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ESSAYS ON MARKETING STRATEGIES IN THE CONTEXT OF INTERDEPENDENT
CONSUMPTION

by

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A dissertation submitted in partial fulfilment of the requirements
for the degree of Doctor of Philosophy
in the Department of Marketing
in the College of Business Administration
at the University of Central Florida
Orlando, Florida

Summer Term

2015

Major Professor: Axel Stock

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ABSTRACT

This dissertation consists of two essays in which I study the impact of two interdependent consumer behaviors, fairness concerns and exclusivity seeking, on a company's marketing strategies and profits specifically in a context where it tries to expand its clientele with the objective of generating repeat purchases, for example by running deals on daily deal platforms. In the first essay, I examine the impact of customers' fairness concerns on the profitability of a company running promotions on daily deal platforms. With the prevalence of social media and the internet, information about such targeted promotions can become available to all consumers including those who did not have access to the platform and paid a full-price. Conducting a laboratory experiment, I demonstrate that knowledge about targeted promotions often leads to post-promotional fairness concerns among these consumers resulting in an increased tendency to switch providers. Incorporating the results of the experiment in a two-period game-theoretic model I analyze the impact of customers' post-promotional fairness concerns on the profits of quality differentiated companies who compete by running targeted promotions. I find that the low quality provider always suffers from consumers' sensitivity to unfairness. Contrary, I show that the high quality provider can counterintuitively benefit from consumers' fairness concerns as long as its quality advantage is not too large. Furthermore, I analyze how profits are impacted when information about the targeted deals leaks to non-targeted customers who would have bought at the regular price. I find that, counterintuitively, competing firms' profits increase with leakage. In the second essay of this dissertation, I start with the observation that many platform members are new customers and are uncertain about the quality of the company's product or service until they consume it. In such a context, I examine a high quality seller's optimal signaling strategy in a market where consumers prefer to purchase a scarce product due to desire for exclusivity or to receive a service in a non-crowded environment due to better experience and service delivery. Utilizing a repeat purchase signaling model I show

that, consistent with prior literature, the high quality firm signals its quality by making its product scarce as well as charging a high price when consumers desire for exclusivity is high and cost of quality is great. Contrary, I also find conditions under which the high quality firm counterintuitively makes its product widely available and prices it low to signal its quality. The model may in part explain how high quality sellers market their products or services on daily deal websites.

I dedicate this dissertation to my loving parents, my wonderful siblings, and my precious niece,
Parnian, whose beautiful face and voice is the joy of my life.

ACKNOWLEDGMENTS

First, I would like to express my deepest gratitude to my adviser, Dr. Axel Stock, for his guidance throughout this dissertation. With patience and encouragement, he helped me explore new ideas and find solutions to my research project. As my mentor, he inspired me and offered many advices that are useful to my academic work and my life. I am deeply grateful for his careful reading and constructive feedback of all my writings. Without his tremendous support, this dissertation would not have been possible.

I would also like to acknowledge the members of my dissertation committee, Dr. Huifang Mao, Prof. Michael Caputo, and Dr. Lin Liu, for their effort in evaluating my work and providing me with invaluable feedback. Next, I am deeply grateful to Dr. Ronald Michaels, the chair, and Dr. Pradeep Bhardwaj, the PhD Coordinator of the marketing department. Without their support and patience, I could not pass this stage of my life. Furthermore, I want to thank the other faculty and staff in Marketing Department at the University of Central Florida for their support during my doctorate training.

My appreciation also goes on to Mr. and Mrs. Davoudian who have helped me tremendously during the past five years. I am deeply touched by their kindness, generosity, and support. A special thanks must also go to all my friends who have been encouraging me along the way.

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CHAPTER 1: GENERAL INTRODUCTION

Social Decision Theory implies that consumers make their consumption decisions incorporating other consumers consumption decisions (Festinger, 1954; Leibenstein 1950; Gaertner 1974). In other words, the utility that consumers obtain depends not only on their own purchase experiences but also on other consumers purchase experiences and moreover, on how sensitive they are toward their comparative social gains and losses (Bernheim, 1994; Fehr and Schmidt, 1999; Feinberg, Krishna and Dhar, 2002). Consumers may experience a negative utility when they realize that their purchase outcome is lower than those of their peer consumers (social loss) or they may experience a positive utility when they find out they are standing in a better position compared to their peer consumers (social gain). The mere act of socially interdependent consumption is not a new phenomenon. However, penetration of the social media and other online platforms has magnified the potential and impact of it. Online platforms have increased consumers ability of sharing and obtaining information about each others consumptive practices and experiences, thereby increasing the extent of interdependent consumption. Although, there has been much research on interdependent consumer behaviors and their considerable impact on firms profitability (Fehr and Schmidt, 1999; Feinberg, Krishna and Dhar, 2002; Amaldos and Jain, 2005; Balachander and Stock, 2009), yet more research needs to be done on understanding these behaviors and developing suitable marketing strategies for businesses in different contexts. In this dissertation, I study two interdependent consumer behaviors, fairness concerns and exclusivity seeking, and investigate their impact on a firms marketing strategies specifically in a context where firms try to expand their clientele and generate repeat purchases among them. Recently, many firms try to increase awareness and consequently increase repeat purchases by running promotions on daily deal platforms such as Groupon and LivingSocial . While some businesses earn higher profits and report higher repeat purchases than expected, others are disappointed (Dholakia, 2011). In this dissertation, I take a behavior-

ist approach to explain the impact of interdependent consumption behaviors on profitability and marketing strategies of firms in such contexts. In the first part of this dissertation, I study the impact of consumers fairness concerns. While platform members appear happy about the huge discounts that they receive, non-member consumers who paid the regular price while the promotion was running perceive price unfairness and react negatively to the unfair firm since they realize the prices they paid are higher from the prices some other customers paid. In a report, Turow, Feldman, and Meltzer (2005) mention that 76 percent of American consumers would be bothered if they find out another consumer paid less for the same product that they purchased. Numerous examples of consumers' negative reactions to discriminatory coupon targeting can be found on companies' customer forums and social networks (BestBuy customer Forum, 2012; Techenclave, 2011). Similarly, academic research in Marketing has shown that ignoring consumers' price fairness concerns may lead firms to overestimate the profitability of targeted promotions (Feinberg, Krishna, and Zhang, 2002). Contributing to the fairness concern literature, I investigate the effect of post-promotional fairness concern on firms pricing strategy and profits in a profit maximization framework. I develop a two-period game theoretic model where firms that are differentiated in quality run a promotion in the first (promotional) period. In the second (post-promotional) period, consumers who have paid the full price receive information about the price discrimination that had been going on in the promotional period and perceive unfairness. I assume that customers post-promotional product value will be impacted negatively due to their perception of unfairness. First I, conducted an experiment to provide evidence that such an assumption is valid in a deal platform setting. The findings of the experiment, contrary to rationality aspect of standard theory of economics, show that consumers take fairness concerns about past firm behavior into consideration for their future purchase decisions. Incorporating this assumption into an analytical model, I analyze the impact of post-promotional fairness concerns on profitability of targeted promotions on a daily deal platform. I find that the low quality providers always suffer from consumers sensitivity to unfairness. Contrary, I show that the high quality providers can counterintuitively benefit from

consumers fairness concerns as long as their quality advantage is not too large. These findings contribute to the understanding of the impact of fairness concerns on a firms strategies and profits and can, in part, explain why some companies overestimate and others underestimate profits resulting from running promotions on a daily deal platform. In the second essay of this dissertation, I investigate another issue might be faced by a company promoting its product or service on a daily deal platform, the fact that many platform members are new customers and are uncertain about the quality of the companys product or service until they consume it. In such a context, high quality providers have an incentive to use different marketing strategies to signal their quality to platform members and generate repeat purchases from them. Stock and Balachander (2005) have shown that in such an asymmetric information environment, it is more efficient for a high quality provider to signal their quality by making their product scarce and their intuition is that consumers seek exclusivity and they perceive what is more exclusive is more valuable. This finding is consistent with real business cases where early product shortage are mostly observed for new discretionary or specialty products such as Samsung Galaxy (The Gaurdian, 2013), Microsoft Xbox (CNN 2013), Microsoft windows 8, etc. products or services. However, observations show that many unknown restaurants, spas, yoga classes and so on aggressively penetrate the market with the availability of their product deals on daily deal platforms (Groupon, 2015). The above conflicting examples (shortage vs. availability) poses the following question: What does possibly explain the reason why some firms eschew product shortage in favor of product availability and vice versa to signal their quality in their initial release stages? In the second essay, I extend the purchase context from one-time purchased products to repeatedly purchased ones and I incorporate the impact of consumers exclusivity seeking behavior to answer the puzzling question above. Consistent with research in psychology and scarcity literature, I assume that exclusivity seeking (or snobbish) consumers make their purchase decisions not only on product attributes such as price and quality but also on how many other consumers in the market could have access to the same product and purchase it (Lynn, 1987; Verhallen and Robben, 1994, Amaldos and Jain, 2005). Following the aforementioned liter-

ature, I model the impacts of product availability/stock-out in a consumer's utility, such that their value for a product decreases as the number of people who buy the product increases. Thus, consumers in my model derive utility from three different factors: the product quality, the availability degree of the product, and its price. I use a two-period signaling model in which a monopoly firm sells a new repeatedly purchased good to uninformed consumers such as daily deal platforms. In such a market the low quality provider is willing to signal as a high quality type in the introductory period. Thus, the high quality firm tends to set his availability/scarcity strategy in the introductory period in a way to not only maximize his profits but prevent the low quality firm from imitating his strategy. Interestingly, even in the presence of exclusivity seeking consumers, contrary to the previous literature, I could identify a set of conditions in which introductory availability is a more effective signaling strategy than introductory scarcity for a high quality firm. The intuition is that although making the product available to more consumers in the introductory period negatively impacts the snobbish consumers' product valuation and consequently firm's profits, consumers are able to infer that only high quality firm is able to compensate for the current loss in future. That is because a high quality firm attracts more repeat purchases. As more uninformed consumers purchase high quality brand in the first period, more informed consumers may proceed to repurchase it in the second period. Furthermore, high quality firm's increasing availability makes mimicry less attractive for low quality firm, since low quality firms introductory stage profits is reduced and he will not be able to cover this profits loss with future returns. My findings are consistent with the business observation that high quality service providers are more willing to making their product more available on daily deal platforms by providing deep discounts since the initial sales is more valuable in generating repeat purchases to a high quality firm than a low quality one. Overall, this dissertation contributes to different streams of research in marketing and economics. First, it enhances our understanding of the impact of customer behaviors (e.g. fairness concern and exclusivity seeking behaviors) on optimality of firms marketing strategies (e.g. pricing, promotion, and availability/scarcity) and profits when they tend to induce repeat purchases. Second, it extends

the signaling literature by showing the conditions under which availability rather than scarcity is a more effective signaling strategy for a high quality firm selling an uncertain quality product.

CHAPTER 2: THE DYNAMIC IMPACT OF PERCEIVED PRICE UNFAIRNESS ON THE PROFITABILITY OF DAILY DEAL PROMOTIONS

2.1 Introduction

Recently, many firms try to generate awareness for their product or service among potential customers and to induce trial by running promotions on deal platforms. For example, spas run deals on Groupon or LivingSocial to attract new customers and to provide them with incentives to try their services¹. While consumers appear happy about the huge discounts that companies provide on deal platforms, we often observe in practice that companies have mixed opinions about the performance of such promotions. While some businesses report higher than expected profits others are disappointed (Dholakia, 2011). The business press and academic research (The Dailybeast, 2012; Gupta et al., 2012; Dholakia, 2011) propose several factors which may negatively impact firm's profits from daily deal promotions. For example, they suggest that information leakage about such promotions may erode profits, i.e. some consumers who were members of the platforms and purchased at the promotional price would have purchased at the regular rate without using the vouchers. Another concern is that only a small percentage of the customers who redeem the deal may become regulars after the promotional period is over because they are inherently price-sensitive. In this research, we focus on analyzing the impact of another factor which may affect profits from running targeted promotions on a deal platform: full-price customers' fairness concerns in post-promotional periods. The business press is unequivocal in its judgment about how price fairness concerns of disgruntled customers may impact a firm's bottom line. Most notably,

¹Dholakia (2011) reports that 80 % of users of a daily deal are new customers.

AMAZON dropped its dynamic pricing strategy after some customers complained that they were paying 3 to 5 percent more for the same set of DVDs than some other customers (Adamy, 2000). In a report, Turow, Feldman, and Meltzer (2005) mention that 76% percent of American consumers would be bothered if they find out another consumer paid less for the same product that they purchased. Numerous examples of consumers' negative reactions to discriminatory coupon targeting can be found on companies' customer forums and social networks (BestBuy customer Forum, 2012; Techenclave, 2011). Similarly, academic research in Marketing has shown that ignoring consumers' price fairness concerns may lead firms to overestimate the profitability of targeted promotions (Feinberg, Krishna, and Zhang, 2002). In an experiment Feinberg, Krishna, and Zhang (2002) find that loyal customers who pay the full-price perceive promotions targeted at switchers as unfair and thus, their purchase intentions for the product or service during the promotional period decrease. Drawing upon the behaviorist approach of Feinberg, Krishna, and Zhang (2002) to targeted promotions, we incorporate fairness concerns of consumers in an analytical model to provide a new perspective for analyzing the profitability of running promotions on deal platforms.

Our model is able to address the following interesting research questions: What is the effect of post-promotional price fairness concerns on a firm's pricing strategy and profits running targeted promotions on deal platforms? How does product or service quality impact the result? Furthermore, how does type of differentiation between firms influence the effect of price fairness concerns on firm profits? Finally, how does information leakage about the promotions to non-targeted consumers in the promotional period affect firm strategies and profits in the presence of fairness concerns? To answer these research questions we develop a 2 period game theoretic model where, in the first period, firms target members of a deal platform with a promotional offer while charging a full price to all other customers. At the beginning of the second period all customers learn about the prices charged during the promotional period and we assume that they take this information into consideration when making their next purchase decision. Specifically, we assume that

non-targeted consumers who were not aware of the promotional offer and paid a full price perceive price unfairness and that their post-promotional valuation of the product will be impacted negatively. Since this assumption is a key behavioral element in our model, we first conducted an experiment to provide evidence that such an effect exists in a deal platform setting. Afterward, we incorporate this behavioral assumption into our analytical model and analyze its impacts on firms' profits. Thus, in the next section we describe the experiment and discuss its results followed by a presentation of the model.

2.2 Literature Review

Our paper is related to the broad literature in marketing and psychology on consumers' perceived price fairness. A thorough review of antecedents and consequences of price fairness on consumer behaviors can be found in Xia, Monroe and Cox (2004). Price fairness judgments involve a comparison that a consumer makes between the price she pays for a product and a reference price. The reference price may be a price that another customer pays for the same product or the price that the customer herself paid for the product earlier (Jin, He, and Zhang, 2013). In this research, we focus on the former reference price since (as previous literature has shown) similar purchases made by other customers have a greater effect on the perception of price unfairness than previous purchases made by oneself. This is particularly true when this information is salient and when the other individuals in consideration are immediately relevant to the buyer (Xia, Monroe and Cox, 2004), or when individuals perceive that they are powerful (Jin, He, and Zhang, 2013). Consumers' fairness concerns arise when they realize the prices they paid are different from the prices other customers paid. Literature has shown that customers may also suffer from "advantageous price inequity" but in the present research we just focus on perception of unfairness due to "disadvantageous price inequity" since customers suffer more from inequity that is to their disadvantage than from inequity

that is to their advantage (Xia, Monroe and Cox, 2004).

There is an extensive literature in Economics on fairness as well which focuses on how to incorporate customers' observed reactions to unfairness in their utility functions. Fehr and Schmidt (1999) model fairness as "inequity aversion". In their model, consumers dislike an unequal outcome whether the inequality is to their advantage or to their disadvantage. Ho and Su (2009) also suggest that agents can have peer-induced fairness concerns when they engage in social comparison. Similar to previous research, we also incorporate fairness concerns in customers' utility functions. However, in our model we assume, consistent with our findings from the experiment, that consumers perceive unfairness even in the post-promotional period when they realize they experienced disadvantaged price inequity in the past.

Although there has been a quite number of behavioral studies on the consequences of price fairness perceptions on consumer behaviors, there has been little academic research which specifically considers the impacts of fairness perceptions on firms' optimal pricing strategies and profits. Chen and Cui (2013) provide an analytical model of price competition that incorporates consumers' fairness concerns to explain why uniform pricing of branded variants can increase firms' profits. In their model, consumers' fairness concerns make firms commit to uniform pricing rather than non-uniform pricing. Feinberg, Krishna, and Zhang (2002) examine the issue of price fairness in the context of targeted promotions. They demonstrate that when a firm in a competitive setting offers a lower price to the switchers (i.e. potential customers) rather than to their loyals (i.e. current customers), its profits go down with loyals' perception of unfairness ("betrayal effect"). However, while Feinberg, Krishna, and Zhang (2002) study the impact of fairness concerns on firm profits, they do not analyze the optimal pricing strategies of firms when they implement promotions. In recent working papers, Li and Jain (2014) and Lee and Fay (2014) extend Feinberg, Krishna, and Zhang (2002) to study optimal competitive pricing for firms in a profit maximization framework and study how firms' profits and their behavior based pricing (BBP) strategies are impacted by

customers' fairness concerns. Li and Jain (2014) find that competing firms which implement BBP make more profit as consumers' fairness concerns increase.

Although our research and the previously mentioned studies are similar to each other in terms of studying the impacts of customers' perceived price unfairness on firm profitability with an analytical model, in this paper, we analyze a scenario that differs from the ones studied above in several ways. First, in the daily deal scenario price unfairness does not result from targeted pricing based on past purchase behavior. In contrast, both Feinberg, Krishna, and Zhang (2002) and Li and Jain (2014) study a scenario where firms offer promotions in the second period based on customers' purchase behaviors in the first period. In these papers, in the second period, loyal customers react to price discrimination which is applied in favor of switching customers. However, we analyze firms' optimal pricing strategies in a 2-period model where firms offer promotions in the first period considering the impact of post-promotional fairness concerns on customers' purchase intentions in the second period. While we also consider the possibility that some non-targeted customers may learn about the promotion when it is offered, we center our attention on the impact of post-promotional fairness concerns of full-price customers. The reason is that although social media and the internet may allow non-members to become aware of promotions quicker, anecdotal evidence suggests that many still learn about them from other customers or other sources of information after the deal has expired. As we explained earlier, through the laboratory study, we demonstrate that full-price customers perceive unfairness about a Groupon promotion that some other customers took advantage of and that their post-promotional preferences for their first choice brand decrease in response to price unfairness they perceived. Thus, our first contribution to the related literature is that we study the dynamic impact of price unfairness on firms profits and strategies in a setting without BBP. We thereby take into account the possibility of firms influencing the extent of unfairness that full-price customers experience in the post-promotional period, and that firms compensate them for feelings of unfairness by offering a price cut in that period. Furthermore, our model is consistent with

the scenario of a firm running promotions on deal platforms to attract new customers. In contrast, Feinberg, Krishna, and Zhang (2002) and Li and Jain (2014) assume that information about the targeted promotion is available to all customers in the promotional period and that the non-targeted customers cannot obtain the promotion even if they are aware of it. As we pointed out earlier, we also study how the type of differentiation between competing firms can change the direction and degree of the effect of price unfairness on firms' strategies and profits. Based on our knowledge we are the first to address the issue of price fairness in a market where brands differ in quality. In Chen and Cui (2013), competitive firms prefer to apply uniform pricing rather than discriminatory pricing for their branded variants because uniform pricing mitigates price competition between them.

In summary, we expand upon the aforementioned literature by specifically studying the impact of full-price customers' fairness concerns in the post-promotional period on differentiated firms' profits and pricing strategies. This research problem has recently become important since businesses are desperate to find the most profitable marketing avenues, however, they are not aware of the pitfalls when calculating their profits. Relatedly, academic research and business press has highlighted the impact of bounded rational consumer behaviors like fairness concerns on firms' strategies and profits (Forbes, 2014; Rabin, 1993; Fehr and Schmidt, 1999). Overall, past research has often emphasized the adverse/negative effects of price unfairness on customers' purchase intentions and eventually firms' profits. However, in this paper, we find that under some conditions firms can benefit from the perception of unfairness. More specifically, when two horizontally differentiated firms differ in quality, the high quality firm's profit increases with fairness concerns as long as the quality difference between the firms is not too great.

The remainder of the article is organized as follows: in the next section we introduce the modeling framework followed by a discussion of our analysis. We begin by considering the case of a market where firms are vertically differentiated and subsequently, we analyze the case of horizontally

differentiated firms. We conclude the paper with a discussion of the results and limitations of the research as well as suggest some future research avenues.

2.3 Model

2.3.1 Consumers

We consider a product category where two firms, denoted A and B respectively, compete for a unit mass of consumers who have demand for one unit of the product in each of two periods. We assume that the market consists of two consumer segments, promotional customers and full-price customers, denoted with subscripts P and F , respectively. Promotional customers, who comprise γ percent of the market, have signed up on a Daily Deal platform like Groupon and thus, can be reached by the firms with a special promotional offer, R . The rest of the market, $1 - \gamma$ percent of consumers, are full-price customers who are not members of the Daily Deal platform and who, in the first period, are only aware of the regular price, P^2 . Furthermore, consumers in both segments have a base value V for the product in each period. Thus, the utilities that promotional and full-price customers receive from the purchase of product i in the first period are given by equations 2.1 and 2.2, respectively, with $i = A, B$.

$$U_{Pi1} = V - R_{i1} \tag{2.1}$$

$$U_{Fi1} = V - P_{i1} \tag{2.2}$$

We assume that in the second period pricing information from the first period becomes available to all customers in the market. In particular, the full-price customers receive information about the

²Later we relax this assumption and consider a situation where α percent of full-price customers become aware of the deal due to the leakage of information during the promotional period.

foregone deal and, consistent with our experimental results, they perceive unfairness. As a consequence, their valuation of the previously purchased brand is impacted negatively in the post promotional period. Following Ho and Su (2009), we assume that these customers of firm i ($i = A, B$) experience a disutility $b(P_{i1} - R_{i1})$ due to unfairness upon repurchasing product i . Alternatively, they can switch to the competing firm j ($j = A, B$ and $j \neq i$) and avoid the aforementioned utility loss because they have not experienced unfairness by firm j ³. In this formulation, the extent of unfairness perceptions is a multiplicative function of the difference between promotional and regular prices in the first period, $(P_{i1} - R_{i1})$, and consumers' sensitivity to unfairness, $b > 0$ ⁴. There are other possible unfairness effects that one could capture in a dynamic framework, for example, the unfairness a consumer may experience when buying the product at the regular price after having purchased it at the deal price. However, for parsimony we focus on the effect of customers' fairness concerns about not receiving a deal on firms' profits, without implying that other unfairness effects are weaker or less predominant than this effect. In summary, the post-promotional utilities U_{Fii} for full-price customers who purchase from firm i twice, where $i = A, B$, and U_{Fij} for full-price customers who switch firms in the second period, where $i, j = A, B$ with $i \neq j$, are given in equations 2.3 and 2.4, respectively.

³We could consider the possibility that full-price customers of a firm assess the pricing policy of the other firm as well, e.g. in the second period full-price customers of firm A who switch to firm B experience a disutility of $b(P_{A1} - R_{B1})$ because they were not able to obtain firm B 's deal price in the first period. We do not study this effect, since as Feinberg et al (2002) argue customers are more concerned about their favored firm's mistreatment than another firm's mistreatment. More specifically, we assume the effect of the other firm's mistreatment to be zero.

⁴Although the multiplicative function of the unfairness effect in the consumer's utility function has been previously suggested in the literature (Ho and Su, 2009), we tested the correctness of this formulation, conducting a laboratory experiment (see Appendix for details). The results of the experiment strongly suggest that consumer's switching behavior due to unfairness are affected by the interaction of both their degree of sensitivity to unfairness and the degree of price unfairness, $(P_1 - R_1)$.

$$U_{Fii} = V - b(P_{i1} - R_{i1}) - P_{i2} \quad (2.3)$$

$$U_{Fij} = V - P_{j2} \quad (2.4)$$

Finally, as per assumption the firms do not offer the daily deal in the post promotional period and therefore, promotional customers who purchase product i in that period receive a utility of $U_{P_{i2}} = V - P_{i2}$, where $i = A, B$. All notations used in this paper are summarized in Table 2.1.

2.3.2 Firms

There are two firms in the market, denoted A and B , which offer a product or a service at a discounted price on a deal platform to attract promotional customers while serving the remaining market at the regular price. We analyze the scenario where both firms offer a deal in order to focus on the impact of customers' fairness concerns on firm profits, although theoretically either firm could refrain from offering a deal. In the Appendix we identify the parameter conditions under which both firms run the daily deal promotion in equilibrium. We assume that both firms have identical marginal costs which we set to zero without loss of generality. Furthermore, we consider a two-period game where the deal is offered in the first period while in the second period firms charge the same price to all customers. Although a firm could run several deals in sequence, our set up is consistent with industry practice which shows that Daily Deal promotions are used temporarily followed by non-promotional periods (GrouponWorks.com).

With the above-specified base model of consumer behavior, we analyze two cases of differentiation

between firms A and B : (a) vertical differentiation, and (b) horizontal differentiation. For the latter case we also consider the possibility that brands differ with respect to quality.

2.3.3 Vertical Differentiation Case

In this case we assume that brands A and B are differentiated with respect to a vertical attribute and that all consumers prefer more of that attribute at equal prices (Tirole 1988, p. 296). One vertical attribute that has been suggested in the literature is quality (Balachander and Stock, 2009). Without loss of generality, we assume that firm A produces a higher quality product than firm B and thus, we use notation H and L for firms A and B , respectively. The exogenous qualities of the firms' products are given by s_H and s_L , with $s_H > s_L$. Each consumer has a value θ for a unit of quality which is distributed uniformly between $\underline{\theta}$ and $\bar{\theta}$ ($\bar{\theta} > \underline{\theta} > 0$). For simplicity, we assume $s_L = 1$ and $s_H = 1 + s$ where s denotes the quality difference between the brands. Thus, the customers' base values V for the products of firm H and firm L are equal to $\theta(1 + s)$ and θ , respectively. Substituting $\theta(1+s)$ and θ in equations 2.1 and 2.2, we can find the marginal full-price and promotional customers, θ_{FL1} and θ_{PL1} respectively, who are indifferent between purchasing from H and L in the first period (see Figure 2.1-a). Next, we consider the demands for both firms in the second period (see Figure 2.1-b). Firm H 's full-price customers who still repurchase from H have $\theta > \theta_{FHH}$ where θ_{FHH} can be found solving $U_{FHH} = U_{FHL}$ (See Figure 2.1-b). The remaining full-price customers who purchased from firm H in the first period switch to firm L in the second period and are located between θ_{FL1} and θ_{FHH} . Furthermore, the marginal full-price customer who is indifferent between staying loyal to firm L and switching to H is located at θ_{FLL}

which can be obtained by equating $U_{FLH} = U_{FLL}$. Consequently, firm H obtains a switching segment of consumers who are located between θ_{FLL} and θ_{FL1} . Moreover, in the second period, platform members who paid the promotional price in the first period buy a product from the firm that maximizes their utility, $U_{PH2} = V - P_{H2}$ or $U_{PL2} = V - P_{L2}$.

We assume for simplicity that $\underline{\theta} = 0$ and $\bar{\theta} = 1$, and that the market is covered in both full-price and promotional segments. Thus, given the demands developed above, the firms' profit functions for the vertical differentiation case are as follows:

$$\pi_H = \pi_{H1} + \pi_{H2} = (1 - \gamma)(1 - \theta_{FL1})P_{H1} + \gamma(1 - \theta_{PL1})R_{H1} + (1 - \gamma)(1 - \theta_{FHH} + \theta_{FL1} - \theta_{FLL})P_{H2} + \gamma(1 - \theta_{PL2})P_{H2} \quad (2.5)$$

$$\pi_L = \pi_{L1} + \pi_{L2} = (1 - \gamma)(\theta_{FL1})P_{L1} + \gamma(\theta_{PL1})R_{L1} + (1 - \gamma)(\theta_{FLL} + \theta_{FHH} - \theta_{FL1})P_{L2} + \gamma(\theta_{PL2})P_{L2} \quad (2.6)$$

2.3.4 Horizontal Differentiation Case

In this case, we assume that brands are horizontally differentiated and we consider a Hotelling framework (Hotelling, 1929), with two firms A and B located at the end points 0 and 1, respectively, of a line of unit length. Consumers' ideal values with respect to a taste based attribute are uniformly distributed along this line. More specifically, a consumer whose ideal point is located at x and who purchases from firm A incurs a disutility of $t * x$ where t is a cost per unit of distance between the consumer's ideal value and the firm's location. Thus, a customer who is located at x has base values $u - tx$ and $u - t(1 - x)$ for products A and B , respectively, where u is a constant. We substitute the base values for each firm for V in equations 2.1 and 2.2 to find firm A and B 's

full-price and promotional customers' demand in period 1, x_{FA1} and $(1 - x_{FA1})$ as well as x_{PA1} and $(1 - x_{PA1})$, respectively. As shown in Figure 2.2-a, Firm A 's loyal full-price customers are located between point 0 and x_{FAA} and the rest of them switch to firm B : $x_{FAB} = x_{FA1} - x_{FAA}$. Similarly, the loyal full-price customers of firm B are located between x_{FBB} and 1 and the rest switch to firm A : $x_{FBA} = x_{FBB} - x_{FA1}$. Furthermore, the members' demand in each segment for brands A and B in the second period are equal to x_{PA2} and $1 - x_{PA2}$, respectively.

Given the demands for each segment in both periods, firms' profit functions in horizontal differentiation case are:

$$\pi_A = \pi_{A1} + \pi_{A2} = (1 - \gamma)x_{FA1}P_{A1} + \gamma x_{PA1}R_{A1} + (1 - \gamma)(x_{FAA} + x_{FBA})P_{A2} + \gamma x_{PA2}P_{A2} \quad (2.7)$$

$$\pi_B = \pi_{B1} + \pi_{B2} = (1 - \gamma)(1 - x_{FA1})P_{B1} + \gamma(1 - x_{PA1})R_{B1} + (1 - \gamma)(1 - x_{FBB} + x_{FAB})P_{B2} + \gamma(1 - x_{PA2})P_{B2} \quad (2.8)$$

For each of the cases we solve the game using backward induction, first, solving for the second period prices and demands by maximizing the second period profits. Given optimal second period prices and demands, forward looking firms maximize their total profits π_i ($i = A, B$) with respect to their first period full- and discounted prices, taking into consideration the impact of their pricing strategy on full price customers' perception of price unfairness in the second period. Substituting both periods' equilibrium prices and demands in the total profit functions, we find firms' equilibrium profits which are depicted in tables 2.2, 2.3, and 2.4. In the next section we discuss our comparative statics results for both models.

2.4 Analysis

2.4.1 Vertical Differentiation Case

In this section, we first analyze the case where two vertically differentiated brands, H and L , compete for the two segments across two periods. The derivations of the equilibrium are presented in the Appendix and the equilibrium prices, demands, profits are summarized in Table 2.2.

The following proposition summarizes the main results of our investigation for this case.

Proposition 2.1. *When firms are vertically differentiated and offer targeted promotions on a deal platform, both firms' profits decrease as customers' sensitivity to unfairness, b , increases, $\frac{\partial \pi_i}{\partial b} < 0$ ($i = H, L$); however, the high quality firm's profit is impacted less negatively by fairness concerns, $\frac{\partial \pi_H}{\partial b} > \frac{\partial \pi_L}{\partial b}$. Proof: see Appendix.*

Intuitively, as customers' sensitivity to unfairness, b , increases firm H , which captures a larger market share in period 1 due to its quality advantage, decreases its price in the second period, P_{H2} , to prevent resentful customers from switching to the competing firm. In turn, firm L increases its second-period price, P_{L2} , to take advantage of the switching segment from firm H . Thus, in the second period, an increase in b results in lower profits for firm H and higher profits for firm L . On the other hand, because firms are forward looking they reduce the adverse effects of unfairness on their second-period profits by decreasing the extent of discriminatory pricing in the first period, $P_{i1} - R_{i1}$, with $i = H, L$. More specifically, we find that firms charge a lower regular price and a higher discounted price in the first period. The rationale for this change in

pricing is as follows. First, due to our assumption of market coverage the number of promotional customers obtained in the first period does not have an effect on the firm's ability to generate profits in the post promotional period. Therefore, firms increase their promotional prices with b . Second, they decrease their regular price in the first period to further reduce the extent of unfairness that full-price customers experience in the second period, and to compete for the higher margin segment. Consequently, both firms' profits generated from their full-price customers shrink while their profits from their promotional customers increase with b . However, due to its quality advantage, firm H attracts more full-price customers by decreasing his regular price than firm L since high quality products have higher demand elasticity to price decreases than low quality products (Chen and Cui, 2013). Furthermore, firm H does not lose many promotional customers to firm L by increasing his discounted price since high quality products have lower demand elasticity to price increases than low quality products. Substituting fewer promotional customers with more full-price customers in the equilibrium generates higher profits for firm H in the first period, since at any level of b , the marginal profits gained by selling to a full-price customer exceeds the marginal profits gained by selling to a promotional customer ($P_{i1} > R_{i1}$). In summary, when b increases, firm H loses less profit from increased competition for full-price customers and gains more profit from reduced competition for promotional customers compared to firm L . Overall, for a given quality difference, s , the high (low) quality firm's profits increases (decreases) with b in the first period and decreases (increases) with b in the second period.

When brands are vertically differentiated, although adjusting first-period prices enables the high quality firm to increase his profits in that period, the profit increase cannot compensate for the loss

incurred in the second period. The reason is as follows. In a vertical differentiated market, at equal prices, the high quality firm can capture all consumers' demand. Thus, the low quality provider tends to charge a significantly lower price to obtain at least some of the demand. In turn, the high quality firm will cut its prices as well leading to increased priced competition and lower prices of both firms in equilibrium. An increase in b reduces the willingness to pay of full-price customers for their preferred brand in period 2 and thus, incentivizes further price cuts by both firms causing a decrease in total profits for firm H .

On the other side of the market, due to its quality disadvantage and already low prices, firm L 's ability to decrease the extent of unfairness, $P_{L1} - R_{L1}$, when b increases is small. Furthermore, firm L is constrained in increasing his second-period price with b because the customers' willingness to pay for its product is lower than for the high quality product. Thus, as b increases, the low quality firm cannot fully cover his loss due to perception of unfairness by decreasing the price difference between his offers or increasing his second period price. In summary, at any quality difference level, s , both firms H and L profits decrease with customers' sensitivity to unfairness, while firm H suffers less.

Next, we analyze another interesting case of brand differentiation in the real world which is Horizontal Differentiation. First, we assume that brands A and B have the same quality and consumers' willingness to pay for both brands are equal. Later, we consider the case where one brand has a quality advantage.

2.4.2 Horizontal Differentiation Case

2.4.2.1 Products Do Not Differ in Quality

In this model, we consider two firms, denoted A and B , which produce horizontally differentiated products. Furthermore, we assume that the customer's reservation price for both firms' products are equal to u (see Model section) which is sufficiently high so that the market between the two firms is covered in both periods. We derive the Nash equilibrium in the Appendix and present the equilibrium prices, demands, and profits in Table 2.3⁵. The following proposition summarizes our main result for this case.

Proposition 2.2. *When firms are horizontally differentiated and offer targeted promotions on a deal platform, customers' sensitivity to unfairness b does not have any influence on firms' equilibrium profits. Proof: See Appendix.*

Similar to the vertical differentiation case, the forward looking firms adjust their prices in the first period to reduce the negative impact of customers' perception of unfairness in the second period. As customers' fairness concerns increase, the firms simultaneously increase their promotion prices and decrease their full prices to diminish the extent of unfairness, $b(P_{i1} - R_{i1}), i \in \{A, B\}$. However, in contrast to the previous case, an increase in the fairness sensitivity b surprisingly does not affect profits of the horizontally differentiated firms. In both cases, the customers have the option

⁵In this case, we set $\lambda = 1/2$ for the purpose of tractability and it is possible to show that the results regarding the propositions do not change considering any $\lambda \neq 1/2$. Chen and Cui (2013) also consider equal sizes for the consumer segments who purchase the two differently priced branded variants of the same firm and feel unfair when they buy a higher priced one.

to switch to the other firm in the market after they perceive they were treated unfairly; however, in the horizontal differentiation case, due to symmetry of firms, the percentage of full-price customers who switch between the firms in the market are equal. Therefore, in equilibrium, given our assumption of market coverage, the same percentage of resentful customers who refrain from repurchasing from their preferred firm will be substituted by the switching resentful customers of the other firm in the market. This explains why the horizontally differentiated firms' equilibrium profits do not change with customers' sensitivity to unfairness in a market without product quality difference.

Next, we examine the impact of customers' sensitivity to unfairness on firms' pricing strategies and profits in a horizontally differentiated market when they also differ with respect to quality.

2.4.2.2 *Products Differ in Quality*

In this case, we assume, without loss of generality, that firm A offers a product of greater quality than firm B . Therefore, we denote firms A and B as H and L , respectively. We assume that the market is aware of the quality differentiation and thus, consumers' base value V for the low and high quality products are equal to $u + Q_L - t(1 - x)$ and $u + Q_H - tx$, respectively, where $Q_H > Q_L$. For simplicity, we consider $Q_L = 0$ and $Q_H = Q > 0$. We also assume that that higher quality firm has the same marginal cost as the lower quality firm because we want to focus on the demand side effects of quality differentiation. The rest of the assumptions remain the same as the ones outlined in the Model section. Similar to prior analyses, we analyze the equilibrium in which

both high and low quality firms decide to offer targeted promotions on the same deal platform. In the Appendix, we derive the equilibrium conditions and all the equilibrium results are included in Table 2. 4.

The equilibrium results reveal that the profits, prices and demands are greater for the high quality brand than for the low quality brand in both periods. This result is similar to that obtained in the vertical differentiation model. However, our main focus is on the comparative statics regarding consumers' fairness concerns. The following proposition relates the changes in the equilibrium profits of both brands to changes in customer's fairness concerns b and the quality difference between the brands, Q .

Proposition 2.3. *Profits for two horizontally quality differentiated firms which offer targeted promotions on a daily deal platform do not change in the same direction as b increases. More specifically, as customer's sensitivity to unfairness b increases,*

(i) the low quality firm's profit decreases at all ranges of quality difference (Q). However,

(ii) the high quality firm's profit increases when Q is low enough, $0 < Q < \underline{Q}$

(iii) the high quality firm's profit follows a U-shape function when Q is in an intermediate range $\underline{Q} < Q < \bar{Q}$

(iv) the high quality firm's profit decreases when Q is high enough. $\bar{Q} < Q$. Proof: see Appendix.

The qualitative impact of b on pricing and profits of firms H and L in each of the periods is the same as for the vertical differentiation case and therefore, we do not replicate its rationale

here. We recall that for a given quality difference, Q , the high (low) quality firm's profits increases (decreases) with b in the first period and decreases (increases) with b in the second period. However, in contrast to the vertical differentiation case presented earlier, the interaction of the two focal parameters, the customers' sensitivity to unfairness b and the quality difference between the brands, Q , affect the impact of b on total profits of the high quality firm in this case which we will detail below.

In a horizontally differentiated market where firms differ in quality, the competition is less fierce than in the vertically differentiated market since at equal prices, there are some customers located close to L who prefer to purchase the low quality brand despite the quality advantage of firm H . The locational advantage of firm L relative to some consumers lowers the level of competition in the market and enables firm H to adjust its prices more freely than in the vertical differentiation case. When the quality difference between the firms is large, firm H attracts a lot more full-price customers in period 1 than firm L , thereby more of his customers perceive unfairness and tend to switch to firm L in the second period than vice versa. The difference between promotional and full prices and thus, the extent of unfairness is bigger for the high quality than for the low quality firm's customers, $P_{H1} - R_{H1} > P_{L1} - R_{L1}$. Furthermore, as the quality advantage of firm H increases, the perception of unfairness for its customers increases. Thus, when Q is big, firm H needs to decrease his second-period prices more aggressively with b , leading to a greater loss in the second period. On the other hand, note that in the first period firm H captures a high share of full-price customers at given levels of b due to its quality advantage. However, at higher levels of Q more customers with weaker brand preferences for the high quality firm are drawn into his turf.

Thus, when Q is big enough, firm H 's ability to gain a greater share of full-price customers and to increase its profit in the first period and moreover, his ability to prevent resentful customers from switching in the second period are small. Therefore, firm H cannot fully compensate for the loss in the second period with profit gains in the first period as b increases.

As the quality difference between the competing firms decreases, firm H becomes more able to increase his full-price customer demand by reducing his first period regular prices and this ability increases with b since the rate of regular price reduction increases as b increases. Furthermore, as explained before, firm H needs to reduce his second-period price to maintain his market share but the rate of price reduction goes down with decrease in Q . At a given quality difference, as customers' sensitivity to unfairness increases, more customers with strong preference for brand H decide to switch and these customers can be convinced to stay with a slight price reduction in period 2. Thus, when the quality difference Q is in the intermediate range, firm H 's profits in period 2 go down at a diminishing rate and go up in period 1 at an increasing rate with b . Summing up the two explained effects across different values of b , firm H 's profits follows a U -shape function with b when the quality difference between the competing firms is intermediate.

Finally, when the quality advantage of firm H is low enough, firm H only needs to reduce his second-period price relatively little with b , leading to smaller loss in the second period. Moreover, firm H 's ability to expand his demand among full-price customers by regular price reduction increases as its quality advantage decreases. Thus, when Q is small enough, the loss in firm H profits in period 2 due to increase in b is outweighed by its profit gain in period 1; hence, firm H profits

increases as b increases.

The proposition above, interestingly, suggests that a high quality firm in a horizontally differentiated market can benefit from the increasing customers' sensitivity to unfairness when its quality advantage over the competing firm is low enough. Moreover, when the quality difference between the firms is in the intermediate range, the high quality firm can benefit from consumers' concern about unfairness when customers' sensitivity to unfairness is sufficiently high. On the other hand, for a very high quality firm profits decrease with customers' fairness concerns. Next, we explore the impact of another factor that has been suggested to reduce the profitability of daily deal promotions, the possibility that information about the promotion leaks to full-price consumers who in turn take advantage of the deal.

2.5 Model Extensions

2.5.1 *Impact of Information Leakage*

In this section, we consider an extension of the horizontal differentiation model in which the information about the deals becomes available to some full-price customers during the promotional period⁶. In the basic model outlined earlier, we assumed that there is no cannibalization effect of full-price customers. In other words, in the previous models, none of the full-price customers becomes aware of the targeted promotions in the first period. However, in many circumstances,

⁶We also studied the impact of information leakage on firms' profits in the vertically differentiated market and the horizontally differentiated market with quality difference and reached the same conclusion as the ones presented in proposition 2.4. The technical derivation of the results are available from the authors upon request.

when running promotions on a platform, due to reputation of the platform or leakage of information, a percentage of regular customers opportunistically use promotions for purchases they would otherwise have made at full price (Gupta et al., 2012). Consider a firm which runs a targeted promotion on Groupon. As Dholakia (2011) shows, on average close to 20% of customers who buy the deals on Groupon are not new customers of the firms and thus they were not the target of the firms' promotion. In this section, we examine a horizontally differentiated market where α percent of non-targeted customers learn about the deal and pay R_1 rather than P_1 . Therefore, due to cannibalization effect of promotions, $((1 - \gamma)\alpha + \gamma)$ percent of customers pay the promotional price in the market and only $(1 - \gamma)(1 - \alpha)$ percent of the customers pay the regular price. The main results of this case with leakage are summarized in the proposition below.

Proposition 2.4. *In the horizontal differentiation case with information leakage to non-targeted customers, firms' profits increase with information leakage, α , ($\frac{d\pi_i}{d\alpha} > 0$). Proof: see Appendix.*

The firms offer discounts on platforms to take advantage of the advertising effect of promotions and to acquire new customers. However, if any non-targeted customer who is aware of the firm's product and is willing to pay the full-price, P_1 , purchases at a discounted price, R_1 , firms' profits in the first period decrease since $R_1 < P_1$. On the other hand, as more customers become aware of the promotion in the first period, fewer customers perceive unfairness in the second period. Thus, the negative impact of unfairness on the firms' second-period profits decreases with the cannibalization effect. In other words, at a given level of customers' fairness concerns (b), firms' profits in the second period increase with cannibalization of full-price customers (α). However, surprisingly we find that increasing α softens price competition between the firms in the first period. The rationale

is that as α increases, the size of full-price customer segment shrinks and thus, firms have a smaller incentive to cut prices to obtain these customers. Consequently, at any level of fairness concerns, a firm's profits will increase with information leakage in the competitive case.

2.6 Summary and Conclusion

There is a broad recent literature which suggest that behavioral theory-based assumptions need to be incorporated into quantitative models since neglecting such assumptions may lead to sub-optimal pricing strategies and profits for firms (Amaldoss and Jain, 2005; Feinberg, Krishna, and Zhang, 2002; Chen, Iyer, Pazgal, 2010; Ho and Su, 2009). In this paper, we add to this literature by studying the impact of consumer's perception of price fairness on their post-promotional purchase intentions and consequently on firm's strategies and profits from running a targeted promotion on a deal platform. Intuitively, similar to previous research (Anderson and Simester, 2008; Feinberg, Krishna, and Zhang, 2002), we expected that an increase in consumers' perception of unfairness leads to lower profits for a firm in the market since customers' willingness to pay for the discriminating firm will decrease. We observe such an effect for a vertically differentiated market. This result implies that without considering the dynamic impact of price unfairness on consumers' post-promotional purchase behaviors, the profitability of daily deal promotions is exaggerated for firms which are vertically differentiated. However, we find that this result may not hold for horizontally differentiated firms. More specifically, we surprisingly show that firms' profits are not at all impacted by customers' fairness concerns in this scenario. The rationale for this finding is that

for competing firms who are symmetric the negative effects caused by unfairness considerations cancel each other. Moreover, our analysis of a horizontally market where competing brands differ in quality lead to some additional counterintuitive results. In such a market, a high quality firm can take advantage of an increase in consumers' fairness concerns only when the quality difference between the firms' products is not too high. Contrary, our model suggests that when the quality difference between the two horizontally differentiated firms is large, both high and low quality firms' profits decrease with consumers' perception of unfairness. Furthermore, when the quality difference between the two brands is in an intermediate range, the high quality firm's profits first decrease and then increase as customers' fairness concerns increase. The main intuition behind this finding is as follows. At any given level of quality difference, the high quality firm's profits decrease in the second period with consumers' sensitivity to unfairness, since he reduces his price to discourage the resentful customers from switching. However, the high quality firm's profits in the first period increase with fairness concerns since as consumers' fairness concerns increase, the high quality firm reduces the extent of unfairness by shrinking the difference between his promotional- and full prices. Thus, as explained before, due to higher elasticity of demand to price-decreases and lower elasticity of demand to price-increases compared to a low quality firm, a high quality firm can attract more full-price customers in the first period and increase his profits. The overall effect of fairness perception on high quality firm's profits depends on the rate of increase and decrease of profits in each period which changes with quality difference between the brands. When the quality difference between the firms is very big, the profit increase in the first period cannot compensate for the profit decrease in the second period, because the high quality firm attracts a lot

of low preference customers to its turf. Contrary, as the quality difference between the firms decreases, the high quality firm attracts more customers with higher brand preference for its product. If these customers perceive unfairness in the second period and intend to switch, the high quality firm can convince them to stay by reducing price only slightly. Therefore, when the difference in quality between firms is small, the high quality firm's profit increases in the first period can cover his loss in the second period resulting in overall profit increase.

In an extension, we also find, interestingly, that information leakage about the promotion to full-price customers has a positive effect on a firm's profits in a competitive market. The competing firms gain profits as the percentage of deals sold to their customers who would have bought at full price in the absence of the deal, increases. The main rationale behind this finding is that information leakage decreases competition between the firms in the competitive setting.

Our main results have some important managerial implications. First, firms should account for customer's perception of fairness and its impacts on their profits when running promotions on daily deal platforms. Moreover, we show that the effect of unfairness on firm's profits change under different conditions of competition, quality difference, and cannibalization of full-price customers. Second, in cases when sensitivity to unfairness does have a negative impact on profits firms may want to alleviate these concerns by explaining the reasons behind their targeted promotions and revealing information about the dissimilarity between their full-price- and promotional customers' transactions. Third, in a competitive setting, a slightly higher quality firm may not only want to reveal the information about their targeted promotions but also may want to increase their cus-

tomers' fairness concerns. Fourth, in a competitive market firms do not lose profits as their regular customers become aware of the promotions and pay the discounted price. Therefore, they do not have to limit the redemption of their promotions by their non-targeted customers.

It is important to point out some of the limitations of this research. First, while we studied the impact of fairness concerns when firms use the same platform for their daily deal promotions it is important for future research to consider a competitive market where firms offer promotions on competing platforms. In the current research, we study a situation where the competitive firms offer promotional prices to the same pool of customers. This is consistent with a case where two firms (e.g. two Spas or two Restaurants) run promotions on the same couponing platform, e.g. Groupon. However, there are some cases where two firms offer promotions on different platforms (i.e. one firm on Groupon and one firm on LivingSocial). It will be interesting to analyze how firms' profits and strategies may change in this scenario.

2.7 Appendix

2.7.1 Derivation of the Equilibrium for the Vertically Differentiated Market

We derive the customers' demand functions in the first and second periods of purchase. Thus, we have $q_H = \frac{\bar{\theta} - \theta}{\theta - \underline{\theta}}$ and $q_L = \frac{\theta - \underline{\theta}}{\bar{\theta} - \underline{\theta}}$ where θ is the preference of a marginal consumer who is indifferent between purchasing the high quality product or the low quality product (Tirole 1988, p. 296). Equating $\underline{\theta} = 0$ and $\bar{\theta} = 1$ for simplicity, we have $q_H = 1 - \theta$ and $q_L = \theta$. Thus, in the first period, the full price and promotional customers who purchase from firm L have demands equal to θ_{FL1} and θ_{PL1} , respectively. Consequently, firm H 's full-price customers (γ percent of the market) and promotional customers ($1 - \gamma$ percent of the market) have demands equal to $1 - \theta_{FL1}$ and $1 - \theta_{PL1}$, respectively.

$$U_{FH1} = U_{FL1}$$

$$\theta(1 + s) - P_{H1} = \theta - P_{L1} \quad (2.9)$$

$$\theta_{FL1} = \frac{P_{H1} - P_{L1}}{s} \quad (2.10)$$

$$U_{PH1} = U_{PL1}$$

$$\theta(1 + s) - R_{H1} = \theta - R_{L1} \quad (2.11)$$

$$\theta_{PL1} = \frac{R_{H1} - R_{L1}}{s} \quad (2.12)$$

In the second period, full-price customers who decide to stay loyal to firm H despite the perception of unfairness have demand equal to $1 - \theta_{FHH}$.

$$U_{FHH} = U_{FHL}$$

$$\theta(1 + s) - b(P_{H1} - R_{H1}) - P_{H2} = \theta - P_{L2} \quad (2.13)$$

$$\theta_{FHH} = \frac{b(P_{H1} - R_{H1}) + P_{H2} - P_{L2}}{s} \quad (2.14)$$

Similarly, full-price customers who decide to repurchase from firm L have demand equal to θ_{FLL} .

$$U_{FLL} = U_{FLH}$$

$$\theta - b(P_{L1} - R_{L1}) - P_{L2} = \theta(1 + s) - P_{H2} \quad (2.15)$$

$$\theta_{FLL} = \frac{P_{H2} - P_{L2} - b(P_{L1} - R_{L1})}{s} \quad (2.16)$$

The rest of the full-price customers in the second period will either switch from firm L to firm H and have a demand equal to $\theta_{FL1} - \theta_{FLL}$ or switch from firm H to firm L and have a demand equal to $\theta_{FHH} - \theta_{FL1}$. On the other hand, promotional customers do not perceive any unfairness, therefore, their demand for the low quality firm (high quality firm) in the second period is equal to $\theta_{PL2} (1 - \theta_{PL2})$.

$$U_{PL2} = U_{PH2}$$

$$\theta - P_{L2} = \theta(1 + s) - P_{H2} \quad (2.17)$$

$$\theta_{PL2} = \frac{P_{H2} - P_{L2}}{s} \quad (2.18)$$

The profit functions of high and low quality firms in the second period are as follows:

$$\pi_{H2} = (1 - \gamma)(1 - \theta_{FHH} + \theta_{FL1} - \theta_{FLL})P_{H2} + \gamma(1 - \theta_{PL2})P_{H2}$$

$$\pi_{L2} = (1 - \gamma)(\theta_{FLL} + \theta_{FHH} - \theta_{FL1})P_{L2} + \gamma(\theta_{PL2})P_{L2}$$

After substituting the customers' demand functions into the profit functions above, we solve the first order conditions to obtain the second-period demand and prices as a function of first period prices.

$$P_{H2} = \frac{b(1 - \gamma)(R_{H1} - R_{L1}) - 2s + (1 - b)(1 - \gamma)(P_{H1} - P_{L1})}{3(2 - \gamma)}$$

$$P_{L2} = \frac{b(1 - \gamma)(R_{L1} - R_{H1}) - s + (1 - b)(1 - \gamma)(P_{L1} - P_{H1})}{3(2 - \gamma)}$$

It is easy to show that the second order conditions for a local maximizer are fulfilled for P_{H2} and P_{L2} , i.e. $\frac{\partial^2 \pi_{H2}}{\partial P_{H2}^2} = \frac{\partial^2 \pi_{L2}}{\partial P_{L2}^2} = -\frac{2(2-\gamma)}{s} < 0$. We plug P_{H2} and P_{L2} into the first period profit functions of the firms. The forward looking firms, anticipating customers' perception of unfairness in the second period maximize their total profits with respect to the first period regular and discounted prices, simultaneously.

$$\pi_H = \pi_{H1} + \pi_{H2} = (1 - \gamma)(1 - \theta_{FL1})P_{H1} + \gamma(1 - \theta_{PL1})R_{H1} + \pi_{H2}$$

$$\pi_L = \pi_{L1} + \pi_{L2} = (1 - \gamma)(\theta_{FL1})P_{L1} + \gamma(\theta_{PL1})R_{L1} + \pi_{L2}$$

We obtain equilibrium solutions for R_{H1} , P_{H1} , R_{L1} , and P_{L1} as they are summarized in Table 2.2.

With tedious algebra we can also show that the second order conditions ($\frac{\partial^2 \pi_i}{\partial P_{i1}^2} < 0$; $\frac{\partial^2 \pi_i}{\partial R_{i1}^2} < 0$; and $\frac{\partial^2 \pi_i}{\partial P_{i1}^2} * \frac{\partial^2 \pi_i}{\partial R_{i1}^2} - \frac{\partial^2 \pi_i}{\partial R_{i1} \partial P_{i1}} * \frac{\partial^2 \pi_i}{\partial R_{i1} \partial P_{i1}} > 0$; $i = H, L$) are fulfilled only when $0 < b <$

$b_1^* = \gamma + \sqrt{\frac{17\gamma - 7\gamma^2 + \gamma^3}{1-\gamma}}$). Substituting all prices and demands in the firms' profit function, we obtain equilibrium profits for both firms as are also mentioned in Table 2.2. We also check for other equilibrium conditions. First we have to demonstrate that the promotional price is less than the regular price for both firms in the first period. Considering the constraint from the second order conditions ($0 < b < b_1^*$), we can easily show $P_{i1}^* - R_{i1}^* > 0$ only when $0 < b < \gamma$. Now we need to check whether the following conditions on demands are also fulfilled: $0 < \theta_{FLL}^* < \theta_{FL1}^* < \theta_{FHH}^* < 1$, $0 < \theta_{PL2}^* < 1$, $0 < \theta_{PL1}^* < 1$, and $0 < \theta_{FL1}^* < 1$. We find that these inequalities are fulfilled when $0 < b < \gamma$.

Proof of Proposition 2.1:

$$\begin{aligned}
 \frac{\partial \Pi_H^*}{\partial b} &= \frac{8s\gamma(5-7\gamma+2\gamma^2)(\gamma^2(-160+83\gamma-4\gamma^2)+6b^2\gamma(1+\gamma-2\gamma^2)+b^3(-2-2\gamma+4\gamma^2)+b\gamma(160-87\gamma+8\gamma^3))}{9(4b^2(\gamma-1)+\gamma(50-23\gamma)+8b(1-\gamma)\gamma)^3} < 0 \text{ and } \frac{\partial \Pi_L^*}{\partial b} = \\
 &= \frac{-8s\gamma(5-7\gamma+2\gamma^2)(2b^3(7-11\gamma+4\gamma^2)-6b^2\gamma(7-11\gamma+4\gamma^2)+\gamma^2(310-302\gamma+73\gamma^2)+b\gamma(-310+330\gamma-117\gamma^2+16\gamma^3))}{9(4b^2(\gamma-1)+\gamma(50-23\gamma)+8b(1-\gamma)\gamma)^3} < 0 \text{ for all} \\
 0 < b < \gamma. \text{ Moreover, } \frac{\partial \Pi_H^*}{\partial b} - \frac{\partial \Pi_L^*}{\partial b} &= \frac{8s\gamma(\gamma-b)(1-\gamma)^2(5-2\gamma)}{3(4b^2(\gamma-1)+\gamma(50-23\gamma)+8b(1-\gamma)\gamma)^2} > 0; \text{ thus, } \frac{\partial \Pi_H^*}{\partial b} > \frac{\partial \Pi_L^*}{\partial b}.
 \end{aligned}$$

2.7.2 Derivation of the Equilibrium for the Horizontally Differentiated Market

The derivation of the equilibrium for the horizontally differentiated market without quality difference follows the one of the model with quality difference presented later and is omitted here for simplicity. Details are available from the authors upon request. The results of this special case are summarized in the Table 2.3.

Proof of Proposition 2.2: $\Pi_i^* = \frac{17t}{18}$ is not a function of b , hence firms' equilibrium profits do not change with increasing or decreasing customers' fairness concerns.

2.7.3 Derivation of the Equilibrium for the Horizontal Differentiated Market with Quality

Difference

In this model, in contrast to the basic horizontally differentiation game, firms' product differ in quality and customers are willing to pay higher for the quality product. If a full-price customer purchases from firm H in the first period, she obtains a utility of $U_{FH1} = V + Q - tx - P_{H1}$ and if she purchases from firm L , she obtains a utility $U_{FL1} = V - t(1 - x) - P_{L1}$. The marginal full-price customer can be found at x_{FH1} by solving $U_{FH1} = U_{FL1}$. The promotional customers in the first period, decide whether to purchase from firm H and pay the deal price R_{H1} or purchase from firm L and pay R_{L1} . The position of the marginal promotional customer is at x_{PH1} .

In the second period, resentful customers of high quality brand will either purchase from firm H again and experience the unfairness disutility or switch to the low quality firm. The full-price customers of high quality firm who stay loyal will have a demand x_{FHH} which can be found solving $U_{FHH} = V + Q - tx - b(P_{H1} - R_{H1}) - P_{H2} = U_{FHL} = V - t(1 - x) - P_{L2}$. The rest of the full-price customers decide not to purchase from firm H any more and switch to firm L . Their demand is equal to, $x_{FHL} = x_{FH1} - x_{FHH}$.

Customers of the low quality firm maximize their utility by deciding whether to stay with the low quality firm or switch to the high quality one. Demand of full-price customers of low quality

firm with feelings of unfairness is equal to $1 - x_{FLL}$ where x_{FLL} is solved by equating $U_{FLH} = V + Q - tx - P_{H2}$ and $U_{FLL} = V - t(1 - x) - b(P_{L1} - R_{L1}) - P_{L2}$. Consequently, there is a switching segment to the high quality firm whose demand is equal to $x_{FLH} = x_{FLL} - x_{FH1}$. Furthermore, promotional customers will have the demands, x_{PH2} and $1 - x_{PH2}$ for firm H and firm L in the second period, respectively. x_{PH2} is solved by $U_{PH2} = V + Q - tx - P_{H2} = U_{PL2} = V - t(1 - x) - P_{L2}$.

The firms' profits functions in the second period are: $\pi_{H2} = (1 - \gamma)(x_{FHH} + x_{FLH})P_{H2} + (\gamma)(x_{PH2})P_{H2}$ and $\pi_{L2} = (1 - \gamma)(1 - x_{FLL} + x_{FHL})P_{L2} + (\gamma)(1 - x_{PH2})P_{L2}$. Similar to the previous cases, solving the game through backward induction we first find the second period prices and demands. Subsequently, we substitute them in the total firms' profits across two period and maximize the whole profits with respect to the discounted and regular prices in the first period.

The derivation of the equilibrium can be done in a similar way as the horizontally differentiation case. We summarized the equilibrium prices, demands, and profits for both firms in Table 2.4.

In this section, we just show conditions that ensure existence of the equilibrium in vertically differentiated case with the following properties: $P_{H1} > R_{H1} > 0$; $P_{L1} > R_{L1} > 0$; $P_{H1} > P_{L1} > 0$; $P_{H2} > P_{L2} > 0$; $1 > x_{PH1}, x_{PH2} > 0$; and $1 > x_{FLL} > x_{FH1} > x_{FHH} > 0$.

The second order conditions for P_{i1} , R_{i1} , and P_{i2} , $i = L, H$ to be maximizers are the same as the second order conditions in horizontally differentiated case which lead us to the constraint:

$0 < b < b_1^* = \frac{1}{2}(1 + \sqrt{53})$. We start with $P_{L1} - R_{L1} > 0$ and $P_{H1} - R_{H1} > 0$:

$$P_{L1} - R_{L1} = \frac{4(1-2b)(-12Q + (77 + 8b(1-b))t)}{9(77 + 8b(1-b))} > 0$$

$$77 + 8b(1-b) > 0 \text{ and } (1-2b)(-12Q + (77 + 8b(1-b))t) > 0$$

$$0 < b < \frac{1}{2} \text{ and } 0 < Q < \frac{(77 + 8b(1-b))t}{12} \text{ or } \frac{1}{2} < b < \frac{1}{2}(1 + \sqrt{53}) \text{ and } \frac{(77 + 8b(1-b))t}{12} < Q$$

Since $77 + 8b(1-b)$ cannot be negative, $P_{L1} - R_{L1} < 0$

$$P_{H1} - R_{H1} = \frac{4(1-2b)(12Q + (77 + 8b(1-b))t)}{9(77 + 8b(1-b))} > 0$$

$$77 + 8b(1-b) > 0 \text{ and } (1-2b)(12Q + (77 + 8b(1-b))t) > 0$$

$$0 < b < \frac{1}{2} \text{ and } 0 < Q < \frac{(77 + 8b(1-b))t}{12}$$

Therefore the conditions so far are: $0 < b < \frac{1}{2}$ and $0 < Q < \frac{(77+8b(1-b))t}{12}$

Now having the constraints above, we find the conditions under which R_{L1} and $R_{H1} > 0$:

$$R_{L1} = \frac{Q(-231 - 24b(3-b)) + t(693 + b(380 - 8b(5+4b)))}{9(77 + 8b(1-b))} > 0$$

$$77 + 8b(1-b) > 0 \text{ and } Q(-231 - 24b(3-b)) + t(693 + b(380 - 8b(5+4b))) > 0$$

$$0 < b < \frac{1}{2} \text{ and } 0 < Q < \frac{t(693 + b(380 - 8b(5+4b)))}{231 + 24b(3-b)}$$

$R_{H1} = \frac{3Q(77+8b(3-b))+t(693+b(380-8b(5+4b)))}{9(77+8b(1-b))} > 0$ under conditions mentioned above and therefore,

since $\frac{t(693+b(380-8b(5+4b)))}{231+24b(3-b)} < \frac{(77+8b(1-b))t}{12}$ for $0 < b < \frac{1}{2}$, the final constraints for equilibrium

conditions on first period prices are $0 < b < \frac{1}{2}$ and $0 < Q < \frac{t(693+b(380-8b(5+4b)))}{231+24b(3-b)}$. Moving to the

second period equilibrium conditions on prices and applying the constraints above we will have

the overall constraints for conditions on both period prices which are $0 < b < \frac{1}{2}$ and $0 < Q < \frac{t(693+b(380-8b(5+4b)))}{231+24b(3-b)}$

$$\frac{(77+8b(1-b))t}{36}.$$

Similarly, we can find the conditions under which the following requirements on both-period demands are fulfilled ($1 > x_{PH1}, x_{PH2} > 0$; and $1 > x_{FLL} > x_{FH1} > x_{FLH} > 0$). Combining the constraints for equilibrium conditions for demands with the ones for prices we will have the overall equilibrium conditions which are as follows: $0 < b < \frac{1}{2}$ and $0 < Q < \bar{Q}_1 = \frac{tb(154-b(292+16b(3-2b)))}{63-24b(2-b)}$.

Proof of Proposition 2.3:

$$\frac{\partial \Pi_L^*}{\partial b} = \frac{-32Q(1-2b)(Q(1187+56b(1-b)) + 3t(77+8b(1-b)))}{9t(77+8b(1-b))^3} < 0 \text{ for all } 0 < b < \frac{1}{2}$$

Now we have to find the sign for the term $\frac{\partial \Pi_H^*}{\partial b} = \frac{-32Q(1-2b)(Q(1187+56b(1-b))-3t(77+8b(1-b)))}{9t(77+8b(1-b))^3}$. Since $0 < b < \frac{1}{2}$, $0 < Q$, and $0 < t$, we have to just find the sign for $3t(77+8b(1-b)) - Q(1187+56b(1-b))$.

$$3t(77+8b(1-b)) - Q(1187+56b(1-b)) > 0$$

$$\text{if } 0 < Q < \bar{Q}_2 = \frac{3t(77+8b(1-b))}{1187+56b(1-b)}$$

$$3t(77+8b(1-b)) - Q(1187+56b(1-b)) < 0$$

$$\text{if } Q > \bar{Q}_2 = \frac{3t(77+8b(1-b))}{1187+56b(1-b)}$$

Now we have to figure out the conditions under which $\bar{Q}_1 > \bar{Q}_2$ and vice versa.

$$\begin{aligned} \bar{Q}_2 - \bar{Q}_1 &= \frac{(77+8b(1-b))(189-2b(1259-2b(1177+28b(3-2b))))t}{(1187+56b(1-b))(63-24b(2-b))} > 0 \\ \implies (189-2b(1259-2b(1177+28b(3-2b)))) &> 0 \end{aligned}$$

$$\begin{aligned}
&\implies 0 < b < .09 \text{ and } .43 < b < \frac{1}{2} \\
\bar{Q}_2 - \bar{Q}_1 &= \frac{(77 + 8b(1 - b))(189 - 2b(1259 - 2b(1177 + 28b(3 - 2b))))t}{(1187 + 56b(1 - b))(63 - 24b(2 - b))} < 0 \\
&\implies (189 - 2b(1259 - 2b(1177 + 28b(3 - 2b)))) > 0 \\
&\implies .09 < b < .43
\end{aligned}$$

Thus:

$$\begin{aligned}
\frac{\partial \Pi_H^*}{\partial b} &> 0 \text{ when } \{0 < b < .09 \text{ and } .43 < b < \frac{1}{2} \text{ and } 0 < Q < \bar{Q}_1\} \\
\frac{\partial \Pi_H^*}{\partial b} &> 0 \text{ when } \{.09 < b < .43 \text{ and } 0 < Q < \bar{Q}_2\} \\
\frac{\partial \Pi_H^*}{\partial b} &< 0 \text{ when } \{.09 < b < .43 \text{ and } \bar{Q}_2 < Q < \bar{Q}_1\}
\end{aligned}$$

Note that the sign for $\frac{\partial \bar{Q}_1}{\partial b}$ and $\frac{\partial \bar{Q}_2}{\partial b}$ change with different values of b . $\bar{Q}_1 = F_1(b)$ and $\bar{Q}_2 = F_2(b)$.

When $0 < b < .09 \implies \frac{\partial \bar{Q}_1}{\partial b} > 0$ and when $.43 < b < \frac{1}{2} \implies \frac{\partial \bar{Q}_1}{\partial b} < 0$. Thus, $\bar{Q}_1(b = 0) = 0$, $\bar{Q}_1(b = .09) = .195t$, $\bar{Q}_1(b = .43) = .197t$, $\bar{Q}_1(b = .5) = 0$.

When $.09 < b < .43 \implies \frac{\partial \bar{Q}_2}{\partial b} > 0$ and when $.09 < b < .27 \implies \frac{\partial \bar{Q}_1}{\partial b} > 0$ and when $.27 < b < .43 \implies \frac{\partial \bar{Q}_1}{\partial b} < 0$. Thus, $\bar{Q}_2(b = .09) = .195t$, $\bar{Q}_2(b = .43) = .197t$. $\bar{Q}_1(b = .09) = .195t$, $\bar{Q}_1(b = .27) = .38t$, $\bar{Q}_1(b = .43) = .197t$.

Consequently,

$$\begin{aligned}
&\text{If } .197t < Q < .38t, \text{ then } \frac{\partial \Pi_H^*}{\partial b} < 0 \text{ for all } F_1^{-1}(\bar{Q}_1) < b < F_1^{-1}(\bar{Q}_1) \\
&\text{If } .195t < Q < .197t, \text{ then } \frac{\partial \Pi_H^*}{\partial b} < 0 \text{ when } F_1^{-1}(\bar{Q}_1) < b < F_2^{-1}(\bar{Q}_2) \text{ and } \frac{\partial \Pi_H^*}{\partial b} > 0 \\
&\text{when } F_2^{-1}(\bar{Q}_2) < b < F_1^{-1}(\bar{Q}_1) \\
&\text{If } 0 < Q < .195t, \text{ then } \frac{\partial \Pi_H^*}{\partial b} > 0 \text{ when } F_1^{-1}(\bar{Q}_1) < b < F_1^{-1}(\bar{Q}_1)
\end{aligned}$$

2.7.4 The Effect of Information Leakage

In this model, similar to the monopoly case with cannibalization effect $0 < \alpha < 1$, the percentage of promotional customers in the market increases to $\gamma + (1 - \gamma)\alpha$ and percentage of full-price customers in the market decreases to $(1 - \gamma)(1 - \alpha)$. Solving the game through backward induction similar to the basic horizontal differentiation case, we find the equilibrium profits of the firm i ($i = A, B$) : $\pi_i^* = \frac{t(17-5\alpha)}{6(3-\alpha)}$. Checking all the following equilibrium conditions: $P_{i1}^* - R_{i1}^* > 0$ ($i = A, B$), $0 < x_{FA1}^* < 1$, $0 < x_{PA1}^* < 1$, $0 < x_{FAA} < x_{FA1} < x_{FBB} < 1$, and $0 < x_{PA2}^* < 1$ lead us to the constraint $0 < b < b^* = \frac{1+\alpha}{2}$.

Proof of Proposition 2.4: $\frac{\partial \Pi_i^*}{\partial \alpha} = \frac{t}{3(3-\alpha)^2} > 0$ for $t > 0$.

2.7.5 Detailed Description of the Experiments and Results

We conducted 2 laboratory experiments to show how customers fairness perceptions and eventually their post-promotional purchase behaviors are impacted by the "degree of discriminative pricing" and "customers' sensitivity to unfairness (fairness concerns)". Feinberg et al (2002) experimentally show that consumers when facing an unfair situation attempt to punish their favored firm by switching to the competing firms. In their model, firms identify two segments loyals and switchers in the second period based on the customers' first period purchases. Then they decide which segment receives the promotion in the second period. Their experiment shows that loyals of one firm observing that their favored firm offers promotions to the switchers feel unfair (betrayed) and tend to switch to the competing firm in the market. We set up our experiments following Feinberg et al (2002); however, we examine a duopoly market where the firms run targeted promotions in the first period and they exclude a segment of the market (e.g. Groupon non-members) from receiving the promotions. In our scenario, the excluded customers receive the information on promotions after they made their full-price purchases and we show that their post-promotional purchase intentions from the unfair firm will be impacted negatively.

2.7.6 *First Experiment*

2.7.6.1 *Design, Subjects, and Results*

The primary goal of the first experiment is to establish evidence for the assumption that a consumer would take past firm behavior into consideration when making their future purchase decisions. 157 students participated in the experiment. All the subjects were first given the same set of information. They were asked to read the description of two music downloading firms (Table 2.5), choose to subscribe to one of them (Either GlobalAudio or DigiMusic, Not both) and split 100 points between the two. The information regarding the descriptions were collected from the 2014 Music Download comparison survey online. The descriptions were designed to be balanced in order to make sure that the subjects' preferences are not skewed toward one firm confirming the fact the firms are not different in terms of quality. Moreover, the subscription fee for both service providers was chosen to be \$12/ Month which is also the average of the subscription fee for the "to go program" in the music subscription industry at the time of the experiment.

As a consequence of balancing the descriptions and fees, the percentage of subjects who chose to subscribe to either firm in the first period was not significantly different from 50% (48.4% chose DigiMusic and 51.6% chose GlobalAudio) and this ensures that subjects are indifferent in purchasing either firm based on the descriptions above. After splitting their total 100-point preferences between the two firms and choosing one firm to subscribe to for one month, the subjects were told to imagine that one month has passed and that they had to renew their subscriptions

and split their preferences one more time. At this stage before they make their second month subscription decisions, we randomly assigned the subjects to 2 treatment and control groups. The subjects in the treatment group ($n = 79$) received information about a Groupon promotion that had been run during the first month by the firm they chose to subscribe to but they did not become aware of the promotion and paid the full subscription fee. The subjects in the control group ($n = 78$) did not receive such information about the Groupon promotion. In this experiment we test the hypothesis below:

H1-a: Consumers who receive information about a firm's promotion that they were excluded from show lower preferences for the firm's product in their future purchase occasions.

H1-b: However, *ceteris paribus*, consumers who do not receive any information about a firm's promotion that they were excluded from do not change their preferences for the firm's product in their next purchase occasions.

As we expected, the results of our experiment show that 38 out of 79 subjects in the treatment group (48.1%) decided to switch providers since they found the situation to be unfair while only 9 out of 78 subjects in the control group switched providers for the second renewal. More importantly, an independent-sample-t-test shows that subjects in the treatment group showed lower preference for their first chosen provider after experiencing the unfairness, i.e., 47.81 in the second month compared with 60.54 in the first month ($t = 5.22, p < .01$). However, similar comparison in the control group shows that subjects' preferences do not change across the two periods of subscription i.e. 64.28 in the second month compared with 62.83 in the first month ($t = 0.62, p = .535 > .1$)

(See Figure 2.3).

Our results in this experiment confirm our assumption that consumers take feelings of price unfairness into consideration when making their future purchase decisions, even though the situation where the unfairness occurred has already passed.

2.7.7 Second Experiment

2.7.7.1 Design and Subjects

The main goal of the second experiment is to replicate the findings of experiment of 1 and explore the extent to which the amount of discrimination and consumers' sensitivity to unfairness or discrimination may impact the consumers' post-promotional preferences. This experiment was conducted with 188 undergraduate students from a large southern university. The design of the experiment was 2 (high/Low sensitivity to unfairness) \times 2 (High/Low degree of discriminatory pricing) between-subjects. The first purchase occasion procedure is exactly the same as the procedure in the first experiment. However, for the subscription renewal period, we randomly assigned the subjects to 4 groups. The subjects in all groups are given information about the promotion that had been going on but they were excluded from during the first period. The subjects in each group will either observe a high amount of the promotional discount that other customers received or a low one. Furthermore, we emphasize that customers' sensitivity to unfairness is not fixed and as previous research has shown, it may change with different factors such as degree of similar-

ity between the comparative transactions (Xia et al, 2002). For example, b decreases if full-price customers realize that deal receivers had to spend some effort or incurred a cost (e.g. paying a subscription fee for a couponing magazine) to become eligible for the promotion. Thus, the subjects' sensitivity to fairness was also manipulated. For the low sensitivity case, we decreased the similarity of transactions of the subjects and the customers who received the promotion by telling the full-price subjects that the promotion receivers had to register on the firm's customer forum, create an account, wait to receive an email with a survey, and take the 20-minute survey to become eligible for the discount. On the other hand, for priming the high sensitivity, we increased the similarity of customers' transactions. The full-price subjects were told that the promotion receivers had to only take a 5-minute survey to be eligible for the discount.

Four different groups of customers studied information regarding the promotion that they were excluded from and they were asked to first express their emotions about this situation. We asked: how do they feel about paying higher subscription fee than some other consumers paid in the market? and how do they feel about being excluded by their chosen firm from receiving the discount? Then the subjects were asked to choose a firm for their subscription renewal knowing that the switching cost for them is negligible. 108 of the 188 subject pool decided to switch to the competing firm since they found the situation to be unfair. We also performed a pretest with 56 subjects to check the manipulation of our independent variables. The students were asked some questions regarding the descriptions, the amount of discount they missed, how similar they perceive their transaction is to the person who received the promotion and etc. The results indicated that the subjects understood the features of the scenarios.

2.7.7.2 Model estimation and results

Since the dependent variable here was the switching behavior of the customers in the second period and it is a binary variable, we ran a logistic regression with the following regression equation

$$\text{SwitchingBehavior}_i = \beta_0 + \beta_1 \text{Discount}_i + \beta_2 \text{Sensitivity}_i + \beta_3 \text{Discount}_i * \text{Sensitivity}_i$$

The β terms are all estimated coefficients of the independent variables and their interactions. Significance of β_1 and β_2 can be interpreted as the significance of the main effects of Discount and Sensitivity to fairness on subjects' post-promotion behavior (whether they stay with their first period subscribed firm or they feel unfair and switch). The laboratory experiment enabled us to rule out other explanations for switching behavior of the subjects since not only the subscription fees but also the description of the firms did not change and the subjects' decision must have resulted from their sensitivity to unfair situations and the amount of discount they were excluded from. The significance of β_3 shows that the interaction effect of both discount amount and sensitivity to fairness might have affected subject's decision to switch or not. The findings of the logistic regression are reported in Table 2.6. Although the main effect of sensitivity to fairness is not significant, the main effect of discount amount and the interaction effect are significant. The conclusion of these results is as follows. The sensitivity coefficient did not reach a significant level ($P = .83 > .05$), suggesting that subjects' fairness concerns does not make them feel unfair unless they face an unfair situation. Significance and positivity of interaction term coefficient ($\beta_3 = 1.38$, $P = .04 < .05$) proves the fact that unfairness sensitive subjects make their decision to punish

the unfair firm by switching or not only when price comparisons are unfavorable to them and the degree of the unfavorability (amount of discriminatory pricing) will also increase their intention to switch. Figure 2.4 shows how the number of subjects who switched between the firms due to unfairness is different across the 4 conditions. The result of the experiment strongly suggests that consumer's switching behavior due to unfairness are affected by the interaction of both their degree of sensitivity to unfairness and they degree of price unfairness. Therefore, we found an evidence that first, the consumers carry their grudge over time and they will punish the firm even if the unfair situation is already passed and moreover, second, we could test the correctness of the unfairness effect in the consumers' utility functions.

2.8 Tables

Table 2.1: Notation

P_{ik}	Firm $i \in \{A, B\}$ or $\{L, H\}$'s full price in period $k \in \{1, 2\}$
R_i	Firm $i \in \{A, B\}$ or $\{L, H\}$'s promotional price in the first period
b	Customer's sensitivity to unfairness (fairness concerns)
V	Customers' base value for each unit of product
γ	Percentage of customers who are platform members and receive the promotions
t	Mismatching cost per unit of distance between a customer's ideal product and a firm's product
Q	Quality difference between the products in horizontal differentiated market
s	Quality difference between the products in vertical differentiated market
θ	Consumer's value for a unit of quality in vertical differentiated market
α	Degree of cannibalization effect
π_{ik}	Firm $i \in \{A, B\}$ or $\{L, H\}$'s profit in period $k \in \{1, 2\}$
π_i	Firm $i \in \{A, B\}$ or $\{L, H\}$'s total profit which is equal to $\pi_{i1} + \pi_{i2}$

Table 2.2: Equilibrium solutions for the Vertically Differentiated Market

First Period	
P_{L1}^*	$\frac{s(4b^3(1-\gamma)+4b^2(\gamma^2+2\gamma-3)+2b\gamma(5\gamma^2-9\gamma-8)+\gamma(21\gamma^2-110\gamma+140))}{3(2-\gamma)(\gamma(50-23\gamma)+8b(1-\gamma)\gamma-4b^2(1-\gamma))}$
R_{L1}^*	$\frac{s(-4b^3(1-\gamma)^2-4b^2(1-\gamma)\gamma^2+\gamma^2(23\gamma^2-96\gamma+100)+2b\gamma(5\gamma^3-6\gamma^2-19\gamma+20))}{3(2-\gamma)\gamma(\gamma(50-23\gamma)+8b(1-\gamma)\gamma-4b^2(1-\gamma))}$
P_{H1}^*	$\frac{2s(-10b^2(1-\gamma)+2b^3(1-\gamma)+b\gamma(7\gamma^2-12\gamma-10))+2\gamma(12\gamma^2-56\gamma+65)}{3(2-\gamma)(\gamma(50-23\gamma)+8b(1-\gamma)\gamma-4b^2(1-\gamma))}$
R_{H1}^*	$\frac{2s(-2b^3(1-\gamma)^2-4b^2(1-\gamma)\gamma^2+\gamma^2(23\gamma^2-96\gamma+100)+b\gamma(7\gamma^3-7\gamma^2-30\gamma+30))}{3(2-\gamma)\gamma(\gamma(50-23\gamma)+8b(1-\gamma)\gamma-4b^2(1-\gamma))}$
θ_{FL1}^*	$\frac{4b^2(1-\gamma)+3\gamma(9\gamma-20)+2b\gamma(1+2\gamma)}{3(4b^2(1-\gamma)+\gamma(23\gamma-50)-8b(1-\gamma)\gamma)}$
θ_{PL1}^*	$\frac{4b^2(1-\gamma)+\gamma(23\gamma-50)+2b(2\gamma^2+3\gamma-5)}{3(4b^2(1-\gamma)+\gamma(23\gamma-50)-8b(1-\gamma)\gamma)}$
Second Period	
θ_{FLL}^*	$\frac{4b^4(1-\gamma)+12b^3(1-\gamma)\gamma+2b\gamma^2(\gamma^2+7\gamma-20)+9\gamma^2(2\gamma^2-9\gamma+10)+2b^2\gamma(3\gamma^2-11\gamma+20)}{3(2-\gamma)\gamma(\gamma(50-23\gamma)+8b(1-\gamma)\gamma-4b^2(1-\gamma))}$
θ_{FHH}^*	$\frac{4b^4(1-\gamma)-12b^3(1-\gamma)\gamma+2b\gamma^2(\gamma^2-16\gamma+30)-10b^2\gamma(\gamma^2-4\gamma+6)+9\gamma^2(2\gamma^2-9\gamma+10)}{3(2-\gamma)\gamma(\gamma(50-23\gamma)+8b(1-\gamma)\gamma-4b^2(1-\gamma))}$
θ_{PL2}^*	$\frac{3\gamma(2\gamma-5)}{4b^2(1-\gamma)+\gamma(23\gamma-50)-8b(1-\gamma)\gamma}$
P_{H2}^*	$\frac{12sb\gamma(b-\gamma)(2\gamma^2-7\gamma+5)}{(\gamma(23\gamma-53)-8b(1-\gamma)\gamma)4b^2(1-\gamma))^2}$
P_{L2}^*	$\frac{12sb\gamma(b-\gamma)(2\gamma^2-7\gamma+5)}{(\gamma(23\gamma-53)-8b(1-\gamma)\gamma)4b^2(1-\gamma))^2}$
π_H^*	$\frac{s(4b^4(1-\gamma)^2(59-28\gamma)+16b^3(1-\gamma)^2\gamma(59-28\gamma)+8b\gamma^2(-1480+2853\gamma-1687\gamma^2+312\gamma^3+2\gamma^4))}{9(2-\gamma)(\gamma(50-23\gamma)+8b(1-\gamma)\gamma-4b^2(1-\gamma))}$ $+\frac{s(\gamma^2(-37800+52480\gamma-24193\gamma^2+3662\gamma^3+19\gamma^4)+4b^2\gamma(1480-3089\gamma+2271\gamma^2-772\gamma^3+110\gamma^4))}{9(2-\gamma)(\gamma(50-23\gamma)+8b(1-\gamma)\gamma-4b^2(1-\gamma))}$
π_L^*	$\frac{s(4b^4(1-\gamma)^2(11-4\gamma)+16b^3(1-\gamma)^2\gamma(11-4\gamma)+\gamma^2(-9300+13420\gamma-7006\gamma^2+1547\gamma^3-119\gamma^4))}{9(2-\gamma)(\gamma(50-23\gamma)+8b(1-\gamma)\gamma-4b^2(1-\gamma))}$ $+\frac{s(8b\gamma^2(3100-588\gamma+349\gamma^2-75\gamma^3+4\gamma^4)+4b^2\gamma(310-632\gamma+453\gamma^2-151\gamma^3+20\gamma^4))}{9(2-\gamma)(\gamma(50-23\gamma)+8b(1-\gamma)\gamma-4b^2(1-\gamma))}$

Table 2.3: Equilibrium solution for the Horizontal Differentiated market (Without Quality Difference)

	First Period	Second Period
P_{A1}^*, P_{B1}^*	$\frac{(13-4b)t}{9}$	—
R_{A1}^*, R_{B1}^*	$\frac{(9+4b)t}{9}$	
x_{FA1}^*, x_{FB1}^*	$\frac{1}{2}$	—
x_{PA1}^*, x_{PB1}^*	$\frac{1}{2}$	
π_{A1}^*, π_{B1}^*	$\frac{11t}{18}$	—
P_{A2}^*, P_{B2}^*	—	$\frac{2t}{3}$
x_{FAA}^*, x_{FBB}^*	—	$\frac{(9-4b(1-2b))t}{18}$
x_{PA2}^*, x_{PB2}^*	—	$\frac{1}{2}$
x_{FAB}^*, x_{FBA}^*	—	$\frac{2b(1-2b)}{9}$
π_{A2}^*, π_{B2}^*	—	$\frac{t}{3}$
π_A^*, π_B^*		$\frac{17t}{18}$

Table 2.4: Equilibrium solution for the the Horizontal Differentiated market (With Quality Difference)

	First Period	Second Period
P_{H1}^*	$\frac{3Q(93-8b(1+b))+t(1001-b(204+8b(17-4b)))}{9(77+8b(1-b))}$	—
P_{L1}^*	$\frac{-3Q(93-8b(1+b))+t(1001-b(204+8b(17-4b)))}{9(77+8b(1-b))}$	—
R_{H1}^*	$\frac{3Q(77-8b(3+b))+t(693-b(380+8b(5-4b)))}{9(77+8b(1-b))}$	—
R_{L1}^*	$\frac{Q(231-8b(9+b))+t(693-b(380+8b(5-4b)))}{9(77+8b(1-b))}$	—
x_{FH1}^*	$\frac{1}{2} + \frac{Q(45+8b(5-b))}{6t(77+8b(1-b))}$	—
x_{PH1}^*	$\frac{1}{2} + \frac{Q(77-8b(3+b))}{6t(77+8b(1-b))}$	—
π_{H1}^*	$\frac{Q^2(5057+16b(1-b)(105+(1-b)b))}{18t(77+8b(1-b))^2} + \frac{12Qt(77+b(1-b))(39+8(1-b)b)+11t^2(77+8b(1-b))^2}{18t(77+8b(1-b))^2}$	—
π_{L1}^*	$\frac{Q^2(5057+16b(1-b)(105+(1-b)b))}{18t(77+8b(1-b))^2} + \frac{-12Qt(77+b(1-b))(39+8(1-b)b)+11t^2(77+8b(1-b))^2}{18t(77+8b(1-b))^2}$	—
P_{H2}^*	—	$\frac{2(36Q+(77+8b(1-b))t)}{3(77+8b(1-b))}$
P_{L2}^*	—	$\frac{2(-36Q+(77+8b(1-b))t)}{3(77+8b(1-b))}$
x_{FHH}^*	—	$\frac{1}{2} + \frac{3Q(87+8b(1+b))-4bt(77-b(146+8b(3-2b)))}{18t(77+8b(1-b))}$
x_{FLL}^*	—	$\frac{1}{2} + \frac{-3Q(87+8b(1+b))-4bt(77-b(146+8b(3-2b)))}{18t(77+8b(1-b))}$
x_{FLH}^*	—	$\frac{+3Q(21-8b(2-b))+2bt(77-b(146+8b(3-2b)))}{9t(77+8b(1-b))}$
x_{FHL}^*	—	$\frac{-3Q(21-8b(2-b))+2bt(77-b(146+8b(3-2b)))}{9t(77+8b(1-b))}$
π_{H2}^*	—	$\frac{(36Q+(77+8b(1-b))t)^2}{3t(77+8b(1-b))^2}$
π_{L2}^*	—	$\frac{(36Q-(77+8b(1-b))t)^2}{3t(77+8b(1-b))^2}$
π_H^*	$\frac{Q^2(12833+b(1680-b(1616-128b(1+64b))))+12Qt(5775+b(1216-b(1152+b(128-64b))))+17t^2(77+8b(1-b))^2}{18t(77+8b(1-b))^2}$	
π_L^*	$\frac{Q^2(12833+b(1680-b(1616-128b(1+64b))))-12Qt(5775+b(1216-b(1152+b(128-64b))))+17t^2(77+8b(1-b))^2}{18t(77+8b(1-b))^2}$	

Table 2.5: Firms' Description

	Global Audio	DigiMusic
Download Features		
Music Titles available	5 Million	5 Million
24-hour/7-day availability	Yes	Yes
Maximum downloads in a month	30	30
Help/Support (Rate out of 10)	10	7
Maximum Simultaneous download	10	5
The quality that song is encoded	192	192
File types supported	Mp3, wma, aac	Mp3, wma, aac
Free Song Preview	Partial-Length Preview	Full-Length Preview
Playlist/Organizer	Yes	Yes
Services and Capabilities		
Search Capabilities rate in terms of Genre, Artist, Song, and Album (out of 10)	7	10
Support customs "Skins"	Yes	No
Online radio Stream	Yes	Yes
A digital locker to store music	No	Yes
Supported Configurations	Windows, iOS, Android	Windows, iOS, Android, Linux

Table 2.6: Equilibrium solution for the the Horizontal Differentiated market (With Quality Difference)

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)
Step 1 ^a Discount	.989	.424	5.446	1	.020	2.687
Sensitivity	-.089	.422	.045	1	.833	.915
Interaction	1.386	.679	4.163	1	.041	3.997
Constant	-.388	.297	1.702	1	.192	.679

a. Variable(s) entered on step 1: Discount, Sensitivity, Interaction.

2.9 Figures

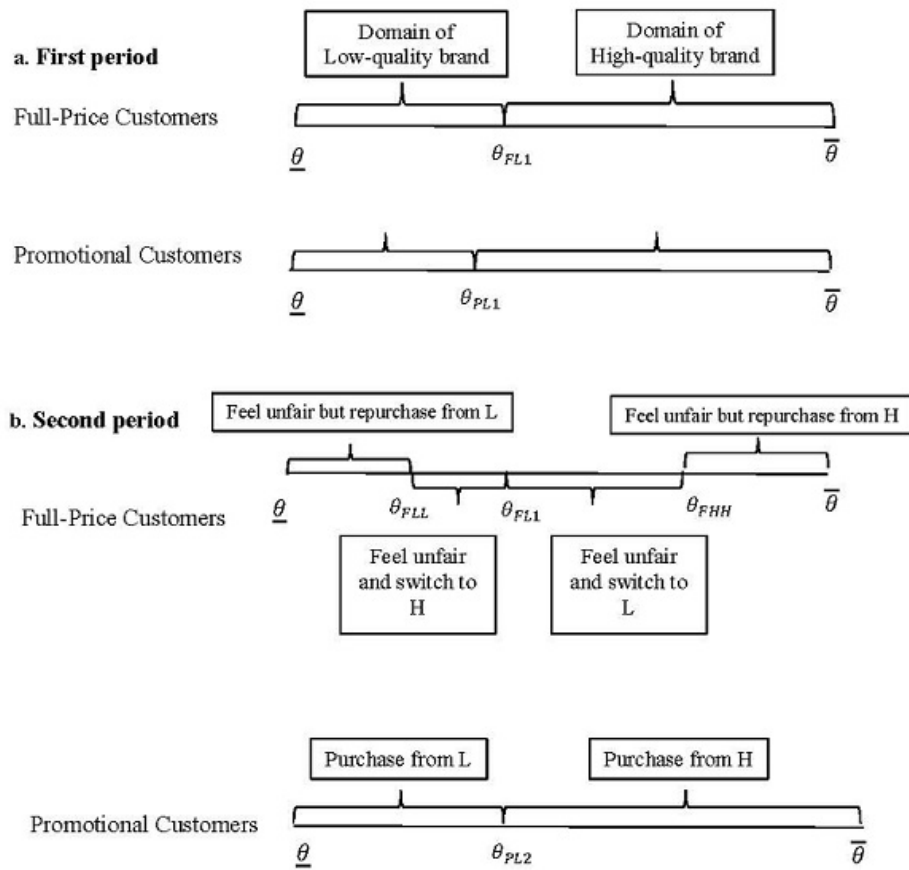


Figure 2.1: Vertically Differentiated Market in the Equilibrium

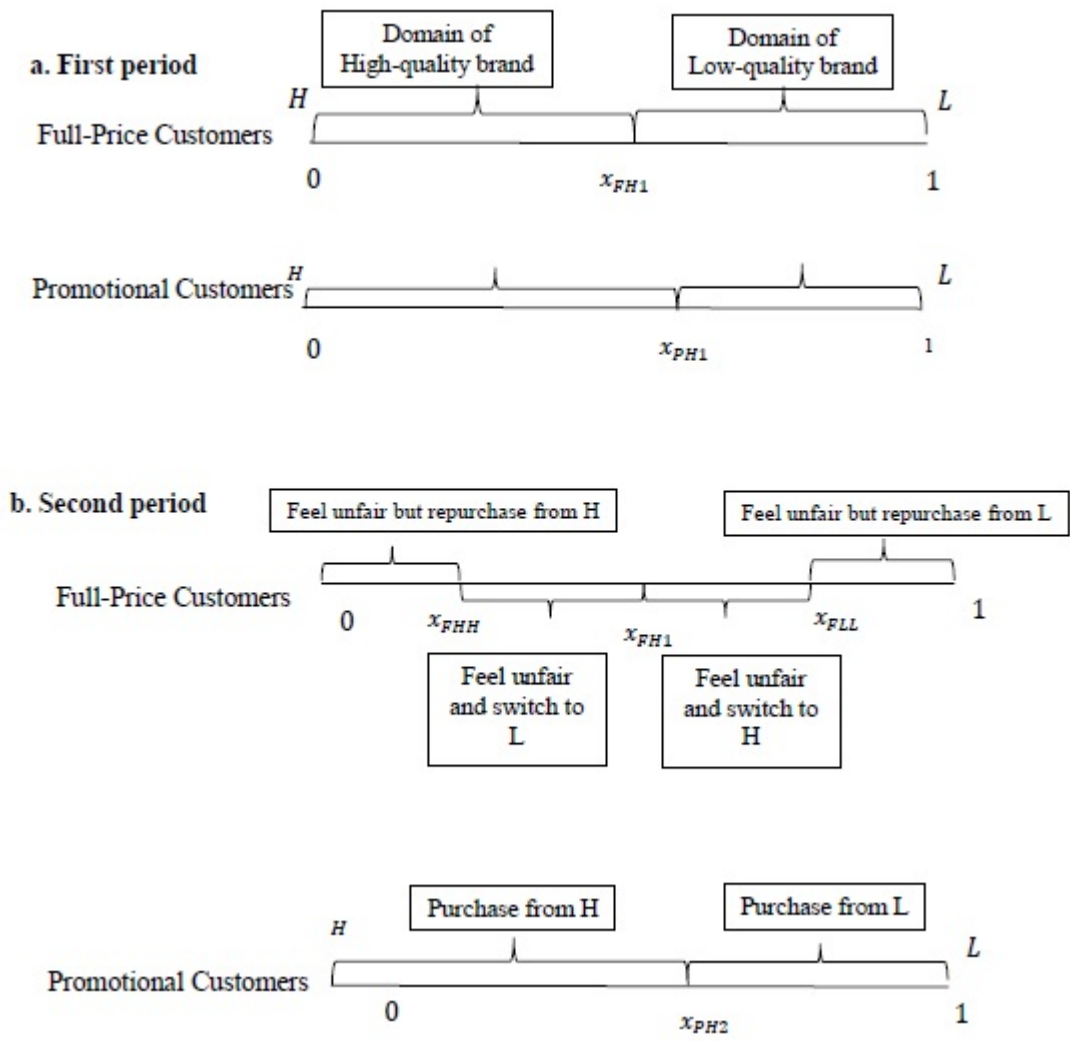


Figure 2.2: Horizontally Differentiated Market with Quality Difference in Equilibrium

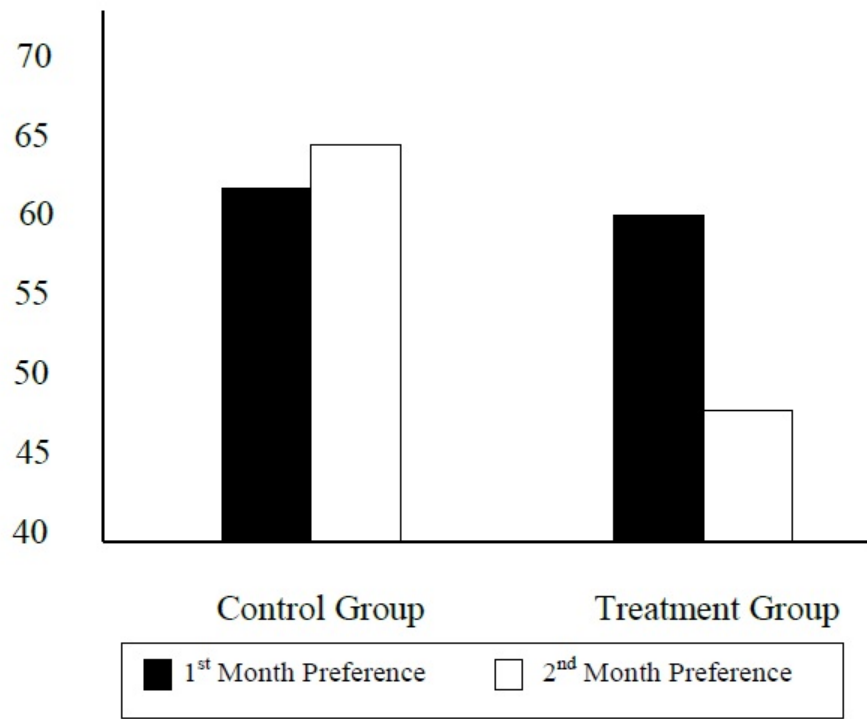


Figure 2.3: Across Period Consumers' Brand Preferences

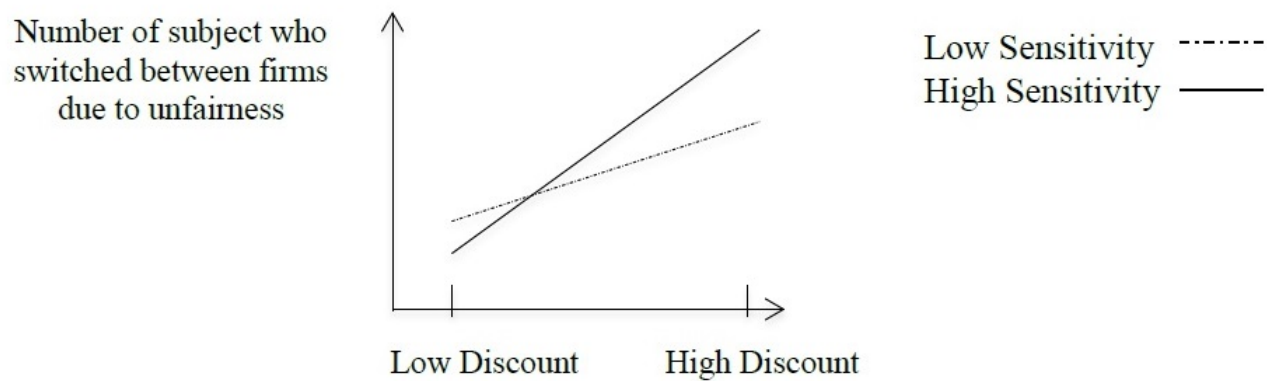


Figure 2.4: Interaction Effect Between Sensitivity and Amount of Discount

CHAPTER 3: SIGNALLING QUALITY THROUGH AVAILABILITY IN THE CONTEXT OF REPEAT PURCHASE

3.1 Introduction

Many manufacturers commonly apply scarcity strategies for their innovative products. For instance, Apple made its gold iPhone scarce during the product launch. In the first month of the gold iPhone release, Apple's flagship store in San Francisco had only 20 gold iPhones and even the Verizon Store on Wall Street had none (Business Insider, 2013). Similarly, some service providers deliberately place limitations on the quantity of service goods they make available to their potential customers. For example, unknown restaurants or spas which promote their services on daily deal platforms such as Groupon and LivingSocial to attract new customers might offer only a limited number of deals on the aforementioned platforms (Figure 3.1) (Groupon, 2015). Business press has documented that scarcity strategies can be effective for many product or service categories (Business Insider, 2013; SeekingAlpha, 2015; TIMEBusiness, 2011; Entrepreneurs-Journey, 2015). Despite the benefits and successes of scarcity practices for some companies, yet, many do not limit availability of their goods to the new customers but instead make them widely accessible to any consumer who is willing to purchase. Product or service abundance can be observed among businesses which aggressively try to penetrate new markets with the availability of deals on daily deal platforms (Figure 3.2) (Groupon, 2015). The above conflicting examples (shortage vs. availability in Figure 3.1 vs. Figure 3.2) suggest the following research question:

why do some firms eschew service/product shortage in favor of availability and vice versa when selling to new consumer markets?

In this paper, we offer a signaling model to answer this puzzling question. Many businesses operate in an asymmetric information environment in which new consumers have less information than them about their quality of the products or services¹. The literature has shown that in such environments, firms can employ various marketing strategies like pricing, advertising, and warranties to signal their quality to uninformed consumers (Bagwell and Riordan, 1991; Desai and Sirinivasan, 1995; Nelson, 1970, 1974; Milgrom and Roberts, 1986; Zhao, 2000; Moorthy and Sirinivasan, 1995). Bagwell and Riordan (1991) have examined the signaling role of pricing and they have demonstrated that a high introductory price signals high quality because the consequent loss of sales volume is higher for a low quality firm than for the high quality firm. In addition to pricing, Nelson (1970, 1974) and Milgrom and Roberts (1986) have suggested that uninformative advertising may be a signal of high quality. Their basic idea is that advertising expenditure is a signal that the high quality provider rather than low quality one is able to afford. However, Zhao (2000) constructed a model where advertising is not just considered as burning money to signal quality. He showed that when advertising is informative or is used to raise awareness, a high quality firm signals quality by spending less on advertising than a low quality one. The rationale for this finding is that decreasing sales results in a smaller loss in profits for the high quality firm than the low quality firm. Apart from aforementioned signaling strategies, product or service scarcity has also received a considerable attention in the Economics and Marketing literature (Becker, 1991; DeGraba, 1995;

¹The terms product and service are used interchangeably for the rest of the essay.

Stock and Balachander, 2005, Parker and Lehmann, 2011). DeGraba (1995) concludes that excess of demand is beneficial for firms because it induces a buying frenzy. In a buying frenzy, consumers purchase the product before they become informed about their valuation because if they wait till they are informed, the product is likely to be sold out. Stock and Balachander (2005) are the first to address the signaling role of seller-induced scarcity. They assume there are two segments of customers in the market, innovators who are informed about the product quality and late buyers who are uninformed. They show that signaling through scarcity can be more efficient than signaling through price under some conditions. The key to their intuition is that scarcity only affects the uninformed customers or late buyers, while pricing affects all customers. Furthermore, a low-quality seller who pretends to offer a high-quality product expects to make his sales from uninformed consumers alone and such a pretender is hurt more effectively by the scarcity strategy. Based on their results, Stock and Balachander (2005) argue that scarcity strategies are useful for discretionary or specialty products (non-convenience products). This is consistent with real business cases where early product shortage are mostly observed for new one-time purchased goods such as Gold iPhone (Business Insider, 2013), Samsung Galaxy S series phones (The Gaurdian, 2013), Microsoft Xbox (CNN 2013), etc. Limited availability of aforementioned products made them more precious in the eyes of their customers.

In the present paper, we extend the scarcity signaling literature by expanding the purchase context from durable products to repeatedly purchased products or services to answer the puzzling question mentioned earlier. We use a two-period signaling model in which a monopoly provider sells a repeatedly purchased good to uninformed new consumers. Consistent with prior research in

psychology and marketing we assume that consumers desire exclusivity and make their purchase decisions not only based on product attributes and price but also based on how many other consumers in the market could have access to the same product (Amaldos and Jain, 2005). In other words, we assume consumers perceive an exclusive product to be more valuable (Leibenstein, 1950; Cialdini, 1987; Lynn, 1987). In the service industry, the consumers' desire for exclusivity can be interpreted as their desire for avoiding congestion or crowdedness which leads to poor service delivery (Mendelson and Whang 1990; Tereyagoglu and Veeraraghavan, 2012). Numerous examples of consumers' negative reactions to careless service delivery due to traffic and crowdedness can be found on companies' customer forums and social networks (Harvard Business Review, 2012; Yelp, 2015). We show that, in such an asymmetric information market, somewhat consistent with prior literature, the high quality seller signals its quality by making its product scarce as well as charging a high price when consumers' desire for exclusivity is high or cost of quality is great. We also show that, even in the presence of exclusivity seeking consumers, there are conditions in which product availability and introductory pricing is a more effective signaling strategy for the high quality seller than product scarcity and high pricing. The intuition is that although making the product available to more consumers in the introductory period negatively impacts the snobbish consumers' product valuation and consequently firm's profits, consumers are able to infer that only the high quality seller is able to compensate for the current loss in the future. That is because the high quality seller attracts more repeat purchases than the low quality one and as more uninformed consumers purchase the high quality brand in the first period, more informed consumers may proceed to repurchase it in the second period. Furthermore, note that the high quality seller's in-

creasing availability makes mimicry less attractive for the low quality one, because its introductory stage profits are reduced and he will not be able to cover this profit loss with future returns. Thus, the low quality firm would prefer to make its product less available and price it higher, revealing its actual quality. Our findings are consistent with the business observation that some high quality service providers are more willing to make their product more available on daily deal websites by providing deep discounts because the repeat customers are more valuable to them than to the low quality providers. Not surprisingly, our findings on low introductory pricing are consistent with the past signaling literature in the repeat purchase context (Nelson, 1970, 1974; Tirole, 1988) The reasoning is that consumers observing the low introductory pricing infer that only the high quality firm is able to forgo the current profits in exchange of future returns from repeat purchases. Moreover, low introductory pricing hurts the low quality firm since he is not able to sell his products in the post-introductory period. In sum, this paper contributes to the signaling literature by showing conditions under which availability supplements low introductory pricing as a signaling strategy in a repeat purchase context even in the presence of snobbish consumers who seek exclusivity. The remainder of this paper is organized as follows. In section 3.2, we present our basic model of asymmetric information about product quality. The analysis in section 3.3 proceeds by analyzing the separating equilibrium and the implications for the model results. Concluding remarks and limitation of this research are provided in section 3.4. All proofs are relegated to the appendix.

3.2 Model

We consider a two-period repeat purchase framework where one seller offers a new product of uncertain quality. The exogenous quality, Q , of the seller's product could be high, Q_H , or low, Q_L , with $Q_H > Q_L > 0$. Without loss of generality, we assume that $Q_L = 1$ and $Q_H = 1 + q$ where $q > 0$. Each seller i ($i = H, L$) incurs a cost c_i per unit production where $c_H > c_L$. In this model, consistent with the signaling literature (Nelson, 1970, 1974; Milgrom and Roberts, 1986, Stock and Balachandar, 2005) we assume that the providers are aware of their product or service quality; however, consumers are not till they purchase and consume it. In other words, the seller offers an experience good. Characteristics of experience products are not evident on inspection and the consumers can verify their quality only by purchasing and using them. In such a market, low quality sellers have the incentive to represent their product as high quality thereby increasing profits. Thus, while low quality sellers have an incentive to mislead consumers that they are offering a high quality product, high quality sellers are willing to employ strategies giving up profits to separate themselves from low quality sellers.

3.2.1 Consumers

In our model, there is a mass M of consumers who have a common value θ for a unit of quality. Thus, we have a model where *ceteris paribus*, every consumer prefers a high quality product over a low quality one because their values for the high and low quality products are equal to $\theta(1 + q)$ and θ , respectively. In this model, consumers demand one unit of the product in each period and more-

over, they are sensitive to product availability, consistent with Amaldos and Jain (2005)'s notion that some consumers are snobs and desire uniqueness. Thus, their value for a product decreases as the number of people who buy the product increases. Furthermore, some research suggests that congestion/crowdedness which results from the increasing number of product/service users has also an adverse effect on the utility of consumers (Lippman and Stidham 1977; Mendelson and Whang 1990; Tereyagolu and Veeraraghavan, 2012). Following the aforementioned literature we model the negative impact of percentage of product availability/stockout in a consumer's utility. We assume that consumers have a lower utility for consuming a product when they realize higher percentage of potential consumers are able to consume the same product.

Particularly, when the firm of quality type i ($i = H, L$) announces the percentage $\alpha_{ti} \in (0, 1]$, $t = 1, 2$ of buyers who can access and purchase the product in each period, consumers' willingness to pay for the product goes down by $k_i \alpha_{ti}$ where k_i is the measure of consumers' sensitivity to availability of product type i ($i = H, L$). When a firm announces the availability α_1 in the introductory period, consumers realize that only a fraction α_1 of the whole mass market M will have the opportunity to purchase the product (See Figure 3.3). Similarly, in the second period, the firm decides on percentage of its product availability, α_2 , and only serves a fraction α_2 of consumers who proceed to repurchase the product. In this model, consistent with the literature (Milgrom and Roberts, 1986, Tirole, 1988) we assume that only those consumers who purchase in the introductory period (i.e $\alpha_1 M$) proceed to repurchase in the post-introductory period (See Figure 3.3). Thus, in our model, the number of people who purchase the product in the second period ($\alpha_2 \alpha_1 M$) is less than or equal to the number of people who purchase in the first period ($\alpha_1 M$). In this case,

based on Amaldos and Jain (2005), value of the product in consumers' mind could be higher in the second period than the first period. However, we argue that might not be the case since consumers in our model are sensitive to the percentage of product availability to the potential market in the current period. For instance, consumers of a spa or a restaurant do not care about the previous periods' crowdedness because it does not impact the current period service delivery.

Overall, consumers in our model derive utility from three different factors: the product quality, the degree of product availability, and its price. Putting the three components of consumer's utility together, the per-period utility of a consumer from using a new product quality type i ($i = H, L$) in period t ($t = 1, 2$) is given by $U_{ti} = \theta Q_i - k\alpha_{ti} - P_{ti}$, where P_{ti} is the product price in each period.

3.2.2 *Sequence of Events and Specification of the Game*

In this model, the consumers and the firm move sequentially in each period. In the first period, the firm which is aware of its quality decides on its price P_1 and the percentage of its product availability to consumers, α_1 . Consumers observing P_1 and α_1 , create a belief $0 \leq b = b(P_1, \alpha_1) \leq 1$ about the product quality i ($i = H, L$) and purchase the product only if their net utility U_{1i} is non-negative and the product is available to them. Normalizing M to be 1 without loss of generality, the first-period profits function of a firm with quality type Q_i , given the belief b about its quality is $\pi_{1i}(Q_i, c_i, b, P_{1i}, \alpha_{1i}) = \alpha_{1i}(P_{1i} - c_i)$. Note that this is a repeat purchase model and we assume that between the two periods there is no communication among consumers; thus, in the second

period, only consumers who purchase the experience good in the first period will be able to detect its quality and proceed to repurchase it. Moreover, in the basic model, consistent with previous research, we assume that consumers do not repurchase the low quality product in the second period after they detect its quality in the first period (Tirole, 1988; Kirmani and Rao, 2000)².

Therefore, in the second period, only in the case of high quality product, those consumers who purchased from the high quality firm in the first period will be willing to repurchase but only α_{2H} percent of them will be able to do so. Hence, the high quality firm's profits function in the second period is $\pi_{2H}(Q_H, 1, P_{2H}, \alpha_{2H}) = \alpha_{1H}\alpha_{2H}(P_{2H} - c_H)$ while the low quality firm's second period profits is 0. In the next section first we analyze the full information case as a benchmark and then proceed to solve for the separating equilibrium in the asymmetric information game.

3.3 Analysis

3.3.1 Full-Information Game

We consider a benchmark case where both consumers and the firm are aware of the product quality. In such a market, consumers make their purchase decisions observing the firm's product quality, price, and availability. Note that in the full-information game, all consumers are informed about the product quality in both periods. Thus, in the second period in a full-information market, all

²One may argue that low quality firm is a monopolist which sells a convenience (repeatedly purchased) good and the consumers have no option rather than purchasing a low quality product from a monopolist who has cheated on them. Following this argument, we explored the alternative assumption that consumers purchase the low quality product despite being aware of its quality and we found out that our qualitative results did not change.

consumers are interested in purchasing the product, but only a limited number of them will be able to do so due to availability of the product imposed by the firm. Without loss of generality, we assume that high quality firm's cost is equal to $c > 0$ and the cost for the low quality product is equal to zero. Considering this assumption, we show that in the full-information case, the high quality seller charges the price $P_{Hf} = \frac{\theta(1+q)+c}{2}$ and makes its product available to a fraction $\alpha_{Hf} = \frac{\theta(1+q)-c}{2k_H}$ of the consumers in both periods, while the low quality monopolist sets the price and availability as $P_{Lf} = \frac{\theta}{2}$ and $\alpha_{Lf} = \frac{\theta}{2k_L}$. Thus, the high quality firm which sells in both periods earns a profit of $\frac{(\theta(1+q)-c)^2}{2k_H}$ and low quality firm which sells only in the first period earns a profits of $\frac{\theta^2}{4k_L}$, respectively. It is trivial to show that $0 < \alpha_{Lf}, \alpha_{Hf} < 1$ and $0 < P_{Lf}, P_{Hf}$ only when consumers' sensitivity to availability is high enough and cost of quality is low, $\frac{\theta(1+q)-c}{2} < k_H$, $\frac{\theta}{2} < k_L$, and $c < \theta(1+q)$.

Considering the conditions above, it is easy to show that

Proposition 3.1. *In a full-information game, the high quality firm charges a higher price than the low quality firm, $P_{Hf} > P_{Lf}$. Furthermore, when k_H is low enough ($k_H < \underline{k}_H$), the high quality firm makes its product more available than low quality one's, $\alpha_{Hf} > \alpha_{Lf}$, but when k_H is high ($k_H > \underline{k}_H$) he makes it scarcer, $\alpha_{Hf} < \alpha_{Lf}$, where $\underline{k}_H = \frac{k_L(\theta(1+q)-c)}{\theta}$. Proof. See the Appendix Section.*

In the full-information game, all consumers are informed and their reservation price for a high quality product is more than their reservation price for a low quality product. Thus, the high quality seller prices its product higher to take advantage of consumers' extra willingness to pay for

quality. The high quality firm tends to use this leverage and makes its product available to more consumers. However, it is limited in doing so in the presence of snobs who react negatively to product abundance. Particularly, when consumers are highly sensitive to the high quality product's availability compared to the low quality one's, the high quality firm's incentive to make its product abundant in the market decreases.

Next, we consider a case where all consumers are uninformed about the product quality and compare the firm's strategies (pricing and availability) with the benchmark case where all consumers are informed. As is standard in signaling models we use the concept of pure strategy perfect Bayesian equilibrium to solve for the separating equilibrium under asymmetric information.

3.3.2 *Incomplete Information Game*

3.3.2.1 *Separating Equilibrium*

In this section, we investigate the firm's pricing and availability strategies in a market where consumers are not aware of the firm's product quality. In such a market, the low quality firm has an incentive to signal high quality by providing the same availability and price as the high quality firm. In this situation, the consumers are not able to infer the product's quality from the signals. To avoid this, the high quality seller sets his strategy pair in the first period (P_{1HI}, α_{1HI}) in such a way to not only maximize his total profits across two periods but also to not let the low quality firm imitate his strategy. This equilibrium is a separating equilibrium where the low quality firm finds

it optimal to reveal its true quality. Hence, the necessary mimicking constraint for the existence of this equilibrium is as follows:

$$\pi(L, 0, P_{1Lf}, \alpha_{1Lf}) \geq \pi(L, 1, P_{1HI}, \alpha_{1HI}) \quad (3.1)$$

The constraint above states that it is undesirable for the low quality firm to mimic the high quality firm's introductory strategies (P_{1HI}, α_{1HI}) . Recall that in the second period consumers realize the seller's low quality type and will not proceed to repurchase its product. Note that the mimicking condition is binding. If it was non-binding, the high quality firm would increase his profits by increasing the availability (price) of its product without changing its price (availability) meaning that there exists a $(P'_{1HI}, \alpha'_{1HI})$ such that $\pi_H(P'_{1HI}, \alpha'_{1HI}) > \pi_H(P_{1HI}, \alpha_{1HI})$. Therefore, a separating equilibrium with a non-binding mimicking constraint would not fulfill the intuitive criterion (Cho and Kreps, 1987). The parabolas in Figure 3.4 show the strategy pairs (P_{1HI}, α_{1HI}) which satisfy the binding mimicking constraint for different values of k_H and c . Thus, the strategy pairs (P_{1HI}, α_{1HI}) that satisfy (3.1) are those outside or on the parabolas for the respective values of k_H and c .

Furthermore, for a unique equilibrium to exist, we have to make sure that the high quality firm is not better off by deviating from the equilibrium by mimicking the low quality firm's period 1 choice (P_{1Lf}, α_{1Lf}) , thereby suggesting low quality with certainty. If he does so, in the first period, consumers believe that the firm is a low quality type. However, recall that after they consume the product, they become aware of its quality. The deviation constraint below guarantees that the high

quality firm does not find it profitable to deviate from the separating equilibrium.

$$\pi(H, 1, P_{1HI}, \alpha_{1HI}) \geq \pi(H, 0, P_{1Lf}, \alpha_{1Lf}) \quad (3.2)$$

3.3.2.2 Equilibrium Results

3.3.2.2.1 Costless Signaling

In a costless separating equilibrium, the low quality firm will be worse off even if he mimics the high quality firm's full information strategies. Thus, the high quality firm is able to separate from the low quality one by revealing its quality without incurring any cost. The proposition below summarizes the costless separating equilibrium for the high quality firm.

Proposition 3.2. *If $k_H \geq \bar{k}_H = \frac{k_L(\theta^2(1+q)^2 - c^2)}{\theta^2}$, the high quality firm separates from the low quality firm in the introductory period by applying its full-information strategy pair (P_{1Hf}, α_{1Hf}) . Proof. See the Appendix Section*

Recall that we assume that consumers show different sensitivities to high versus low quality products' availabilities. Moreover, when the low quality firm mimics the high quality firm's strategies, uninformed consumers update their belief about their willingness to pay as well as their sensitivity to product availability. Thus, when consumers are highly sensitive to the high quality product's availability compared to the low quality one's, the low quality firm will lose too much profits by mimicking the high quality firm's strategies since he does not have access to the customers in the

post-introductory period and he is willing to make its product more available in the introductory period. Imitation, therefore, is not profitable for the low quality firm and the high quality firm is able to separate without any cost.

3.3.2.2.2 Costly Signaling

When $k_H \leq \bar{k}_H$, the high quality provider incurs a cost to make mimicking undesirable for the low quality provider. Considering the constraints (3.1) and (3.2), we obtain a least-cost separating equilibrium for the high quality firm in which the low quality firm reveals his quality by implementing its complete information strategies (P_{1Lf}, α_{1Lf}) and the high quality firm employs $(P_{1HI}^\mp, \alpha_{1HI}^\pm)$ ³ as stated below. All proofs and derivations are deferred to the appendix.

$$P_{1HI}^\mp = \frac{\theta(k_L(1+q) \mp \sqrt{k_L(k_L(1+q)^2 - k_H)})}{2k_L}$$

$$\alpha_{1HI}^\pm = \frac{\theta(k_L(1+q) \pm \sqrt{k_L(k_L(1+q)^2 - k_H)})}{2k_L k_H}$$

We summarize the costly separating equilibrium results in the propositions below. In the next propositions we restrict ourselves to the more interesting case where the high quality firm makes its product scarcer than the low quality firm in the full information game ($k_H > \underline{k}_H$).

Proposition 3.3. *When $\underline{k}_H < k_H < \bar{k}_H$, in the separating equilibrium, the low quality firm implements its full-information strategy pair (P_{1Lf}, α_{1Lf}) but the high quality firm*

³Note that, the respective availability strategy for P_{HI}^+ is α_{HI}^- , while the respective availability strategy for P_{HI}^- is α_{HI}^+ .

(i) increases its product availability and lowers its price from their respective complete information levels, i.e., $P_{1HI}^- < P_{1Hf}$ and $\alpha_{1HI}^+ > \alpha_{1Hf}$, when $0 < c < c^*$ and $\underline{k}_H < k_H < \tilde{k}_H$ or when $c^* < c < c^{**}$ and $\underline{k}_H < k_H < k_H^*$ and

(ii) lowers its product availability and increases its price from their respective complete information levels, i.e., $P_{1HI}^+ > P_{1Hf}$ and $\alpha_{1HI}^- < \alpha_{1Hf}$, when $c^* < c < c^{**}$ and $k_H^* < k_H < \bar{k}_H$ or when $c^{**} < c$ and $\underline{k}_H < k_H < \bar{k}_H$.

Where⁴ $c^* = 2(3k_L + \theta) - 2\sqrt{3k_L(3k_L + 2\theta)}$, $c^{**} = \frac{2\theta^2}{4k_L + \theta}$, and $k_H^* = \frac{(c-2\theta)^2}{4c}$. *Proof.* See the Appendix Section.

In the separating equilibrium, the consumers perceive that a product is a high quality one when they observe either $(P_{1HI}^+, \alpha_{1HI}^-)$ or $(P_{1HI}^-, \alpha_{1HI}^+)$ and a low quality one when they observe (P_{1Lf}, α_{1Lf}) . The proposition above states that the separating equilibrium for the high quality firm involves either upward (downward) distortion $(P_{1HI}^-, \alpha_{1HI}^+)$ or downward (upward) distortion $(P_{1HI}^+, \alpha_{1HI}^-)$ from its full information availability (price) depending on c and k_H . The downward distortion of the high quality product's availability along with the upward distortion of its price is consistent with the established findings (Balachander and Stock, 2005; Bagwell and Riordan, 1991; Parker and Lehmann, 2011) that higher price and lower availability are associated with higher quality in specialty product (one-time) purchase contexts. In proposition 3.3, we confirm that such relationship exists in a repeat purchase context only when c is high or when c is intermediate and k_H is high (Scarcity Region in Figure 3.5). In contrast to the aforementioned literature, when c is low or c is intermediate and k_H is low (Availability Region in Figure 3.5) we, interestingly, show that the

⁴For simplicity, we considered $q = 1$.

high quality firm not only does not find it profitable to apply scarcity and high pricing but that he makes its product more abundant and prices it lower to signal its quality. The intuition for these results is as follows.

In an asymmetric information market, consumers learn the quality of the product only if they purchase and consume the product, and as Nelson (1984) suggested, the high quality product's repeat sales increases only if its actual quality is revealed to more consumers. Thus, the high quality firm has a greater incentive to attract more customers in the introductory period under asymmetric information than under full-information. This means that the high quality firm, in order to take advantage of a larger customer base in the post-introductory period, tends to charge an introductory price below its full-information price and make its product available to more uninformed customers. However, he is limited in doing so depending on customers' sensitivity to availability and marginal cost of producing quality. Although making the product more available in period 1 will generate a larger profit for the high quality firm in period 2, in the Scarcity Region, the second-period extra profits is not enough to compensate for his large first-period loss due to the high degree of customers' sensitivity to availability (high k_H) and/or low price margins (high c). Therefore, in order to make mimicking undesirable for the low quality firm in this region, the high quality firm distorts from its full information strategies by making its product even scarcer and pricing it even higher than their respective full-information levels. A high quality seller loses less by making its product scarce in the introductory period because of his lower margin compared to a mimicking low quality seller. Furthermore, the low quality seller, who does not sell in the post-introductory period, would lose so much profits by mimicking the upward distorted price or

downward distorted availability that he prefers to reveal his quality by implementing (P_{1Lf}, α_{1Lf}) .

Unlike in the Scarcity Region, in the Availability Region, by making its product available to more uninformed consumers in period 1, the high quality firm is able to secure high demand and profits in period 2 which is big enough to compensate for his small profit loss in the first period stemming from the low degree of customers' sensitivity to availability (low k_H) and/or high profits margin (low c). Under these conditions, consistent with the notion of a wasteful expenditure suggested by Nelson (1970, 1974), the high quality firm is willing to forgo a fraction of his first-period profits to signal its quality and earn higher future profits in return. However, a mimicking low quality firm is not able to cover his introductory profit loss resulting from first-period low prices since he will have no future sales.

It is worth mentioning that we assume that there is enough information for the consumers in the market to interpret the pricing/availability signals of the firms. The consumers are aware of the extent of future repeat sales for the high quality firm vs low quality firm in each of the availability versus scarcity regions. In other words, they know there will be no future sales and returns for the low quality provider after its quality is revealed and they know under what conditions, the high quality firm is able to compensate for its first period loss. For example, in the scarcity region, consumers make an assessment of both high and low quality firms' losses and they realize only the high quality firm can make its product scarce and still make a profit. Moreover, in the availability region, consumers know that both high and low quality monopolists lose demand and incur a loss in the first period if they increase their availability, however only the high quality firm

is able to compensate for their loss by their post-introductory repeat sales.

Next, we compare the strategies of the high quality firm and the low quality firm in the separating equilibrium. It is trivial to check whether there is a parameter region in which the high quality firm makes its product more available and prices it lower than the low quality firm in the separating equilibrium. We showed that in the region ($0 < c < c^*$ and $\underline{k}_H < k_H < \tilde{k}_H$ or when $c^* < c < c^{**}$ and $\underline{k}_H < k_H < k_H^*$), the high quality firm makes its product more available than under full-information. Thus, the relationship between the quality and scarcity is weakened in this region. More specifically, we find that,

Proposition 3.4. *When $0 < c < c^*$ and $\underline{k}_H < k_H < \tilde{k}_H$ or when $c^* < c < c^{**}$ and $\underline{k}_H < k_H < k_H^*$, in the separating equilibrium, the high quality firm makes its product more available and prices it lower than the low quality firm ($\alpha_{1HI} > \alpha_{1Lf}$ and $P_{1HI} < P_{1Lf}$) while he makes its product scarcer and prices it higher than the low quality firm under full information ($\alpha_{1Hf} < \alpha_{1Lf}$ and $P_{1Hf} > P_{1Lf}$). Proof. See the Appendix Section.*

As shown in proposition 3.1, under full information, when consumers are highly sensitive to product availability, the high quality provider implements a scarcity strategy in the introductory period and does not sell as many products as the low quality firm. However, proposition 3.4 interestingly shows that under asymmetric information, in order to signal its quality to uninformed customers, the high quality seller applies the exact opposite strategy and makes its product more available than the low quality firm. The results of this proposition stand in contrast to the results of the signaling literature in case of durable goods that have shown scarcity and high price to be signals of prod-

uct quality. However, interestingly, we show that in a repeat purchase context, there is a negative relationship between quality and scarcity or quality and high price. In the separating equilibrium under some conditions, even in the presence of snobs, the high quality firm makes its product more available rather than scarce ($\alpha_{1HI} > \alpha_{1Hf}$) and prices it lower rather than higher ($P_{1HI} < P_{1Lf}$) to signal its quality. Our results may in part explain the fact that local and unknown high quality providers are more willing to offer high number of huge deals on daily deal platforms than low quality ones to build a larger customer base (Zhao, Wang, and Gan, 2014).

Now we make some remarks on existence of the separating equilibrium in this model. The following proposition identifies the parameter ranges of k_H and c which do not support a separating equilibrium.

Proposition 3.5. *When $0 < c < c^{***}$ and $\tilde{k}_H < k_H < \bar{k}_H$ or $c^{***} < c < c^*$ and $\tilde{k}_H < k_H < k_H^*$, the high quality firm deviates from the separating equilibrium by applying $P_{1HI} = P_{1Lf}$ and $\alpha_{1HI} = \alpha_{1Lf}$.*

As we showed in previous propositions, when the cost of high quality production is significantly low, the high quality provider prefers to signal its quality by making its product more available than the low quality provider. However, when consumers are extremely sensitive to high quality product's availability, increasing the degree of product availability is not a profitable strategy for the high quality provider. Thus, when c is sufficiently low and k_H is very high, neither making the product more available nor making it less available than the low quality firm will be profitable for the high quality firm, leading it to deviate.

Summing up propositions 3.2 to 3.5, we could show different equilibria depending on parameters k_H and c in Figure 3.5. The intuitions of the aforementioned propositions help us to better understand the choice of signaling strategy by the high quality firm in different regions in Figure 3.5. This figure shows that for a given level of cost of quality less than c^{**} , as customers' sensitivity to product availability decreases availability becomes a more efficient strategy than scarcity. Furthermore, for a given level of customers' sensitivity to product's availability less than \bar{k}_H , as cost of quality decreases, availability becomes a more efficient strategy than scarcity. Moreover, in this figure, we also observe that if customers' sensitivity to product availability exceeds the threshold \bar{k}_H , regardless of the cost of quality, the high quality firm is able to separate cheaply by applying its full-information strategies.

3.4 Conclusion and Limitations

In this paper, we show that for a repeatedly purchased good or service, a high quality seller may make its product more available and price it low to signal its quality to uninformed consumers despite consumers' desire for exclusivity. In our model, we consider a monopoly firm providing a new repeatedly purchased good with two possible quality levels of high or low. We show that in a separating equilibrium, to signal its quality, a high quality provider makes its product more available and prices it lower than its respective full-information levels when cost of quality or consumers' desire for exclusivity are sufficiently small and he makes its product less available and prices it higher than its respective full-information levels when cost of quality or consumers' desire

for exclusivity are sufficiently high. In any of these situations, it is not effective for a low quality provider who does not sell in the second period to mimic high quality firm's strategies in the first period since he is not able to compensate for his introductory profits loss in the post-introductory period. Furthermore, we interestingly show that although the high quality firm might make its product scarcer than the low quality firm under full information when customers' sensitivity to availability is high, he makes its product more available than the low quality firm under asymmetric information. The basic intuition is that under asymmetric information, the high quality firm moves opposite of what is profitable for the low quality firm. If the low quality firm represents himself as a high quality provider, then consumers will have a higher sensitivity to his product availability, thereby he is more interested in making its product scarce in the introductory period.

The existing literature on scarcity strategies predominantly describe positive effects for managers that scarcity strategies lead to enhancement of value and perception of product quality. However, results of this research provide implications and insights for managers that success of scarcity strategy in signaling product quality depends on the frequency of product purchase (repeated vs. one-time purchase product) as well as the cost of quality and customers' levels of snobbishness. Our analysis specifically provides conditions under which product availability rather than deliberate product stock-out could be used as a signal of quality for repeat purchase products. The results of our paper could explain under what conditions of consumers' desire for exclusivity and cost of quality, new high quality providers should offer discounted or high prices and to how many consumers they should make their product available. The effect of k_H suggests that the high quality providers whose customers are extremely snobbish should not be worried about low quality service

providers mimicking their strategies since it would not be profitable to do so. However, as customers' level of sensitivity to product availability or the cost of quality decreases, availability along with low pricing rather than scarcity along with high pricing becomes a more efficient signaling strategy for high quality firms.

We assume in the analysis that customers show different sensitivities to high versus low quality products' availabilities. A laboratory experiment could be done to show support for this consumer behavioral assumption. Furthermore, in our model, consistent with the literature in signaling we assumed that the low quality service providers is not able to sell to any consumer in the second period. Future research could relax this assumption and study a market where low quality firm is still able to mimic the strategies of high quality firm in the post-introductory period to trick remaining uninformed customers who did not purchase from him in the first period.

3.5 Appendix

3.5.1 Derivation of the Full-Information Market Equilibrium

In a full-information market consumers are aware of the product quality and they purchase a product type i ($i = H, L$) in period t ($t = 1, 2$) if and only if their net utility consuming the product in each period is non-negative, i.e. $U_{tif} = \theta Q_i - k_i \alpha_{tif} - P_{tif} \geq 0$. Thus firms can charge a maximum full-information price of $P_{if} = \theta Q_i - k_i \alpha_{if}$ in order to have α_{if} fraction of the market purchase the product in each period and earn profits $\pi_{if} = 2\alpha_{if}(P_{if} - c_i)$ across periods. Substituting P_{if}

into firms' profits function and considering $Q_L = 1$, $Q_H = 1 + q$, $c_L = 0$, and $c_H = c$, we solve the first order conditions to obtain the optimum full-information availabilities in both periods $\alpha_{Hf} = \frac{\theta(1+q)-c}{2k_H}$ and $\alpha_{Lf} = \frac{\theta}{2k_L}$ for product type H and L , respectively. It is easy to show that the second order condition for a local maximizer is fulfilled for both α_{Hf} and α_{Lf} i.e. $\frac{\partial^2 \pi_{if}}{\partial \alpha_{if}^2} = -4k_i < 0$ because measure of consumers' sensitivity to product availability (k_i) is positive. Plugging α_{Hf} and α_{Lf} into the full-information prices and total profits functions, we obtain equilibrium solutions, $P_{Hf} = \frac{\theta(1+q)+c}{2}$, $\pi_{Hf} = \frac{(\theta(1+q)-c)^2}{2k_H}$ for the high quality provider and $P_{Lf} = \frac{\theta}{2}$, $\pi_{Lf} = \frac{\theta^2}{2k_L}$ for the low quality one. We also check for equilibrium conditions $0 < P_{Hf}, P_{Lf}$ and $0 < \alpha_{Hf}, \alpha_{Lf} < 1$. With a tedious algebra and considering $0 < k_H, k_L, q, \theta$, we show that $0 < \alpha_{Hf} = \frac{\theta(1+q)-c}{2k_H} < 1$ only if $\frac{\theta(1+q)-c}{2} < k_H$ and $c < \theta(1+q)$, moreover, $0 < \alpha_{Lf} = \frac{\theta}{2k_L} < 1$ only when $\frac{\theta}{2} < k_L$.

Proof of Proposition 3.1: $P_{Hf} - P_{Lf} = \frac{\theta q + c}{2} > 0$ for all $q, \theta > 0$. The sign of $\alpha_{Hf} - \alpha_{Lf} = \frac{k_L(\theta(1+q)-c) - \theta k_H}{2k_H k_L}$ depends on the sign of the numerator $k_L(\theta(1+q) - c) - \theta k_H$. Thus, $\alpha_{Lf} < \alpha_{Hf}$ if $k_H < \underline{k}_H$ and $\alpha_{Lf} > \alpha_{Hf}$ only if $k_H > \underline{k}_H$ where $\underline{k}_H = \frac{k_L(\theta(1+q)-c)}{\theta}$.

3.5.2 Derivation of the Incomplete-Information Market Equilibrium

In an incomplete information market, consumers are not aware of the product quality. Thus, the low quality firm has an incentive to mislead the consumers by mimicking the high quality firm's introductory strategies while the high quality firm chooses a price-availability combination (P_{1HI}, α_{1HI}) to not only maximize his total profits but also separate itself from the low quality one in the introductory period. In the post-introductory period, the qualities are revealed to those

consumers who purchased the product and high quality firm applies his full-information strategies knowing the fact that consumers repurchase his product rather than the low quality product. Hence, (P_{1HI}, α_{1HI}) is the optimum separating solution for high quality firm in the first period if it solves the following problem:

$$\pi_{HI} = \max_{0 \leq \alpha_{HI} \leq 1, 0 < P_{HI}} \alpha_{1HI}(P_{1HI} - c) + \alpha_{1HI}\alpha_{Hf}(P_{Hf} - c) \quad (3.3)$$

$$\text{s.t. } \alpha_{Lf}P_{Lf} \geq \alpha_{1HI}P_{1HI} \quad (3.4)$$

where condition (3.4) is equivalent to the mimicking constraint (inequality (3.1)).

Proof of proposition 3.2: The maximum profits that the low quality seller can obtain by mimicking happens when he imitates the high quality firm's full-information strategies. Thus, maximum $\pi_{LI} = \alpha_{Hf}P_{Hf} = \frac{\theta^2(1+q)^2 - c^2}{4k_H}$. If this maximum profit does not exceed the revealing profits for the low quality firm, $\alpha_{Lf}P_{Lf} = \frac{\theta^2}{4k_L}$, then the low quality firm does not have any incentive to deviate from his full-information strategies. Inequality $\alpha_{Lf}P_{Lf} - \alpha_{Hf}P_{Hf} = \frac{k_L(c^2 - \theta^2(1+q)^2) + \theta^2k_H}{4k_Lk_H} > 0$ is satisfied only when $k_L(c^2 - \theta^2(1+q)^2) + \theta^2k_H > 0$. Hence, when $k_H > \bar{k}_H = \frac{k_L(\theta^2(1+q)^2 - c^2)}{\theta^2}$, high quality firm can charge his full-information strategies (P_{Hf}, α_{Hf}) and separate without incurring any cost.

When $k_H < \bar{k}_H$, high quality seller needs to reveal its quality by solving (3.3). Plugging P_{Hf} , α_{Hf} , α_{Lf} , P_{Lf} , and $P_{1HI} = \theta(1+q) - k_H\alpha_{1HI}$ into the problem, we can write the Lagrangian as

$L = \alpha_{1HI}(\theta(1+q) - k_H\alpha_{1HI} - c + \frac{(\theta(1+q)-c)^2}{2k_H}) + \lambda(\frac{\theta^2}{4k_L} - \alpha_{1HI}(\theta(1+q) - k_H\alpha_{HI}))$ where λ is the Kuhn-Tucker multiplier. Taking the partial derivatives with respect to α_{1HI} and λ yield to the following Kuhn-Tucker conditions:

$$\frac{\partial L}{\partial \alpha_{1HI}} = \frac{\theta^2(1+q)^2 - 8k_H^2\alpha_{1HI}(1-\lambda) + 4k_H\theta(1+q)(1-\lambda) + c(c - 2(2k_H + \theta(1+q)))}{4k_H} \geq 0, \alpha_{1HI} \geq 0, \quad (3.5)$$

$$\text{and } \alpha_{1HI} \frac{\partial L}{\partial \alpha_{1HI}} = 0$$

$$\frac{\partial L}{\partial \lambda} = \frac{4k_L k_H \alpha_{1HI}^2 + \theta(\theta - 4k_L \alpha_{1HI}(1+q))}{4k_L} \geq 0, \lambda \geq 0, \text{ and } \lambda \frac{\partial L}{\partial \lambda} = 0 \quad (3.6)$$

We break the rest of the proof into two cases.

Case 1: Inequality constraint is not binding. In this case, from condition (3.6) we have $\frac{\partial L}{\partial \lambda} > 0$ which implies that $\lambda = 0$. Substituting $\lambda = 0$ in (3.5) and considering a positive availability degree, we can solve $\frac{\partial L}{\partial \alpha_{1HI}} = 0$ for α_{1HI} as follows: $\alpha_{1HI} = \frac{(\theta(1+q)-c)(\theta(1+q)-4k_H-c)}{8k_H^2}$ which is positive if only if the expression in the numerator $\theta(1+q) - 4k_H - c$ is positive implying that $k_H < \frac{\theta(1+q)-c}{4}$ which does not satisfy the condition $\frac{\theta(1+q)-c}{2} < k_H$ for $0 < \alpha_{HI} < 1$. Therefore, the results of case 1 are not acceptable.

Case 2: Inequality constraint is binding. In this case, from condition (3.5), we solve $\frac{\partial L}{\partial \alpha_{1HI}} = 0$ for λ . Substituting $\lambda^\pm = \frac{4k_H\theta(k_H - k_L(1+q)^2) \pm \sqrt{k_L(k_L(1+q)^2 - k_H)((\theta(1+q)-c)^2 - 4k_Hc)}}{4k_H(k_H - k_L(1+q)^2)\theta}$ in (3.5) and considering a positive availability degree, we can solve $\frac{\partial L}{\partial \alpha_{1HI}} = 0$ for α_{1HI} as follows:

$$\alpha_{1HI}^{\pm} = \frac{\theta(k_L(1+q) \pm \sqrt{k_L(k_L(1+q)^2 - k_H)})}{2k_H k_L}$$

The corresponding price and profit are

$$P_{1HI}^{\mp} = \frac{\theta(k_L(1+q) \mp \sqrt{k_L(k_L(1+q)^2 - k_H)})}{2k_L}$$

$$\pi_{HI}^{\pm} = \frac{\theta(\sqrt{k_L(k_L(1+q)^2 - k_H)} \pm k_L(1+q))((k_L\theta(1+q)(2k_H + \theta(1+q)) + ck_L(c - 2(2k_H + \theta(1+q)))) - 2k_H\theta\sqrt{k_L(k_L(1+q)^2 - k_H)})}{8k_H^2 k_L^2}$$

The second order condition for maximum $\pi_{HI}^{\pm}(Q_H, 1, P_{1HI}^{\mp}, \alpha_{1HI}^{\pm})$ is satisfied: $\frac{\partial^2 \pi_{HI}^{\pm}}{\partial \alpha_{1HI}^{\pm 2}} = -2k_H <$

0.

It is trivial to show that this equilibrium is the only separating equilibrium which exists. Thus, we have to make sure the high quality firm's introductory strategies fulfill the following condition that there does not exist a $(P'_{1HI}, \alpha'_{1HI})$ such that $\pi_{HI}(P'_{1HI}, \alpha'_{1HI}) > \pi_{HI}^{\pm}(P_{1HI}^{\mp}, \alpha_{1HI}^{\pm})$. Therefore, to complete the rest of the equilibrium derivation, it suffices to show that $(P_{1HI}^{\mp}, \alpha_{1HI}^{\pm})$ meet the following conditions. The first conditions is the same as the deviation constraint (3.2) meaning that high quality provider is better off by signaling his quality than by being perceived to be of low quality.

$$\pi_{HI}^{\pm}(P_{1HI}^{\mp}, \alpha_{1HI}^{\pm}) \geq \pi_{HI}(P_{1Lf}, \alpha_{1Lf})$$

For simplicity for the rest of the proofs we consider $q = 1$.

Proof of proposition 3.3:

First Solution $(P_{1HI}^-, \alpha_{1HI}^+)$ will be the equilibrium solution if and only if it satisfies the conditions

below

$$(i) \pi_{HI}^+(P_{1HI}^-, \alpha_{1HI}^+) > \pi_{HI}^-(P_{1HI}^+, \alpha_{1HI}^-) \quad \text{and} \quad (ii) \pi_{HI}^+(P_{1HI}^-, \alpha_{1HI}^+) \geq \pi_{HI}(P_{1Lf}, \alpha_{1Lf})$$

$$(i) \frac{\theta \sqrt{k_L(4k_L - k_H)}(c^2 + 4\theta^2 - 4c(k_H + \theta))}{4k_H^2 k_L} > 0 \quad \Rightarrow \quad c^2 + 4\theta^2 - 4c(k_H + \theta) > 0$$

and

$$(ii) \frac{\theta(2k_L - k_H + \sqrt{k_L(4k_L - k_H)})(c^2 + 4\theta^2 - 4c(k_H + \theta))}{8k_H^2 k_L} > 0$$

Considering both (i) and (ii) we have $k_H^* = \frac{c^2 + 4\theta^2 - 4c\theta}{4c} > k_H$ and $2k_L + \sqrt{k_L(4k_L - k_H)} > k_H$.

We break the rest of the proof into two parts: $k_H < \tilde{k}_H = 3k_L$ and $k_H > \tilde{k}_H = 3k_L$.

First case: If $k_H < \tilde{k}_H$, then condition (ii) will be $k_H < k_H^* = \frac{c^2 + 4\theta^2 - 4c\theta}{4c}$ and $k_H < \tilde{k}_H$. Considering $k_H < \bar{k}_H = \frac{k_L(4\theta^2 - c^2)}{\theta^2}$, we will have two cases, (a) $k_H^* > \bar{k}_H \Rightarrow 0 < c < c^{***} = \frac{\theta(\sqrt{64k_L^2 + 48k_L\theta + \theta^2} - (8k_L + \theta))}{8k_L}$ and (b) $k_H^* < \bar{k}_H \Rightarrow c^{***} < c < c^* = 2((3k_L + \theta) - \sqrt{3k_L(k_L + 2\theta)})$.

For the case (a), we have $\tilde{k}_H < \bar{k}_H$. Similarly for the case (b), we also have $\tilde{k}_H < k_H^*$. Hence, when $c < c^*$, the equilibrium condition is $k_H < \tilde{k}_H$. However, when $c^* < c$, then $k_H^* < \bar{k}_H$. Hence, when $c^* < c$, the equilibrium condition is $k_H < k_H^*$.

Second case: If $\tilde{k}_H < k_H$, then condition (ii) is ruled out since $2k_L + \sqrt{k_L(4k_L - k_H)} < \tilde{k}_H$.

Consequently, the first strategy pair is the equilibrium solution so far only when $c < c^*$ and $k_H < \tilde{k}_H$ or $c^* < c$ and $k_H < k_H^*$. As we also noted in the main body of the paper, we focus on the interesting case where $\underline{k}_H < k_H$. When $c < c^*$, we definitely know that $\underline{k}_H < \tilde{k}_H$. However, when

$c^* < c$, we have $\underline{k}_H < k_H^*$ only when $c < c^{**} = \frac{2\theta^2}{4k_L + \theta}$. Furthermore, it is easy to show that

$$P_{Hf} - P_{1HI}^- = \frac{ck_L + \theta\sqrt{k_L(4k_L - k_H)}}{2k_L} > 0$$

$$\alpha_{Hf} - \alpha_{1HI}^+ = -\frac{ck_L + \theta\sqrt{k_L(4k_L - k_H)}}{2k_L k_H} < 0$$

Similarly, the second solution $(P_{1HI}^+, \alpha_{1HI}^-)$ will be the equilibrium solution if and only if it satisfies the conditions below:

(i) $\pi_{HI}^-(P_{1HI}^+, \alpha_{1HI}^-) > \pi_{HI}^+(P_{1HI}^-, \alpha_{1HI}^+)$ and (ii) $\pi_{HI}^-(P_{1HI}^+, \alpha_{1HI}^-) \geq \pi_{HI}(P_{1Lf}, \alpha_{1Lf})$

(i) $\frac{\theta\sqrt{k_L(4k_L - k_H)}(c^2 + 4\theta^2 - 4c(k_H + \theta))}{4k_H^2 k_L} < 0 \Rightarrow c^2 + 4\theta^2 - 4c(k_H + \theta) < 0$

and

(ii) $\frac{\theta(2k_L - k_H - \sqrt{k_L(4k_L - k_H)})(c^2 + 4\theta^2 - 4c(k_H + \theta))}{8k_H^2 k_L} > 0$

Based on (i) and (ii) we have $k_H^* = \frac{c^2 + 4\theta^2 - 4c\theta}{4c} < k_H$ and $2k_L - \sqrt{k_L(4k_L - k_H)} < k_H$. Considering $k_H < \bar{k}_H$ we have $k_H^* < \bar{k}_H$ if and only if $c > c^{***} = \frac{\theta(\sqrt{64k_L^2 + 48k_L\theta + \theta^2} - (8k_L + \theta))}{8k_L}$. Furthermore, considering $\underline{k}_H < k_H$, then $\underline{k}_H < k_H^*$ only when $c < c^{**}$.

Consequently, the second strategy pair is the equilibrium solution only when $c^{***} < c < c^{**}$ and $k_H^* < k_H < \bar{k}_H$ or $c^{**} < c$ and $\underline{k}_H < k_H < \bar{k}_H$. Under these conditions it is easy to show that

$$P_{Hf} - P_{1HI}^+ = \frac{ck_L - \theta\sqrt{k_L(4k_L - k_H)}}{2k_L} < 0$$

$$\alpha_{Hf} - \alpha_{1HI}^- = \frac{-ck_L + \theta\sqrt{k_L(4k_L - k_H)}}{2k_Lk_H} > 0$$

Note that in previous equilibria for both strategy pairs, the high quality firm signals its product quality via both product price and product availability. We are obligated to show that the high quality seller would not be better off signaling through price alone or through availability alone. When signaling through price (availability) alone, the high quality firm sets its product availability (price) equal to its corresponding level under full information and sets its price (availability) in a way to make mimicking unattractive for the low quality firm. Solving both aforementioned equilibria similar to the basic model under asymmetric information, we find the following profits (considering $q = 1$) for the high quality firm when signaling via price alone (π_{HIP}) and availability alone (π_{HIA}), respectively.

$$\pi_{HIP} = \frac{2c^2k_L(2k_H + 3\theta) + 2\theta^2(k_H^2 + 4k_L\theta) - 4ck_L\theta(2k_H + 3\theta) - c^3k_L}{8k_H^2k_L}$$

$$\pi_{HIA} = \frac{\theta^2(c - 2\theta)(c - 2(k_H + \theta))}{8k_Hk_L(c + 2\theta)}$$

With basic algebra we can show that $\pi_{HI}^+ > \pi_{HIP}$, $\pi_{HI}^+ > \pi_{HIA}$, $\pi_{HI}^- > \pi_{HIP}$, and $\pi_{HI}^- > \pi_{HIA}$ under their corresponding equilibrium conditions: $c < c^*$ and $\underline{k}_H < \tilde{k}_H$ or $c^* < c < c^{**}$ and $\underline{k}_H < k_H^*$ for the first strategy pair and $c^{***} < c < c^{**}$ and $k_H^* < k_H < \bar{k}_H$ or $c^{**} < c$ and $\underline{k}_H < k_H < \bar{k}_H$ for the second strategy pair).

Proof of proposition 3.4: In the availability region, because $\underline{k}_H < k_H$, under full information, the high quality firm makes its product less available than the low quality firm while it makes it more

available than the low quality firm under asymmetric information as you observe below.

$$P_{Lf} - P_{1HI}^- = \frac{\theta(-k_L + \sqrt{k_L(4k_L - k_H)})}{2k_L} > 0$$

$$\alpha_{Lf} - \alpha_{1HI}^+ = \frac{\theta(k_H - 2k_L - \sqrt{k_L(4k_L - k_H)})}{2k_L k_H} < 0$$

Proof of proposition 3.5: There is a parameter region where neither availability nor scarcity in separation is profitable for the high quality firm. Thus, he prefers to deviate from the separating equilibrium.

$$\pi_{HI}(P_{1HI}^-, \alpha_{1HI}^+) < \pi_{HI}(P_{1Lf}, \alpha_{1Lf}) \text{ and } \pi_{HI}(P_{1HI}^+, \alpha_{1HI}^-) < \pi_{HI}(P_{1Lf}, \alpha_{1Lf})$$

$$\frac{\theta(2k_L - k_H \pm \sqrt{k_L(4k_L - k_H)})(c^2 + 4\theta^2 - 4c(k_H + \theta))}{8k_H^2 k_L} < 0$$

either (i) $2k_L - k_H \pm \sqrt{k_L(4k_L - k_H)} > 0$ and $c^2 + 4\theta^2 - 4c(k_H + \theta) < 0$

or (ii) $2k_L - k_H \pm \sqrt{k_L(4k_L - k_H)} < 0$ and $c^2 + 4\theta^2 - 4c(k_H + \theta) > 0$

$$(i) k_H < 2k_L - \sqrt{k_L(4k_L - k_H)} \text{ and } \frac{c^2 + 4\theta^2 - 4c\theta}{4c} < k_H$$

$$(ii) 2k_L + \sqrt{k_L(4k_L - k_H)} < k_H \text{ and } \frac{c^2 + 4\theta^2 - 4c\theta}{4c} > k_H$$

We break the rest of the proof into two parts: $k_H < \tilde{k}_H = 3k_L$ and $k_H > \tilde{k}_H = 3k_L$.

First case: If $k_H < 3k_L$, then condition (i) will be $k_H^* = \frac{c^2 + 4\theta^2 - 4c\theta}{4c} < k_H < k_L$ and condition (ii)

is ruled out. We can show that considering $k_H < \bar{k}_H = \frac{k_L(4\theta^2 - c^2)}{\theta^2}$ condition (i) is also ruled in this case.

Second case: If $k_H > 3k_L$, then condition (ii) will be $\tilde{k}_H < k_H < k_H^* = \frac{c^2 + 4\theta^2 - 4c\theta}{4c}$ and condition


(i) is ruled out. Considering $k_H < \bar{k}_H$, we will have two cases, (a) $k_H^* > \bar{k}_H = \frac{k_L(4\theta^2 - c^2)}{\theta^2}$
 $\Rightarrow 0 < c < c^{***} = \frac{\theta(\sqrt{64k_L^2 + 48k_L\theta + \theta^2} - (8k_L + \theta))}{8k_L}$ and (b) $k_H^* < \bar{k}_H = \frac{k_L(4\theta^2 - c^2)}{\theta^2} \Rightarrow c^{***} < c <$
 $c^* = 2((3k_L + \theta) - \sqrt{3k_L(k_L + 2\theta)})$. In summary, no separating equilibrium conditions are (a)
 $0 < c < c^{***}$ and $\tilde{k}_H < k_H < \bar{k}_H$ and $c^{***} < c < c^*$ and $\tilde{k}_H < k_H < k_H^*$


3.6 Figures

\$41

BUY!

VALUE	DISCOUNT	YOU SAVE
\$75	45%	\$34

 GIVE AS A GIFT

 **Limited time remaining!**


ONLY 10 LEFT
 4 bought





Figure 3.1: Limitations Are Placed on Availability of Deals


FROM
\$42

BUY! >

VALUE	DISCOUNT	YOU SAVE
\$120	65%	\$78

 GIVE AS A GIFT



 Limited time remaining!


 Pampered

Figure 3.2: No Limitations Are Placed on Availability of Deals

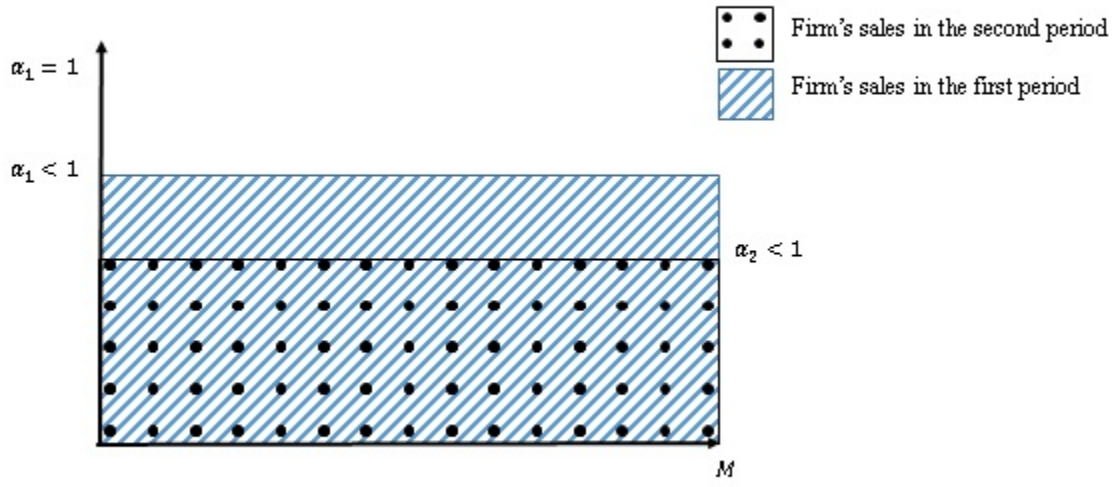


Figure 3.3: Total Sales in Each Period

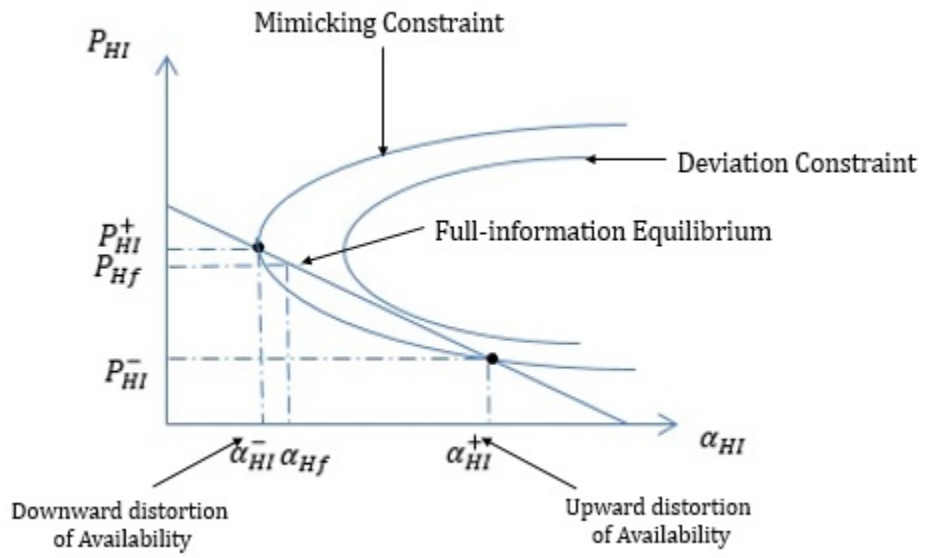


Figure 3.4: Mimicking and Deviation Parabola

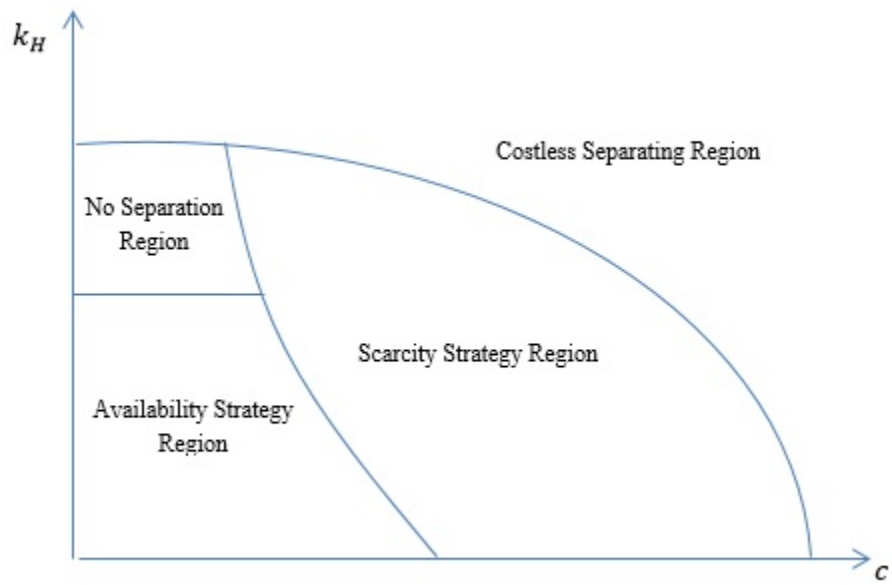


Figure 3.5: Strategy Regions

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