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Price Matching Policies and Consumer Loyalty

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TABLE OF CONTENTS

ABSTRACT

I examine the relationship between brick-and-mortar retailers offering price-matching guarantees and the atmosphere of their stores. In an extension of the Hotelling model, if a retailer improves the atmosphere of its store, then it raises its price. However, with a price-match guarantee and a competitor with a lower-quality store and a lower price, some of the retailer's consumers may demand a price match. I identify the circumstances under which a price-match guarantee prevents a retailer from earning increased revenues that may result from improving its in-store atmosphere. In my model, the results depend on the share of consumers who seek price matches and the share of consumers who are loyal to the retailer.

1. INTRODUCTION

The way that consumers make purchasing decisions today has dramatically changed: they can easily get information from different retailers, using their computers and network to compare prices and product reviews. Consumers who do not have brand loyalty for retailers will like to purchase the goods at the store which offers a lower price since the goods are identical in different stores. To retain consumers, a lot of retailers who sell homogeneous goods in the market offer price match guarantees. For example, Walmart could match the price to Target, Bestbuy, Sears and vice-versa. A "horizontal price match policy" matches the lower price of the same product with that of competitors. The "horizontal price match policy" usually has two forms: match the price immediately or match after the purchase. If consumers want to purchase goods from a retailer but find out the same goods in the competitor's store are at the better deal, consumers can prove it when they check out and buy at a lower price. In addition, consumers could also submit their request for a price adjustment within a specified period after the purchase and the price difference of the identical products in two stores will be refunded to consumers.

What's more, Consumers now buy products not only because they need the products physically but also because they could be satisfied mentally by means of such products. The store atmosphere will generate specific emotional effects on the buyers, playing an important part of the decision-making process of the consumer. For example, a decent shopping environment and good service will increase the incentives of the consumers to buy products in this store. Therefore, in order to obtain some competitive advantages, some retailers allocate investment resources to create good store atmosphere. [1]

At first glance, only retailers that have low in-store atmospheres will offer price match guarantees. However, because all consumers do not demand that a retailer match a competitor's lower price, and consumers prefer shopping at stores with nice atmospheres, retailers may be willing to spend resources to improve the store's atmosphere. Not all consumers demand price-matching for the following two reasons. First, some consumers may consider purchasing at multiple retailers, and even know that a competitor has set a lower price. However, these consumers may not be willing to spend time asking for a price match. Second, other consumers may be loyal to a particular retailer and may be uninformed about competitors' prices.

One crucial observation is that retailers in a competitive relationship will set the same price for the same period. It is also important to explain in which conditions retailers should invest in improving their in-store atmosphere and in what conditions retailers should offer only basic, spartan stores.

In this paper, consumers are assigned three categories: the general consumer who will invoke their right under price-matching guarantee, the loyal consumer, and the general consumers who neglect the price-matching policy. I set up a Hotelling model to see how retailers react in setting price and investment for store ambience. I found out they will set the highest Nash equilibrium price among several Nash equilibria prices and Nash equilibrium investment in in-store atmosphere. If there are not loyal consumers, both retailer will not invest in store ambience.

The rest of the paper is organized as follows. Section 2 provides related literature that I reviewed. I set up the model in Section 3 and analyze different cases of price setting in Section 4. In Section 5, I draw conclusions.

2. LITERATURE REVIEW

Cooperation and competition are two important economic activities for retailers. However, coordination also exists in competing companies and they do not have to discuss it.

Belton (1987) set up duopoly model that two firms producing differentiated products to analyze the effect of meeting competition clauses (MCCs). Belton (1987) made the conclusions that MCC reduces the competition and leads to a price increase above non- cooperative levels by both firms [2]

In Png and Hirshleifer (1987), price matching policy was treated as special price discrimination that happens in competition. In addition, if there are a certain number of firms and the firms coordinate the pricing, they could discriminate more effectively and gain more profits by selling to customers at a lower opportunity cost. [3]

Moorthy and Winter (2006) assumed that the information about prices is costly because buyers will spend a lot of time in comparing different prices in different stores to find the best deal, but the pricing policies of retailers are not expensive to find. They found that the price match guarantees serve as a signal for their relative low-price position which attracts more consumers who are not informed about the prices of competitive stores. Price match guarantees are anti-competitive. [4] On a different perspective, Caminal and Claici (2007) who did the research about the effects of loyalty programs on competition found that loyalty-rewarding pricing schemes have a pro-competitive effect and hence they reduce average prices. [5]

Those essays state the effects of competition. In my paper, I take both price match guarantees and loyalty consumers into consideration. I found that the combined effect is pro-competitive, using a Hotelling model to find the specific demand related to two retailers' price and the in-store ambience. What's more, I take the proportion of people who are willing to ask for price-match and loyalty consumer into consideration to see whether those two segments of people will influence retailers' decisions.

3. THE MODEL

We assume that two retailers (denoted 1 and 2) are located at the extreme locations of the $[0,1]$interval, l_i, sell a homogeneous product at their own retail price, p_1, p_2, and the same constant marginal cost, c. Two retailers all have "horizontal price match policy" and they will match their price to the competitors' lower price if consumers submit requirements so that they could prevent their customers from shifting to rival retailers. To attract loyal customers, both Retailers also have the incentive to invest in store ambience, q_1, q_2, to improve the shop quality perceived by consumers at the cost of k, and the desired store atmosphere also benefits customers who are not loyal consumer scaled by α, which is positive.

I divided all consumers into three types in this paper: Consumers who aware of the "horizontal price match policy" and are willing to apply for a price adjustment with a share of all consumers, λ. We assume that there is no cost for searching for the price information in different stores and invoking price match guarantees. There is a share of all consumers, δ (between 0 and 1), Loyal Consumer, who are committed to one of the retailers not matter how the price of another retailer changes. Therefore, the share of loyal consumers for retailer 1 and retailer 2 is $\delta/2$ respectively. The rest of consumers, $1 - \lambda - \delta$, who are unaware of such policy or unwilling to put effort into the application of price refund.

From the perspective of the consumer, consumers are uniformly distributed on the unit interval, x and bear a unit travel cost, τ. A consumer's basic indirect utility equals to the reservation income, r, plus the gain from store atmosphere, αq_i, then minus unit travel cost, τ, times distance, $|l_i - x|$ and then minus price, which is written as $r + \alpha q_i - \tau|l_i - x| - p_i$. What's more, if the price of one retailer is less than another retailer, it will sell at the price that it set for all its consumers. If the product of one retailer is more expensive than another retailer, a part of its consumers who know the policy will submit the requests of price match and buy the product at the same price that another retailer set.

The profit functions of retailer 1 and 2 are:

$$\pi_1 = \begin{cases} (1-\lambda-\delta)(p_1-c)D_{11}(p_1,p_2,q_1,q_2) + \lambda(p_1-c)D_{12}(q_1,q_2) \\ \quad + \frac{\delta}{2}(p_1-c)D_{13}(q_1,p_1) - kq_1{}^2 & if\ p_1 \le p_2 \\ (1-\lambda-\delta)(p_1-c)D_{11}(p_1,p_2,q_1,q_2) + \lambda(p_2-c)D_{12}(q_1,q_2) \\ \quad + \frac{\delta}{2}(p_1-c)D_{13}(q_1,p_1) - kq_1{}^2 & if\ p_1 > p_2 \end{cases}$$

$$\pi_2 = \begin{cases} (1-\lambda-\delta)(p_2-c)D_{21}(p_1,p_2,q_1,q_2) + \lambda(p_1-c)D_{22}(q_1,q_2) \\ \quad + \frac{\delta}{2}(p_2-c)D_{23}(q_1,p_1) - kq_2{}^2 & if\ p_1 \le p_2 \\ (1-\lambda-\delta)(p_2-c)D_{21}(p_1,p_2,q_1,q_2) + \lambda(p_2-c)D_{22}(q_1,q_2) \\ \quad + \frac{\delta}{2}(p_2-c)D_{23}(q_1,p_1) - kq_2{}^2 & if\ p_1 > p_2 \end{cases}$$

4. ANALYSIS

In this section, I start with the normal case when two retailers set the same price and find the Nash equilibrium level of investment they will set.

After retailers set their prices, for the people who will not seek for the price match, $1-\lambda-\delta$ shares of all consumers, there is exactly one consumer $\hat{x}$ who is indifferent from buying in retailer 1 or buying in retailer 2:

$$r + \alpha q_1 - \tau\,|\hat{x}| - p_1 = r + \alpha q_2 - \tau\,|1-\hat{x}| - p_2$$

$$\hat{x} = \frac{1}{2} + \frac{(p_2-p_1) + \alpha(q_1-q_2)}{2\tau}$$

The demand of the general consumer who will not seek for the price match for retailer 1 and 2 are:

$$D_{11}(p_1,p_2) = \hat{x} = \frac{1}{2} + \frac{(p_2-p_1) + \alpha(q_1-q_2)}{2\tau}$$

$$D_{21}(p_1,p_2) = 1-\hat{x} = \frac{1}{2} + \frac{(p_1-p_2) + \alpha(q_2-q_1)}{2\tau}$$

Since general consumer who will invoke price match policy will buy the identical product at the same price from either of two retailers, $p_1 = p_2$, the demand for retailer 1 and 2 are:

$$D_{12}(p_1, p_2) = \frac{1}{2} + \frac{\alpha(q_1 - q_2)}{2\tau}$$

$$D_{22}(p_1, p_2) = \frac{1}{2} + \frac{\alpha(q_2 - q_1)}{2\tau}$$

For loyal consumers, they have a linear demand with price, p and investment in store atmosphere, q, which is:

$$D_{13} = (p_1, q_1) = q_1 - p_1$$

$$D_{23} = (p_2, q_2) = q_2 - p_2$$

Therefore, the profit functions of retailer 1 and 2 are:

$$\pi_1 = \begin{cases} (p_1 - c)(1 - \lambda - \delta)\left(\frac{1}{2} + \frac{(p_2 - p_1) + \alpha(q_1 - q_2)}{2\tau}\right) + \lambda(p_1 - c)(\frac{1}{2} + \frac{\alpha(q_1 - q_2)}{2\tau}) \\ \quad + \frac{\delta}{2}(p_1 - c)(q_1 - p_1) - kq_1^2 \qquad if\ p_1 \le p_2 \\ (p_1 - c)(1 - \lambda - \delta)\left(\frac{1}{2} + \frac{(p_2 - p_1) + \alpha(q_1 - q_2)}{2\tau}\right) + \lambda(p_2 - c)(\frac{1}{2} + \frac{\alpha(q_1 - q_2)}{2\tau}) \\ \quad + \frac{\delta}{2}(p_1 - c)(q_1 - p_1) - kq_1^2 \qquad if\ p_1 > p_2 \end{cases}$$

$$\pi_2 = \begin{cases} (p_2 - c)(1 - \lambda - \delta)\left(\frac{1}{2} + \frac{(p_1 - p_2) + \alpha(q_2 - q_1)}{2\tau}\right) + \lambda(p_1 - c)(\frac{1}{2} + \frac{\alpha(q_2 - q_1)}{2\tau}) \\ \quad + \frac{\delta}{2}(p_2 - c)(q_2 - p_2) - kq_2^2 \qquad if\ p_1 \le p_2 \\ (p_2 - c)(1 - \lambda - \delta)\left(\frac{1}{2} + \frac{(p_1 - p_2) + \alpha(q_2 - q_1)}{2\tau}\right) + \lambda(p_2 - c)(\frac{1}{2} + \frac{\alpha(q_2 - q_1)}{2\tau}) \\ \quad + \frac{\delta}{2}(p_2 - c)(q_2 - p_2) - kq_2^2 \qquad if\ p_1 > p_2 \end{cases}$$

Proposition 1. The stage-2 price setting game has a continuum of Nash equilibria.

Specifically, any $p_1^* = p_2^* \in \left[\frac{(\alpha-\delta\alpha-\lambda\alpha+\tau\delta)q_1-(\alpha-\delta\alpha-\lambda\alpha)q_2+(1-\lambda-\delta+\tau\delta)c+(1-\lambda-\delta)\tau}{1-\lambda-\delta+2\tau\delta}, \frac{(\alpha-\delta\alpha+\tau\delta)q_1-(\alpha-\delta\alpha)q_2+(1-\lambda-\delta+\tau\delta)c+(1-\delta)\tau}{1-\lambda-\delta+2\tau\delta}\right]$ is a Nash equilibrium.

When we take the derivative of the profit of a retailer to its own price and set it equals to 0, we get the best response of that retailer.

The best response function of retailer 1 and retailer 2 respectively is:

$$p_1 = \begin{cases} \frac{(1-\lambda-\delta)}{2(1-\lambda-\delta+\tau\delta)}p_2 + \frac{(\alpha-\delta\alpha+\tau\delta)}{2(1-\lambda-\delta+\tau\delta)}q_1 - \frac{\alpha(1-\delta)}{2(1-\lambda-\delta+\tau\delta)}q_2 \\ \quad + \frac{(1-\delta)\tau}{2(1-\lambda-\delta+\tau\delta)} + \frac{c}{2} & if\ \ p_1 \le p_2 \\ \frac{(1-\lambda-\delta)}{2(1-\lambda-\delta+\tau\delta)}p_2 + \frac{(\alpha-\lambda\alpha-\delta\alpha+\tau\delta)}{2(1-\lambda-\delta+\tau\delta)}q_1 - \frac{\alpha(1-\lambda-\delta)}{2(1-\lambda-\delta+\tau\delta)}q_2 \\ \quad + \frac{(1-\lambda-\delta)\tau}{2(1-\lambda-\delta+\tau\delta)} + \frac{c}{2} & if\ \ p_1 > p_2 \end{cases}$$

$$p_2 = \begin{cases} \frac{(1-\lambda-\delta)}{2(1-\lambda-\delta+\tau\delta)}p_1 + \frac{(\alpha-\lambda\alpha-\delta\alpha+\tau\delta)}{2(1-\lambda-\delta+\tau\delta)}q_2 - \frac{\alpha(1-\lambda-\delta)}{2(1-\lambda-\delta+\tau\delta)}q_1 \\ \quad + \frac{(1-\lambda-\delta)\tau}{2(1-\lambda-\delta+\tau\delta)} + \frac{c}{2} & if\ \ p_1 \le p_2 \\ \frac{(1-\lambda-\delta)p_1}{2(1-\lambda-\delta+\tau\delta)} + \frac{(\alpha-\delta\alpha+\tau\delta)q_2}{2(1-\lambda-\delta+\tau\delta)} - \frac{\alpha(1-\delta)q_1}{2(1-\lambda-\delta+\tau\delta)} \\ \quad + \frac{(1-\delta)\tau}{2(1-\lambda-\delta+\tau\delta)} + \frac{c}{2} & if\ \ p_1 > p_2 \end{cases}$$

We could see the Figure 1 that a retailer will increase its price as the price of the rival increase and end up setting the same price. We could find the range of Nash equilibria by setting the same price in the best response function of retailer 1. In other words, find the intersections of the best response function of retailer 1 and the forty-five-degree line. There are multiple Nash equilibria ranging from $p_L^* = \frac{(\alpha-\delta\alpha-\lambda\alpha+\tau\delta)q_1-(\alpha-\delta\alpha-\lambda\alpha)q_2+(1-\lambda-\delta+\tau\delta)c+(1-\lambda-\delta)\tau}{1-\lambda-\delta+2\tau\delta}$ to $p_H^* = \frac{(\alpha-\delta\alpha+\tau\delta)q_1-(\alpha-\delta\alpha)q_2+(1-\lambda-\delta+\tau\delta)c+(1-\delta)\tau}{1-\lambda-\delta+2\tau\delta}$. Both retailers have no incentive to deviate from Nash equilibrium price (proof. See the appendix) and have the incentive to set the highest Nash equilibrium price p_H^*. What's more, if there is not consumer implement price match ($\lambda = 0$), $p_L^* = p_H^*$. Therefore, there are several symmetric Nash equilibria of prices set by retailers due to the existence of price match consumers.

Corollary 1. The stage-2 Nash equilibrium prices, p_1^* and p_2^*, are increasing in one firm's investment, q_1 and cost, c, and decreasing in the other firm's investment, q_2.

A retailer will set a higher retail price when the price of its rival increases, the investment of store ambience of its rival decreases or the investment of store ambience of its own increases. Since $1-\lambda-\delta \in [0,1]$, $(1-\delta) \in [0,1]$, $(1-\lambda) \in [0,1], \tau > 0, \alpha > 0$. The best response of the price for a retailer has a positive correlation with its own quality level and another retailer's price but has a negative correlation with another retailer's quality level.

We will focus on the greatest of the stage-2 Nash equilibria. Specifically,

$$p_1^* = p_2^* = \frac{(\alpha-\delta\alpha+\tau\delta)}{1-\lambda-\delta+2\tau\delta} q_1 - \frac{(\alpha-\delta\alpha)}{1-\lambda-\delta+2\tau\delta} q_2 + \frac{(1-\lambda-\delta+\tau\delta)}{1-\lambda-\delta+2\tau\delta} c + \frac{(1-\delta)\tau}{1-\lambda-\delta+2\tau\delta}.$$

Proposition 2. The symmetric subgame perfect equilibrium in-store atmospheres is:

$$q_1^* = q_2^* = \frac{\delta^2\tau[2\alpha(1-\delta)+(1-2\tau)\delta+(\lambda-1)]c+(2\alpha+1)(\delta-1)^2+2\tau(1-\delta)+\lambda(\delta-1)}{4k[4\delta^2\tau^2+4\delta\tau(1-\lambda-\delta)+(1-\lambda-\delta)^2]+\delta^2\tau[2\alpha(\delta-1)+(\lambda+\delta-1)-2\tau\delta]}$$

Corollary 2. The stage-1 subgame perfect equilibrium store atmospheres, q_1^* and q_2^*, are increasing in the share of people who will invoke their right under price-matching guarantee, λ and decreasing in the share of loyal customers, δ.

In graph 2, when $q_1 \geq q_2$, the best response function of retailer 1 will shift to the right and the best response function of retailer 2 will shift to the left. Two retailers will still set the highest symmetric Nash equilibrium at

$$p^* = \frac{(\delta\alpha - \alpha)}{1-\lambda-\delta+2\tau\delta} q_1 + \frac{(\alpha - \delta\alpha + \tau\delta)}{1-\lambda-\delta+2\tau\delta} q_2 - \frac{(1-\lambda-\delta+\tau\delta)}{1-\lambda-\delta+2\tau\delta} c + \frac{(1-\delta)\tau}{1-\lambda-\delta+2\tau\delta}$$

Solve for the first-order condition of profit maximization π_1 respect to its own quality level (q_1) under this condition, we get

$$fq1 = \frac{(1-\delta)(\delta\alpha-\alpha)\left[\frac{1}{2}+\frac{\alpha(q_1-q_2)}{2\tau}\right]}{1-\lambda-\delta+2\tau\delta} + \frac{\alpha(1-\delta)(p^*-c)}{2\tau} + \frac{(\delta\alpha-\alpha)\delta(q_1-p^*)}{1-\lambda-\delta+2\tau\delta} + \frac{\delta(p^*-c)\left(1-\frac{\delta\alpha-\alpha}{1-\lambda-\delta+2\tau\delta}\right)}{2} - 2kq_1$$

i) Especially, when $\delta = 0; 0 \leq \lambda < 1$, there are no loyal customers, the first-order condition of profit maximization π_1 is negative.

$$fq1 = \frac{\alpha^2(q_2 - q_1)}{\tau(1-\lambda)} - 2kq_1$$

Therefore, a retailer does not have the incentive to invest in its quality when there are no loyal customers and customers will not match the price. Solve for symmetric Nash equilibrium, $q_1^* = q_2^* = 0$. Both retailers will set a Nash equilibrium price

$$p_1^* = p_2^* = \frac{(1-\delta)\tau}{1-\lambda-\delta+2\tau\delta} - \frac{(1-\lambda-\delta+\tau\delta)c}{1-\lambda-\delta+2\tau\delta}$$

$ii)$ When $0 < \delta < 1; 0 < \lambda < 1;\ q_1{}^* = q_2{}^*$, we found the level investment, q^*, that maximize the profit.

$$\frac{\delta^2\tau[2\alpha(1-\delta)+(1-2\tau)\delta+(\lambda-1)]c+(2\alpha+1)(\delta-1)^2+2\tau(1-\delta)+\lambda(\delta-1)}{4k[4\delta^2\tau^2+4\delta\tau(1-\lambda-\delta)+(1-\lambda-\delta)^2]+\delta^2\tau[2\alpha(\delta-1)+(\lambda+\delta-1)-2\tau\delta]}$$

When I set $\alpha = 1, k = 1, \tau = 1, c = 0$

$$q^* = \frac{\delta(\delta^2+(\lambda-4)\delta+(3-\lambda))}{\delta^3+(\lambda+1)\delta^2+8*(1-\lambda)\delta+4(\lambda-1)^2}$$

Because $0 < \delta < 1; 0 < \lambda < 1,\ q^* > 0$. Especially, when $\delta = 1,\ q^* = 0$.

Therefore, if k=1, when there are not loyal customers, or all the customers are loyal customers, both retailers will set zero quality investment. Otherwise, both retailers will set the same symmetric Nash equilibrium quality (q^*). What's more, for the lower proportion of loyal customers, the symmetric Nash equilibrium quality that two retailers set will increase in the proportion of loyal customers, δ. But for the higher value of the proportion of loyal customers, the symmetric Nash equilibrium quality that two retailers set will decrease in the proportion of loyal customers, δ. In sum, If there exist loyal customers, both retailers will set the same positive quality investment.

5. CONCLUSION

In this paper, I prove that the price match policy can soften competition and that retailers will not deviate from the Nash-equilibrium price. In addition, retailers will invest the same amount in in-store ambience to attract more loyal customers. Otherwise, the retailers have no incentive to improve their in-store ambience.

I first set up a duopoly Hotelling model to get the market share for 2 retails. There is a trade-off between modifying the price and the demand. Price match policy helps retailers to retain consumers so as not to buy the identical product at a lower price from competitors. A reduction in price is not profitable because the competitors will match the lower price and profit will not increase. Therefore, retailers will divide the market equally at the highest price of a continuum of Nash-equilibria prices because some consumers will ask for the price match. At the second stage, retailers will set the Nash-equilibrium investment. If there are loyal consumers, the Nash-equilibrium investment will be positive and if there are not loyal consumers, the Nash-equilibrium investment will be zero.

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APPENDIX

Proof of Proposition 1. In this assumed two retailers model, each retailer has two profit functions because the retailer will set the lowest price of the prices set by two retailers for consumers who will implement price match policy.

Case 1. When $p_1 > p_2$,

$$\pi_1 = (p_1 - c)(1 - \lambda - \delta)\left(\frac{1}{2} + \frac{(p_2 - p_1) + \alpha(q_1 - q_2)}{2\tau}\right) + \lambda(p_2 - c)(\frac{1}{2} + \frac{\alpha(q_1 - q_2)}{2\tau})$$
$$+\frac{\delta}{2}(p_1 - c)(q_1 - p_1) - kq_1{}^2$$

Take the derivative of the profit of retailer 1 respect to the price of retailer 1 and the result is:

$$\frac{\partial \pi_1}{\partial p_1} = \frac{1}{2\tau}(1 - \lambda - \delta)(\tau + p_2 - 2p_1 + c + \alpha(q_1 - q_2)) + \frac{\alpha}{2}(q_1 - 2p_1 + c)$$

Let $p_1{}^* = p_2{}^* = p_L^*$, $\frac{\partial \pi_1}{\partial p_1} = 0$; Let $p_1{}^* = p_2{}^* = p_H^*$, $\frac{\partial \pi_1}{\partial p_1} = -\frac{(\tau + \alpha(q_1 - q_2))\lambda}{2\tau} < 0$. Therefore, when $p_1 > p_2$, as price of retailer 1 increase, the profit of retailer 1 decrease.

Case 2. When $p_1 \leq p_2$,

$$\pi_1 = (p_1 - c)(1 - \lambda - \delta)\left(\frac{1}{2} + \frac{(p_2 - p_1) + \alpha(q_1 - q_2)}{2\tau}\right) + \lambda(p_1 - c)(\frac{1}{2} + \frac{\alpha(q_1 - q_2)}{2\tau})$$
$$+\frac{\delta}{2}(p_1 - c)(q_1 - p_1) - kq_1{}^2$$

Take the derivative of the profit of retailer 1 respect to the price of retailer 1 and the result is:

$$\frac{\partial \pi_1}{\partial p_1} = \frac{1}{2\tau}[(1 - \lambda - \delta)(\tau + p_2 - 2p_1 + c + \alpha(q_1 - q_2)) + \lambda(\tau + \alpha(q_1 - q_2)]$$
$$+\frac{\alpha}{2}(q_1 - 2p_1 + c)$$

Let $p_1{}^* = p_2{}^* = p_L^*$, $\frac{\partial \pi_1}{\partial p_1} = \frac{(\tau + \alpha(q_1 - q_2))\lambda}{2\tau} > 0$; Let $p_1{}^* = p_2{}^* = p_H^*$, $\frac{\partial \pi_1}{\partial p_1} = 0$.

Therefore, when $p_1 \leq p_2$, as the price of retailer 1 increase, the profit of retailer 1 increase. In sum, the retailer 1 will set the same price as retailer 2. There are several symmetric Nash equilibria.

Figure 1: Multiple Nash equilibria prices for retailers

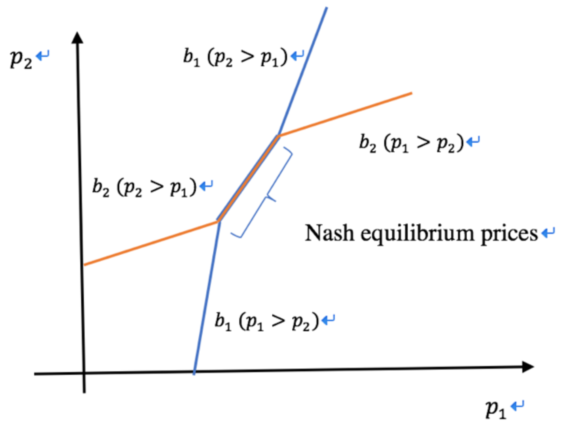
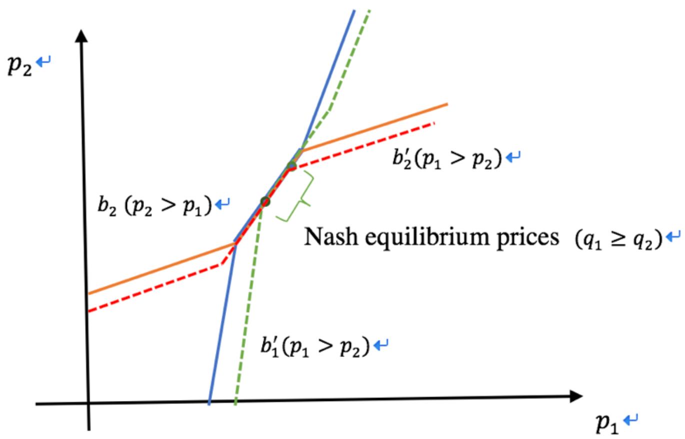


Figure 2: Multiple Nash equilibria prices for retailers when $q_1 \geq q_2$



BIOGRAPHICAL SKETCH

Gaojie Lin, born at Haikou, Hainan province in China. She received her Bachelor of Economics degree in Beijing Institute of Technology, majored in International Trade and Economics. She was an exchange student at the University of Regensburg, in Germany. She is pursuing her Master of Science in Applied Economics degree at Lehigh University.

Gaojie Lin wishes to devote my life to be a prominent scholar in the fields of environmental economics, corporate finance and industrial organization. She was invited to join the research group at the Center for Energy and Environmental Policy Research at Beijing Institute of Technology and done several projects such as "The Study of Risk Assessment on the Electric Car Industry Constrained by the Low-Carbon Policy." What's more, she joined the Martindale Center for the Study of Private Enterprise and Microfinance Program as a research assistant and she was a teaching assistant for Statistical Methods and Applied Microeconomic Analysis at Lehigh University. Gaojie is more than happy to communicate with other outstanding scholars around the world. Her email is peking_lin@yeah.net.