The Benefit of Uniform Price for Branded Variants

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Abstract

The extensive adoption of uniform pricing for branded variants is a puzzling phenomenon considering that firms may improve profitability through price discrimination. In the paper, we incorporate consumers' concerns of price fairness into a model of price competition and show that uniform price for branded variants may emerge in equilibrium. Interestingly, we find that uniform pricing induced by consumers' concerns of fairness can actually help mitigate price competition and hence increase firms' profits. Furthermore, an individual firm may not have incentive to unilaterally mitigate consumers' concerns of price fairness to its own branded variants, which suggests the long-run sustainability of the uniform pricing strategy. As a result, fairness concerns from consumers provide a natural mechanism for firms to commit to uniform pricing which enhances their profits.

The paper also studies how uniform pricing may affect firms' choices of channel structures. We show that with strong concerns of price fairness from consumers, competing firms are more likely to adopt integrated channels. The reason is that firms may not need to rely on decentralized channel structures to soften competition in the presence of fair-minded consumers because uniform pricing strategy itself mitigates price competition.

Keyword: Pricing; Price Fairness; Behavioral Economics

1. Introduction

Branded variants, *i.e.*, horizontally differentiated SKUs of a brand, are often sold at the same price. We are used to the same price for S-size and XXL-size Polo T-shirts, the same price for Diet Coke and Classic Coke, and the same price for vanilla and strawberry flavored Yoplait yogurts, etc. in the marketplace. Such practices of charging a uniform price to branded variants are in fact puzzling because consumer demand tends to be different across branded variants[1] and the standard economic theory would suggest differential prices in those situations. To understand this puzzling aspect of uniform pricing, researchers have proposed several explanations, among them two are particularly popular.[2] One explanation is based on consumers' concerns on price fairness, which suggests that non-uniform pricing on branded variants could be perceived by consumers as unfair and thus reduces consumer demand for the differentially priced branded variants (Kahneman, Knetsch and Thaler 1986a,b). The other explanation is based on the cost-benefit tradeoff of uniform pricing, which suggests that the benefit of differential pricing for branded variants might be too small comparing to the menu costs of managing prices changes (Levy, Bergen, Dutta, and Venable 1997; McMillan 2007).

We believe that the fairness based explanation, even though it does not preclude other possible explanations, is the most appealing one because of its ability to explain both the ubiquitous and the persistent nature of the uniform pricing practice on branded variants. First, the foundation of this explanation, *i.e.*, the universal nature of consumers' fairness concerns on prices, is well documented in psychology, economics and marketing literature (Anderson and Simester 2008; Bolton, Warlop and Alba 2003; Kahneman, Knetsch and Thaler 1986a,b; Xia, Monroe and Cox 2004). Second, while the menu costs of making prices changes are arguably

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[1] For example, experience tells us it is easier to find an XL-sized T-shirt than an M-sized one in end–of-season sales, which indicates different demand conditions for different sizes of T-shirts.
[2] Orbach and Einav (2007) provide a comprehensive review of various explanations for the uniform pricing phenomenon.

much lower online, we do not observe firms selling products online deviating from the uniform pricing practice on branded variants. Actually, a casual observation at Walmart.com can easily verify this. Finally, while the origin of uniform pricing might be due to other reasons (Orbach and Einav 2007), uniform pricing tends to stay even after the original reasons behind it no longer exist because consumers are likely to view the deviation from past pricing practice as unfair (Kahneman, Knetsch and Thaler 1986a,b; Patrick 2005).

In this paper, we investigate the impacts of consumers' fairness concerns on firms' competitive pricing strategies for their branded variants and the resultant profits with a formal economic modeling approach. Specifically, we are interested in addressing the following research questions. First, while it is expected that uniform pricing will arise in equilibrium when consumers have strong preference for it due to their fairness concerns, we are interested in understanding the implications of uniform pricing on firms' profits. Can uniform pricing be more profitable for firms than differentiated pricing, and if so, under what conditions? Second, we further examine whether firms have an incentive to unilaterally deviate from uniform pricing if it can mitigate consumers' fairness concerns to its prices through marketing communication such as emphasizing the cost difference among branded variants. These two questions are important because they are related to the long-run sustainability of uniform pricing. Furthermore, we extend our analysis to investigate whether uniform pricing due to consumers' fairness concerns may influence other marketing mixes decisions by firms such as their choices of distribution channel structures.

Our analysis shows that uniform pricing of branded variants due to consumers' fairness concerns can lead to higher profits for firms comparing to non-uniform pricing. Interestingly, we also find that a firm may not deviate from uniform pricing unilaterally even if it can mitigate consumers' fairness concerns to its price at no cost. Moreover, even if different branded variants may have different costs, firms may still prefer consumers to perceive the costs to be the same and feel it is unfair to have the branded variants charged with different prices. Those findings suggest the sustainability of uniform pricing and further indicate that firms may benefit from consumers' fairness concerns on prices and even want to facilitate such concerns for strategic reasons.

The main intuition behind our results is that uniform pricing may increase total demand of all branded variants in the product category comparing to non-uniform pricing. This occurs when the high-price variant under non-uniform pricing has high category demand elasticity than the low-price variant under non-uniform pricing. In addition, the competition among firms is softened as firms take advantage of the category demand expansion by setting high margin under uniform pricing than the average margin under non-uniform pricing. Consequently, those positive effects on firms' profits from uniform pricing can make it more profitable than the non-uniform pricing and reduce firms' incentive to deviate from it unilaterally even at no extra communication cost.

We show in the paper that the intuition behind our main results also applies to the situation where firms sell through distribution channels to reach end consumers. In addition, we find that uniform pricing due to consumers' fairness concerns has profound impact on firms' choices of channel structures. Interestingly, comparing to the standard results on channel structures from McGuire and Staelin (1983), we find that firms are more likely to adopt the integrated channel structure under uniform pricing. This is because uniform pricing may soften competition which makes the role of decentralized channel in mitigating competition less important.

This research complements the literature on the causes of uniform pricing for branded variants (Blinder, Canetti, Lebow and Rudd 1998; Litman 1998; McMillan 2007; Orbach and Einav 2007) by further showing the profitability and sustainability of this practice as the result of consumers' fairness concerns on price. It also extends the literature that suggests uniform pricing can be more profitable than the third-degree price discrimination or customized pricing in a competitive environment (Bester and Petrakis 1996; Chen 1997; Corts 1998; Holmes 1989; Shaffer and Zhang 1995, 2002; Taylor 2003; Villas-Boas 1999). A common feature of the papers in this literature, with the exception of Holmes (1989), is that firms are assumed to have asymmetric market powers on different consumer segments [3] or product markets. However, this is unlikely to hold for branded variants. For example, it is hard to justify that one firm is stronger at L-sized T-shirt and the other is stronger at the S-sized T-shirt. We show that uniform pricing can rise in equilibrium and give firms higher profits than non-uniform pricing even if firms have symmetric market powers on each consumer segment and product market.

Our research is closely related to Holmes (1989) which shows that uniform pricing can be more profitable than the third degree discrimination for product variants. While he obtained a necessary condition for such outcome under linear demand assumption, we provide the exact conditions in our analysis and extend it into the channel context. More importantly, we go beyond the simple profit comparison by showing that fairness concerns of consumers provide a natural mechanism for firms to commit to uniform pricing and firms may not want to unilaterally deviate from it even at no cost. We view this as an important contribution to the literature as the commitment mechanism to uniform pricing is a critical but understudied research issue.

The only paper that we are aware of regarding the credibility of firms' commitment to uniform pricing is Corts (1998). He shows that committing to uniform pricing can emerge credibly in equilibrium if competing firms have asymmetric best response functions to each other's prices and price discounts are feasible only to certain segments of the consumers, such as senior citizens or people with low cost of clipping coupons. In contrast, we show that firms can credibly commit to uniform pricing by not unilaterally mitigating consumers' fairness concerns on prices. This occurs in equilibrium even if firms are symmetric and discounts can be given to any consumer segment.

More broadly speaking, our research also adds to the growing literature on incorporating behavior theory based assumptions into quantitative models to generate deep insights on marketing phenomena and firms' strategic marketing decisions (Amaldoss and Jain 2005;

[3] For example, consumers along a Hotelling line have different preferences to firms located at the ends of the line.

Bradlow, Hu and Ho 2004a,b; Chen, Iyer and Pazgal 2006; Cui, Raju and Zhang 2007; Feinberg, Krishna and Zhang 2002; Hardie, Johnson and Fader 1993; Ho and Zhang 2008; Lim and Ho 2007; Orhun 2007; Syam, Krishnamurthy and Hess 2008; etc.).

The rest of the paper is organized as follows. In the next section, we lay out the basic model for this research and present the conditions for firms to adopt uniform pricing and be better off from it. In Section 3, we extend our basic model in several ways to examine the impact of consumers' fairness concerns on uniform pricing in the channel context as well as firms' incentive to deviate from uniform pricing through changing consumers' fairness perception. We also show the robustness of our main results under more flexible demand assumptions. Finally, Section 4 summarizes the main findings from our analysis and points out the direction of future research.

2. Basic Model and Analysis

In this section, we present the basic model of our study, derive our main results from it and discuss the intuitions behind those results. We start with the case where consumers' fairness concerns on prices are absent, followed by the case where the fairness concerns are present.

2.1 When fairness concerns are absent

Consider two competing firms, Firm 1 and Firm 2, each selling two products (branded variants) in a product category. The two products have the same production costs that are normalized to zero for both firms. In the absence of fairness concerns of consumers, the demand, q_{ij}, of product variant i ($i=A, B$) from firm j ($j=1, 2$) is

$$q_{ij} = a_{ij} - b_{ij} p_{ij} + c_{ij} p_{i3-j}, \tag{1}$$

where $a_{ij} > 0$, $b_{ij} > 0$, $0 < c_{ij} \leq b_{ij}$, and p_{ij} is the price of product variant i from firm j. This demand specification is consistent with a demand model derived from consumer utility maximization where the direct utility function is in quadratic form (Dixit 1979, Singh and Vives

1984). Notice that the demand assumption as in Equation (1) implies that the demand of a firm's two branded variants are independent. It is applicable to situations such as firms selling apparels with different sizes, or baby clothes with different genders, etc. In Section 3, we relax this assumption and show that the main results from our basic model are robust.

Equation (1) can be rewritten as

$$q_{ij} = b_{ij}(a_{ij} / b_{ij} - p_{ij} + c_{ij} / b_{ij} p_{i3-j}) . \tag{2}$$

Without affecting the main results of the paper, we can further reduce the number of parameters in the model by assuming that $b_{ij}=1$, $a_{Aj}/b_{ij}=1$, $a_{Bj}/b_{ij}=a$, $c_{Aj}/b_{ij}=c_1$, and $c_{Bj}/b_{ij}=1$. Therefore, the demand function in Equation (2) becomes

$$\begin{aligned} q_{Aj} &= 1 - p_{Aj} + c_1 p_{A3-j} \\ q_{Bj} &= a - p_{Bj} + p_{B3-j} \end{aligned} \tag{3}$$

Firms compete with a simultaneous move game where firm j sets p_{Aj} and p_{Bj} simultaneously to maximize the total profits from its two branded variants,

$$\pi_j = \pi_{Aj} + \pi_{Bj} = (1 - p_{Aj} + c_1 p_{A3-j}) p_{Aj} + (a - p_{Bj} + p_{B3-j}) p_{Bj} \tag{4}$$

It is straightforward to show that the equilibrium prices, demand and profits are

$$\begin{cases} p_{A1}^* = p_{A2}^* = p_A^{NU} = \dfrac{1}{2-c_1} \\ p_{B1}^* = p_{B2}^* = p_B^{NU} = a \\ q_{A1}^* = q_{A2}^* = q_A^{NU} = \dfrac{1}{2-c_1} \\ q_{B1}^* = q_{B2}^* = q_B^{NU} = a \\ \pi_1^* = \pi_2^* = \pi_{NU} = \dfrac{1}{(2-c_1)^2} + a^2 \end{cases} . \tag{5}$$

In the following discussion, we focus on the case $a < \dfrac{1}{2-c_1}$, which ensures that product variant A has higher price and demand than product variant B. Because the cross-price elasticity for product variant A is $c_1 \leq 1$, the assumption $a < \dfrac{1}{2-c_1}$ implies that the product variant with higher price and higher demand has lower cross-price elasticity than the other product variant. While the negative relationship between price and cross-price elasticity is easily justifiable from the standard economics theory, empirical evidence also exists for the negative relationship between the market demand of a product variant and the cross-price elasticity among the brands within it. For example, the estimations by McMillian (2007) in studying the uniform pricing behavior in the soft drink category show that the regular soft drink variant has high market demand but lower average cross-price elasticity than the diet soft drink variant.

For the ease of future discussion, we call product variant A the *strong product variant* and product variant B the *weak product variant*, following the tradition in the literature (Holmes 1989). It is quite intuitive for firms to charge different prices for two product variants in the absence of consumers' fairness concerns. Since the demand of the two product variants is different, setting uniform prices will not be an optimal strategy.

2.2 When fairness concerns are present

In the presence of consumer fairness concern, when a firm charges different prices to different branded variants (e.g., T-shirts with sizes M and L), a consumer may feel the prices are unfair. Such fairness concerns can induce the consumer to behave in the following way: she would like to sacrifice her consumption utility by consuming a less amount of a branded variant if its price is higher than the other branded variant offered by the same firm. To reflect this behavior from consumers, we modify the demand function in Equation (3) to Equation (6) below.

$$\begin{aligned} q_{Aj} &= 1-(p_{Aj}+z_{Aj})+c_1(p_{A3-j}+z_{A3-j}) \\ q_{Bj} &= a-(p_{Bj}+z_{Bj})p_{Bj}+(p_{B3-j}+z_{B3-j}) \end{aligned}, \tag{6}$$

where $z_{ij} = \theta[p_{ij} - \min(p_{Aj}, p_{Bj})]$ and $\theta \geq 0$. It can be shown that the demand as in (6) can be derived from consumer utility maximization where the utility function is quadratic with an additional term - $q_{ij} \times z_{ij}$. The term $q_{ij} \times z_{ij}$, which is proportional to the price difference of the two branded variants from firm *j*, thus reflects consumers' disutility from consuming a product with a perceived unfair price.

Given the demand functions as in Equation (6), we can solve for firms' equilibrium prices and profits for the case where consumers have strong concerns on price fairness. Lemma 1 summarizes the results.

Lemma 1 *If* $\theta \geq \underline{\theta} = \frac{2-c_1}{1+a}(\frac{1}{2-c_1} - a)$ *, both firms choosing uniform pricing is a unique equilibrium and firms' equilibrium prices, demand and profits are given by*

$$\begin{cases} p_{ij}^* = p_U = \dfrac{1+a}{3-c_1} \\ q_{A1}^* = q_{A2}^* = q_A^U = \dfrac{2(1-2a+ac_1)}{3-c_1} + a \\ q_{B1}^* = q_{B2}^* = q_B^U = a \\ \pi_1 = \pi_2 = \pi_U = \dfrac{2(1+a)^2}{(3-c_1)^2} \end{cases}$$

Proof. Please see Appendix. [4]

Lemma 1 shows that, as expected, if consumers' concerns of price fairness are strong, *i.e.* $\theta \geq \underline{\theta}$, firms will adopt uniform pricing strategy in equilibrium. It is also easy to verify that $p_B^{NU} < p_U < p_A^{NU}$. Notice that $\frac{1}{2-c_1} - a = p_A^{NU} - p_B^{NU}$, which, according to Lemma 1, implies that firms are more likely to choose uniform pricing when the equilibrium price difference between the two product variants is smaller in the absence of consumers' fairness concerns. Firms face tradeoffs when making pricing decisions with the presence of consumers' fairness concerns. On one hand, they have incentive to charge different prices to their branded

[4] Unless otherwise stated, the proofs of lemmas and propositions are all in Appendix.

variants based on different consumer demands. On the other hand, they have to close the gap between prices charged for different product variants in order to minimize the negative impact of consumers' fairness concerns on the demand of the high-price product variant. When θ is large, the force to reduce the price gap dominates so that firms adopt uniform pricing. When $p_A^{NU} - p_B^{NU}$ is small, the benefit of setting differential prices diminishes. Therefore, firms are more likely to adopt uniform pricing in such a case.

An interesting question regarding uniform pricing is its profit implications to firms. Without fairness concerns from consumers, firms will set non-uniform prices and get profits of $\pi_{NU} = \frac{1}{(2-c_1)^2} + a^2$ as shown in Equation (5). From Lemma 1, the change of firms' profits from non-uniform pricing to uniform pricing due to fairness concerns is therefore given by

$$\pi_U - \pi_{NU} = \frac{2(1+a)^2}{(3-c_1)^2} - \frac{1}{(2-c_1)^2} - a^2 \tag{7}$$

Figure 1 shows how the sign of $\pi_U - \pi_{NU}$ changes with a and c_1. The precise condition is given in Proposition 1 below.

[Insert Figure 1 about Here]

Proposition 1 *Firms' equilibrium profits in the presence of consumers' concerns of fairness are higher than those in the absence of consumers' concerns of fairness if (i) firms adopt uniform pricing in equilibrium and (ii)* $\frac{1+2c_1-c_1^2}{14-19c_1+8c_1^2-c_1^3} < a < \frac{1}{2-c_1}$.

Figure 1 and Proposition 1 show that firms' profits with uniform pricing strategy can actually be *higher* when consumers care about price fairness than when they do not demand fairness. This outcome is more likely to occur when c_1 is small and a is large (but given that the assumption $a < \frac{1}{2-c_1}$ is met).

To understand the intuition behind this result, we rewrite Equation (7) as

$$\pi_U - \pi_{NU} = -\frac{p_A^{NU} - p_B^{NU}}{2}(q_A^{NU} - q_B^{NU}) + p_U(q_A^U - q_A^{NU} + q_B^U - q_B^{NU}) + (p_U - \frac{p_A^{NU} + p_B^{NU}}{2})(q_A^{NU} + q_B^{NU}) \tag{8}$$

From (8), we can see that there are three effects on profits when firms shift from non-uniform pricing to uniform pricing due to consumers' fairness concerns. First, uniform pricing takes away firms' ability to price discriminate consumers. This has a negative impact on firms' profits and is reflected by the first term on the right-hand side of Equation (8). Second, there is a demand expansion effect. While the demand of the weak product variant stays the same, the demand of the strong product variant increases as its price falls with uniform pricing. This has a positive impact on firms' profits and is shown by the second term on the right-hand side of Equation (8). Finally, there is an increase in average price with uniform pricing, which has a positive impact on firms' profits and is reflected by the third term on the right-hand side of Equation (8).[5]

When a increases to $\frac{1}{(2-c_1)}$, as shown in Equation (5), the price difference between the two product variants becomes smaller under non-uniform pricing. Therefore, the negative impact of uniform pricing on profits reduces under large a so that uniform pricing is likely to be more profitable than non-uniform pricing when a is large (*i.e.*, towards $\frac{1}{(2-c_1)}$).

It is easy to show that the total demand elasticity of the product category, $\frac{d(2q_A^U(p_U) + 2q_B^U(p_U))}{dp_U}\frac{p_U}{(2q_A^U(p_U) + 2q_B^U(p_U))}$, is equal to $-\frac{1-c_1}{2}$ in equilibrium.

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[5] $p_U - \frac{p_A^{NU} + p_B^{NU}}{2} \geq 0$ because $p_U - p_A^{NU} = -\frac{1}{(2-c_1)}(p_U - p_B^{NU})$ and $c_1 \leq 1$.

Therefore, the magnitude of demand expansion increases when c_1 becomes small. Furthermore, the fact that $p_U - p_A^{NU} = -\frac{1}{(2-c_1)}(p_U - p_B^{NU})$ shows that firms increase the price of the lower priced product variant (B) more than reduce the price of the higher priced product variant (A) when they switch to uniform pricing, and $p_U - \frac{p_A^{NU} + p_B^{NU}}{2}$ increases when c_1 becomes smaller. This is because the demand expansion effect under uniform pricing reduces firms' incentive to cut price as they are interested in taking advantage of this demand expansion effect to improve profits. Thus, the magnitude of increase-in-average-price effect increases when c_1 becomes small. Hence, from the above discussion, $\pi_U - \pi_{NU} > 0$ is more likely to hold when a is large and c_1 is small as illustrated in Figure 1.

It is worth noting that the demand expansion of the product category under uniform pricing is critical for uniform pricing to be more profitable than non-uniform pricing. If $c_1=1$, *i.e.*, there is no demand expansion in equilibrium, $\pi_U - \pi_{NU} > 0$ cannot hold from Proposition 1 and Figure 1. This is also consistent with the result of Holmes (1989). In the following discussion, we will further show that the essential role of demand expansion for the profitability of uniform pricing is likely to hold under more general demand specifications.

Consider a general demand function in the absence of negative utility from consumers' fairness concerns as $D_{ij} = D_{ij}(p_{i1}, p_{i2})$ with the partial derivatives $D_{ij}^{'} = \frac{\partial D_{ij}(p_{i1}, p_{i2})}{\partial p_{ij}} < 0$. Firm j's profit in the absence of consumers' fairness concerns is therefore given by $\pi_j = p_{Aj}D_{Aj} + p_{Bj}D_{Bj}$. Assuming that the demand function leads to the existence of a unique pure strategy equilibrium of the pricing game, we have the equilibrium prices determined by the first order conditions as $p_{ij}^{*}=-\frac{D_{ij}^{*}}{D_{ij}^{'*}}$, where D_{ij}^{*} are $D_{ij}^{'*}$ are evaluated at the equilibrium prices.

Firm *j*'s equilibrium profit is then equal to

$$\pi_j^{*}=-\frac{(D_{Aj}^{*})^2}{D_{Aj}^{'*}}-\frac{(D_{Bj}^{*})^2}{D_{Bj}^{'*}}$$

Similarly, we can obtain firm *j*'s equilibrium price and profit in the case when both firms adopt uniform pricing, which occurs in equilibrium when θ is sufficiently large, as

$$\begin{cases} p_j^{**}=-\dfrac{D_{Aj}^{**}+D_{Bj}^{**}}{D_{Aj}^{'**}+D_{Bj}^{'**}} \\ \pi_j^{**}=-\dfrac{(D_{Aj}^{**}+D_{Bj}^{**})^2}{D_{Aj}^{'**}+D_{Bj}^{'**}} \end{cases}$$

where D_{ij}^{**} are $D_{ij}^{'**}$ are evaluated at the equilibrium uniform price. Therefore,

$$\begin{aligned}\Delta\pi &=\pi_j^{**}-\pi_j^{*}=-\frac{(D_{Aj}^{**}+D_{Bj}^{**})^2}{D_{Aj}^{'**}+D_{Bj}^{'**}}-\left[-\frac{(D_{Aj}^{*})^2}{D_{Aj}^{'*}}-\frac{(D_{Bj}^{*})^2}{D_{Bj}^{'*}}\right] \\ &=\varphi\left[D_{Aj}^{'*}D_{Bj}^{'*}(D_{Aj}^{**}+D_{Bj}^{**})^2-(D_{Aj}^{'**}+D_{Bj}^{'**})\left(D_{Bj}^{'*}(D_{Aj}^{*})^2+D_{Aj}^{'*}(D_{Bj}^{*})^2\right)\right]\end{aligned}$$

where $\varphi=\frac{-1}{D_{Aj}^{'*}D_{Bj}^{'*}(D_{Aj}^{'**}+D_{Bj}^{'**})}>0$. If there is no category demand expansion due to uniform pricing, *i.e.* $D_{A1}^{**}+D_{B1}^{**}\le D_{A1}^{*}+D_{B1}^{*}$, we have

$$\begin{aligned}\frac{\Delta\pi}{\varphi} &=D_{Aj}^{'*}D_{Bj}^{'*}(D_{Aj}^{**}+D_{Bj}^{**})^2-(D_{Aj}^{'**}+D_{Bj}^{'**})\left(D_{Bj}^{'*}(D_{Aj}^{*})^2+D_{Aj}^{'*}(D_{Bj}^{*})^2\right) \\ &\le D_{Aj}^{'*}D_{Bj}^{'*}(D_{Aj}^{*}+D_{Bj}^{*})^2-(D_{Aj}^{'**}+D_{Bj}^{'**})\left(D_{Bj}^{'*}(D_{Aj}^{*})^2+D_{Aj}^{'*}(D_{Bj}^{*})^2\right) \\ &=-(D_{Aj}^{'*}D_{Bj}^{*}-D_{Bj}^{'*}D_{Aj}^{*})^2+\varepsilon\end{aligned}$$

where $\varepsilon=\left[\left(D_{Aj}^{'*}-D_{Aj}^{'**}\right)+\left(D_{Bj}^{'*}-D_{Bj}^{'**}\right)\right]\cdot\left[D_{Bj}^{'*}\left(D_{Aj}^{*}\right)^2+D_{Aj}^{'*}\left(D_{Bj}^{*}\right)^2\right]$.

$\left(D_{Aj}^{'*}-D_{Aj}^{'**}\right)+\left(D_{Bj}^{'*}-D_{Bj}^{'**}\right)=0$ will hold if the demand function D_{ij} is linear in both firms' prices, which is the case of our basic model presented early. In more general cases, recall that the equilibrium uniform price p_U is always between the two non-uniform prices, p_A^{NU} and p_B^{NU}. Thus, as long as p_A^{NU} and p_B^{NU} are not very different, which is likely to be true in most horizontal product line pricing cases (McMillan 2007), the demand function for each product can be reasonably well approximated by a linear function in the vicinity of (p_B^{NU} , p_A^{NU}). Then $\left(D_{Aj}^{'*} - D_{Aj}^{'**}\right) + \left(D_{Bj}^{'*} - D_{Bj}^{'**}\right)$ will be close to zero so that $\Delta\pi < 0$ will hold from above derivations. Therefore, we can see that, under fairly general demand assumptions, category demand expansion is a necessary condition for uniform pricing to be more profitable than non-uniform pricing.

Finally, it is important to point out that consumers' concerns about price fairness are crucial for the uniform pricing to be the equilibrium outcome although it does not affect the equilibrium profits under uniform pricing. Essentially, consumers' fairness concerns provide a mechanism for firms to credibly commit to uniform pricing in equilibrium, which can make firms better off under the conditions given in Proposition 1. In the absence of consumers' fairness concerns, firms will end up in a situation of Prisoners' Dilemma by adopting non-uniform pricing even though both firms would be better off if they could commit to uniform pricing when the condition (ii) in Proposition 1 holds.

3. Extensions

In this section, we further investigate the robustness and generalizability of the main results obtained from the basic model through several model extensions. In Section 3.1, we examine the profitability of uniform pricing in the channel context and study the impact of price fairness concerns on firms' choices of channel structures. In Section 3.2, we extend the basic model by allowing firms to strategically influence consumers' fairness concerns on prices. We also study the case where the production costs of the two products are different. Finally, in Section 3.3 we show the robustness of our findings from the basic model by letting the product variants be substitutes.

3.1 Fairness Concerns and Uniform Pricing in the Channel Context

In the basic model, firms are assumed to sell directly to end consumers. In reality, however, many firms sell through distribution channels. To study the robustness of the main results obtained in our basic model in the channel context, we follow the setup in McGuire and Staelin (1983) to allow each firm (manufacturer) to sell to end consumers through an exclusively contracted retailer. McGuire and Staelin (1983) show that manufacturers may be willing to strategically decentralize their channels in order to alleviate the price competition between them. It will be interesting to know how this result may be affected when each manufacturer offers multiple brand variants and consumers have fairness concerns on retail prices.

As demonstrated in previous research, retailers may also have fairness concerns on prices offered by the manufacturers (Cui, Raju and Zhang 2007; Scheer, Kumar and Steenkamp 2003). Therefore, to facilitate the comparison to the result of McGuire and Staelin (1983), we consider two cases. The first case corresponds to the situation where neither retailers nor consumers have fairness concerns on prices, which is implicitly assumed in McGuire and Staelin (1983). The second case corresponds to the situation where both retailers and consumers have sufficiently strong concerns (*i.e.*, incur sufficiently high disutility) on being charged different prices for product variants from the same manufacturer. In this case, both manufacturers and retailers will have to set uniform prices for product variants from the same brand.

We maintain the same assumptions on manufacturers' production costs and consumer demand functions as in the basic model and also assume, without loss of generality, that there is no retail cost. Following McGuire and Staelin (1983), we assume that each manufacturer may adopt either an integrated channel structure with which the manufacturer owns the retailer selling its products, or a decentralized channel structure with which the manufacturer sells its products through an independent retailer which exclusively sells the manufacturer's products. The sequence of the game is as follows. Manufacturers simultaneously decide on their channel structures first. When both manufacturers adopt integrated channel structures, they compete directly by simultaneously setting retail prices for their branded variants as in our basic model. When both manufacturers adopt decentralized channel structures, they simultaneously set wholesale prices followed by retailers simultaneously setting retail prices after observing both manufacturers' wholesale prices. With mixed channel structure decisions, *i.e.*, when one manufacturer adopts an integrated channel structure but the other manufacturer adopts a decentralized channel structure, the manufacturer with decentralized channel structure sets its wholesale price first followed by its retailer and the other manufacturer simultaneously setting retail prices after observing that wholesale price.

Table 1 in Appendix summarizes the equilibrium results in the absence of fairness concerns on prices, and Table 2 in Appendix summarizes the equilibrium results for the case where both retailers and consumers have sufficiently high concerns on price fairness so that both manufacturers and retailers set uniform prices in equilibrium. Based on Tables 1 and 2, we obtain the following proposition regarding the equilibrium channel structure and manufactures' profits.

Proposition 2 *(i) In the absence of fairness concerns on prices, both manufacturers adopting integrated channel structures is always an equilibrium. Further, both manufacturers choosing decentralized channels may also be an equilibrium and a Pareto dominating one. (ii) When firms set uniform prices at both the retail and wholesale levels due to fairness concerns on prices, both manufacturers adopting integrated channel structures is the unique equilibrium; and manufacturers can be better off in this case than in the absence of fairness concerns*

Part (i) of Proposition 2 is similar to the result from McGuire and Staelin (1983), which implies that their main insights also apply to the context where each manufacturer offers multiple branded variants instead of a single product. Part (ii) of Proposition 2 shows that when consumers' fairness concerns force firms to adopt uniform pricing for branded variants, firms are unlikely to adopt decentralized channel structure. This result adds to the insights offered by McGuire and Staelin (1983). The intuition behind this result is as follows. From the equilibrium results given in Table 1 in the Appendix, firms have incentive to adopt decentralized channel structure when a is large. This is because price competition is more intensive for larger a when firms set non-uniform prices. Therefore, following the intuition of McGuire and Staelin (1983), manufacturers in the case where a is large would like to use independent retailers in order to mitigate price competition between them when they adopt non-uniform pricing. However, as shown in Proposition 1, uniform pricing makes firms better off at large a and thus reduces manufacturers' incentive to keep retailers between them as a buffer to competition. Consequently, integrated channel structure becomes the unique equilibrium under uniform pricing.

It is also important to notice that the main result from the basic model, *i.e.*, firms can be more profitable with uniform pricing than with non-uniform pricing, still holds in the channel context as stated in part (ii) of Proposition 2.

3.2 Firms' Incentives of Influencing Consumers' Fairness Concern

In the basic model discussed in Section 2, consumers' concerns of price fairness are assumed to be exogenous. In many circumstances, however, firms may be able to influence consumers' perceptions of price fairness through marketing communication. For example, a firm may emphasize the difference in product popularity and/or production costs among its branded variants to justify non-uniform pricing. In this section, we explicitly examine firms' incentive of influencing consumers' fairness perception through a two-stage game setup. In the first stage, each firm simultaneously decides whether to influence consumers' fairness concerns so that charging different prices to branded variants by the firm will not be perceived as unfair. Without qualitatively affecting the results presented below, we assume that firms can change consumers' fairness concerns at no cost if they choose to do so. In the second stage, firms simultaneously choose prices to maximize the total profits from their branded variants. An interesting question to address in this analysis is whether a firm has incentive to unilaterally mitigate consumers' fairness concerns on prices if it comes with no communication cost.

We solve for the sub-game perfect equilibrium of this two-stage game using backward induction. We start with solving for firms' equilibrium pricing strategies and profits in the four second stage sub-games given firms' decisions in the first stage on either mitigating or not mitigating consumers' fairness concerns. Equation (5) and Lemma 1 in the previous section have given the equilibrium solutions to the cases where both firms mitigate or neither firm mitigates consumers' fairness concerns. Next we derive the equilibrium results for the asymmetric case where one firm mitigates but the other does not mitigate consumers' fairness concerns.

Without loss of generality, we solve the case where Firm 1 mitigates consumers' fairness concerns but Firm 2 does not. The case in which Firm 2 mitigates consumers' fairness concerns but Firm 1 does not can be solved in a similar fashion. When only Firm 1 mitigates consumers' fairness concerns on prices, the demand function as in Equation (6) becomes

$$\begin{aligned} q_{A1} &= 1 - p_{A1} + c_1(p_{A2} + z_{A2}) \\ q_{B1} &= a - p_{B1} + (p_{B2} + z_{B2}) \\ q_{A2} &= 1 - (p_{A2} + z_{A2}) + c_1 p_{A1} \\ q_{B2} &= a - (p_{B2} + z_{B2}) + p_{B1} \end{aligned} \tag{9}$$

and the equilibrium results are summarized in Lemma 2 below.

Lemma 2 *When only Firm 1 mitigates consumers' fairness concerns on prices, Firm 2 will choose uniform pricing if* $\theta \geq \underline{\theta}_e = \dfrac{3(2+c_1)(2-c_1)(\frac{1}{2-c_1} - a)}{2(2+3a+c_1)}$, *and firms' equilibrium prices and profits are given by*

$$
\begin{cases}
p_{A1}^{e*} = \dfrac{7+2c_1+3ac_1}{2(7-c_1^2)} \\
p_{B1}^{e*} = \dfrac{10a+2+c_1-ac_1^2}{2(7-c_1^2)} \\
p_{A2}^{e*} = p_{B2}^{e*} = p_U^{eN} = \dfrac{2+3a+c_1}{7-c_1^2} \\
\pi_1^{eN} = \dfrac{a^2c_1^4-2ac_1^3-11a^2c_1^2+8ac_1^2+5c_1^2+32c_1+62ac_1+100a^2+40a+53}{4(7-c_1^2)^2} \\
\pi_2^{eN} = \dfrac{2(2+3a+c_1)^2}{(7-c_1^2)^2}
\end{cases}
$$

It can be easily verified that $\underline{\theta}_e > \underline{\theta}$. In the following discussion, we will focus on the cases where $\theta \geq \underline{\theta}_e$ so that uniform pricing can occur in equilibrium as long as at least one firm is facing price fairness concerns from consumers. Figure 2 shows firms' equilibrium strategies in the first stage game for the entire parameter ranges of *a* and c_1, which is formalized in Proposition 3 below.

[Insert Figure 2 about Here]

Proposition 3 *Firms will have no incentive to unilaterally mitigate consumers' concerns of price fairness when (i)* $\theta \geq \underline{\theta}_e$ *and (ii)* $\dfrac{85-30c_1+18c_1^2+2c_1^3-3c_1^4}{254-173c_1-30c_1^2+18c_1^3+4c_1^4-c_1^5} \leq a < \dfrac{1}{2-c_1}$.

Interestingly, Figure 2 and Proposition 3 show that the case in which neither firm mitigates consumers' fairness concerns can occur in equilibrium even if each firm can do that unilaterally without any cost. Therefore, the profit enhancement result of uniform pricing shown in Proposition 1 can hold even when consumers' fairness concerns can be strategically influenced by each firm.

Proposition 3 and Figure 2 suggest that neither firm has any incentive to mitigate consumers' fairness concerns when a is large (given that the assumption $a < \frac{1}{2-c_1}$ is met) and c_1 is small. The intuition is as follows. When a firm unilaterally derivates from uniform pricing by mitigating consumers' fairness concerns on differentiated prices, it can compete more effectively than prior to deviation as it gains the flexibility of setting two different prices. As a response to this deviation, the competing firm will have to lower the uniform price it charges to both product variants. When a is large, the response from the competing uniform pricing firm will be aggressive as it has strong incentive to protect its share of the weak product variant because its demand potential is large (a is large) and the deviating firm can set a low price just for this product variant. Consequently, this competitive reaction reduces the potential gain to the deviating firm. When c_1 is small, the benefit towards the deviating firm will also be small because in such a case the total category demand loss will be large for the firm that switches to non-uniform pricing. Hence, the incentive for a firm to deviate from uniform pricing by mitigating consumers' fairness concerns is lower when a is larger and c_1 is smaller.

The results of Proposition 3 are based on the assumption that the production costs of the two product variants are the same. When the strong product variant incurs higher product cost than the weak product variant, firms will have a natural "excuse" to let consumers believe that it is fair to charge a higher price to the product with a higher production cost (Bolton and Alba 2006). Even under this circumstance, we can show that firms may not have incentive to unilaterally disclose the cost differences for the two product variants. This occurs as an equilibrium when the cost difference is small, a is large, and c_1 is small. The intuition is similar to that behind Proposition 3 and the details of derivation can be found in Appendix. This result offers an explanation to the frequently observed phenomena that branded variants which are likely to have different production costs are charged with the same price.

3.3 Substitution between Product Variants

In our basic model, we assume that the demand of the two product variants is non-substitutable. This assumption applies to product categories such as clothes with different sizes. However, in many other circumstances, the demand of different product variants tends to be substitutable. For example, the price of one flavor of yogurt is likely to affect the demand of another flavor of yogurt. To allow the possibility of demand substitution between product variants, we extend the demand specification given in Equation (3) to

$$\begin{cases} q_{A1} = 1 - p_{A1} + c_1 p_{A2} + kp_{B1} + c_1 hp_{B2} \\ q_{A2} = 1 - p_{A2} + c_1 p_{A1} + kp_{B2} + c_1 hp_{B1} \\ q_{B1} = a - p_{B1} + p_{B2} + kp_{A1} + hp_{A2} \\ q_{B2} = a - p_{B2} + p_{B1} + kp_{A2} + hp_{A1} \end{cases} \tag{10}$$

Here the parameter *k* captures the substitution effect within a brand – the impact that the price of one branded variant has on the demand of the other branded variant by the same firm, and the parameter *h* captures the cross-brand cross-variant substitution effect – the impact that the price of a branded variant has on the demand of the other firm's other product variant. We further assume that $0 \le k \le 1$ and $0 \le h \le 1$. The equilibrium prices and profits for the case where consumers do not concern about fairness can be solved as

$$\begin{cases} p_{A1}^{s*} = p_{A2}^{s*} = p_A^s = \dfrac{1 + 2ak + ac_1 h}{2 - c_1 - c_1 h^2 - 2c_1 hk - 2hk - 4k^2} \\ p_{B1}^{s*} = p_{B2}^{s*} = p_B^s = \dfrac{2a - ac_1 + h + 2k}{2 - c_1 - c_1 h^2 - 2c_1 hk - 2hk - 4k^2} \\ \pi_1^s = \pi_2^s = \pi_{NU}^s = \dfrac{(1 + 2ak + ac_1 h)(1 + ac_1 h + ac_1 k - hk - 2k^2)}{(2 - c_1 - c_1 h^2 - 2c_1 hk - 2hk - 4k^2)^2} \\ \qquad + \dfrac{(2a - ac_1 + h + 2k)(2a - ac_1 + h + k - ac_1 hk - 2ak^2)}{(2 - c_1 - c_1 h^2 - 2c_1 hk - 2hk - 4k^2)^2} \end{cases} \tag{11}$$

When consumers have sufficiently strong concerns of price fairness, both firms will adopt uniform pricing and the equilibrium prices and profits are summarized in Lemma 3 below.

Lemma 3 *If* $\theta \geq \underline{\theta}_s = \dfrac{1-a(2-c_1)-h(1-ac_1)-2k(1-a)}{1+a}$, *both firms choosing uniform pricing is a unique equilibrium. Firms' prices and profits in equilibrium are given by*

$$\begin{cases} p_{ij}^{s*} = p_U^s = \dfrac{1+a}{3-c_1-h-c_1h-4k} \\ q_{A1}^{s*} = q_{A2}^{s*} = q_A^s = \dfrac{2-2h-4k-a(4-2c_1-2c_1h-4k)}{3-c_1-h-c_1h-4k} + a + \dfrac{(k+h)(1+a)}{3-c_1-h-c_1h-4k} \\ q_{B1}^{s*} = q_{B2}^{s*} = q_B^s = a + \dfrac{(k+h)(1+a)}{3-c_1-h-c_1h-4k} \\ \pi_1^s = \pi_2^s = \pi_U^s = \dfrac{2(1+a)^2(1-k)}{(3-c_1-h-c_1h-4k)^2} \end{cases} \tag{12}$$

Comparing the results of Lemma 3 and those of Lemma 1, we have the following proposition.

Proposition 4 *Firms are more likely to adopt uniform pricing with the presence of the substitution effect between product variants than without it.*

Moreover, similar to Proposition 1, we can show that both firms can be better off with uniform pricing than with non-uniform pricing. As an illustration, Figure 3 shows the parameter ranges of a and c_1 for firms to be better off with uniform pricing with k=0.2 and h=0.1. In addition, we find that the parameter ranges of (a, c_1) within which firms are better off with uniform pricing increase with k and h. These results and Proposition 4 indicate that the main results from our basic model are not only robust but also enhanced when we consider the substitution effects between product variants.

[Insert Figure 3 about Here]

4. Conclusion

It is puzzling for uniform pricing to be widely adopted in retailing industry since it seems that retailers may improve profitability with variable pricing to exploit the difference in products' demand. In this paper, we show that uniform pricing policy can emerge as an equilibrium result in a model of price competition that incorporates consumers' concerns of price fairness. More interestingly, we find that uniform pricing of branded variants can help mitigate price competition and thus increase firms' profits. In this sense, fairness concerns from consumers may provide a natural mechanism for firms to commit to uniform pricing and maintain high profits.

In addition, we show that a firm may not have any incentive to unilaterally mitigate consumers' concerns of fairness so that consumers believe that it is "fair" for the firm to charge non-uniform prices. This holds even if the firm incurs no communication cost to change consumers' fairness concerns on price. Furthermore, even if different product variants may have different costs so that consumers, if informed with such information, may feel it is fair for a firm to charge different prices to its branded variants, the firm may still prefer consumers to perceive the costs to be the same and feel it is unfair for the firm to charge non-uniform prices. These results suggest the sustainability and persistency of the uniform pricing strategy.

The main intuition behind our findings is that uniform pricing, induced by consumers' fairness concerns, may increase total demand of all branded variants in comparison to non-uniform pricing. This occurs when the higher priced variant under non-uniform pricing has higher category demand elasticity than the lower priced variant under non-uniform pricing. Since uniform pricing is between the high and low prices under non-uniform pricing, the adoption of uniform pricing will increase the demand of the higher priced variant in a greater degree than reducing the demand of the lower priced variant. Thus, the overall effect suggests an increase in total demand of all branded variants which benefits both firms directly. In addition, the category demand expansion effect reduces firms' incentive in engaging in intensive price competition, which again benefits firms.

The paper further studies how uniform pricing may affect the equilibrium channel structure. We show that the intuition and results from McGuire and Staelin (1983) still apply when the price fairness concerns from consumers are weak. When consumers are strongly concerned about price fairness, however, competing firms will have more incentive to integrate the channels.

It is important to point out some limitations of our study, which call for investigations by future research. First, we have not examined how consumers' fairness concerns may affect firms' decisions on product assortments. Since the demand of a product could be dependent on the prices of other branded variants by the same firm, it might be optimal for a firm to reduce its product assortments in order to prevent consumers from comparing prices of branded variants and perceiving prices as unfair. Future research may explicitly model the product assortments decisions along with pricing decisions given consumers with fairness concerns on prices. Second, the current paper provides insights on the uniform pricing phenomenon through an analytical modeling framework. Future empirical and experimental studies on the issue of uniform pricing may generate additional insights on the underlying rationale behind it. In particular, as we mentioned in Introduction, the explanation of the uniform pricing phenomenon based on consumers' fairness concerns on prices is just one of many possible explanations proposed in the literature. It will be important for future research to examine the relative explanatory powers of the various theories on uniform pricing.

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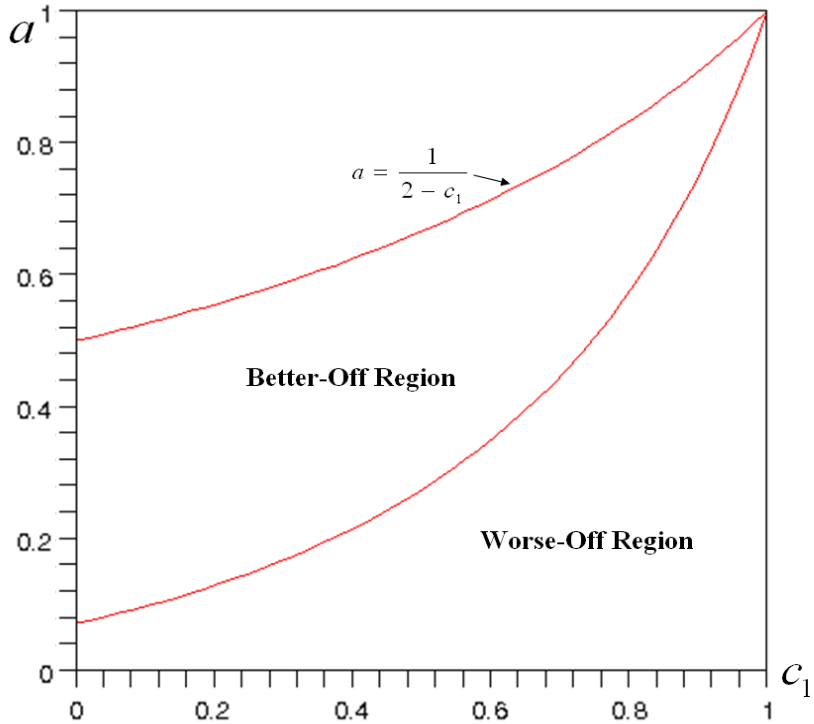

Figure 1
Value of $\pi_U - \pi_{NU}$ with Uniform Pricing as the Equilibrium Strategy

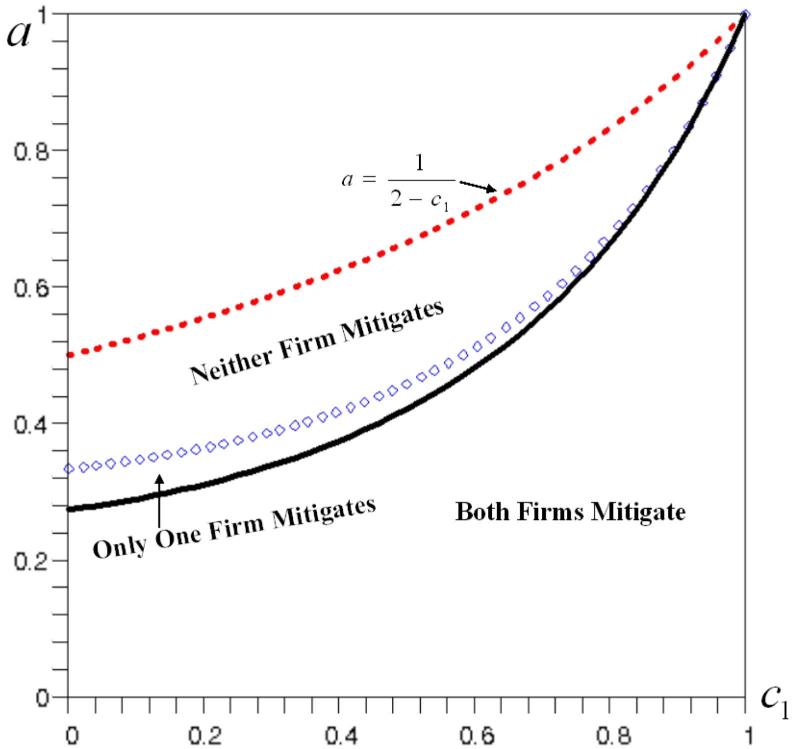

Figure 2
Equilibrium Strategies for $\theta \geq \underline{\theta}_e$ When Firms Can Mitigate Consumers' Fairness Concerns on Prices in The First Stage

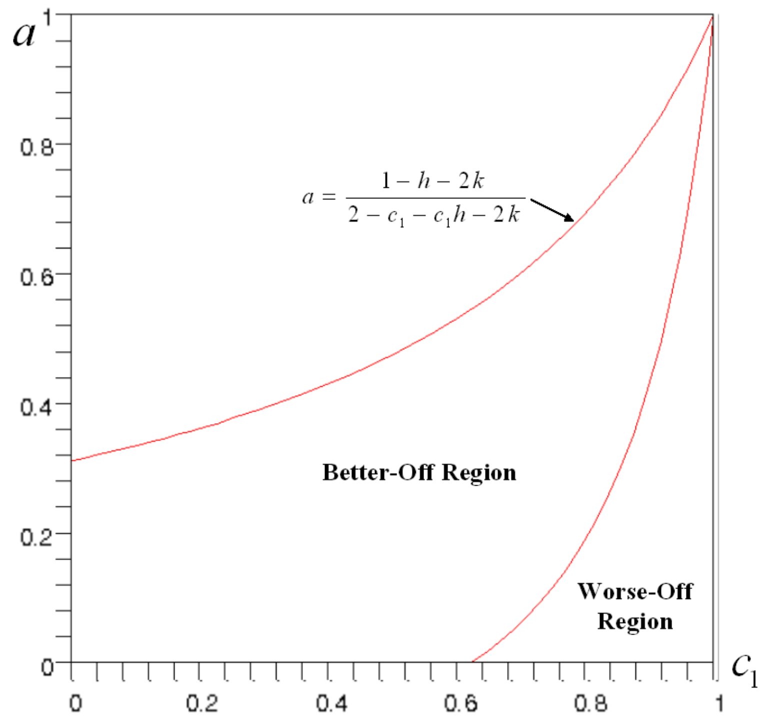

Figure 3

Value of $\pi_U^s - \pi_{NU}^s$ with Uniform Pricing as the Equilibrium Strategy (k = 0.2, h = 0.1)

Appendix

Proof of Lemma 1.

When both firms are charging uniform prices, the profit function of firm *j* is

$$\pi_j = \pi_{Aj} + \pi_{Bj} = q_{Aj} p_{Uj} + q_{Bj} p_{Uj} \tag{A1}$$

where q_{ij} is given by Equation (6) in the paper. Firms set uniform prices p_{Uj} simultaneously to maximize their profits as given in (A1), which leads to the solution

$$\begin{cases} p_{ij}^* = p_U = \dfrac{1+a}{3-c_1} \\ q_{A1}^* = q_{A2}^* = q_A^U = \dfrac{2(1-2a+ac_1)}{3-c_1} + a \\ q_{B1}^* = q_{B2}^* = q_B^U = a \\ \pi_1 = \pi_2 = \pi_U = \dfrac{2(1+a)^2}{(3-c_1)^2} \end{cases} . \tag{A2}$$

For the results in (A2) to be equilibrium, we need to check firms' incentive to deviate from such a uniform pricing strategy. Without loss of generality, we examine the case where Firm 2 deviates from uniform prices to non-uniform prices $\tilde{p}_{A2} > \tilde{p}_{B2}$ given Firm 1's strategy as in (A2). Using the demand function given by Equation (6) in the paper, we obtain the following results regarding the optimal deviating prices and Firm 2's profit change $\tilde{\pi}_2^{UU} - \pi_2^{UU}$:

$$\begin{cases} \tilde{p}_{A2} = \dfrac{8+4a\theta+(2-\theta)(ac_1-1)}{(3-c_1)(4+4\theta-\theta^2)} \\ \tilde{p}_{B2} = \dfrac{8a+8a\theta+4\theta-(2+\theta)(ac_1-1)}{(3-c_1)(4+4\theta-\theta^2)} \\ \tilde{p}_{A2} - \tilde{p}_{B2} = \dfrac{4\left[1-a(2-c_1)-\theta(1+a)\right]}{(3-c_1)(4+4\theta-\theta^2)} \\ \tilde{\pi}_2^{UU} - \pi_2^{UU} = \dfrac{2\left(1-2a-\theta-a\theta+ac_1\right)^2}{(3-c_1)^2(4+4\theta-\theta^2)} \end{cases} . \tag{A3}$$

For (A2) to be equilibrium, we must have $\tilde{\pi}_2^{UU} - \pi_2^{UU} < 0$ or $\tilde{p}_{A2} \le \tilde{p}_{B2}$, which results in $\theta \ge \dfrac{1-a(2-c_1)}{1+a} = \underline{\theta}$. Similarly, it is easy to show that Firm 2 has no incentive to deviate to $\tilde{p}_{A2} < \tilde{p}_{B2}$ for any $\theta > 0$. Therefore, for any $\theta \ge \underline{\theta}$, neither firm will have any incentive to deviate from (A2). We can further show that the equilibrium described in (A2) is unique for

$\theta \geq \underline{\theta}$. As the above discussion has shown that (A2) is the unique equilibrium when both firms set uniform price and $\theta \geq \underline{\theta}$, we just need to prove that both firms set non-uniform prices or only one firm sets non-uniform price cannot be equilibrium for $\theta \geq \underline{\theta}$. Due to the limit of space, we omit the details of the proof but use the scenario that both firms charge higher prices for product variant A than for product variant B as an example to illustrate the proof. The proofs under other scenario can be obtained similarly.

When both firms charge higher prices for product variant A than for product variant B, we can solve firms' optimal prices and the resultant profits as given below using the demand specification in Equation (6)

$$\begin{cases} p_{A1} = p_{A2} = \dfrac{1 + a\theta(1-c_1)}{(2-c_1)(1+\theta) - \theta^2(1-c_1)} \\ p_{B1} = p_{B2} = \dfrac{\theta + a(1+\theta)(2-c_1)}{(2-c_1)(1+\theta) - \theta^2(1-c_1)} \\ p_{A1} - p_{B1} = \dfrac{1 - 2a + ac_1 - \theta(1+a)}{(2-c_1)(1+\theta) - \theta^2(1-c_1)} \\ \pi_1^{NN} = \pi_2^{NN} = \dfrac{(1+\theta)\left[1 + a\theta(1-c_1)\right]^2}{\left[(2-c_1)(1+\theta) - \theta^2(1-c_1)\right]^2} + \dfrac{a\left[\theta + a(1+\theta)(2-c_1)\right]}{\left[(2-c_1)(1+\theta) - \theta^2(1-c_1)\right]} \end{cases} . \qquad \text{(A4)}$$

Then we solve for Firm 2's optimal pricing strategy if it deviates to uniform pricing strategy. The resultant profits $\tilde{\pi}_2^{NN}$ and profits change $\pi_2^{NN} - \tilde{\pi}_2^{NN}$ are given by

$$\begin{cases} \tilde{\pi}_2^{NN} = \dfrac{\left[2 + 4a - 2ac_1 + \theta(3 + 4a - 3ac_1) - \theta^2(1+a)\right]^2}{8\left[(2-c_1)(1+\theta) - \theta^2(1-c_1)\right]^2} \\ \pi_2^{NN} - \tilde{\pi}_2^{NN} = \dfrac{(4 + 4\theta - \theta^2)\left[1 - 2a + ac_1 - \theta(1+a)\right]^2}{8\left[(2-c_1)(1+\theta) - \theta^2(1-c_1)\right]^2} \end{cases} . \qquad \text{(A5)}$$

It is easy to show that for $\theta \geq \underline{\theta}$ we have either $p_{A1} \leq p_{B1}$ or $\pi_2^{NN} - \tilde{\pi}_2^{NN}$ <0. Hence, (A4) cannot be equilibrium. With the similar approach, we can show than no scenario except that given in (A2) can be equilibrium for $\theta \geq \underline{\theta}$. Hence Lemma 1 is proved. Q.E.D.

Proof of Proposition 1. From Equation (5) and Lemma 1 of the paper, we have

$\pi_U - \pi_{NU} = -\dfrac{(1-2a+ac_1)[1+2c_1-c_1^2-a(14-19c_1+8c_1^2-c_1^3)]}{(3-c_1)^2(2-c_1)^2}$. $\pi_U - \pi_{NU} > 0$ and

$a < \frac{1}{2-c_1}$ lead to $\frac{1+2c_1-c_1^2}{14-19c_1+8c_1^2-c_1^3} < a < \frac{1}{2-c_1}$. Q.E.D.

Proof of Proposition 2. In each of both games of with or without concerns of price fairness by consumers, there are three sub-games: both firms integrate channels, both firms decentralize channels, and only one firm integrates the channel. For the sake of succinctness, we solve for the decentralized game in each of both games. Other games can be solved in a similar fashion. When both firms decentralize their channels, the sequence of events is given below. In the first stage, both manufacturers simultaneously decide on wholesale prices for their branded variants w_{ij} (i = A,B; j = 1,2). Given wholesale prices w_{ij}, the retailers simultaneously decide on retail prices p_{ij} for the products they sell where refers to the retail price of product variant i that is produced by manufacturer j and sold through manufacturer j's exclusive retailer j. We solve for the sub-game perfect equilibrium of this game using backward induction. When there is no concern of price fairness, retailer j's demand functions are given by

$$\begin{aligned} q_{Aj} &= 1 - p_{Aj} + c_1 p_{A3-j} \\ q_{Bj} &= a - p_{Bj} + p_{B3-j} \end{aligned} . \tag{A6}$$

Given wholesale prices w_{Aj} and w_{Bj}, retailers compete with a simultaneous move game where retailer j sets p_{Aj} and p_{Bj} simultaneously to maximize the total profits from the two products it carries,

$$\pi_j = \pi_{Aj} + \pi_{Bj} = (1 - p_{Aj} + c_1 p_{A3-j})(p_{Aj} - w_{Aj}) + (a - p_{Bj} + p_{B3-j})(p_{Bj} - w_{Bj}) . \tag{A7}$$

It is straightforward to show that the equilibrium retail prices are

$$\begin{cases} p_{A1} = \dfrac{2 + c_1 + c_1 w_{A2} + 2w_{A1}}{(2-c_1)(2+c_1)} \\ p_{B1} = \dfrac{a + 2w_{B1} + w_{B2}}{3} \\ p_{A2} = \dfrac{2 + c_1 + c_1 w_{A1} + 2w_{A2}}{(2-c_1)(2+c_1)} \\ p_{B2} = \dfrac{a + w_{B1} + 2w_{B2}}{3} \end{cases} . \tag{A8}$$

Given retailers' above responses to their wholesale prices, manufacturers compete with a simultaneous move game where manufacturer j sets w_{Aj} and w_{Bj} simultaneously to maximize the total profits from its two branded variants,

$$\Pi_j = \Pi_{Aj} + \Pi_{Bj} = (1 - p_{Aj} + c_1 p_{A3-j}) w_{Aj} + (a - p_{Bj} + p_{B3-j}) w_{Bj} . \qquad \text{(A9)}$$

It is straightforward to show that the equilibrium prices, demands and firms' profits are

$$\begin{cases} w_{A1}^* = w_{A2}^* = \dfrac{2+c_1}{4-c_1-2c_1^2} \\ w_{B1}^* = w_{B2}^* = 3a \\ p_{A1}^* = p_{A2}^* = \dfrac{2(3-c_1^2)}{(2-c_1)(4-c_1-2c_1^2)} \\ p_{B1}^* = p_{B2}^* = 4a \\ q_{A1}^* = q_{A2}^* = \dfrac{2-c_1^2}{(2-c_1)(4-c_1-2c_1^2)} \\ q_{B1}^* = q_{B2}^* = a \\ \pi_1^* = \pi_2^* = \dfrac{(2-c_1^2)^2}{(2-c_1)^2(4-c_1-2c_1^2)^2} + a^2 \\ \Pi_1^* = \Pi_2^* = \dfrac{(2+c_1)(2-c_1^2)}{(2-c_1)(4-c_1-2c_1^2)^2} + 3a^2 \end{cases} . \qquad \text{(A10)}$$

When there are concerns of price fairness by consumers and manufacturer j have to set uniform wholesale prices $w_{Aj} = w_{Bj} = w_{Uj}$, we solve the game in a similar fashion as the proof of Lemma 1. When both retailers are charging uniform retail prices, the profit function of retailer j is

$$\pi_j = \pi_{Aj} + \pi_{Bj} = q_{Aj}(p_{Uj} - w_{Uj}) + q_{Bj}(p_{Uj} - w_{Uj}) \qquad \text{(A11)}$$

where q_{ij} is given by Equation (6) in the paper. Given wholesale prices w_{U1} and w_{U2}, retailers compete with a simultaneous move game where retailer j sets p_{Uj} to maximize its profit as given in (A11), which leads to the solution

$$p_{Uj} = \frac{(1+a)(5+c_1) + 8w_{U1} + 2(1+c_1)w_{U2}}{(5+c_1)(3-c_1)} . \qquad \text{(A12)}$$

Given retailers' above responses to their wholesale prices, manufacturers compete with a simultaneous move game where manufacturer j sets w_{Uj} to maximize the total profits from its two branded variants,

$$\Pi_j = \Pi_{Aj} + \Pi_{Bj} = (1 - p_{Uj} + c_1 p_{U3-j})w_{Uj} + (a - p_{Uj} + p_{U3-j})w_{Uj}. \qquad \text{(A13)}$$

It is straightforward to show that the optimal prices, demands and firms' profits are

$$\begin{cases} w_{U1}^* = w_{U2}^* = \dfrac{(1+a)(5+c_1)}{2(6-3c_1-c_1^2)} \\ p_{U1}^* = p_{U2}^* = \dfrac{(1+a)(11-2c_1-c_1^2)}{(3-c_1)(6-3c_1-c_1^2)} \\ q_{A1}^* = q_{A2}^* = \dfrac{7-2c_1-c_1^2-a(11-13c_1+c_1^2+c_1^3)}{(3-c_1)(6-3c_1-c_1^2)} \\ q_{B1}^* = q_{B2}^* = a \\ \pi_1^* = \pi_2^* = \dfrac{(1+a)^2(7-2c_1-c_1^2)^2}{2(3-c_1)^2(6-3c_1-c_1^2)^2} \\ \Pi_1^* = \Pi_2^* = \dfrac{(1+a)^2(5+c_1)(7-2c_1-c_1^2)}{2(3-c_1)(6-3c_1-c_1^2)^2} \end{cases}. \qquad \text{(A14)}$$

For the results in (A14) to be equilibrium, we need to check retailers' incentive to deviate from such a uniform pricing strategy. Without loss of generality, we examine the case where Retailer 2 deviates from uniform prices to non-uniform prices $\tilde{p}_{A2} > \tilde{p}_{B2}$ given Retailer 1's strategy as in (A14). Using the demand function given by Equation (6) in the paper, we obtain the following results regarding the optimal deviating prices and Retailer 2's profit change $\tilde{\pi}_2^{UU} - \pi_2^{UU}$:

$$\begin{cases} \tilde{p}_{A2} - \tilde{p}_{B2} = \dfrac{2\left[7-2c_1-c_1^2-a(29-28c_1+c_1^2+2c_1^3)-\theta(1+a)(7-2c_1-c_1^2)\right]}{(3-c_1)(6-3c_1-c_1^2)(4+4\theta-\theta^2)} \\ \tilde{\pi}_2^{UU} - \pi_2^{UU} = \dfrac{[(7-2c_1-c_1^2)(1-\theta-a\theta)-a(29-28c_1+c_1^2+2c_1^3)]^2}{2(3-c_1)^2(6-3c_1-c_1^2)^2(4+4\theta-\theta^2)} \end{cases}. \qquad \text{(A15)}$$

For (A14) to be equilibrium, we must have $\tilde{\pi}_2^{UU} - \pi_2^{UU} < 0$ or $\tilde{p}_{A2} \le \tilde{p}_{B2}$, which results in $\theta \ge \max\{\dfrac{7-2c_1-c_1^2-a(29-28c_1+c_1^2+2c_1^3)}{(1+a)(7-2c_1-c_1^2)}, 0\}$. Similarly, it is easy to show that Retailer 2 has no incentive to deviate to $\tilde{p}_{A2} < \tilde{p}_{B2}$ for any $\theta \ge \max\{-\dfrac{7-2c_1-c_1^2-a(29-28c_1+c_1^2+2c_1^3)}{(1+a)(7-2c_1-c_1^2)}, 0\}$. Therefore, for any $\theta \ge \underline{\theta}_c$, $\underline{\theta}_c =$

$\left|\dfrac{7-2c_1-c_1^2-a(29-28c_1+c_1^2+2c_1^3)}{(1+a)(7-2c_1-c_1^2)}\right|$, neither retailer will have any incentive to deviate from (A14).

Given manufacturers' profits in each sub-game, the way to solve for equilibrium channel structure is in the same manner as that in McGuire and Staelin (1983) and thus is omitted here for the sake of succinctness. Q.E.D.

Proof of Lemma 2. The proof is similar to that of Lemma 1. When Firm 1 sets non-uniform prices and Firm 2 charges uniform prices, solving for both firms' profit maximization problems based on the demand function as in Equation (6) leads to the following results:

$$\begin{cases} p_{A1}^{e*} = \dfrac{7+2c_1+3ac_1}{2(7-c_1^2)} \\ p_{B1}^{e*} = \dfrac{10a+2+c_1-ac_1^2}{2(7-c_1^2)} \\ p_{A2}^{e*} = p_{B2}^{e*} = p_U^{eN} = \dfrac{2+3a+c_1}{7-c_1^2} \\ \pi_1^{eN} = \dfrac{a^2c_1^4-2ac_1^3-11a^2c_1^2+8ac_1^2+5c_1^2+32c_1+62ac_1+100a^2+40a+53}{4(7-c_1^2)^2} \\ \pi_2^{eN} = \dfrac{2(2+3a+c_1)^2}{(7-c_1^2)^2} \end{cases} \tag{A6}$$

If Firm 2 deviates from $p_{A2} = p_{B2}$ to $\tilde{p}_{A2} > \tilde{p}_{B2}$, we have the following results:

$$\begin{cases} \tilde{p}_{A2} = \dfrac{3\left[2+c_1+a\theta(2-c_1^2)\right]}{(12-3c_1^2)(1+\theta)-2\theta^2(2-c_1^2)} \\ \tilde{p}_{B2} = \dfrac{a(2+c_1)\left[a(1+\theta)(6-3c_1)+2\theta\right]}{(12-3c_1^2)(1+\theta)-2\theta^2(2-c_1^2)} \\ \tilde{p}_{A2}-\tilde{p}_{B2} = \dfrac{6-12a+3c_1+3ac_1^2-2\theta\left(2+3a+c_1\right)}{(12-3c_1^2)(1+\theta)-2\theta^2(2-c_1^2)} \end{cases} \tag{A7}$$

Similar to the proof for Lemma 1, we can show that (A6) gives the unique equilibrium for $\theta \geq \underline{\theta}_e = \dfrac{3(2+c_1)(2-c_1)(\dfrac{1}{2-c_1}-a)}{2(2+3a+c_1)}$, where $\underline{\theta}_e$ is the threshold value of θ that makes $\tilde{p}_{A2}-\tilde{p}_{B2}=0$ binding. Q.E.D.

Proof of Proposition 3. From Lemma 1 and Lemma 2, we have that $\pi_1^{eN} < \pi_U$ and $a < \dfrac{1}{2-c_1}$ lead to $\dfrac{85-30c_1+18c_1^2+2c_1^3-3c_1^4}{254-173c_1-30c_1^2+18c_1^3+4c_1^4-c_1^5} \le a < \dfrac{1}{2-c_1}$. Q.E.D.

Analysis of Unequal Production Costs for Brand Variants. Assume the production cost for the strong product variant A is given by w>0 and the production cost for the weak product variant B is given by zero. The proof is similar to that of Proposition 3.

When neither firm mitigates and both firms charge uniform prices, the profit function of firm j is

$$\Pi_j = (p_{Aj} - w)q_{Aj} + p_{Bj}q_{Bj} \tag{A8}$$

where q_{ij} is given by Equation (6) in the paper. Firms set uniform prices simultaneously to maximize their profits as given in (A8), which leads to the solution

$$\begin{cases} p_{A1}^{eN} = p_{A2}^{eN} = p_{B1}^{eN} = p_{B2}^{eN} = p_U^{eN} = \dfrac{1+a+w}{3-c_1} \\ \pi_1^{eN} = \pi_2^{eN} = \pi_U^{eN} = \dfrac{(1+a-2w+wc_1)(2-a-w+wc_1+ac_1)}{(3-c_1)^2} + \dfrac{(1+a+w)(3a-ac_1)}{(3-c_1)^2} \end{cases} \tag{A9}$$

For the results in (A9) to be equilibrium, we need to check firms' incentive to deviate from such a non-mitigating strategy. Without loss of generality, we examine the case where Firm 1 mitigates and charges non-uniform prices but firm 2 does not mitigate and charges uniform prices. Using the demand function given by Equation (6) in the paper, we obtain the following results regarding the optimal prices and profits for both firms:

$$
\begin{cases}
p_{A1}^{e1} = \dfrac{7+7w+2c_1+2wc_1+3ac_1}{2(7-c_1^2)} \\
p_{B1}^{e1} = \dfrac{10a+2+2w+c_1+wc_1-ac_1^2}{2(7-c_1^2)} \\
p_{A2}^{e1} = p_{B2}^{e1} = \dfrac{2+3a+2w+c_1+wc_1}{7-c_1^2} \\
\pi_1^{e1} = \dfrac{(7-7w+2c_1+3ac_1+2wc_1+2wc_1^2)^2}{4(7-c_1^2)^2} + \dfrac{(2+10a+c_1+wc_1+2w-ac_1^2)^2}{4(7-c_1^2)^2} \\
\pi_2^{e1} = \dfrac{(2+3a-5w+c_1+wc_1+wc_1^2)\cdot(10-6a-4w+5c_1+5wc_1+3ac_1^2+2wc_1^2)}{2(7-c_1^2)^2} \\
\qquad + \dfrac{(2+3a+2w+c_1+wc_1)\cdot(18a-2-2w-c_1-wc_1-3ac_1^2)}{2(7-c_1^2)^2}
\end{cases} \tag{A10}
$$

For (A9) to be equilibrium, we must have $\pi_1^{e1} - \pi_1^{eN} \le 0$ or $p_{A1}^{e1} \le p_{B1}^{e1}$, which results in $w \le \overline{w}$. The threshold value $\overline{w}$ is given by

$$
\overline{w} = \frac{a(254-173c_1-30c_1^2+18c_1^3+4c_1^4-c_1^5)-(85-30c_1+18c_1^2+2c_1^3-3c_1^4)}{85+54c_1-94c_1^2+18c_1^3+13c_1^4-4c_1^5} \tag{A11}
$$

Therefore, for any $w \le \overline{w}$, neither firm will have any incentive to deviate from (A9). Q.E.D.

Proof of Lemma 3. The analysis of Lemma 3 is similar to that of Lemma 1. When both firms are charging uniform prices, the demand functions are given by Equation (10) in the paper. Both firms will set uniform prices simultaneously to maximize their profits, which leads to the solution

$$
\begin{cases}
p_{ij}^{s*} = p_U^s = \dfrac{1+a}{3-c_1-h-c_1h-4k} \\
\pi_1^s = \pi_2^s = \pi_U^s = \dfrac{2(1+a)^2(1-k)}{(3-c_1-h-c_1h-4k)^2}
\end{cases} \tag{A12}
$$

For the results in (A12) to be equilibrium, we need to check firms' incentive to deviate from such a uniform pricing strategy. Without loss of generality, we examine the case where Firm 2 deviates from uniform prices to non-uniform prices $\tilde{p}_{A2}^s > \tilde{p}_{B2}^s$ given Firm 1's strategy in (A12). When Firm 2 charges non-uniform prices, its demand is given by

$$q_{Aj} = 1-(p_{Aj}+z_{Aj}) + c_1(p_{A3-j}+z_{A3-j}) + kp_{Bj} + c_1 h p_{B3-j}$$
$$q_{Bj} = a-(p_{Bj}+z_{Bj})p_{Bj} + (p_{B3-j}+z_{B3-j}) + kp_{Aj} + hp_{A3-j}, \qquad \text{(A13)}$$

where $z_{ij} = \theta[p_{ij} - \min(p_{Aj}, p_{Bj})]$ and $\theta \geq 0$. Using the demand function given by Equation (A13), we obtain the following results regarding Firm 2's profit change $\tilde{\pi}_2^s - \pi_2^s$:

$$\tilde{\pi}_2^s - \pi_2^s = \frac{(1-k)(1-2a+ac_1-\theta-a\theta-2k+2ak-h+ac_1h)^2}{(3-c_1-4k-h-hc_1)^2(4+4\theta-\theta^2-4k^2-4k\theta)} \qquad \text{(A14)}$$

For (A12) to be equilibrium, we must have $\tilde{\pi}_2^s - \pi_2^s \leq 0$ or $\tilde{p}_{A2}^s \leq \tilde{p}_{B2}^s$, which results in $\theta \geq \underline{\theta}_s = \frac{1-a(2-c_1)-h(1-ac_1)-2k(1-a)}{1+a}$. Similarly, it is easy to show that firm 2 has no incentive to deviate to $\tilde{p}_{A2}^s < \tilde{p}_{B2}^s$ for any $\theta > 0$. Therefore, for any $\theta \geq \underline{\theta}_s$, neither firm will have any incentive to deviate from (A12). We can further show that the equilibrium described in (A12) is unique. The proof is similar to that in Lemma 1 and is omitted here. Hence Lemma 3 is proved. Q.E.D.

Proof of Proposition 4. Given $\underline{\theta}_s = \frac{1-a(2-c_1)-h(1-ac_1)-2k(1-a)}{1+a}$, we have

$\frac{\partial a(\underline{\theta}_s)}{\partial k} = -\frac{2(1+h)(1-c_1)}{(2-c_1-2k-hc_1)^2} < 0$, $\frac{\partial a(\underline{\theta}_s)}{\partial h} = -\frac{2(1-k)(1-c_1)}{(2-c_1-2k-hc_1)^2} < 0$,

$\frac{\partial c_1(\underline{\theta}_s)}{\partial k} = \frac{2(1-a)}{a(1+h)} > 0$, and $\frac{\partial c_1(\underline{\theta}_s)}{\partial h} = \frac{2(1-k)(1-a)}{a(1+h)^2} > 0$. Q.E.D.

Table 1
Sub-Game Equilibrium Prices and Profits in the Absence of Fairness Concerns on Prices

Game and Structures	Wholesale Price A	Wholesale Price B	Retail Price A	Retail Price B	Manufacturer Profits
Integrated Structure					
Non-Uniform Retail Prices	--	--	$\frac{1}{2-c_1}$	a	$\frac{1}{(2-c_1)^2}+a^2$
Decentralized Structure					
(Non-Uniform Wholesale Prices, Non-Uniform Retail Prices)	$\frac{2+c_1}{4-c_1-2c_1^2}$	$3a$	$\frac{2(3-c_1^2)}{(2-c_1)(4-c_1-2c_1^2)}$	$4a$	$\frac{(2+c_1)(2-c_1^2)}{(2-c_1)(4-c_1-2c_1^2)^2}+3a^2$
Mixed Structure					
(Non-Uniform, Non-Uniform) Decentralized Channel	$\frac{2+c_1}{2(2-c_1^2)}$	$\frac{3a}{2}$	$\frac{3-c_1^2}{(2-c_1)(2-c_1^2)}$	$2a$	$\frac{2+c_1}{4(2-c_1)(2-c_1^2)}+\frac{3a^2}{4}$
(Non-Uniform, Non-Uniform) Integrated Channel	--	--	$\frac{4+c_1-2c_1^2}{2(2-c_1)(2-c_1^2)}$	$\frac{3a}{2}$	$\frac{(4+c_1-2c_1^2)^2}{4(2-c_1)^2(2-c_1^2)^2}+\frac{9a^2}{4}$

Table 2
Sub-Game Equilibrium Prices and Profits in the Presence of Strong Fairness Concerns on Prices

Game and Structures	Wholesale Price A	Wholesale Price B	Retail Price A	Retail Price B	Manufacturer Profits
Integrated Structure					
Uniform Retail Prices	--	--	$\frac{1+a}{3-c_1}$	$\frac{1+a}{3-c_1}$	$\frac{2(1+a)^2}{(3-c_1)^2}$
Decentralized Structure					
(Uniform, Uniform)	$\frac{(1+a)(5+c_1)}{2(6-3c_1-c_1^2)}$	$\frac{(1+a)(5+c_1)}{2(6-3c_1-c_1^2)}$	$\frac{(1+a)(11-2c_1-c_1^2)}{(3-c_1)(6-3c_1-c_1^2)}$	$\frac{(1+a)(11-2c_1-c_1^2)}{(3-c_1)(6-3c_1-c_1^2)}$	$\frac{(1+a)^2(5+c_1)(7-2c_1-c_1^2)}{2(3-c_1)(6-3c_1-c_1^2)^2}$
Mixed Structure					
(Uniform, Uniform) Decentralized Channel	$\frac{(1+a)(5+c_1)}{2(7-2c_1-c_1^2)}$	$\frac{(1+a)(5+c_1)}{2(7-2c_1-c_1^2)}$	$\frac{(1+a)(11-2c_1-c_1^2)}{(3-c_1)(7-2c_1-c_1^2)}$	$\frac{(1+a)(11-2c_1-c_1^2)}{(3-c_1)(7-2c_1-c_1^2)}$	$\frac{(1+a)^2(5+c_1)}{2(3-c_1)(7-2c_1-c_1^2)}$
(Uniform, Uniform) Integrated Channel	--	--	$\frac{(1+a)(8-c_1-c_1^2)}{(3-c_1)(7-2c_1-c_1^2)}$	$\frac{(1+a)(8-c_1-c_1^2)}{(3-c_1)(7-2c_1-c_1^2)}$	$\frac{2(1+a)^2(8-c_1-c_1^2)^2}{(3-c_1)^2(7-2c_1-c_1^2)^2}$