Asymmetric Pricing Policies in Chain Store Competition

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Abstract

Retail chains that operate multiple stores need to decide whether to charge a uniform price or to customize their prices for each local market. Practice has been mixed. There are observations where some retail chains choose uniform pricing whereas their rivals in the same sector adopt customized pricing. In this paper we show that such asymmetric pricing policies can soften price competition between retail chains. A "win-win" situation would arise if competing retail chains endogenously choose asymmetric pricing policies. This result suggests that pricing policy can serve as a strategic instrument for differentiation.

Key words: chain store; competition; price discrimination; pricing policy

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1 Introduction

An important decision for retail chains with geographically separated stores is how to set prices across stores.[1] The general belief is that retail chains should make pricing decisions on a store-by-store basis to take advantage of local market information (e.g., competition). This type of location-based price discrimination is followed by a great number of retailers, ranging from fast food chains, grocery stores, gasoline stations, hotels, to department outlets.[2] For example, restaurants normally charge higher prices at airports, fuel is usually more expensive at remote resorts, and a premium rate is expected for hotels situated in city centers. As exemplified in the following Wal-Mart statement (ABC15, July 28, 2009), firms strive to adapt their prices in order to keep competitive at local markets:

> "When a competitor may choose to advertise an item we carry at a lower price, we will lower the price in that market to keep our stores competitive in each market we serve. Additionally, our Ad Match (price matching program) allows our stores in every market to match the price of any local competitor's printed ad for an identical product for that period advertised."

On the other hand, it is not uncommon for some retail chains to restrict their own flexibility to vary prices from store to store. Electronics shops may voluntarily commit to "most-favored-customer" (MFC) clauses that promise to offer the same price to all consumers, which effectively removes price discrimination across stores. Clothing and fashion goods retailers (e.g., Marks & Spencer, Zara) may utilize integral price tags and implement a national or even global pricing strategy. Moreover, with the help of the Internet, some retailers are able to enforce uniform pricing with unprecedented credibility and scope. In particular, with the rise of online presence, traditional retailers can help

[1]We will use "retail chains," "retailers," and "firms" interchangeably throughout the paper. Nevertheless, we will distinguish decisions made at the chain level (i.e., pricing policy) from those at the local store level (i.e., pricing).

[2]Differences in store prices within the same chain are also well noticed by consumers (WBZ TV, December 10, 2009). See http://wbztv.com/food/grocery.store.prices.2.1363410.html for the online news and video.

their customers overcome geographic boundaries and essentially commit to charging a uniform price across locations.

What is more puzzling is that, even within the same sector, some chairs may adopt totally different pricing policies than their rivals. While some retailers choose customized pricing, others enforce uniform pricing. Anecdotal evidence suggests that some but not all shops adopt a MFC clause. Although some online stores make their offerings accessible to all consumers regardless of their locations, others customize delivery prices based on zip code (Newsfactor Business 2010). Similarly, some online sellers facilitate price comparison across local stores, whereas other retailer websites suppress the online selling function altogether.[3] According to a recent study by ABC15 Investigators in the Phoenix AZ area, nine retail chains follow remarkably different store pricing strategies for prescription drugs (ABC15, July 28, 2009).[4] Some chains basically do not vary prices from store to store (e.g., Albertsons, Costco, Target). In contrast, significant across-store price variations can be seen at retail chains such as CVS, Fry's, Safeway, Walgreens, and Wal-Mart. Prices at different Sam's Club stores can range from \$108 to \$122 for Lipitor and \$118 to \$140 for Plavix. Similar mixed practice is also prevalent in the UK, in which seven out of fifteen major supermarkets adopt customized pricing and eight adopt uniform pricing (Competition Commission 2000).

Why do competing firms in the same sector follow nonidentical pricing policies? That is, why do some retail chains favor location-based price discrimination whereas others avoid it? The answer we offer in this paper is that asymmetric pricing policies can lead to a situation we call "all-up differentiation," softening price competition in all local markets and thus resulting in a "win-win" outcome for all firms. To elaborate on this idea, we consider a simple model with two competing retail chains, each selling an identical product and operating a store in each of two local markets. The markets are independent from each other in both demand and costs. In each market, some consumers buy only from a particular local store, while the others are incaptive to either store. Both markets have

[3] A notable example is Walmart.com that provides no price information on grocery items but explicitly states that "price varies by store."

[4] See http://www.abc15.com/content/news/investigators/consumeralerts/story/Pharmacy-prices-Same-chain-different-store/TPZ3AVOjF0mpPVk_BPPAag.cspx for the online news and video.

constant demand, but differ from each other in the number of incaptive consumers and hence in the intensity of competition. The firms are ex ante identical in all aspects, and can choose whether to price discriminate at the beginning of the game.

Under this setup, neither pricing policy is superior to the other one, when both retail chains follow identical policy choice. The adoption of uniform pricing by both firms softens competition in one market while intensifying it in the other market without increasing total demand. However, we show that the unilateral adoption of a pricing policy that is different from the rival's can mitigate the rival's pricing aggressiveness in both markets. In particular, when a firm unilaterally chooses not to price discriminate, it commits to be more aggressive in the less competitive market, thus pushing the rival to charge higher prices in that market. At the same time, it also commits to be less aggressive in the other more competitive market, thus pulling the competitor to increase prices in that market as well. Importantly, we demonstrate that it is not the adoption of uniform pricing per se, but the asymmetry in the retail chains' pricing policies, that mitigates competition in both markets. In particular, the unilateral choice of customized pricing can make the rival who sticks to uniform pricing less aggressive as well. As a result, exogenously symmetric retail chains can endogenously choose different pricing policies and thus become asymmetrically aggressive in different markets, leading to softened competition in both markets, i.e., all-up differentiation.

We obtain a counter-intuitive result that a firm's profit can increase with the fraction of incaptive consumers, when the firms choose asymmetric pricing policies. In particular, when one market is sufficiently competitive and the other one is sufficiently uncompetitive, the equilibrium profit of the firm adopting uniform pricing can increase with the size of the incaptive consumers in the less competitive market. This is because the commitment to uniform pricing makes the firm increasingly aggressive in the less competitive market, which in turn pushes the rival to focus on its own captive consumers. This means that it becomes more likely for the firm adopting uniform pricing to win the incaptive consumers in the less competitive market. Therefore, an increasing number of incaptive consumers can result in higher expected sales and improved profitability, which is unlikely under symmetric pricing policies.

We also confirm that asymmetric pricing policies can emerge as the firms' equilibrium choices, and improve both firms' equilibrium profits. This is indeed the case when they make their policy choices either simultaneously or sequentially. We highlight the role of all-up differentiation in this win-win outcome. With the choice of differential pricing policies, the firms effectively develop asymmetric pricing aggressiveness and thus establish their respective "strong" territory, each in a different market. The firm choosing uniform pricing becomes more aggressive than the rival in the less competitive market, and vice versa in the more competitive market. It is this staggered relative pricing aggressiveness across firms that underlies the emergence of the all-up differentiation and the increase in both firms' equilibrium payoffs.

This research extends the literature on third-degree price discrimination in competitive environments.[5] Early studies focus on symmetric firms and demonstrate that customized pricing would intensify competition and lead to a "prisoner's dilemma," whereby it is dominant for individual firms to pursue price discrimination while all competing firms will be worse off by doing so (e.g., Thisse and Vives 1988, Shaffer and Zhang 1995).

Later studies explore conditions under which unilateral adoption of uniform pricing can be more profitable than customized pricing and the prisoner's dilemma can be escaped. One notable contribution is by Corts (1998) who shows that uniform pricing can soften competition in all markets if there exists best-response asymmetry, i.e., the asymmetry in the firms' rankings of the best-response functions of different markets. In other words, price discrimination may lead to unambiguously lower prices in all markets, a situation he termed "all-out competition." Moreover, he shows that the prisoner's dilemma can be avoided if best-response asymmetry holds and only incentive-compatible price discrimination schemes are allowed. Therefore, his analysis centers on the best-response asymmetry property that is exogenously imposed. In comparison, we consider exogenously symmetric firms and highlight the role of endogenously chosen asymmetric pricing policies in mitigating price competition in all markets, which we call all-up differentiation.

[5]See, for example, Schmidt-Mohr and Villas-Boas (2008) on competitive second-degree price discrimination. There is also an extensive literature on behavior-based price discrimination under competition (e.g., Villas-Boas 1999, Fudenberg and Tirole 2000, Fudenberg and Villas-Boas 2006).

Other researchers also pursue the idea that firm asymmetry in demand or market power on different consumer segments may lead competing firms to prefer uniform pricing, (e..g, Bester and Petrakis 1996, Chen 1997, Taylor 2003). Shaffer and Zhang (2002) investigate one-to-one promotions by asymmetric firms with both vertical and horizontal differentiation. They show that although personalized pricing always intensifies competition, it may have differential effects on the firms' equilibrium profits: one-to-one promotions may increase the market share and hence the equilibrium payoff of the firm with the higher-quality product. In contrast, we focus on symmetric firms and find that all firms can benefit from the asymmetric choice of pricing policies.

Another mechanism under which uniform pricing may be beneficial for symmetric firms is due to market expansion (e.g., Holmes 1989). This occurs when category demand elasticity is higher in the less competitive market than in the more competitive one (Chen and Cui 2013). The intuition is that, under this condition, uniform pricing would increase the demand in the less competitive market disproportionately more than decrease the demand in the more competitive market. To contrast with this mechanism, in this paper we intentionally consider a setup with constant demand. We show that the adoption of uniform pricing can be profitable even in the absence of firm asymmetry or market expansion, only if the rival adopts a different pricing policy.

Chen et al. (2001) consider imperfect price discrimination and find that increasing targetability can lead to a win-win outcome. Their study differs from ours in two significant aspects. First, it is always dominant to increase targetability in their setup, whereas the only equilibrium in our model is asymmetric under which it is better off to switch to uniform pricing if and only if the rival chooses to price discriminate. Second, it is increasing targetability in their model, while asymmetric pricing policies in our case, that results in the win-win outcome. Therefore, if the rival has adopted customized pricing, following the rival's suit to price discrimination will lead to a "lose-lose" situation. Another related study is Chen et al. (2002) who also identify an asymmetric equilibrium, under which only one firm chooses to price discriminate through contracting with a referral infomediary. However, unlike our case, price discrimination necessarily intensifies competition and hurts the rival's profitability in their setup.

2 The Model

Consider two retail chains, $c \in \{A, B\}$, selling an identical product to end consumers. Each retail chain operates two stores, S_{cj}, each in a local market $j = 1, 2$. The local markets are geographically and economically separated from each other. The size of total demand is constant in each market. This assumptions allows us to rule out market expansion as a potential driver in the chains' strategic choice of pricing policy (Chen and Cui 2013). The operating costs are identical for all chain stores in both markets. In addition, we assume that the operating costs, both fixed and marginal, are constant and normalized to zero without loss of generality. To simplify matters, we assume that there is no demand or cost dependence across the markets for each chain. As a result, the chains compete directly within each local market, but not across markets.

In each market $j = 1, 2$, there is a unit mass of consumers and each consumer buys at most one unit of the product from either chain store. The utility of no purchase is set to zero. The consumers have an identical reservation value for either chain store, S_{Aj} or S_{Bj}, which is without loss of generality normalized to 1. Nevertheless, the consumers differ in their propensity to purchase from a particular store. There is a segment of size $\beta_j \in (0, 1)$ consumers who are indifferent to buying from either store. As a result, they purchase only from the store charging a lower price, and purchase with equal probability from either store if the charged prices are identical. This is the "incaptive segment," akin to the "informed consumers" as in Varian (1980) or the "switchers" as in Narasimhan (1988). There is another segment of consumers who consider buying only from store S_{Aj}, but not from store S_{Bj}. Conversely, the remaining segment of consumers consider shopping only at S_{Bj} but not at S_{Aj}. The last two segments of consumers are called the "captive segments" and are akin to the "uninformed consumers" as in Varian (1980) or the "loyals" as in Narasimhan (1988). The size of the these two captive segments are identical and given by $\alpha_j \equiv \frac{1-\beta_j}{2}$.

We can interpret the parameter β_j as capturing the intensity of competition in market j. Without loss of generality, we assume $\beta_1 > \beta_2$. Thus market 1 is more competitive than market 2. This can be due to across-market difference in geographic distance between the stores within a market. For example, market 1 can represent a urban area in which store location is closer and comparison shopping is less costly, than in market 2 in which stores are remotely located and consumers tend to shop primarily at a nearby store. Alternatively, this market-specific difference in competitiveness can be driven by the underlying difference in consumer demographic profile. For instance, market 1 may be composed of consumers who are less affluent and hence have lower opportunity costs of search than consumers in market 2.

The sequence of moves is as follows. In the first stage, the retail chains non-cooperatively decide on their pricing policy, which will become common knowledge to all parties. Note that only the pricing policies, but not the specific prices, are decided and committed in this stage. A retail chain $c = A, B$ can choose a localized pricing policy (L), in which case it can potentially charge different prices across its local stores, S_{c1} and S_{c2}. Alternatively, it can choose a uniform pricing policy (U), in which case it commits to charge the same price across its local stores. Note that the localized pricing policy is the default choice unless a commitment is effectively made to implement the uniform pricing policy. There are a variety of visible mechanisms to ensure the credibility of adopting a uniform pricing policy. A retail chain can impose a most-favored-customer (MFC) clause, under which consumers are entitled to receive rebates/refunds, should purchases be made at different prices across the chain's stores. It can also adopt integral price tags through which price adjustments will be conducted across all stores. Moreover, retail chains can commit to the uniform pricing policy by effectively removing the geographical boundary and facilitating consumer arbitrage across local markets. For example, firms can set up online stores that are accessible to all consumers across markets. To focus on the strategic incentives in deciding between the alternative pricing policies, we assume that their implementation costs are identical and without loss of generality set to zero.

In the second stage, the retail chains simultaneously make pricing decisions for their stores, P_{cj}, $c = A, B$, $j = 1, 2$, subject to their pricing policy choice in the first stage. If the localized pricing policy is chosen, then a different pricing decision will be made for each store. If otherwise the uniform pricing policy has been adopted, a retail chain

$c = A, B$ will charge the same price across its stores, i.e., $P_{c1} = P_{c2} = P_c$. This completes the description of the model.

It is important to note that we consider two retail chains that are completely symmetric in all aspects. We intentionally make this assumption to make sure that there exist no exogenous chain-specific differences that drive the firms to adopt asymmetric pricing policies. This permits us to contrast with Corts (1998) in which best-response asymmetry may lead to competition being softened by the adoption of a uniform pricing policy.

3 Analysis and Results

In solving the game, we will use backward induction to ensure sub-game perfection. We need to consider three possible scenarios following the chains' pricing policy decisions in the first period: Both choose the customized pricing policy, both adopt the uniform pricing policy, and one retail chain adopts localized pricing while the other chooses uniform pricing. In Section 3.1, we examine the chains' equilibrium pricing behavior following each of these possible scenarios, highlighting the role of asymmetric pricing policies in softening competition. We will use the superscripts "L", "U", and "D" to represent the equilibrium outcomes for each of the three sub-games, respectively. The equilibrium payoff implications are investigated in Section 3.2.

3.1 Equilibrium Pricing Behavior

3.1.1 Both Chains Adopt Localized Pricing

When both retail chains have adopted the localized pricing policy, given the separability of store demand and costs, their pricing decisions can be independently made across the two markets. As a result, the chain store competition in each market $j = 1, 2$ collapses to a standard model of price competition as in Varian (1980) or Narasimhan (1988). In particular, there is a segment of β_j consumers who consider both chain stores S_{Aj} and S_{Bj}

and buy at the lower price, and two segments of $\alpha_j = (1 - \beta_j)/2$ consumers who consider only one retail store. The price competition leads to a unique, symmetric mixed-strategy equilibrium. Define the cumulative price distribution for a chain store in market j as $F_{cj}(P) = Pr(P_{cj} < P)$, where P_{cj} is the price charged by chain store S_{cj}. The (expected) profit function for chain store S_{Aj} is thus $\Pi_{Aj} = P_{Aj}\{\alpha_j + \beta_j[1 - F_{Bj}(P_{Aj})]\}$, and similarly for chain store S_{Bj} is $\Pi_{Bj} = P_{Bj}\{\alpha_j + \beta_j[1 - F_{Aj}(P_{Bj})]\}$, where $j = 1, 2$. This gives rise to the (symmetric) equilibrium price distribution for either chain store, $F_j^L(P) = 1 - \frac{\alpha_j(1-P)}{\beta_j P}$, for $P \in (P_j^L, 1)$, where $P_j^L = \frac{\alpha_j}{\alpha_j + \beta_j}$ is the lower bound of the equilibrium price support (i.e., promotion depth). This leads to the equilibrium average price $EP_j^L = \frac{\alpha_j}{\beta_j} ln\left(\frac{\alpha_j + \beta_j}{\alpha_j}\right)$. Moreover, the equilibrium profit for either retail chain in market j is $\Pi_j^L = \alpha_j$. Finally, the total equilibrium profits for the retail chains are then $\Pi^L = \Pi_1^L + \Pi_2^L = \alpha_1 + \alpha_2$.

3.1.2 Both Chains Adopt Uniform Pricing

Now each chain $c = A, B$ charges a single price P_c for both of its retail stores. The pricing equilibrium can be similarly solved as in the previous scenario when both chains choose the localized pricing policy. In particular, if the charged price P_c is not higher than the consumers' reservation value, a retail chain can be guaranteed an aggregate demand of size $\alpha \equiv \alpha_1 + \alpha_2$, including sales from both markets. Moreover, by undercutting the rival chain, an additional sales of size $\beta \equiv \beta_1 + \beta_2$ can be obtained. Define the cumulative price distribution for chain c as $F_c(P) = Pr(P_c < P)$. The (symmetric) equilibrium price distribution for either chain is $F^U(P) = 1 - \frac{\alpha(1-P)}{\beta P}$, for $P \in (P^U, 1)$, where $P^U = \frac{\alpha}{\alpha+\beta}$ is the lower bound of the equilibrium price support. The equilibrium average price is then $EP^U = \frac{\alpha}{\beta} ln\left(\frac{\alpha+\beta}{\alpha}\right)$. Furthermore, the total equilibrium chain profit is $\Pi^U = \alpha$.

It follows that neither pricing policy is superior to the other one, when both retail chains follow identical policy choice. In fact, the adoption of the localized pricing policy by both chains intensifies price competition in market 1 while mitigating the strategic tension in market 2, in comparison to the case when both chains commit to charge uniform prices. Overall, the influence of shifting from symmetric localized pricing to symmetric uniform pricing on price competition is neutral—although the across-market average of the promotion depths is increased (i.e., $(P_1^L + P_2^L)/2 > P^U$), a smaller promotion discount is offered on average (i.e., $(EP_1^L + EP_2^L)/2 < EP^U$). Given the absence of either firm asymmetry (Corts 1998) or market expansion (Chen and Cui 2013), it is then not surprising that neither pricing policy is dominant (i.e., $\Pi^L = \Pi^U$).

3.1.3 Asymmetric Pricing Policies

Let us then examine the asymmetric case when one retail chain adopts the localized pricing policy and the other chain chooses the uniform pricing policy. Without loss of generality, suppose retail chain A customizes its store prices, P_{A1} and P_{A2}, while retail chain B decides to favor uniform pricing and hence offers one single price P_B for both of its stores. Similarly, the equilibrium pricing decisions are in mixed strategy. Define $F_{A1}(P) = Pr(P_{A1} < P)$, $F_{A2}(P) = Pr(P_{A2} < P)$, and $F_B(P) = Pr(P_B < P)$. Retail chain A's profit function is $\Pi_A = \Pi_{A1} + \Pi_{A2}$, where,

$$\Pi_{A1} = P_{A1}\{\alpha_1 + \beta_1[1 - F_B(P_{A1})]\}, \tag{1}$$

and

$$\Pi_{A2} = P_{A2}\{\alpha_2 + \beta_2[1 - F_B(P_{A2})]\}. \tag{2}$$

In contrast, the overall profit for retail chain B is given by,

$$\Pi_B = P_B\{\alpha + \beta_1[1 - F_{A1}(P_B)] + \beta_2[1 - F_{A2}(P_B)]\}. \tag{3}$$

Note that retail chain A's profit functions are separable across the markets, whereas retail chain B's optimal pricing decision takes into account competitive responses from both markets. This asymmetry in the separability of pricing decisions makes the game solution nontrivial. Nevertheless, we show in the Appendix that there exist two points $P_b < P_m < 1$ such that the equilibrium price supports are $P_{A1} \in (P_b, P_m)$, $P_{A2} \in (P_m, 1)$, and $P_B \in (P_b, 1)$. Furthermore, there exists a positive probability mass at $P_{A2} = 1$, i.e.,

$q_{A2} \equiv 1 - F_{A2}(1) > 0$. We provide the full analysis of the equilibrium in the Appendix, and highlight the major results in the following propositions.

Proposition 1. *When retail chain A adopts the localized pricing policy and retail chain B adopts the uniform pricing policy, and in comparison to the case when both retail chains customize prices:*

(i) Chain store S_{A2} in equilibrium has a smaller promotion depth (i.e., $P_m > P_2^L$), promotes less frequently (i.e., $q_{A2} > 0$), and charges a higher average price (i.e., $EP_{A2}^D > EP_2^L$). Furthermore, both the lower bound of its equilibrium price support and its probability mass at the upper bound increase with the size of the incaptive segment in market 1 (i.e., $\frac{\partial P_m}{\partial \beta_1} > 0$ and $\frac{\partial q_{A2}}{\partial \beta_1} > 0$);

(ii) Chain store S_{A1} in equilibrium has a smaller promotion depth (i.e., $P_b > P_1^L$), promotes more frequently (i.e., $P_m < 1$), and may charge a higher average price (i.e., $EP_{A1}^D > EP_1^L$) when the size of the incaptive segment in market 2 is sufficiently small (i.e., $\beta_2 \to 0$).

Proposition 2. *When retail chain A adopts the localized pricing policy and retail chain B adopts the uniform pricing policy, and in comparison to the case when both retail chains commit to charge uniform prices, retail chain B in equilibrium has a smaller promotion depth (i.e., $P_b > P^U$), and charges a higher average price (i.e., $EP_B^D > EP^U$).*

The main message here is that the unilateral adoption of a pricing policy that is different from the rival chain can mitigate the rival chain's pricing aggression. In other words, asymmetric pricing policies can soften price competition in both markets and for both firms, a situation we term "all-up differentiation."

Let us start with the case when retail chain A chooses localized pricing while retail chain B switches to uniform pricing. Proposition 1(i) suggests that retail chain B's policy change makes the pricing decision of chain store S_{A2} less aggressive. In particular, now chain store S_{A2} becomes more reluctant to deepen its promotions, engages in less frequent price cuts, and on average offers fewer discounts. This is because, by adopting the uniform pricing policy, retail chain B essentially commits to become more aggressive in its strategic interaction with retail chain A in (the less competitive) market 2. When this commitment is not made, retail chain B can customize its prices to each market, and charge a relatively high price P_{B2} in market 2 and a relatively low price P_{B1} in market 1. However, now the same price P_B has to be applied to both markets, and given the integrated incentive to attract the incaptive consumers in market 1, retail chain B has an increasing willingness to undercut chain store S_{A2}. This means that the chance for chain store S_{A2} to win the pricing battle in market 2 is diminished. Knowing this, its incentive for price competition would be suppressed. In other words, retail chain B's commitment to be more competitive in market 2 pushes up chain store S_{A2} to raise its prices. Moreover, as the size of the incaptive segment in market 1 increases, retail chain B will be more willing to cut its price. This explains why, as β_1 increases, chain store S_{A2} would respond by reducing its promotion depth as well as promotion frequency.

Interestingly, it follows from Proposition 1(ii) that retail chain A may charge less aggressive prices in (the more competitive) market 1 as well when retail chain B promises to charge uniform prices. Intuitively, the commitment to uniform pricing that makes retail chain B more aggressive in market 2 competition, relatively speaking, would make it more easygoing from the perspective of chain store S_{A1}. In other words, because of the integrated incentive to exploit the larger captive demand from market 2, retail chain B is not as determined as its rival to win the incaptive consumers in market 1. This makes retail chain B more willing to give up the pricing race in market 1 than its competitor. As a result, it becomes easer (in a stochastic sense) for chain store S_{A1} to seize the indifferent consumers even with smaller price cuts. This explains why chain store S_{A1} now promotes less deeply but more frequently. Moreover, as the size of the captive demand in market 2 becomes sufficiently large (i.e., $\beta_2 \to 0$), the integration of retail chain B's store prices would pull retail chain A to charge a higher average price in market 1.

Proposition 2 further confirms that it is not the adoption of uniform pricing per se, but the asymmetry in the retail chains' pricing policies, that leads to the mitigation of chain store competition in both markets. To see this, consider the shift of policy choice by retail chain A to customized pricing from the scenario when both firms choose uniform pricing. This proposition demonstrates that, in response to this policy change, retail chain B would become less aggressive, reducing its promotion depth and charging a higher average price. The intuition is as follows. When both firms choose uniform pricing, their aggressiveness in price competition is comparable to each other. However, by switching to localized pricing, retail chain A basically commits to become less aggressive in market 2 and more aggressive in market 1. In response to the rival's reduced aggressiveness in market 2, retail chain B would find it easier to attract the incaptive consumers in that market even with higher prices. Retail chain B would like to match its rival's intensified aggression in market 1 as well, should it have the flexibility to charge a different, lower price to that market. With uniform prices, the former incentive would dominate: the opportunity cost of price increase is lower in a market in which the rival promises to be friendly than the opportunity cost of price reduction in a market in which the rival is committed to be aggressive.

To summarize, a firm can mitigate its rival's pricing competitiveness in a local market through two mechanisms. It can commit to be more aggressive than the rival through increasing its own expected benefit of a price cut, thus reducing the rival's chance of winning the competition and forcing the rival to charge higher prices. Alternatively, it can become more friendly than the rival through increasing its own opportunity costs of a price cut, thus promising to surrender easily to the rival and pulling up competitive prices. The effectiveness of both mechanisms hinges on increasing firm asymmetry, at the local market level, in determination to price aggressively. Of course, these two mechanisms cannot both be achieved simultaneously when the firms are similar to each other in each local market, which is indeed the case when the firms adopt identical—either customized or uniform—pricing policies. Therefore, with exogenously symmetric retail chains, asymmetry in pricing aggressiveness can be realized and thus competition can be softened, in both markets, if the retail chains strategically choose different pricing policies, a situation we call all-up differentiation. That is, the retail chains can kill two birds with one stone—through endogenously chosen asymmetric pricing policies. For instance, when retail chain A chooses customized pricing while retail chain B commits to uniform pricing, the former can pull up the latter, and the latter can push up the former, to raise prices in their strategic interaction in market 2. A similar story would concurrently happen in market 1 as well, albeit with the firms switching their roles.

3.2 Profit Implications and Equilibrium Pricing Policies

We now investigate the comparative statics of the firms' equilibrium profits under the alternative pricing policy choices. It is straightforward from Section 3.1.1 and 3.1.2 that, when the firms choose identical pricing polices, their equilibrium profits would decrease with the size of the incaptive consumers in either market. Intuitively, with more incaptive demand, the firms would compete more intensely which reduces their profitability. Would it still be the case when the firms adopt asymmetric pricing policies?

Proposition 3. *When retail chain A adopts the localized pricing policy and retail chain B adopts the uniform pricing policy, retail chain B's equilibrium profit first increases, and then decreases, with the size of the incaptive consumers in market* 2*, if the size of the incaptive consumers in market* 1 *is sufficiently large (i.e.,* $\beta_1 \to 1$*).*

Interestingly, this means that a firm's equilibrium payoff may not always decrease monotonically with the size of the incaptive demand. When a firm unilaterally chooses the (asymmetric) uniform pricing policy, its profit may actually improve as the size of incaptive consumers in market 2 increases (i.e., $\frac{\partial \Pi_B^D}{\partial \beta_2} > 0$). This occurs when there are sufficient captive consumers in market 2 (i.e., low β_2) while sufficient incaptive consumers in market 1 (i.e., high β_1). This positive relationship between Π_B^D and β_2 is due to the strategic response of chain store S_{A2}'s pricing behavior to an increase in market-1 incaptive consumers. Recall that, as Proposition 1(i) suggests, a higher β_1 would increase retail chain B's incentive to cut its (uniform) price P_B, which in turn enhances chain store S_{A2}'s incentive to raise its price P_{A2} in market 2. That is, despite the independence in both demand and costs across markets, there exists an endogenous spill-over effect of market-1 demand on price competition in market 2. This spill-over effect arises from retail chain B's incentive to optimize its profits across both markets with a single price P_B. As this spill-over effect is strengthened by a higher β_1, chain store S_{A2} would charge increasingly high prices, magnifying the likelihood that retail chain B would win the incaptive consumers in market 2. Therefore, an increasing number of incaptive consumers may not necessarily decrease profitability if these consumers can be successfully captured. In other words, besides the effect of intensifying price competition, a higher β_2 can also lead to a positive demand effect for the more aggressive player in that local market (i.e., retail chain B). Moreover, all else being equal, chain store S_{A2} would be more likely to stay back and surrender the incaptive consumers to retail chain B, when the size of these incaptive consumers becomes smaller. As a result, the positive demand effect of increasing β_2 reaches its peak when β_2 is sufficiently low and β_1 is sufficiently high, i.e., the condition for Π_B^D to increase with β_2. However, as β_2 becomes sufficiently high, its competition-intensifying effect would loom larger and become dominant. Overall, as Proposition 3 suggests, there may exist an inverted-U relationship between retail chain B's equilibrium profit and the size of market-2 incaptive consumers. Note that this non-monotonic relationship will not arise when symmetric pricing policies are adopted, because then the endogenous spill-over effect of market-1 demand on market 2 competition would be absent.

Next, we examine the firms' equilibrium pricing policy decisions. We start with the case when they make their choices simultaneously.

Proposition 4. *When the retail chains decide simultaneously on their pricing policy, there exists an equilibrium in which one retail chain chooses customized pricing and the other retail chain chooses uniform pricing, and there exists no other equilibrium. Both retail chains' equilibrium profits are higher than when they choose identical pricing policies.*

This proposition confirms that asymmetric pricing policies are indeed the firms' equilibrium choices. This amounts to showing that a unilateral deviation from identical pricing policies—either both firms choosing localized pricing or both choosing uniform pricing—would strictly increase the deviator's equilibrium profits, i.e., $\Pi_A^D > \Pi^U$ and $\Pi_B^D > \Pi^L$. Moreover, asymmetric adoption of pricing policies can create a "win-win" outcome, increasing both firms' equilibrium payoffs from those obtained when they follow the same choice of pricing policy, i.e., $\Pi_c^D > \Pi^L$ and $\Pi_c^D > \Pi^U$.

These results highlight the idea we establish earlier that asymmetric pricing policies can lead to all-up differentiation, softening price competition in both markets and for both firms. Essentially, through the choice of a different pricing policy from the rival's, asymmetric pricing aggressiveness can endogenously arise across the firms in both markets. This asymmetry effectively allows the firms to establish their respective "strong" territory, each in a different market. Note that the establishment of a strong market here does not entail the shift in consumer preference or demand across firms or markets, but is implemented endogenously through the committed determination to become more aggressive than the rival in that particular market. Of course, given firm symmetry, a firm's increasing aggressiveness in one market would imply lower aggressiveness in the other market in which the rival can create its own pricing strength there. For example, when retail chain A adopts customized pricing and retail chain B chooses uniform pricing, the former would be the more aggressive player in market 1, and vice versa. In fact, we can show that firm A's equilibrium profit is increased in market 1 while not lowered in market 2 (i.e., $\Pi^D_{A1} > \Pi^L_1$ and $\Pi^D_{A2} = \Pi^L_2$). In contrast, when the firms choose identical pricing policies, their determination for pricing aggression would be comparable to each other in both markets. As a result, they would compete head-to-head in both markets and neither firm can establish a clear pricing strength. This is why asymmetric pricing policies can increase profitability for exogenously symmetric firms.

Finally, we consider the case when the firms make their pricing policy decisions sequentially. What would be the firms' optimal choices?

Proposition 5. *When the retail chains decide sequentially on their pricing policy, in equilibrium the first mover adopts localized pricing and the second mover chooses uniform pricing.*

This proposition follows from the result that $\Pi^D_A > \Pi^D_B$. This is driven by: 1) all else being equal, it is more profitable to become more aggressive and thus establish a pricing advantage over the rival in a market with more incaptive consumers; and 2) it is the firm that adopts the customized pricing policy that is able to commit to charge lower prices in the more competitive market (and higher prices in the less competitive market), than the rival firm that adopts the uniform pricing policy. As a result, when a firm gains the first-mover advantage in pricing policy choice, it will choose localized pricing and commit to be more aggressive in the more competitive market. This leaves the only option of choosing uniform pricing to the later mover who will then become more price aggressive in the less competitive market, and less aggressive in the more competitive market, than the first mover. Nevertheless, asymmetric pricing policies would be the firms' equilibrium choices, as is the case when they make their policy decisions simultaneously.

4 Conclusion

This study is motivated by the coexistence of both customized pricing and uniform pricing in practice by competing retail chains. Extensive anecdotal and empirical evidence suggests that some firms customize their prices from store to store and others in the same sector do not. In this paper we offer a potential explanation for these differential practices. We show that asymmetric pricing policies can mitigate competition for symmetric firms in all markets even when market expansion is absent, an outcome we call all-up differentiation. The driving force is staggered pricing aggressiveness across firms in different markets. We highlight the role of this all-up differentiation in sustaining the asymmetric equilibrium choice of pricing policies. We show that all firms will benefit from adopting differential pricing polices, whether their choices are simultaneous or sequential. Moreover, we show that the equilibrium profit of the firm unilaterally adopting uniform pricing can increase with the size of the incaptive consumers in the less competitive market, if one market is sufficiently competitive and the other one is sufficiently uncompetitive. Therefore, firm profitability may benefit from increasing competition in some local markets, a result that does not arise when the competing firms choose identical pricing policies.

Managers at multi-store retail chains can benefit from the insights in this paper. The major message is that competing chains can be strategically differentiated from each other in their pricing policies. When the rivals have opted to customize their prices from store to store, it may be a better idea to favor the one-price policy instead, and vice versa. As we demonstrate in this paper, asymmetrical pricing policies can help firms soften their competition across markets and thus increase their profits. As discussed in the Introduction, this differentiation strategy is indeed pursued by many retail chains in both the US and the UK.

In comparison to other dimensions of differentiation that have been previously recognized (e.g., quality, design), this differentiation strategy enjoys the advantage that it can be less costly and more promptly implemented. This is especially the case when the optimal option turns out to be customized pricing, which is the default choice and can be easily adopted in many scenarios.[6] Conversely, firms can make costly investments on committable mechanisms (e.g., MFC clauses, integral price tags, online stores) in order to credibly adopt the uniform pricing policy, when that is the inevitable choice to be differentiated from the rivals. Nevertheless, besides cost considerations, these two pricing policies may have different payoff implications. As we show in the paper, early entrants can gain a first-mover advantage by choosing the customized pricing policy, leaving the need for committing to uniform pricing to later entrants.

An issue that is not considered in this paper and can be investigated in future research regards the conditions under which uniform pricing may emerge even in the absence of precommitment mechanisms. To examine this issue, one may consider an alternative setup where both pricing policy and specific prices are determined simultaneously in the same stage. Consumer fairness is one such endogenous mechanism in favor of uniform pricing (Chen and Cui 2013). It would be interesting to investigate whether other mechanisms may exist. Future research can also empirically examine the theoretical implications obtained in this paper. Moreover, it may be rewarding to examine pricing policy choice in a channel setting when both the upstream and the downstream firms can commit to uniform pricing. For example, manufacturers can decide whether to impose MFC clauses, or whether to set up their own online stores.

[6]Nevertheless, there may exist situations in which it is costly to adjust prices frequently. However, this may not be a significant concern with the help of computer-based pricing systems. Moreover, the restrictions imposed by menu costs on geographic price customization can be lower than on inter-temporal price variation.

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Appendix

We start by solving the sub-game with asymmetric pricing policies. Following Propositions $1-5$ in Narasimhan (1988), we can obtain that (1) the price supports of P_{A1}, P_{A2}, and P_B are continuous, and the joint price support of P_{A1} and P_{A2} coincides with that of P_B (which is continuous); (2) neither retail chain can have a probability mass below 1 in its price support; (3) at most one retail chain can have a probability mass at 1 in its price support. Suppose $P_{A1} \in (\underline{P}_{A1}, \overline{P}_{A1})$, and $P_{A2} \in (\underline{P}_{A2}, \overline{P}_{A2})$.

We first prove that there is no common interval on the equilibrium supports of P_{A1} and P_{A2}. Suppose otherwise there exists an interval $(\underline{P}, \overline{P})$ such that $(\underline{P}, \overline{P}) \subseteq (\underline{P}_{A1}, \overline{P}_{A1}) \cap (\underline{P}_{A2}, \overline{P}_{A2})$. This suggests that the profit for chain store S_{A1} is the same when either $P_{A1} = \underline{P}$ or $P_{A1} = \overline{P}$ is charged, and so is the case for chain store S_{A2} when either $P_{A2} = \underline{P}$ or $P_{A2} = \overline{P}$ is charged. That is, $\Pi_{A1}(\underline{P}) = \underline{P}\{\alpha_1 + \beta_1[1 - F_B(\underline{P})]\} = \Pi_{A1}(\overline{P}) = \overline{P}\{\alpha_1 + \beta_1[1-F_B(\overline{P})]\}$, and $\Pi_{A2}(\underline{P}) = \underline{P}\{\alpha_2+\beta_2[1-F_B(\underline{P})]\} = \Pi_{A2}(\overline{P}) = \overline{P}\{\alpha_2+\beta_2[1-F_B(\overline{P})]\}$. This in turn leads to $\alpha_1/\beta_1 = \alpha_2/\beta_2$, which is a contradiction.

Given the continuity of the (joint) price supports of P_{A1} and P_{A2}, it follows that either $\overline{P}_{A1} = \underline{P}_{A2}$ or $\underline{P}_{A1} = \overline{P}_{A2}$. Suppose $\underline{P}_{A1} = \overline{P}_{A2}$. Then there must exist two points $\overline{P} > \underline{P}$ where $\overline{P} \in (\underline{P}_{A1}, \overline{P}_{A1})$ and $\underline{P} \in (\underline{P}_{A2}, \overline{P}_{A2})$. Since $\underline{P} \notin (\underline{P}_{A1}, \overline{P}_{A1})$, we have $\Pi_{A1}(\overline{P}) = \overline{P}\{\alpha_1 + \beta_1[1 - F_B(\overline{P})]\} > \Pi_{A1}(\underline{P}) = \underline{P}\{\alpha_1 + \beta_1[1 - F_B(\underline{P})]\}$, which implies $\frac{\alpha_1}{\beta_1} > \frac{\underline{P}[1-F_B(\underline{P})]-\overline{P}[1-F_B(\overline{P})]}{\overline{P}-\underline{P}}$. Similarly, since $\overline{P} \notin (\underline{P}_{A2}, \overline{P}_{A2})$, we have $\Pi_{A2}(\overline{P}) = \overline{P}\{\alpha_2 + \beta_2[1-F_B(\overline{P})]\} < \Pi_{A2}(\underline{P}) = \underline{P}\{\alpha_2+\beta_2[1-F_B(\underline{P})]\}$, leading to $\frac{\alpha_2}{\beta_2} < \frac{\underline{P}[1-F_B(\underline{P})]-\overline{P}[1-F_B(\overline{P})]}{\overline{P}-\underline{P}}$. It follows that $\frac{\alpha_1}{\beta_1} > \frac{\alpha_2}{\beta_2}$, which contradicts $\beta_1 > \beta_2$.

Therefore, there must exist two points $P_b < P_m$ such that the equilibrium price supports are $P_{A1} \in (P_b, P_m)$, $P_{A2} \in (P_m, 1)$, and $P_B \in (P_b, 1)$, where P_b and P_m are to be solved.

From $(1)-(3)$, we have,

$$F_{A1}(P) = 1 - \frac{\Pi_B - (\alpha + \beta_2)P}{\beta_1 P}, \text{where } P_b < P < P_m,$$

$$F_{A2}(P) = 1 - \frac{\Pi_B - \alpha P}{\beta_2 P}, \text{where } P_m < P < 1,$$

$$F_B(P) = \begin{cases} 1 - \frac{\Pi_{A1} - \alpha_1 P}{\beta_1 P}, & \text{when } P_b < P < P_m; \\ 1 - \frac{\Pi_{A2} - \alpha_2 P}{\beta_2 P}, & \text{when } P_m < P < 1. \end{cases}$$

Denote $q_{A2} = 1 - F_{A2}(1)$ and $q_B = 1 - F_B(1)$ as the probability mass at the upper bound of the price supports of P_{A2} and P_B, respectively. Using the boundary and the continuity conditions $F_{A1}(P_b) = 0$, $F_{A1}(P_m) = 1$, $F_B(P_b) = 0$, $F_B(P_m^-) = F_B(P_m^+)$, and $q_{A2}q_B = 0$, we can obtain the equilibrium solutions:[A1]

$$P_b = \frac{\alpha_2(\alpha + \beta_2)}{\alpha_2(\alpha_1 + \beta_1) + (\alpha_2 + \beta_2)^2} = \frac{2 - \beta + \beta_2(\beta_1 - \beta_2)}{2 + \beta - \beta_2(\beta_1 - \beta_2)}; \tag{A1}$$

$$P_m = \frac{\alpha_2(\alpha + \beta)}{\alpha_2(\alpha_1 + \beta_1) + (\alpha_2 + \beta_2)^2} = \frac{(1 - \beta_2)(2 + \beta)}{2 + \beta - \beta_2(\beta_1 - \beta_2)}; \tag{A2}$$

$$q_{A2} = \frac{\alpha_2\beta_1 - \alpha_1\beta_2}{\alpha_2(\alpha_1 + \beta_1) + (\alpha_2 + \beta_2)^2} = \frac{2\beta_1 - 2\beta_2}{2 + \beta - \beta_2(\beta_1 - \beta_2)}; q_B = 0; \tag{A3}$$

$$\Pi_{A1}^D = \frac{\alpha_2(\alpha_1 + \beta_1)(\alpha + \beta_2)}{\alpha_2(\alpha_1 + \beta_1) + (\alpha_2 + \beta_2)^2} = \frac{(1 + \beta_1)(1 - \beta_2)(2 - \beta_1 + \beta_2)}{4 + 2\beta - 2\beta_2(\beta_1 - \beta_2)}; \Pi_{A2}^D = \alpha_2; \tag{A4}$$

$$\Pi_B^D = \frac{\alpha_2(\alpha + \beta_2)(\alpha + \beta)}{\alpha_2(\alpha_1 + \beta_1) + (\alpha_2 + \beta_2)^2} = \frac{(2 + \beta)(1 - \beta_2)(2 - \beta_1 + \beta_2)}{4 + 2\beta - 2\beta_2(\beta_1 - \beta_2)}. \tag{A5}$$

It can be readily verified that $P^U = \frac{\alpha}{\alpha+\beta} < P_b < P_2^L = \frac{\alpha_2}{\alpha_2+\beta_2} < P_m < 1$, $q_{A2} > 0$, $\frac{\partial q_{A2}}{\partial \beta_1} > 0$, and $\frac{\partial P_m}{\partial \beta_1} > 0$.

We can also obtain that $\Pi_{A1}^D > \Pi_1^L = \alpha_1$, $\Pi_{A2}^D = \Pi_2^L = \alpha_2$, $\Pi_B^D > \Pi^L = \Pi^U = \alpha$, and $\Pi_{A1}^D + \Pi_{A2}^D > \Pi_B^D$. In addition, $\frac{\partial^2 \Pi_B^D}{\partial \beta_1 \partial \beta_2} > 0$, and as $\beta_1 \to 1$, $\frac{\partial \Pi_B^D}{\partial \beta_2} = \frac{3 - \beta_2(24 + 10\beta_2 + \beta_2{}^3)}{2(3 + \beta_2{}^2)^2}$, which is decreasing in β_2, positive when β_2 is sufficiently small, and negative when β_2 is sufficiently large.

Moreover, $F_{A2}^D(P) = 1 - \frac{\Pi_B^D - \alpha P}{\beta_2 P} < F_2^L(P) = 1 - \frac{\alpha_2(1-P)}{\beta_2 P}$, for all $P \in (P_m, 1)$, since $\Pi_B^D > \alpha$. This suggests that $EP_{A2}^D > EP_2^L = \frac{\alpha_2}{\beta_2} ln\left(\frac{\alpha_2+\beta_2}{\alpha_2}\right)$. In addition, $EP_{A1}^D = \int_{P_b}^{P_m} PdF_{A1}^D(P) =$

[A1]Note that the boundary condition $F_{A1}(P_m) = 1$ implies $F_{A2}(P_m) = 0$.

$\frac{\Pi_B^D}{\beta_1} ln\left(\frac{P_m}{P_b}\right) = \frac{\Pi_B^D}{\beta_1} ln\left(\frac{\alpha+\beta}{\alpha+\beta_2}\right)$. We can then check that $EP_{A1}^D > EP_1^L = \frac{\alpha_1}{\beta_1} ln\left(\frac{\alpha_1+\beta_1}{\alpha_1}\right)$ when $\beta_2 \to 0$. Finally, we can verify that $F_B^D(P) < F^U(P) = 1 - \frac{\alpha(1-P)}{\beta P}$, for all $P \in (P_b, 1)$, which means that $EP_B^D > EP^U = \frac{\alpha}{\beta} ln\left(\frac{\alpha+\beta}{\alpha}\right)$. This completes the proof.