.*

When $\alpha < \alpha_0$, the low-quality service provider can still make a positive profit when quality information is common knowledge as shown by equation (1). Proposition 3 implies that to avoid the high penalty cost of accepting a low-quality service provider, the deal site shall charge a commission rate larger than α_0. We note that in the United States one third national daily deal websites have disappeared just in 2011 (Tutlle, 2011), owing to their inability to exclude low-quality service providers. Henceforth, we only focus on the situation that $\alpha_0 \leq \bar{\alpha}$. Based on Propositions 1 and 2, we can easily obtain the following result.

Proposition 4. *When $(1-\bar{\beta})p_0 \leq (1-\lambda_s)\gamma$ and $\alpha \geq \alpha_0$, the low-quality service provider will not conduct daily deal promotion. The high-quality service provider can signal its quality* *with the optimal discount level given by*

$$\beta_H(\alpha) = \begin{cases} 1 - \frac{c_L}{(1-\alpha)p_0}, & \text{if } 1 - \frac{c_L}{q_L} \le \alpha < \min\left\{\bar{\alpha},\, 1 - \frac{c_L}{(1-\bar{\beta})p_0}\right\}, \\ \bar{\beta}, & \text{if } 1 - \frac{c_L}{(1-\bar{\beta})p_0} \le \alpha \le \bar{\alpha}. \end{cases}$$

Next the daily deal site decides the optimal commission rate to help screen the high-quality service provider from the low-quality one. Denote the generalized failure rate of the customer distribution by

$$h(x) = \frac{xf(x)}{\bar{F}(x)}.$$

Then we can obtain the following proposition.

Proposition 5. *Assume* $(1-\bar{\beta})p_0 \le (1-\lambda_s)\gamma$. *If* $q_L \ge (1-\bar{\beta})p_0$, *the optimal commission rate* $\alpha^* = \bar{\alpha}$. *Otherwise, if the distribution of customer type* $F(\cdot)$ *has an increasing generalized failure rate (IGFR), the optimal commission rate is*

$$\alpha^* = \begin{cases} 1 - \frac{c_L}{q_L}, & \text{if } \alpha_1 < 1 - \frac{c_L}{q_L} \text{ and } \pi_s^H(1 - \frac{c_L}{q_L}) > \pi_s^H(\bar{\alpha}), \\ \alpha_1, & \text{if } 1 - \frac{c_L}{q_L} \le \alpha_1 < \bar{\alpha} \text{ and } \pi_s^H(\alpha_1) > \pi_s^H(\bar{\alpha}), \\ \bar{\alpha}, & \text{otherwise}, \end{cases}$$

where α_1 *is the unique solution of*

$$1 - \alpha h\left(\frac{c_L}{(1-\alpha)q_H}\right) = 0.$$

As the quality level of the low-quality service provider increases, it becomes harder to prevent it from making money. Especially, when $q_L \ge (1-\bar{\beta})p_0$, the site needs to charge the highest possible commission rate. But when $q_L < (1-\bar{\beta})p_0$, the optimal commission rate may be an interior point, depending on the shape of $F(\cdot)$. Note that most distributions used in practise such as normal, uniform, exponential, Gamma and Weibull have the IGFR property (Lariviere and Porteus, 2001), and this assumption has been widely-adopted in the operations management literature (see Lariviere and Porteus, 2001 and the references therein).

Case 2: $(1-\bar{\beta})p_0 > (1-\lambda_s)\gamma$

Here the expected penalty cost from an unsatisfied customer is not so large such that it is also beneficial to accept a low-quality service provider's offer. In this case, the daily deal site may charge a commission rate which is less than α_0. In consequence, case 3 of §4 may happen and the daily deal promotion may not be a good channel to signal product quality.

In next section, we will show that if the daily deal site adopts the charging scheme of a two-part tariff, case 3 of §4 can be avoided and the low-quality service provider will not offer daily deals.

6 Two-Part Tariff

Some people criticize that the steep discount on daily deal sites gives too much value to customers and not enough value to service providers (Dholakia, 2011a). Although the steep discount is necessary to signal quality, our next question is: Does there exist other mechanisms that can balance the value allocation between service providers and customers as well as signal product quality?

It is observed that some daily deal sites like WooEB ADit Deals only charge service providers a fixed payment to conduct their deal promotion while other deal sites like Groupon charge the service provider only the transaction-based commission. Below we consider a combination of the aforementioned two charging schemes, namely, a two-part tariff in which the daily deal site charges the service provider both a fixed side payment $\bar{A}$ and commission.

To both reveal its quality level and maximize its profit, the high-quality service provider needs to solve the following optimal problem:

$$
\begin{aligned}
(\mathcal{TQ}) \quad \max_{\beta} \quad & \pi_H(\beta,\, H) - \bar{A} \\
s.t. \quad & \pi_H(\beta,\, H) - \bar{A} \geq \max\left\{\pi_H(\beta_L^H,\, L) - \bar{A},\, 0\right\}, && (11)\\
& \pi_L(\beta,\, H) - \bar{A} \leq \max\left\{\pi_L(\beta_L^L,\, L) - \bar{A},\, 0\right\}, && (12)\\
& \bar{\beta} \leq \beta \leq 1.
\end{aligned}
$$

Let $\mathcal{H}$ represent the feasible set of β that satisfies constraint (12), and denote $\mathcal{H}_1 = \{\tilde{\beta} | \pi_H(\tilde{\beta},\, H) = \max_{\beta\in\mathcal{H}} \pi_H(\beta,\, H)\}$.

Proposition 6. *When* $\max\{\pi_L(\beta_L^H,\, H),\, \pi_L(\beta_L^L,\, L)\} \leq \bar{A} < \pi_H(1,\, H)$,

1. *there exists a separating equilibrium in which the high-quality service provider offers any* $\hat{\beta} \in \mathcal{H}_1$*, and the low-quality service provider will not do daily deal promotion. Customers' beliefs are* $\lambda(\hat{\beta}) = 1$ *for* $\beta \in \mathcal{H}$*, and* $\lambda(\beta) = 0$ *otherwise.*

2. *when* $c_L \geq (1-\alpha)(1-\bar{\beta})p_0$, $\hat{\beta} = \bar{\beta}$*; when* $(1-\alpha)q_L \leq c_L < (1-\alpha)(1-\bar{\beta})p_0$, $\hat{\beta} < 1 - [c_L/\left((1-\alpha)p_0\right)]$.

3. *when* $c_L \geq (1-\alpha)(1-\bar{\beta})p_0$*, the repeat purchase rate under two-part tariff is the same as that under the revenue-sharing commission charging scheme (see §4.1) but with a higher monetary loss in the promotional period.*

4. *when* $(1-\alpha)q_L \leq c_L < (1-\alpha)(1-\bar{\beta})p_0$*, the repeat purchase rate under the two-part tariff is higher than that under the revenue-sharing commission charging scheme (see §4.2). Moreover,if* $\bar{A} \leq \max_{\beta \in [\bar{\beta}, 1]} \pi_L(\beta, H)$*, the signalling cost incurred in the promotion period under the two-part tariff is lower than that under the revenue-sharing commission charging scheme (see §4.2).*

According to Proposition 6, as long as the long-term profit of the high-quality service provider from repeat purchases is large enough such that $\max\{\pi_L(\beta_L^H, H), \pi_L(\beta_L^L, L)\} < \pi_H(1, H)$, the daily deal site can choose a $\bar{A} \in \big[\max\{\pi_L(\beta_L^H, H), \pi_L(\beta_L^L, L)\}, \pi_H(1, H)\big)$ to facilitate quality signalling. And if the variable cost of the low-quality service provider is relatively large as in case 1 of section 4, the high-quality service provider incurs a larger signalling cost under the two-part tariff than that under the revenue-sharing. But if the variable cost of the low-quality service provider is medium as in case 2 of section 4, the high-quality service provider can enjoy a high repeat purchase rate under the two-part tariff. In addition, if the fixed payment is not too large, the signalling cost under the two-part tariff is less than that under the revenue-sharing. Finally, if the variable cost of the low-quality service provider is relatively low as in case 3 of section 4, the high-quality service provider may not signal its quality under the revenue-sharing, but it can do so under the two-part tariff as shown in part 1 of Proposition 6.

7 Conclusion

Daily deal promotion is positioned as an alternative to traditional advertising by some daily deal sites such as Groupon. In this paper, we examine its quality signalling role. The high-quality service provider offers a daily deal promotion at which it makes a negative profit and hope to recoup such loss in future from repeat purchases. However, such promotional loss cannot be recovered for the low-quality service provider. Thus a deep discount in a daily deal promotion does imply good quality. Second, we show that if the expected penalty cost from an unsatisfied customer is relatively large, the daily deal site has an incentive to charge a high commission rate to facilitate the signalling role of the daily deal promotion.

Due to the penalty cost of a dissatisfied subscriber, it is in the site's self-interest to prevent the low-quality service provider from doing daily deal promotion. Finally, we show that if the deal site adopts the two-part tariff charging scheme, the high-quality service provider can always signal its quality by offering daily deal promotion. Moreover, compared to the revenue-sharing commission charging scheme, the repeat purchase rate under the two-part tariff is higher but the signalling cost is lower when the variable cost of the low-quality service provider is medium.

Our analysis is subject to limitations and leaves some interesting questions for future studies. First, there is only one daily deal site in our model. One straightforward extension is to consider competition among daily deal sites and examine the influence of competition on the signalling role of the daily deal promotion. Another important area for future research is to empirically test the relationship between daily deals and product quality over industries so as to identify to which service industry signalling quality through daily deal promotion is more favorable. Last, since it is well-established that traditional advertising such as television and newspaper can also be used as a signal of quality, it may be interesting to compare the consumer perceptions of the signal in daily deal promotion with that in traditional advertising.

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Appendix

Proof of Proposition 1. By $c_H > c_L$ and $c_L \geq (1-\alpha)(1-\bar{\beta})p_0$, $(1-\alpha)(1-\bar{\beta})p_0 < c_H$. Then, for all $\beta \in [\bar{\beta}, 1]$,

$$\frac{d\pi_H(\beta,\, H)}{d\beta} = -(1-\alpha)p_0 \bar{F}\left(\frac{(1-\beta)p_0}{q_H}\right) + \frac{[(1-\alpha)(1-\beta)p_0 - c_H]p_0}{q_H} f\left(\frac{(1-\beta)p_0}{q_H}\right) < 0.$$

As $\pi_H(1,\, H) > 0$, constraint (4) holds for all $\beta \in [\bar{\beta}, 1]$. Therefore, the optimal solution of $(\mathcal{HQ}1)$ is unique and equal to $\bar{\beta}$. $\square$

Proof of Corollary 1. Let

$$m_1 = [c_H - (1-\alpha)(1-\bar{\beta})p_0]\bar{F}\left(\frac{(1-\bar{\beta})p_0}{q_H}\right) \text{ and } a_1 = \frac{[c_H - (1-\alpha)(1-\bar{\beta})p_0]\bar{F}\left(\frac{(1-\bar{\beta})p_0}{q_H}\right)}{\bar{F}\left(\frac{p_0}{q_H}\right)}.$$

Then we can show that

$$\begin{aligned}\frac{dm_1}{d\alpha} &= (1-\bar{\beta})p_0\bar{F}\left(\frac{(1-\bar{\beta})p_0}{q_H}\right) > 0,\\ \frac{da_1}{d\alpha} &= \frac{(1-\bar{\beta})p_0\bar{F}\left(\frac{(1-\bar{\beta})p_0}{q_H}\right)}{\bar{F}\left(\frac{p_0}{q_H}\right)} > 0.\end{aligned}$$

□

Proof of Lemma 2. According to (1), $\pi_L(\beta,\, L) > 0$ iff $(1-\alpha)(1-\beta)p_0 - c_L > 0$ and $\beta > 1-(q_L/p_0)$. When $(1-\alpha)q_L \le c_L$, we have

$$1 - \frac{q_L}{p_0} \ge 1 - \frac{c_L}{(1-\alpha)p_0}.$$

Thus, if $\beta > 1-(q_L/p_0)$, then $(1-\alpha)(1-\beta)p_0 - c_L < 0$. Consequently, $\pi_L(\beta,\, L) \le 0$. □

Proof of Corollary 2. The customer segment r will buy the product of low quality only if $rq_L > (1-\beta)p_0$. When $\beta \le 1 - [c_L/\,((1-\alpha)p_0)]$,

$$\frac{(1-\beta)p_0}{q_L} \quad \ge \quad \frac{c_L}{(1-\alpha)q_L} \ge 1,$$

where the last inequality is by the assumption of case 2 ($c_L \ge (1-\alpha)q_L$). Therefore, if customers perceive the product to be of low quality, they will not buy it if $\beta \le 1 - [c_L/\,((1-\alpha)p_0)]$. In consequence, $\pi_H(\beta,\, L) = 0$. □

Proof of Proposition 2. According to (5), the second constraint of ($\mathcal{HQ}2$) requires $\beta \ge 1 - [c_L/\,((1-\alpha)p_0)]$. By $c_H > c_L$, $(1-\alpha)(1-\beta)p_0 - c_H < 0$ for all $\beta \ge 1 - [c_L/\,((1-\alpha)p_0)]$. Therefore, for $\beta \ge 1 - [c_L/\,((1-\alpha)p_0)]$,

$$\frac{d\pi_H(\beta,\, H)}{d\beta} = -(1-\alpha)p_0\bar{F}\left(\frac{(1-\beta)p_0}{q_H}\right) + \frac{[(1-\alpha)(1-\beta)p_0 - c_H]p_0}{q_H} f\left(\frac{(1-\beta)p_0}{q_H}\right) < 0.$$

Thus $\pi_H(\beta,\, H)$ decreases in β. As $\pi_H(1,\, H) > 0$, the first constraint of ($\mathcal{HQ}2$) holds for all $\beta \ge 1 - [c_L/\,((1-\alpha)p_0)]$. Hence, the optimal solution of ($\mathcal{HQ}2$) is unique and equal to $1 - [c_L/\,((1-\alpha)p_0)]$. On the other hand, since $\max_{\beta\in[\bar{\beta},\,1]} \pi_L(\beta,\, L) \le 0$, the low-quality service provider will not do daily deal promotion. The separating equilibrium described in Proposition 2 is supported by the customers' beliefs: $\lambda(\beta) = 1$ for $\beta \geq 1 - [c_L/((1-\alpha)p_0)]$ and $\lambda(\beta) = 0$ for $\beta < 1 - [c_L/((1-\alpha)p_0)]$. □

Proof of Corollary 3. It can be easily shown that

$$\frac{d\beta^*}{dc_L} = -\frac{1}{(1-\alpha)p_0} < 0, \text{ and } \frac{d\beta^*}{d\alpha} = -\frac{c_L}{(1-\alpha)^2 p_0} < 0.$$

□

Proof of Corollary 4. Let

$$m_2 = (c_H - c_L)\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right), \quad a_2 = \frac{(c_H - c_L)\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right)}{\bar{F}\left(\frac{p_0}{q_H}\right)} \quad \text{and} \quad R = \frac{\bar{F}\left(\frac{p_0}{q_H}\right)}{\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right)}.$$

Then we can show that

$$\begin{aligned}
\frac{dm_2}{d\alpha} &= -\frac{(c_H - c_L)c_L}{(1-\alpha)^2 q_H} f\left(\frac{c_L}{(1-\alpha)q_H}\right) < 0, \\
\frac{da_2}{d\alpha} &= -\frac{(c_H - c_L)c_L f\left(\frac{c_L}{(1-\alpha)q_H}\right)}{(1-\alpha)^2 q_H \bar{F}\left(\frac{p_0}{q_H}\right)} < 0, \\
\frac{dR}{d\alpha} &= \frac{c_L \bar{F}\left(\frac{p_0}{q_H}\right) f\left(\frac{c_L}{(1-\alpha)q_H}\right)}{(1-\alpha)^2 q_H \bar{F}^2\left(\frac{c_L}{(1-\alpha)q_H}\right)} > 0.
\end{aligned}$$

□

Proof of Proposition 3. When quality information is common knowledge, the site will charge a commission rate such that the low-quality service provider cannot make money by revealing its true quality. According to (1), $\pi_L(\beta, L) > 0$ iff $(1-\alpha)(1-\beta)p_0 - c_L > 0$ and $\beta > 1 - (q_L/p_0)$. Thus, only when $\max\{1 - (q_L/p_0), \bar{\beta}\} \leq \beta \leq 1 - ([c_L/((1-\alpha)p_0))]$, $\pi_L(\beta, L) > 0$. Therefore, the low-quality service provider can make a profit by revealing its true quality iff $\max\{1 - (q_L/p_0), \bar{\beta}\} \leq 1 - [c_L/((1-\alpha)p_0)]$, that is, $\alpha < \alpha_0 = \min\left\{1 - \left[c_L/\left((1-\bar{\beta})p_0\right)\right], 1 - (c_L/q_L)\right\}$. Consequently, the site shall not charge a commission rate smaller than α_0. □

Proof of Proposition 4. When $(1-\bar{\beta})p_0 < (1-\lambda_s)\gamma$ and $\alpha \geq \alpha_0$, according to Proposition 3, the low-quality service provider cannot make a profit by revealing its true quality. The high-quality service provider just need to offer a discount level which can signal its quality.

When $1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right] \leq \alpha \leq \bar{\alpha}$, according to Proposition 1, $\beta_H(\alpha)=\bar{\beta}$. When $1-(c_L/q_L) \leq \alpha \leq \min\left\{\bar{\alpha},\, 1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right]\right\}$, $(1-\alpha)q_L \leq c_L < (1-\alpha)(1-\bar{\beta})p_0$ and according to Proposition 2, $\beta_H(\alpha)=1-[c_L/((1-\alpha)p_0)]$. The results then can be easily derived. $\square$

Proof of Proposition 5. First assume $q_L \geq (1-\bar{\beta})p_0$. Then $1-(c_L/q_L) \geq 1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right]$. Thus, $\alpha_0 = \min\left\{1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right], 1-(c_L/q_L)\right\} = 1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right]$. According to Propositions 3 and 4, $\beta_H(\alpha)=\bar{\beta}$. Then, the daily deal site's problem is reduced to

$$\max_{\alpha\in[\alpha_0,\bar{\alpha}]} \pi_s^H(\alpha) = \alpha(1-\bar{\beta})p_0\bar{F}\left(\frac{(1-\bar{\beta})p_0}{q_H}\right).$$

Thus, $\alpha^* = \bar{\alpha}$.

Next assume that $q_L < (1-\bar{\beta})p_0$. Then $\alpha_0 = 1-(c_L/q_L)$. Thus,

$$\beta_H(\alpha) = \begin{cases} 1-\frac{c_L}{(1-\alpha)p_0}, & \text{if } 1-\frac{c_L}{q_L} \leq \alpha < \min\left\{\bar{\alpha},\, 1-\frac{c_L}{(1-\bar{\beta})p_0}\right\}, \\ \bar{\beta}, & \text{if } 1-\frac{c_L}{(1-\bar{\beta})p_0} \leq \alpha \leq \bar{\alpha}. \end{cases}$$

The daily deal site's problem becomes

$$\max_{\alpha\in[\alpha_0,\bar{\alpha}]} \pi_s^H(\alpha) = \begin{cases} \frac{\alpha c_L}{(1-\alpha)}\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right), & \text{if } 1-\frac{c_L}{q_L} \leq \alpha < \min\left\{\bar{\alpha},\, 1-\frac{c_L}{(1-\bar{\beta})p_0}\right\}, \\ \alpha(1-\bar{\beta})p_0\bar{F}\left(\frac{(1-\bar{\beta})p_0}{q_H}\right), & \text{if } 1-\frac{c_L}{(1-\bar{\beta})p_0} \leq \alpha \leq \bar{\alpha}. \end{cases} \tag{13}$$

Below we first consider the scenario $\bar{\alpha} \leq 1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right]$. Then (13) can be rewritten as

$$\max_{\alpha\in[\alpha_0,\bar{\alpha}]} \pi_s^H(\alpha) = \frac{\alpha c_L}{(1-\alpha)}\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right), \alpha \in \left[1-\frac{c_L}{q_L}, \bar{\alpha}\right].$$

Then the first order condition of $\pi_s^H(\alpha)$ can be derived as

$$\frac{d\pi_s^H(\alpha)}{d\alpha} = \frac{c_L}{(1-\alpha)^2}\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right) - \frac{\alpha c_L^2}{(1-\alpha)^3 q_H} f\left(\frac{c_L}{(1-\alpha)q_H}\right) = 0,$$

which can be rewritten as

$$\frac{d\pi_s^H(\alpha)}{d\alpha} = \frac{c_L}{(1-\alpha)^2}\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right)\left(1-\alpha h\left(\frac{c_L}{(1-\alpha)q_H}\right)\right) = 0. \tag{14}$$

Note that

$$\frac{dh\left(\frac{c_L}{(1-\alpha)q_H}\right)}{d\alpha} = \frac{c_L}{(1-\alpha)^2 q_H} h'\left(\frac{c_L}{(1-\alpha)q_H}\right) > 0,$$

because $F(\cdot)$ has the property of the IGFR and $h(x)$ is increasing in x. Thus, $\alpha h(c_L/\left((1-\alpha)\right)q_H)$ is increasing in α. Therefore, the left side of (14) crosses zero once from above and $\pi_s^H(\alpha)$ is unimodal. Let α_1 denote the optimal solution of (14). Then, we have

$$\alpha^* = \begin{cases} 1-\frac{c_L}{q_L}, & \text{if } \alpha_1 < 1-\frac{c_L}{q_L}, \\ \alpha_1, & \text{if } 1-\frac{c_L}{q_L} \le \alpha_1 \le \bar{\alpha}, \\ \bar{\alpha}, & \text{if } \alpha_1 > \bar{\alpha}. \end{cases} \tag{15}$$

Next we consider the scenario $\bar{\alpha} > 1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right]$. According to (13), $\pi_s^H(\alpha)$ is increasing in α for $1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right] \le \alpha \le \bar{\alpha}$, and is unimodal in α for $1-(c_L/q_L) \le \alpha \le 1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right]$.

When $\alpha_1 \ge 1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right]$, it can be easily shown that $\pi_s^H(\alpha)$ is increasing in α, thus $\alpha^* = \bar{\alpha}$. But when $\alpha_1 < 1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right]$, depends on the value of α_1, we have

$$\alpha^* = \begin{cases} 1-\frac{c_L}{q_L}, & \text{if } \alpha_1 < 1-\frac{c_L}{q_L} \text{ and } \pi_s^H(1-\frac{c_L}{q_L}) > \pi_s^H(\bar{\alpha}), \\ \alpha_1, & \text{if } 1-\frac{c_L}{q_L} \le \alpha_1 < \bar{\alpha} \text{ and } \pi_s^H(\alpha_1) > \pi_s^H(\bar{\alpha}), \\ \bar{\alpha}, & \text{otherwise.} \end{cases} \tag{16}$$

It is worth noting that when $\bar{\alpha} \le 1-\left[c_L/\left((1-\bar{\beta})p_0\right)\right]$, $\pi_s^H(1-(c_L/q_L)) > \pi_s^H(\bar{\alpha})$ if $\alpha_1 < 1-(c_L/q_L)$ and $\pi_s^H(\alpha_1) > \pi_s^H(\bar{\alpha})$ if $1-(c_L/q_L) \le \alpha_1 < \bar{\alpha}$, thus (16) can be reduced to (15). Therefore, (16) is the general expression of the optimal commission rate. □

Proof of Proposition 6. When $\max\{\pi_L(\beta_L^H, H), \pi_L(\beta_L^L, L)\} \le \bar{A} < \pi_H(1, H)$, the quality-signalling problem $(\mathcal{TQ})$ is reduced to

$$\begin{aligned} \max_{\beta} \quad & \pi_H(\beta, H) - \bar{A} \\ s.t. \quad & \pi_H(\beta, H) - \bar{A} \ge \max\left\{\pi_H(\beta_L^H, L) - \bar{A}, 0\right\}, && (17) \\ & \pi_L(\beta, H) - \bar{A} \le 0, && (18) \\ & \bar{\beta} \le \beta \le 1. \end{aligned}$$

By the definition of $\mathcal{H}$ and $\mathcal{H}_1$, $\hat{\beta}$ satisfies the constraint (18). Therefore, to validate that $\hat{\beta}$ is the optimal solution, we only need to check that $\hat{\beta}$ also satisfies constraint (17). As $\pi_L(1, H) = -c_L\bar{F}(0) < 0$, $\beta = 1 \in \mathcal{H}$. By $\pi_H(1, H) - \bar{A} > 0$ and the definition of $\hat{\beta}$, we have $\pi_H(\hat{\beta}, H) - \bar{A} > \pi_H(1, H) - \bar{A} > 0$. Moreover,

$$\pi_H(\beta, L) = \begin{cases} [(1-\alpha)(1-\beta)p_0 - c_H]\bar{F}(\frac{(1-\beta)p_0}{q_L}) + \bar{\delta}(p_0 - c_H)\bar{F}(\frac{p_0}{q_H}), & if\ \beta \ge \max\left\{\bar{\beta}, 1-\frac{q_L}{q_H}\right\}, \\ [(1-\alpha)(1-\beta)p_0 - c_H]\bar{F}(\frac{(1-\beta)p_0}{q_L}) + \bar{\delta}(p_0 - c_H)\bar{F}(\frac{(1-\beta)p_0}{q_L}), & if\ \max\left\{\bar{\beta}, 1-\frac{q_L}{p_0}\right\} \\ & < \beta < 1-\frac{q_L}{q_H}, \\ 0, & otherwise. \end{cases}$$

Thus

$$\pi_H(\beta,\, H) - \pi_H(\beta,\, L) \geq [(1-\alpha)(1-\beta)p_0 - c_H]\left[\bar{F}\left(\frac{(1-\beta)p_0}{q_H}\right) - \bar{F}\left(\frac{(1-\beta)p_0}{q_L}\right)\right] > 0.$$

As $\pi_L(\beta_L^H,\, H) \leq \bar{A}$, $\beta_L^H \in \mathcal{H}$. Consequently, $\pi_H(\hat{\beta},\, H) - \bar{A} \geq \pi_H(\beta_L^H,\, H) - \bar{A} > \pi_H(\beta_L^H,\, L) - \bar{A}$.

Next, we prove that given the customers' beliefs $\lambda(\hat{\beta}) = 1$ for $\beta \in \mathcal{H}$, and $\lambda(\beta) = 0$ otherwise, the strategy in which the high-quality service provider offers $\hat{\beta}$ and the low-quality service provider does not offer deals can form a separating equilibrium. First, as $\pi_L(\beta_L^L,\, L) \leq \bar{A}$, the low-quality service provider cannot make money by revealing its true quality. Thus, it shall not offer $\beta \notin \mathcal{H}$ given $\lambda(\beta) = 0$ for $\beta \notin \mathcal{H}$. If the low-quality service provider offers a β, $\beta \in \mathcal{H}$, then by constraint (18), it also cannot make money. Therefore, the low-quality service provider has no incentive to conduct daily deal promotion. On the other hand, by the definition of $\hat{\beta}$, the high-quality service provider also has no incentive to deviate from $\hat{\beta}$.

Recall that if $c_L \geq (1-\alpha)(1-\bar{\beta})p_0$ (case 1 in \$4), the low-quality service provider cannot make a profit per promotional transaction. Then $\max_{\beta \in [\bar{\beta},\, 1]} \pi_L(\beta,\, H) \leq 0$ and so the constraint (18) holds for all $\beta \in [\bar{\beta},\, 1]$. Furthermore, according to Lemma 1, customer shall believe that only the high-quality service provider may offer daily deals, that is, $\lambda(\beta) = 1$ for all $\beta \in [\bar{\beta},\, 1]$. Thus if $c_L \geq (1-\alpha)(1-\bar{\beta})p_0$, the optimization problem $(\mathcal{TQ})$ can be reduced to

$$\begin{aligned} \max_{\beta} \quad & \pi_H(\beta,\, H) - \bar{A} \\ s.t. \quad & \pi_H(\beta,\, H) - \bar{A} \geq 0, \\ & \bar{\beta} \leq \beta \leq 1. \end{aligned}$$

As $\pi_H(1,\, H) > \bar{A}$, the optimal solution of the above optimization problem exists. Therefore, the optimization problem $(\mathcal{TQ})$ can be further reduced to $\max_{\beta \in [\bar{\beta},\, 1]} \pi_H(\beta,\, H)$. Note that the optimization problem $(\mathcal{HQ}1)$ can also be reduced to $\max_{\beta \in [\bar{\beta},\, 1]} \pi_H(\beta,\, H)$. Thus, if $c_L \geq (1-\alpha)(1-\bar{\beta})p_0$, according to Proposition 1, $\hat{\beta} = \beta^* = \bar{\beta}$.

If $(1-\alpha)q_L \leq c_L < (1-\alpha)(1-\bar{\beta})p_0$, when $\beta \geq 1 - [c_L/\,((1-\alpha)p_0)]$, $(1-\alpha)(1-\beta)p_0 - c_L \leq 0$, thus

$$\pi_L(\beta,\, H) = [(1-\alpha)(1-\beta)p_0 - c_L]\bar{F}\left(\frac{(1-\beta)p_0}{q_H}\right) \leq 0. \tag{19}$$

Therefore, $[1-[c_L/((1-\alpha)p_0)], 1] \subseteq \mathcal{H}$. Furthermore, we can show that when $\beta \geq 1 - [c_L/((1-\alpha)p_0)]$,

$$\begin{aligned}\frac{d\pi_H(\beta, H)}{d\beta} &= -(1-\alpha)p_0\bar{F}\left(\frac{(1-\beta)p_0}{q_H}\right) + \frac{[(1-\alpha)(1-\beta)p_0 - c_H]p_0}{q_H} f\left(\frac{(1-\beta)p_0}{q_H}\right) \\ &\leq -(1-\alpha)p_0\bar{F}\left(\frac{(1-\beta)p_0}{q_H}\right) + \frac{(c_L - c_H)p_0}{q_H} f\left(\frac{(1-\beta)p_0}{q_H}\right) < 0,\end{aligned}$$

therefore, $\hat{\beta} < 1 - [c_L/((1-\alpha)p_0)]$.

When $c_L \geq (1-\alpha)(1-\bar{\beta})p_0$, under the two-part tariff, the monetary losses incurred by the high-quality service provider in the first period and the repeat purchase rate are respectively

$$-[(1-\alpha)(1-\hat{\beta})p_0 - c_H]\bar{F}\left(\frac{(1-\hat{\beta})p_0}{q_H}\right) + \bar{A} \quad \text{and} \quad \frac{\bar{F}\left(\frac{p_0}{q_H}\right)}{\bar{F}\left(\frac{(1-\hat{\beta})p_0}{q_H}\right)},$$

where $\hat{\beta} = \bar{\beta}$. Compared with those obtained in §4.1, it can be easily shown that the repeat purchase rate under the two-part tariff is the same as that under the revenue-sharing charging scheme. As $\bar{A} > 0$, the signalling cost under the two-part tariff is higher than that under the revenue-sharing charging scheme.

When $(1-\alpha)q_L \leq c_L < (1-\alpha)(1-\bar{\beta})p_0$, $\hat{\beta} < 1 - [c_L/((1-\alpha)p_0)]$, then

$$\frac{\bar{F}\left(\frac{p_0}{q_H}\right)}{\bar{F}\left(\frac{(1-\hat{\beta})p_0}{q_H}\right)} > \frac{\bar{F}\left(\frac{p_0}{q_H}\right)}{\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right)}.$$

Furthermore, the expected profit of the high-quality service provider in the promotional period is

$$[(1-\alpha)(1-\hat{\beta})p_0 - c_H]\bar{F}\left(\frac{(1-\hat{\beta})p_0}{q_H}\right) - \bar{A},$$

where the first term is its profit from daily deal transactions and the second term is the fixed fee charged by the daily site. From (5), as $c_H > c_L$,

$$[(1-\alpha)(1-\hat{\beta})p_0 - c_H]\bar{F}\left(\frac{(1-\hat{\beta})p_0}{q_H}\right) < \pi_L(\hat{\beta}, H).$$

According to the definition of $\hat{\beta}$, constraint (18) holds at $\beta = \hat{\beta}$, that is, $\pi_L(\hat{\beta}, H) \leq \bar{A}$. Thus,

$$[(1-\alpha)(1-\hat{\beta})p_0 - c_H]\bar{F}\left(\frac{(1-\hat{\beta})p_0}{q_H}\right) - \bar{A} < 0,$$

which implies in equilibrium, the high-quality service provider incurs monetary loss in the promotional period. And the absolute value of its monetary loss is

$$-[(1-\alpha)(1-\hat{\beta})p_0 - c_H]\bar{F}\left(\frac{(1-\hat{\beta})p_0}{q_H}\right) + \bar{A}.$$

Then if $\max_{\beta\in[\bar{\beta},\,1]} \pi_L(\beta,\, H) \geq \bar{A}$, by the continuity of $\pi_L(\beta,\, H)$, there exists a $\beta_0 \in [\bar{\beta},\, 1]$ such that $\pi_L(\beta_0,\, H) = \bar{A}$. Then $\beta_0 \in \mathcal{H}$. According to (19), $\pi_L(\beta,\, H) - \bar{A} \leq -\bar{A} < 0$ for all $\beta \geq 1 - [c_L/\,((1-\alpha)p_0)]$. Thus, $\beta_0 < 1 - [c_L/\,((1-\alpha)p_0)]$. By the definition of $\hat{\beta}$, we have

$$\begin{aligned}
\pi_H(\hat{\beta},\, H) &= [(1-\alpha)(1-\hat{\beta})p_0 - c_H]\bar{F}\left(\frac{(1-\hat{\beta})p_0}{q_H}\right) \\
&> [(1-\alpha)(1-\beta_0)p_0 - c_H]\bar{F}\left(\frac{(1-\beta_0)p_0}{q_H}\right) = \pi_H(\beta_0,\, H).
\end{aligned}$$

Thus,

$$\begin{aligned}
-[(1-\alpha)(1-\hat{\beta})p_0 - c_H]\bar{F}\left(\frac{(1-\hat{\beta})p_0}{q_H}\right) + \bar{A} &\leq -[(1-\alpha)(1-\beta_0)p_0 - c_H]\bar{F}\left(\frac{(1-\beta_0)p_0}{q_H}\right) + \bar{A} \\
&= (c_H - c_L)\bar{F}\left(\frac{(1-\beta_0)p_0}{q_H}\right) - \pi_L(\beta_0,\, H) + \bar{A} \\
&= (c_H - c_L)\bar{F}\left(\frac{(1-\beta_0)p_0}{q_H}\right) \\
&\leq (c_H - c_L)\bar{F}\left(\frac{c_L}{(1-\alpha)q_H}\right).
\end{aligned}$$

Therefore, when $\max_{\beta\in[\bar{\beta},\,1]} \pi_L(\beta,\, H) \geq \bar{A}$ and $(1-\alpha)q_L \leq c_L < (1-\alpha)(1-\bar{\beta})p_0$, the signalling cost of the high-quality service provider under the two-part tariff is smaller than that under the revenue-sharing charging scheme. □

References

Bagwell K and Riordan M (1991). High and declining prices signal product quality. *American Economic Review* **81**(1): 224-239.

Brint AT (2003). Investigating buyer and seller strategies in online auctions. *Journal of the Operational Research Society* **54**(11): 1177-1188.

Brown MC (2011). 10 Pros and Cons of Using Groupon. http://www.inc.com/guides/201104/10-pros-cons-for-using-groupon.html, accessed 25 April 2011.

Byers J, Mitzenmacher M and Zervas G (2012). *Daily Deals: Prediction, Social Diffusion, and Reputational Ramifications*. Boston University, Boston, MA, and Harvard University, Cambridge, MA, Working Paper.

Cachon GP and Swinney R (2009). Purchasing, pricing, and quick response in the presence of strategic consumers. *Management Science* **55**(3): 497-511.

Chen J, Feng J, and Whinston A (2009). Keyword auctions, unit-price contracts, and the role of committment. *Production and Operations Management* **19**(3): 305-321.

Dellarocas C (2010). Double marginalization in Performance-Based advertising: Implications and solutions. *Management Science* **58**(6): 1178-1195.

Desai P and Srinivasan K (1995). Demand signaling under unobservable effort in franchising: Linear and nonlinear price contracts. *Management Science* **41**(10): 1608-1623.

Dholakia UM (2011a). *What makes Groupon promotions profitable for businesses*? Rice University, Houston, TX, Working Paper.

Dholakia UM (2011b). *A Sstartup's experience with running a Groupon promotion*. Rice University, Houston, TX, Working Paper.

Dholakia UM (2011c). *How Businesses Fare With Daily Deals: A Multi-Site Analysis of Groupon, LivingSocial, OpenTable, Travelzoo, and BuyWithMe Promotions*. Rice University, Houston, TX, Working Paper.

Dholakia UM (2012). *How businesses fare with daily deals as they gain experience: A multi-time period study of daily deal performance*. Rice University, Houston, TX, Working Paper.

Dholakia UM and Kimes SE (2011). *Daily deal fatigue or unabated enthusiasm? A study of consumer perceptions of daily deal promotions*. Rice University, Houston, TX, and Cornell University, Ithaca, NY, Working Paper.

Edelman E, Jaffe S and Kominers DS (2011). *To Groupon or not to Groupon: The profitability of deep discounts*. Harvard University, Cambridge, MA, Working Paper.

Fay S and Xie J (2010). The economics of buyer uncertainty: Advance selling vs. probabilistic selling. *Marketing Science* **29**(6): 1040-1057.

Feng J (2008). Optimal mechanism for selling a set of commonly ranked objects. *Marketing Science* **27**(3): 501-512.

Feng J and Xie J (2012). Performance-based advertising: Advertising as signals of product quality. *Information Systems Research* **23**(3): 1030-1041.

Freed L (2011). New Data: Groupon & Living Social Bring New Customers (and Existing Ones). http://foreseeblog.com/2011/06/22/new-data-groupon-and-living-social-bring-new-customers/, accessed 22 June 2011.

Goldman R (2008). Disadvantages of Viral Marketing. http://bestadagencies.blogspot.hk/2008_11_01_archive.html, accessed 30 November 2008.

Jerath K, Ma L, Park Y and Srinivasan K (2011). A Position Paradox in Sponsored Search Auctions. *Marketing Science* **30**(4): 612-627.

Kimes, SE and Dholakia UM (2011). *Customer response to restaurant daily deals.* Cornell University, Ithaca, NY, and Rice University, Houston, TX, Working paper.

Kirmani A and Rao AR (2000). No pain, no gain: A critical review of the literature on signaling unobservable product quality. *Journal of Marketing* **64**(2): 66-79.

Koh (2011). After Mochi, Osechi: The First Food Brouhaha of the New Year. *The Wall Street Journal.* http://blogs.wsj.com/japanrealtime/2011/01/05/after-mochi-osechi-the-first-food-brouhaha-of-the-new-year/.

Kumar V and Rajan B (2012). Social Coupon as a Marketing Strategy: A Multifaceted Perspective. *Journal of the Academy of Marketing Science* **40**(1): 120-136.

Laffey D, Hunka C, Sharp JA and Zeng Z (2009). Estimating advertisers' values for paid search clickthroughs. *Journal of the Operational Research Society* **60**(3): 411-418.

Lariviere MA and Porteus EL (2001). Selling to the newsvendor: An analysis of price-only contracts. *Manufacturing Service Operations Management* **3**(4): 293-305.

Lewis M (2006). Customer Acquisition Promotions and Customer Asset Value. *Journal of Marketing Research* **43**(2): 195-203.

Li X and Wu L (2012). *Measuring Effect of Observational Learning and Social-Network Word-of-Mouth (WOM) on the Sales of Daily-Deal Vouchers.* Massachusetts Institute of Technology, Cambridge, MA, and University of Pennsylvania, Philadelphia, PA, Working paper.

Li C and Zhang F (2013). Advance demand information, price discrimination, and preorder strategies. *Manufacturing Service Operations Management* **15** (1): 57-71.

Liang X, Ma L, Xie L and Yan H (2013). The Informational Aspect of the Group-buying Mechanism. *European Journal of Operational Research* Forthcoming.

Lu Q and Moorthy S (2007). Coupons versus rebates. *Marketing Science* **26**(1): 67-82.

Malaga R, Porter D, Ord K and Montano B (2010). A new end-of-auction model for curbing sniping. *Journal of the Operational Research Society* **61**(8): 1265-1272.

Milgrom P and Roberts J (1986). Price and advertising signals of product quality. *Journal of Political Economy* **94**(4): 796-821.

Moorthy S and Srinivasan K (1995). Signaling quality with a money-back guarantee: The role of transaction costs. *Marketing Science***14**(4): 442-466.

Narasimhan C (1984). A Price Discrimination Theory of Coupons. *Marketing Science* **3**(2): 128-147.

Nasiry J and Popescu I (2012). Advance selling when consumers regret. *Management Science* **58**(6): 1160-1177.

Neary L (2011). Deal Sites Like Groupon Change How We Shop. http://www.npr.org/2011/02/22/133966410/deal-sites-like-groupon-change-how-we-shop, accessed 22 February 2011.

Nelson P (1974). Advertising as information. *Journal of Political Economy* **82**(4): 729-754.

Prasad A, Stecke KE and Zhao X (2011). Advance Selling by a Newsvendor Retailer. *Production and Operations Management* **20**(1): 129-142.

Smith R (2011). Groupon's Secret: Everybody Has A Price. http://www.npr.org/blogs/money/2011/04/08/135244697/groupons-secret-everybody-has-their-price, accessed 08 April 2011.

Srinivasan A and Kwon C (2012). Operations of online advertising services and publisher's option. *Journal of the Operational Research Society* **63**(5): 674–682.

Subramanian U (2012). *A Theory of Social Coupons*. University of Texas at Dallas, TX, Working Paper.

Swinney R (2011). Selling to strategic consumers when product value is uncertain: The value of matching supply and demand. *Management Science* **57**(10): 1737-1751.

Tirole J (1989). *The theory of industrial organization*. MIT Press: Cambridge.

Tutlle B (2011). Daily Deal Disappearing Act: One-Third of Deal Sites Sold or Closed This Year? http://business.time.com/2011/09/19/daily-deal-disappearing-act-one-third-of-deal-sites-sold-or-closed-this-year/, accessed 19 September 2011.

Xie J and Shugan SM (2001). Electronic tickets, smart cards, and online prepayments: When and how to advance sell. *Marketing Science* **20**(3): 219-243.

Ye M, Wang C, Aperjis C, Huberman BA and Sandholm T (2011). *Collective attention and the dynamics of group deals.* Pennsylvania State University, University Park, PA, Stanford University, Stanford, CA and HP Labs, Palo Alto, CA, Working paper.

Zhang X and Feng J (2011). Cyclical bid adjustments in search engine advertising. *Management Science* **57**(9): 1703-1719.