Consumer Fairness Concerns and Dynamic Pricing in a Channel

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Abstract

Increased consumer valuation or demand for a firm's product may give the firm an incentive to increase its price to extract more surplus from consumers. However, the extant literature has shown that when a firm charges a higher price than what is considered fair (a reference point), some consumers may experience a psychological disutility when buying the firm's product. In this paper, we analyze how consumers' fairness concerns will affect the optimal pricing strategies and profits of the product manufacturer and its retailer in a dynamic setting where market demand grows over time. More specifically, will some consumers' fairness concerns deter an increase in price, benefiting the consumers and making the manufacturer and the retailer worse off? One might intuit that the existence of consumers with fairness concerns would induce the retailer to strategically mitigate their fairness concerns by charging a high initial price so as to be able to charge a high future price without provoking consumers' fairness concerns. Our analysis reveals that the retailer can actually have a cost-reduction incentive, which induces the retailer to charge a *low* price in the initial period so as to induce the manufacturer to reduce its wholesale price in the later period. Interestingly, consumers' fairness concerns will lead to *lower* retail prices in each time period when the market growth rate is relatively small, and an increase in the market growth rate can lead to a decrease in both wholesale and retail prices in each period. Furthermore, we show that consumers' fairness concerns can actually lead to an all-win situation for the manufacturer, the retailer and the consumers.

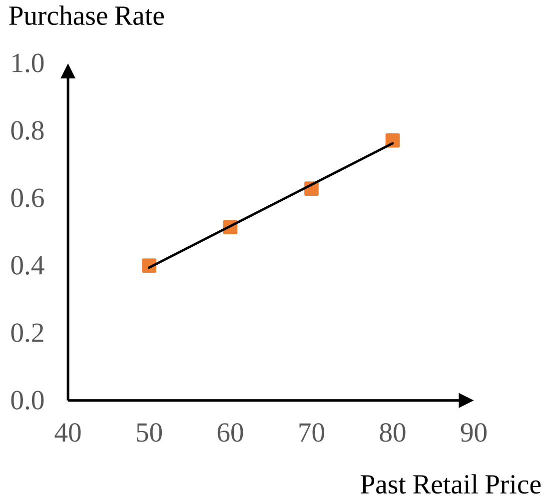
Key words: fairness, behavioral economics, dynamic pricing, channel, double marginalization

INTRODUCTION

When a new product is introduced to the market, its demand is typically low in the beginning. However, over time, product demand may shift upwards due to positive word-of-mouth, increased brand awareness among consumers, etc. Naturally, when a firm experiences an increase in its product's demand, the firm has an incentive to raise its price to increase its profit. However, such price increases may lead to negative responses from some consumers. For example, when Netflix decided to increase its monthly subscription fees in 2011, some consumers felt that the company is exploiting its popularity and trying to profit at their expense. Within several months, Netflix lost more than 800,000 subscribers and consumers' goodwill (Sandoval, 2012). The extant literature in consumer behavior has also established that consumers tend to perceive it as unfair when a firm exploits increased demand to raise its price (e.g., Kahneman et al. 1986, Dickson and Karapurakal 1994). Furthermore, Campbell (1999) shows that consumers tend to consider increased demand to be a negative motive for a firm's price increase and that such a price increase will be perceived as unfair, reducing consumers' willingness to purchase the firm's product.

To investigate whether consumers may change their purchase decisions due to their perception of unfair price increase, we have conducted an online survey with 140 subjects. In the survey, we tell the subjects that their valuation (i.e., usage benefit) for a new product is $100 and the price of the product is $95. This implies that at the current price all subjects should buy the product since they can derive a positive economic surplus buying the product. We then inform the subjects that the firm had been charging a lower price before (at $50, $60, $70, $80 between subjects) and that the firm has increased its price to the current level ($95) due to a demand increase. The result of the survey is illustrated in Figure 1, which shows a clear positive correlation between the purchase rate and the past retail price of the product. That is, the lower the past price of the product (relative to the current price), the lower the consumer's purchase rate (i.e. what fraction of the consumers will buy the product). In other words, a higher price increase will lead to more consumers choosing to not buy the product even though they can obtain a positive economic surplus from the purchase. We also ask the subjects why they would buy (or not buy) the product. The majority of those who choose not to buy the product say that they perceive the price increase as unfair. For example, according to one of the participants, "that is an extreme price jump nearly doubling in price and I don't feel that it is fair to the consumer even if they do get a money's worth of use out of it." Another participant has indicated that "it is unfair that they raised the prices just because they know people will pay it."

Figure 1 Survey Results



One might intuit that consumers' fairness concerns will prevent or mitigate price hikes, making consumers better off and firms worse off. While we find that this intuition holds in a centralized channel, our analysis of a decentralized channel reveals new insights about the effect of consumers' fairness concerns on the manufacturer's and its retailer's pricing strategies and their equilibrium profits. More specifically, we examine a channel, where a manufacturer sells its product through a retailer in two time periods, in a market with a growing demand, which gives both the manufacturer and the retailer an incentive to raise prices in the second period. However, there is a segment of consumers who have fairness concerns, so if the retailer raises its second-period price, there will be a demand drop in that segment of consumers due to their fairness concerns. Our analysis reveals several interesting findings.

First, the existence of consumers with fairness concerns will, in equilibrium, make the manufacturer raise its first-period wholesale price and reduce its second-period wholesale price. Our analysis reveals a critical link between the two periods when the market has a segment of consumers with fairness concerns—the lower the retailer's *first-period* retail price, the lower the manufacturer's best-response *second-period* wholesale price, which is the retailer's second-period marginal cost. So, all else equal, the retailer will have an incentive to keep its first-period retail price low. Thus, anticipating this, the manufacturer will increase its first-period wholesale price, with less concern of causing a high retail price which would reduce first-period sales. Furthermore, when the retailer charges a relatively low first-period price, it gains an incentive to charge a low price in the second period as well in order to avoid raising consumers' fairness concerns, which alleviates the double marginalization problem in the channel, giving the manufacturer an incentive to reduce its second-period wholesale price to increase unit sales in the second period.

Second, counterintuitively, consumer fairness concerns can, in equilibrium, reduce both the first-period and second-period retail prices. One might intuit that the existence of a segment of consumers with fairness concerns will induce the retailer to *raise* its first-period price so that a price increase in the second period (induced by demand growth) will lessen the demand drop due to fairness concerns. However, with a segment of fair-minded consumers in the market, the retailer has to trade off two *opposing* incentives when choosing its first-period price. On one hand, the retailer has an incentive to raise its first-period price to mitigate or eliminate the second-period demand drop due to fairness concerns. We refer to this incentive as the retailer's *fairness-mitigation incentive*. On the other hand, the retailer also has an incentive to reduce its first-period price to induce a lower second-period wholesale price, which directly lowers the retailer's marginal cost in the second period. We refer to this incentive as the retailer's *cost-reduction incentive*. When the market growth rate is relatively small, the retailer's fairness-mitigation incentive will be dominated by its cost-reduction incentive, so the retailer will *lower* its first-period price.

Third, we find that an increase in the market growth rate can induce both the manufacturer and the retailer to *decrease* their prices in both periods. More specifically, when the market growth rate becomes sufficiently high, the second-period market becomes much more "important" relative to the first-period market. So, the manufacturer gains an incentive to dramatically reduce its first-period wholesale price to induce the retailer to lower its first-period price, because a lower first-period retail price will alleviate the double-marginalization problem in the second period, allowing both the manufacturer and the retailer to extract more profit from the growing market. This occurs when the market growth rate increases from below to just above some threshold. Below the threshold, the manufacturer will choose a high first-period wholesale price to exploit the retailer's strong cost-reduction incentive (relative to its fairness-mitigation incentive) whereas above that threshold the manufacturer will charge a low first-period wholesale price to induce a low first-period retail price so as to make the channel much more efficient (coordinated) in the second period. Thus, when the market growth rate increases from below the threshold to just above it, the manufacturer's strategic paradigm shift will lead to a drop in the first-period wholesale price as well as a drop in the first-period retail price and consequently, the second-period wholesale price and the second-period retail price will also decrease.

Fourth, interestingly, though the direct effect of consumer fairness concerns will (weakly) reduce the second-period demand and hurt the manufacturer's profit, its strategic effect can help the manufacturer mitigate the double-marginalization problem and improve its profits in both periods if the market growth rate is not too large. If the market growth rate is relatively small, the retailer has a relatively stronger cost-reduction incentive than the fairness-mitigation incentive when choosing its first-period price, so the manufacturer can increase its first-period wholesale price without inducing much increase in the first-period retail price. Thus, the manufacturer's first-period profit will increase as a result of the existence of consumers with fairness concerns. In the second period, because of fairness concerns, given the retailer's not-too-high first-period price, the manufacturer knows that the retailer will have an incentive to not charge very high prices in the second period in order to mitigate the demand drop due to fairness concerns. That is, the double-marginalization problem is also alleviated in the second period, making the channel more efficient (coordinated) and allowing the manufacturer to reduce its second-period wholesale price to significantly increase its second-period sales, hence improving its second-period profit. Thus, when the market growth rate is not very large, the manufacturer's profit can increase in both periods.

Lastly, we show that the manufacturer's benefit from consumer fairness concerns does not have to come at the expense of the retailer or the consumer, i.e., the retailer and the consumer can also benefit from the existence of consumers with fairness concerns. The underlying reason is that consumer fairness concerns can allow the retailer to strategically decrease its first-period price to induce the manufacturer to lower its wholesale price in the second period. In essence, the retailer can use a low first-period mark-up (over the first-period wholesale price) to "commit" to a relatively low future retail price, sacrificing some first-period profits in order to reduce its marginal cost (wholesale price) in the second period. So, if the market growth rate is relatively large, the retailer's benefit from the second period can more than offset its loss in first-period profit. Moreover, the strategic cost-reduction effect in the second period can also raise the second-period consumer surplus enough to more than compensate for the decrease in the first-period consumer surplus (due to the manufacturer's strategically increased first-period wholesale price), thus making consumers overall better off. In summary, we find that consumer fairness concerns can lead to an all-win outcome for the manufacturer, the retailer, and the consumers.

The rest of the paper is organized as follows. In the next section, we review the related literature. The Model section introduces our core modeling framework of a decentralized channel facing a growing market with a segment of consumers having fairness concerns. In this section, we analyze two useful benchmarks: (1) no consumers in the market have fairness concerns, and (2) the case of a centralized manufacturer (selling directly to consumers). The Analysis and Results section analyzes the core model and discusses the effects of consumer fairness concerns on the equilibrium outcome in the channel. Finally, we conclude the paper with some discussions in the last section.

LITERATURE REVIEW

One significant stream of literature in consumer behavior and psychology has studied consumers' perceptions of price fairness and their impact on the consumers' purchase decisions. Kahneman et al. (1986), Sinha and Batra (1999) and Maxwell (2002) demonstrate that consumers who perceive a firm as unfair will become less willing to purchase that firm's product. Kahneman et al. (1986) document that most consumers consider it unfair for a firm to raise prices to exploit higher product demand. Campbell (1999) shows that consumers tend to consider increased demand to be a negative motive for a firm's price increase and that such a price increase will be perceived as unfair, reducing consumers' willingness to purchase the firm's product. Furthermore, a number of studies have found that consumers often take past prices as a reference point, and thus, consumers tend to perceive a firm's price increase as a loss, making them less likely to purchase from the firm. This paper takes it as given that some consumers may perceive a firm's price increase as unfair and thus be less likely to purchase the firm's product. We investigate how such fairness concerns will affect the manufacturer's and the retailer's dynamic pricing decisions and their profits. We show that, in a decentralized channel, consumer fairness concerns about price increases can actually lead to an *all-win* outcome for the manufacturer, the retailer, and the consumers.

A stream of extant literature has studied the effects of managers' and consumers' behavioral preferences on the market outcome. Fehr and Schmidt (1999) investigate peer-induced inequity aversion, where a player has some disutility if her payoff is different from what other players receive. Extant literature has also analyzed reciprocity among players (Charness and Rabin 2002), consumers' concern for their payoff standing relative to other players (Bolton and Ockenfels 2000), context-dependent preferences (Narasimhan and Turut 2013), outcome-dependent behavioral preferences (Jiang et al. 2017; Zou et al. 2019), peer-induced fairness concerns (Ho and Su 2009; Chen and Cui 2013), the existence of reference groups (Amaldoss and Jain 2008), reference products (Amaldoss and He 2017) and behavioral preferences by managers or firms (Jiang and Liu 2019; Jiang et al. 2014). Several studies have analytically investigated the effects of consumer fairness concerns in monopoly markets. Guo (2015) shows that a monopolist's ex ante profit may increase as more consumers become inequity-averse. Guo and Jiang (2016) show that consumers' fairness concerns can induce a monopolist to reduce its product quality, making consumers worse off. Li and Jain (2015) study consumers' fairness concerns that arise from price discrimination when a firm charges different prices to its existing customers versus new customers.

Note that, from a conceptual point of view, fairness concerns in the aforementioned literature can be seen as a type of loss aversion since one can frame fairness concerns as consumers being averse to paying a higher price than the reference price. In this paper, we will use the "fairness" terminology since many subjects in our survey specifically used "fair" or "unfair" to describe the firm's price increases. Some existing literature has examined firms' pricing decisions when the consumers perceive the firm's price as a gain or a loss relative to some reference price.[1] Greenleaf (1995) studies a firm selling directly to consumers and analyzes the effect of an exogenously given reference price formation process on the firm's optimal price promotions. Kopalle et al. (1996) extend Greenleaf (1995) by examining a firm that sells multiple products; they show that reference prices can lead to constant prices over time if consumers are very sensitive to losses relative to the reference prices. Kuksov and Wang (2014) show that when consumers' search cost is sufficiently small, the existence of loss-averse consumers can alleviate price competition, making firms better off. These studies on reference-dependent consumer preferences have focused on firms that sell directly to consumers.

Several papers in the literature have analyzed reference-dependent preference in distribution channels. For example, Ho and Zhang (2008) show that when the retailer's utility is reference dependent, the manufacturer's use of two-part tariffs may decrease channel efficiency. Cui et al. (2007) show that when the retailer cares about distributional fairness of channel profits, the manufacturer can achieve full channel coordination with a simple wholesale price. Zhang et al. (2014) study dynamic pricing with reference-price effects in a channel; using a continuous-time, infinite-horizon model, and assuming the consumer's reference price evolves following a differential equation with respect to time, they show that both centralized and decentralized channels always prefer that consumers have a higher initial exogenous reference price and are more sensitive to the reference-price effect. Yi et al. (2018) show that if consumers have very strong fairness concerns, the manufacturer may want to sell its product indirectly through an intermediary (i.e. an agent) rather than selling directly to consumers, because selling through an intermediary will prevent consumers from feeling unfair about the manufacturer's high profit margin.

We contribute to the aforementioned literature by explicitly studying the dynamic wholesale and retail pricing decisions in a channel that faces a segment of consumers with fairness concerns about price increases. We find that, in a decentralized channel with consumer fairness concerns, the retailer has both

[1] For a review of the reference price research, see Mazumdar et al. (2005).

fairness-mitigation and *cost-reduction* incentives when choosing its early-period price. We show that the existence of a segment of consumers with fairness concerns can lead to a win-win outcome for the manufacturer and the retailer, because it can enable the retailer to use its first-period price to alleviate the manufacturer's double-marginalization concerns in the second period, hence reducing the equilibrium second-period wholesale price, which makes the channel more efficient. We also study the role of market growth on the market outcome. Interestingly, an increase in the market growth rate can lead to a *decrease* in retail and wholesale prices in both periods. We show that when the market growth rate is not too small, consumer fairness concerns can lead to an *all-win* outcome for the manufacturer, the retailer, and the consumers.

MODEL

Consider a manufacturer selling its product through a retailer in two time periods $t \in \{1,2\}$. In each period *t*, the manufacturer sets its wholesale price (w_t), after which the retailer chooses its retail price (p_t). The manufacturer has a constant marginal cost, which, without loss of generality, we normalize to zero. We assume that the retailer's marginal cost equals the wholesale price, i.e., the retailer does not have any additional selling costs. The game proceeds as follows. First, the manufacturer chooses its first-period wholesale price (w_1). Second, the retailer chooses its first-period retail price (p_1) and subsequently, the first-period demand and sales are realized. Third, the manufacturer chooses its second-period wholesale price (w_2). Lastly, the retailer will choose its second-period retail price (p_2) and the second-period demand and sales are then realized. The manufacturer and the retailer will choose their own pricing strategies to maximize their respective overall profits from both periods.

To better identify and explain the effects of fairness concerns, let us start with a benchmark model without fairness concerns. We will use a superscript "NF" on the variables to indicate this benchmark case without fairness concerns. In the first period, the aggregate market demand is given by $D_1^{NF} = 1 - \beta p_1^{NF}$, where β represents how elastic the market demand is. Such a general reduced-form formulation for demand is commonly used in the literature (e.g., McGuire and Staelin 1983, Moorthy 1988). Market demand is expected to grow in the second period, e.g., due to positive word-of-mouth from first-period customers or other exogenous factors. To capture the market growth, we assume that the second-period market demand will become $D_2^{NF} = 1 + \delta - \beta p_2^{NF}$, where δ represents the growth rate.[2] One can solve the equilibrium outcome using backward induction. All proofs in this paper have been relegated to the Appendix or Online Appendix.

As a side note, we would like to point out that our reduced-form demand model can be mapped into a consumer utility-based model. For example, in the first period, the consumers' valuation for quality (θ) is uniformly distributed on the interval $[0, 1]$, whereas in the second period, the upper bound of that distribution increases (e.g., due to positive reviews, which may increase product's perceived value and also encourage more quality-sensitive consumers to consider the product). Such a model with consumer utility micro-foundation ($u = q\theta - p$) will lead to a linear demand function similar to our model; our main insights should thus persist in such a model.

LEMMA 1. *In equilibrium, the manufacturer's first-period and second-period wholesale prices are given by* $w_1^{*NF} = \frac{1}{2\beta}$ *and* $w_2^{*NF} = \frac{1+\delta}{2\beta}$, *and the retailer's prices are* $p_1^{*NF} = \frac{3}{4\beta}$ *and* $p_2^{*NF} = \frac{3(1+\delta)}{4\beta}$. *The equilibrium unit sales in the two periods are* $D_1^{*NF} = \frac{1}{4}$ *and* $D_2^{*NF} = \frac{1+\delta}{4}$, *respectively. The manufacturer's and the retailer's equilibrium profits are* $\pi_M^{*NF} = \frac{1+(1+\delta)^2}{8\beta}$ *and* $\pi_R^{*NF} = \frac{1+(1+\delta)^2}{16\beta}$, *respectively.*

Lemma 1 characterizes the manufacturer's and the retailer's equilibrium strategies. As one would expect, when the demand potential (i.e. the demand intercept) increases over time, both the wholesale and retail prices tend to increase, i.e. $w_2^{*NF} > w_1^{*NF}$ and $p_2^{*NF} > p_1^{*NF}$. We will show later that, if there exists a

[2] In the Online Appendix, we analyze an alternative demand model where the second-period demand (without fairness concerns) is $D_2^{NF} = (1+\delta)(1 - \beta p_2^{NF})$, rather than $D_2^{NF} = 1 + \delta - \beta p_2^{NF}$. We show that similar to our core model, the existence of consumer fairness concerns can still give the retailer both the fairness-mitigation and cost-reduction incentives, albeit the fairness-mitigation incentive is weakened; thus, most of our main results can hold across these two types of demand models. Note that, for growth factors such as positive word-of-mouth, the consumers' valuations for the product tend to increase, and hence our demand growth model of $D_2^{NF} = 1 + \delta - \beta p_2^{NF}$ is actually more reasonable than the alternative multiplicative demand model that we present in the Online Appendix.

positive fraction of consumers having fairness concerns, the firms' equilibrium prices can exhibit different patterns, e.g., the wholesale price in the first period may be higher than that in the second period.

Next, we explain how we model consumer fairness concerns. Again, the first-period demand function is given by $D_1 = 1 - \beta p_1$. Note that, as shown in Lemma 1, demand growth (δ) in the second period gives the retailer an incentive to increase its price. However, as documented by Kahneman et al. (1986), most consumers consider it unfair for a firm to raise prices to exploit higher product demand. Campbell (1999) also shows that consumers tend to consider increased demand to be a negative motive for a firm's price increase and that such a price increase will be perceived as unfair, reducing consumers' willingness to purchase the firm's product. Moreover, a number of studies, including our own survey, have found that consumers often take past prices as a reference point, and thus, consumers tend to perceive a firm's price increase as a loss, making them less likely to buy the firm's product. To capture how fairness concerns affect the firm's demand function, we assume that consumers can be of two types—one with fairness concerns, and one without fairness concerns. Let $\lambda \in (0,1)$ denote the fraction of consumers with fairness concerns and $1 - \lambda$ be the fraction of consumers without fairness concerns.[3] For consumers with fairness concerns, the demand will be negatively affected if the second-period price increases from the first period. We can express the retailer's second-period aggregate demand function as $D_2 = \lambda(1 + \delta - \beta p_2 - \gamma \max\{p_2 - p_1, 0\}) + (1 - \lambda)(1 + \delta - \beta p_2)$, where $\gamma \max\{p_2 - p_1, 0\}$ captures the potential negative effect of fairness concerns on demand and γ represents the strength of the consumers' fairness concerns. In essence, the second-period demand is a weighted average of the two segments of consumers. Note that if the retailer does not increase its second-period price (i.e., $p_2 \leq p_1$), the second-period demand will simply be $D_2 = 1 + \delta - \beta p_2$.

In essence, the first-period retail price (p_1) serves as the consumer's reference price in the second period. If the second-period retail price p_2 is higher than p_1, some second-period consumers will perceive

[3] Note that a price increase may not trigger fairness concerns in consumers who are not aware of lower past prices. In our model, we essentially include those consumers who are not aware of past prices in the segment of consumers with fairness concerns.

it as unfair and may decide not to buy the product, resulting in a demand drop (represented by $\gamma \max\{p_2 - p_1, 0\}$) from the segment of consumers with fairness concerns.

Centralized-Channel Benchmark

Before we proceed to analyze the core model, we analyze another benchmark where the manufacturer sells its product directly to the consumers (i.e., a centralized channel) in a market with a positive fraction of consumers having fairness concerns. Other aspects of the model are the same as those in the core model. We will use a tilde on a variable to indicate the current case of a centralized channel. Note that the first-period and second-period demand functions are the same as what we have specified in the core model: $\widetilde{D}_1 = 1 - \beta\tilde{p}_1$ and $\widetilde{D}_2 = \lambda\,(1 + \delta - \beta\tilde{p}_2 - \gamma \max\{\tilde{p}_2 - \tilde{p}_1, 0\}) + (1-\lambda)(1 + \delta - \beta\tilde{p}_2)$. The centralized manufacturer's total profit can be expressed as $\tilde{\pi} = \widetilde{D}_1\,\tilde{p}_1 + \widetilde{D}_2\,\tilde{p}_2$. This game is easily solved by backward induction. Lemma 2 shows that, when a positive fraction of consumers have fairness concerns, the manufacturer's equilibrium pricing strategies in *both* periods depend on the market growth rate.

LEMMA 2. *In a market with consumer fairness concerns, the centralized manufacturer's equilibrium first-period and second-period prices are given by*

$$\tilde{p}_1^* = \begin{cases} \frac{2+\delta}{4\beta} & \text{if } 0 \le \delta < \frac{2\gamma\lambda}{2\beta-\gamma\lambda} \\ \frac{2\beta+\gamma\lambda(3+\delta)}{4\beta^2+4\beta\gamma\lambda-\gamma^2\lambda^2} & \text{if } \frac{2\gamma\lambda}{2\beta-\gamma\lambda} \le \delta < \frac{2\beta^2+\beta\gamma\lambda-\gamma^2\lambda^2}{\beta\gamma\lambda} \\ \frac{1+\delta}{2\beta} & \text{if } \delta \ge \frac{2\beta^2+\beta\gamma\lambda-\gamma^2\lambda^2}{\beta\gamma\lambda} \end{cases}, \textit{ and}$$

$$\tilde{p}_2^* = \begin{cases} \frac{2+\delta}{4\beta} & \text{if } 0 \le \delta < \frac{2\gamma\lambda}{2\beta-\gamma\lambda} \\ \frac{2\beta(1+\delta)+\gamma\lambda}{4\beta^2+4\beta\gamma\lambda-\gamma^2\lambda^2} & \text{if } \frac{2\gamma\lambda}{2\beta-\gamma\lambda} \le \delta < \frac{2\beta^2+\beta\gamma\lambda-\gamma^2\lambda^2}{\beta\gamma\lambda} \\ \frac{1+\delta}{2\beta} & \text{if } \delta \ge \frac{2\beta^2+\beta\gamma\lambda-\gamma^2\lambda^2}{\beta\gamma\lambda} \end{cases}, \textit{ respectively.}$$

Note that if no consumers have fairness concerns (i.e. $\lambda = 0$), the centralized manufacturer's optimal first-period price, $\tilde{p}_1^{*NF} = \frac{1}{2\beta}$, does *not* depend on the market growth rate of the second period. But if some positive fraction ($\lambda > 0$) of consumers have fairness concerns, the manufacturer, when choosing its optimal first-period price, will have to weigh the impact of its first-period price on its *second-period* demand. Note that since the second-period demand intercept is higher than that of the first-period demand, the firm's optimal price will naturally tend to increase in the second period. However, we can see from the second-period demand function that if the firm's second-period price is higher than its first-period price, the second-period demand intercept will experience a drop of $\gamma(\tilde{p}_2 - \tilde{p}_1)$, because some consumers who feel the price increase as unfair may no longer buy the product. Thus, the manufacturer will have an incentive to *lower* its second-period price, and it will also have some incentive to *raise* its first-period price so as to avoid triggering too much negative backlash (due to fairness concerns) on the second-period demand. As one can verify from Lemma 2, consumers' fairness concerns will indeed reduce a centralized manufacturer's optimal second-period price (i.e., $\tilde{p}_2^* < \frac{1+\delta}{2\beta} = \tilde{p}_2^{*NF}$) and increase its optimal first-period price (i.e., $\tilde{p}_1^* > \frac{1}{2\beta} = \tilde{p}_1^{*NF}$), unless the market growth rate is very large. When the market growth rate is sufficiently large (i.e., $\delta \geq \frac{2\beta^2+\beta\gamma\lambda-\gamma^2\lambda^2}{\beta\gamma\lambda}$), the manufacturer's optimal second-period price when facing $\lambda > 0$ fraction of consumers with fairness concerns will be the same as that when no consumers have fairness concerns ($\lambda = 0$). This is because a large δ will make the first-period market so small relative to the second-period market that the manufacturer will find it optimal to set a high second-period price to achieve maximum second-period profits as if no consumers have fairness concerns, and to set the same high price in the first period to avoid triggering fairness concerns in the second period.

Moreover, one can easily show from Lemma 2 that $\frac{d\tilde{p}_1^*}{d\delta} > 0$ and $\frac{d\tilde{p}_2^*}{d\delta} > 0$, i.e., when there is a positive fraction of consumers having fairness concerns, a higher market growth rate (δ) will lead to higher equilibrium prices in *both* periods. This is intuitive. As δ increases (the second-period demand intercept is higher), the retailer gains more incentives to raise its second-period price, thus it also has an incentive to increase its first-period price $\tilde{p}_1$ to lessen the second-period demand drop (of $\gamma(\tilde{p}_2 - \tilde{p}_1)$) due to fairness concerns.

From Lemma 2, we can easily obtain the centralized manufacturer's equilibrium profit:

$$\tilde{\pi}^* = \begin{cases} \frac{(2+\delta)^2}{8\beta} & \text{if } 0 \le \delta < \frac{2\gamma\lambda}{2\beta-\gamma\lambda} \\ \frac{\beta(1+(1+\delta)^2+\gamma\lambda(2+\delta))}{4\beta^2+4\beta\gamma\lambda-\gamma^2\lambda^2} & \text{if } \frac{2\gamma\lambda}{2\beta-\gamma\lambda} \le \delta < \frac{2\beta^2+\beta\gamma\lambda-\gamma^2\lambda^2}{\beta\gamma\lambda} \\ \frac{(1+\delta)^2}{4\beta} & \text{if } \delta \ge \frac{2\beta^2+\beta\gamma\lambda-\gamma^2\lambda^2}{\beta\gamma\lambda} \end{cases}.$$

As one would expect, the existence of a segment of consumers with fairness concerns tends to reduce the manufacturer's profit, i.e., $\tilde{\pi}^* < \frac{1+(1+\delta)^2}{4\beta} = \tilde{\pi}^{*NF}$, where $\tilde{\pi}^{*NF}$ is the centralized manufacturer's profit if there are no consumers with fairness concerns. Next, we show that the aforementioned results may no longer hold if the manufacturer sells its product through a retailer (i.e., a decentralized channel).

ANALYSIS AND RESULTS

We now return to analyze our core model where the manufacturer sells its product through an independent retailer in a market that has a segment ($\lambda > 0$) of consumers having fairness concerns. In the following analysis, we assume that the market growth rate is below some threshold (denoted by δ^{**}) such that in equilibrium the retailer will serve a positive fraction of consumers in the first period. We will discuss the case of $\delta \ge \delta^{**}$ in the Discussion and Conclusion section.

The manufacturer's and the retailer's total profits can be written as: $\pi_R = \pi_{R1} + \pi_{R2}$ and $\pi_M = \pi_{M1} + \pi_{M2}$, respectively, where π_{Rt} is the retailer's profit and π_{Mt} is the manufacturer's profit in period $t = 1, 2$. The game proceeds as follows. First, the manufacturer chooses its first-period wholesale price (w_1). Second, the retailer chooses its first-period retail price (p_1) and subsequently, the first-period demand and sales are realized. Third, the manufacturer chooses its second-period wholesale price (w_2). Lastly, the retailer will choose its second-period retail price (p_2) and the second-period demand and sales are then realized. The manufacturer and the retailer will choose their own pricing strategies to maximize their respective overall profits from both periods. We solve the game by backward induction. More specifically, given the first-period prices, the retailer chooses its second-period price p_2 to maximize π_{R2}, and the manufacturer, anticipating the retailer's best-response, chooses its second-period wholesale price w_2 to maximize its second-period profit π_{M2}. After finding the second-period subgame equilibrium outcome, we proceed to solving for the first-period equilibrium prices. Namely, the retailer chooses p_1 to maximize its overall profit π_R, and the manufacturer chooses w_1 to maximize its overall profit π_M. All the details of the technical analysis are provided in the Appendix.

PROPOSITION 1. *If* $p_1 < \hat{P}$, *then* $\frac{\partial w_2^*(p_1)}{\partial p_1} > 0$, *where* $\hat{P} \equiv \frac{(1+\delta)(\sqrt{2\gamma\lambda(\beta+\gamma\lambda)}+6\beta+2\gamma\lambda)}{4\beta(2\beta+\gamma\lambda)}$. *In words, a higher* (*lower*) *first-period retail price will lead to a higher* (*lower*) *second-period subgame equilibrium wholesale price, provided that the first-period retail price is not too high.*

Proposition 1 identifies an important strategic link between the two periods that is not present in the benchmark model where consumers do not have fairness concerns. Recall from Lemma 1 that when consumers do not have fairness concerns, the manufacturer's optimal second-period wholesale price does *not* depend on the first-period outcome (in particular, the *first-period* retail price). However, as Proposition 1 reveals, when there is a segment of consumers with fairness concerns, the manufacturer's optimal second-period wholesale price (w_2) will depend on the first-period retail price (p_1). More specifically, when p_1 is below the threshold $\hat{P}$, a decrease in the retailer's first-period price p_1 will induce the manufacturer to lower its second-period wholesale price $w_2^*(p_1)$. Let us carefully decipher why this occurs. Note that if the retailer sets a low first-period retail price p_1, it will, in the second period, face a demand drop in the segment of consumers with fairness concerns if it charges a higher second-period price p_2. All else constant, the lower p_1 is, the higher this demand drop $\gamma(p_2 - p_1)$ will be, which gives the retailer an incentive to lower its p_2; more formally, $\frac{\partial p_2^*(p_1,w_2)}{\partial p_1} > 0$. Thus, by choosing a low p_1, the retailer essentially commits to not charging a high markup in the second period, because charging a high p_2 will significantly dampen the second-period demand. Anticipating this, when seeing a lowered first-period retail price p_1, the manufacturer knows that the double-marginalization problem in the second period will be less severe, i.e., holding w_2 constant, the lower the first-period retail price p_1, the lower the retailer's second-period markup, $\frac{p_2^*(p_1,w_2)-w_2}{w_2}$, will be. Put differently, a lower p_1 will lead to a higher retail pass-through rate; that is, when choosing its second-period price, the retailer will pass a higher fraction of any decrease in w_2 to the consumer. Thus, a lower p_1 will give the manufacturer more incentive to reduce its w_2 to increase its second-period sales, i.e., mathematically, $\frac{dw_2^*(p_1)}{dp_1} > 0$.

Given the above strategic link between the two periods, the retailer will have an incentive to lower its p_1 to induce a lower second-period wholesale price (w_2), which effectively reduces the retailer's second-period marginal cost. We refer to this incentive as the retailer's *cost-reduction incentive*. Note that the retailer's cost-reduction incentive exists even if the market growth rate (δ) is zero. But a larger δ implies a higher second-period demand (i.e., the retailer will tend to have higher unit sales in the second period), which, for any given drop in w_2, will result in a *higher* increase in the retailer's second-period profit. Thus, a higher market growth rate can give the retailer more incentive to lower its p_1 so as to obtain lower w_2. Lemma 3 shows that indeed the manufacturer's and the retailer's full-equilibrium pricing strategies depend on the market growth rate. For convenience, we have implicitly defined, in the proof of Lemma 3, a critical threshold δ^* for the market growth rate, above which there exists a paradigm shift for the manufacturer's and the retailer's pricing strategies. In the proof of Lemma 3, we also define the critical threshold δ^{**}, above which, in equilibrium, there will be no sales in the first period.

LEMMA 3. *In a market with consumer fairness concerns, the equilibrium wholesale and retail prices are given by*:

$$w_1^* = \begin{cases} \hat{w} & \text{if } 0 \le \delta < \delta^* \\ \frac{128\beta^4+16\beta^3\gamma\lambda(17+\delta)+8\beta^2\gamma^2(17+2\delta)\lambda^2+\beta\gamma^3(\delta-7)\lambda^3+\gamma^4\lambda^4}{32\beta^2(8\beta^3+16\beta^2\gamma\lambda+7\beta\gamma^2\lambda^2-\gamma^3\lambda^3)} & \text{if } \delta^* \le \delta < \delta^{**}, \end{cases}$$

$$p_1^* = \begin{cases} \frac{3(1+\delta)}{4\beta+\gamma\lambda} & \text{if } 0 \le \delta < \delta^* \\ \frac{24\beta^2+3\beta\gamma(9+\delta)\lambda-\gamma^2\lambda^2}{4\beta(8\beta^2+8\beta\gamma\lambda-\gamma^2\lambda^2)} & \text{if } \delta^* \le \delta < \delta^{**}, \end{cases}$$

$$w_2^* = \begin{cases} \frac{2(1+\delta)}{4\beta+\gamma\lambda} & \text{if } 0 \le \delta < \delta^* \\ \frac{32\beta^3(1+\delta)+8\beta^2\gamma\lambda(7+4\delta)-\beta\gamma^2\lambda^2(\delta-23)-\gamma^3\lambda^3}{8\beta(8\beta^3+16\beta^2\gamma\lambda+7\beta\gamma^2\lambda^2-\gamma^3\lambda^3)} & \text{if } \delta^* \le \delta < \delta^{**}, \end{cases}$$

$$p_2^* = \begin{cases} \frac{3(1+\delta)}{4\beta+\gamma\lambda} & \text{if } 0 \le \delta < \delta^* \\ \frac{96\beta^3(1+\delta)+24\beta^2\gamma\lambda(7+4\delta)-3\beta\gamma^2\lambda^2(\delta-23)-3\gamma^3\lambda^3}{16\beta(8\beta^3+16\beta^2\gamma\lambda+7\beta\gamma^2\lambda^2-\gamma^3\lambda^3)} & \text{if } \delta^* \le \delta < \delta^{**}. \end{cases}$$

where $\hat{w}$ is given in the proof of Lemma 3.

By comparing the equilibrium wholesale prices in Lemma 3 with those in the benchmark without fairness concerns (as in Lemma 1), Proposition 2 shows that the existence of consumers with fairness concerns in the market will, in equilibrium, increase the manufacturer's first-period wholesale price and decrease its second-period wholesale price.

PROPOSITION 2. *When a fraction of consumers have fairness concerns, the manufacturer will, in equilibrium, charge a higher first-period wholesale price and a lower second-period wholesale price than when consumers do not have fairness concerns, i.e.* $w_1^* > w_1^{*NF}$ *and* $w_2^* < w_2^{*NF}$.

First, let us examine the intuition of $w_1^* > w_1^{*NF}$. Recall from Proposition 1, when facing a positive segment of consumers with fairness concerns, the retailer has an incentive to lower its p_1 to induce a lower second-period wholesale price (w_2). Anticipating this, the manufacturer will increase its first-period wholesale price (w_1) to exploit its first-period profit margin, with less concern of causing much higher retail price that would reduce its first-period sales. In essence, the manufacturer can benefit from the alleviation of the double-marginalization problem in the first period by charging a higher w_1. Thus, $w_1^* > w_1^{*NF}$.

Now, let us examine the intuition of $w_2^* < w_2^{*NF}$. One may intuit that the presence of consumers with fairness concerns will allow the manufacturer to raise its second-period wholesale price without worrying about causing the retailer to increase its second-period price too much (since that would give the retailer a large demand drop due to fairness concerns). However, recall from Proposition 1, as long as the retailer's first-period price (p_1) is low enough to generate positive sales in the first period, the presence of a segment of consumers with fairness concerns will allow the retailer to lower its first-period retail price to obtain a lower second-period wholesale price (w_2). In other words, any not-too-high first-period retail price will essentially commit the retailer to not charging too high a second-period price, which alleviates the double-marginalization problem in the second period, giving the manufacturer an incentive to reduce its second-period wholesale price to increase unit sales in the second period.

We now turn to examine how the retailer's prices are affected by the existence of consumers with fairness concerns. Proposition 3 shows that the presence of a segment of consumers with fairness concerns can reduce the equilibrium retail prices in both periods when the market growth rate is relatively small.

PROPOSITION 3. *For* $\delta < \frac{\gamma\lambda}{4\beta}$, $p_1^* < p_1^{*NF}$ *and* $p_2^* < p_2^{*NF}$. *That is, when the market growth rate is relatively small, the presence of a segment of consumers with fairness concerns will in equilibrium reduce both the first-period and second-period retail prices.*

One may intuit that consumer fairness concerns will induce the retailer to increase its first-period retail price (p_1) and reduce its second-period price (p_2) to mitigate or eliminate the demand drop due to fairness concerns. This intuition has been shown to hold for the case of an integrated manufacturer, i.e. a manufacturer selling directly to consumers (see the discussion following Lemma 2). However, as Proposition 3 shows, in a *decentralized* channel, the existence of consumer fairness concerns can actually lead to a lower retail price not only in the second period, but also in the first period. The intuition for this result hinges on the fact that, in a decentralized channel, a lower first-period retail price (p_1) will induce a lower second-period wholesale price (w_2) when there is a segment of consumers with fairness concerns in the market (as shown in Proposition 1). Note that, with a segment of fair-minded consumers in the market, the retailer has to trade off two opposing incentives when selecting its first-period price. On one hand, the retailer has an incentive to raise p_1 to mitigate or eliminate the second-period demand drop due to fairness concerns (as represented by the γ term). We refer to this incentive as the retailer's *fairness-mitigation incentive*. On the other hand, the retailer also has an incentive to reduce p_1 to induce a lower second-period wholesale price (w_2), which directly lowers the retailer's marginal cost in the second period. We refer to this incentive as the retailer's *cost-reduction incentive*. Note that, intuitively speaking, when the market growth rate, δ, is relatively small, the retailer's second-period price will tend to be only a little higher than its first-period price, and thus, the retailer's profit loss due to consumers' fairness concerns will be small. So, when δ is small enough ($\delta < \frac{\gamma\lambda}{4\beta}$), the retailer's fairness-mitigation incentive will be dominated by its cost-reduction incentive, making it optimal for the retailer to choose a low first-period price, i.e., $p_1^* < p_1^{*NF}$. As the market growth increases to $\delta > \frac{\gamma\lambda}{4\beta}$, the retailer's fairness-mitigation incentive will start to dominate its cost-reduction incentive, leading to $p_1^* > p_1^{*NF}$.

One may wonder whether a higher market growth rate will always imply higher equilibrium retail prices in a market with consumer fairness concerns, as is the case in the direct-selling (centralized-channel) benchmark. Proposition 4 shows that this may not hold true in a decentralized channel.

PROPOSITION 4. *In a decentralized channel with fair-minded consumers, an increase in the market growth rate (δ) can lead to a decrease in retail and wholesale prices in both periods.*

Proposition 4 shows that an increase in the market growth rate δ may induce both the manufacturer and the retailer to *decrease* their prices. When δ is small, knowing that the retailer has strong cost-reduction incentive of keeping p_1 low, the manufacturer will find it optimal to raise w_1 to exploit the retailer; as δ increases, w_1 will increase at a higher rate than p_1. However, when δ becomes sufficiently high (i.e., it reaches δ^*), the second-period market becomes relatively more important for the manufacturer, so the manufacturer will strategically give up some of its first-period profit to significantly increase its second-period profit. More specifically, the manufacturer will prefer to significantly decrease its w_1 to induce a substantial reduction in p_1, which will alleviate the double-marginalization problem in the second period, making the channel much more efficient (coordinated). This strategic paradigm shift is illustrated in Figures 2 and 3. Thus, when the market growth rate increases from just below δ^* to just above it, the first-period wholesale price and the first-period retail price will both decrease, and consequently, the second-period wholesale price and the second-period retail price will also exhibit a drop.

Figure 2 Equilibrium Retail Prices[4]

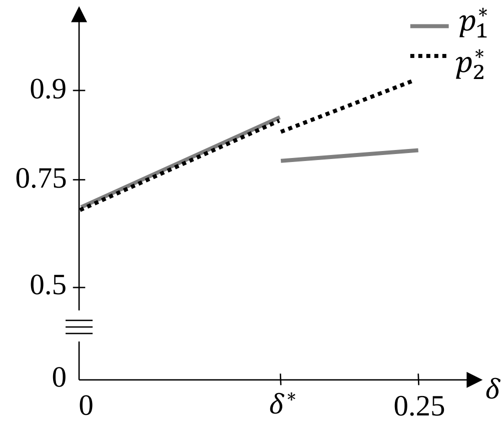
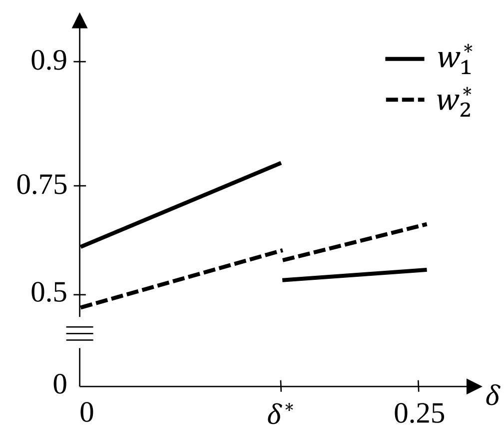


Figure 3 Equilibrium Wholesale Prices



So far, we have analyzed the manufacturer's and the retailer's pricing strategies when facing a positive fraction of consumers with fairness concerns. Now, we examine how the existence of consumers with fairness concerns affects the firms' profits. Let us start with the manufacturer's profit.

PROPOSITION 5. *There exists $\bar{\delta} > 0$ such that if $\delta \in [0, \bar{\delta})$, then $\pi_{M1}^* > \pi_{M1}^{*NF}$ and $\pi_{M2}^* > \pi_{M2}^{*NF}$. That is, the existence of consumers with fairness concerns increases both the manufacturer's first-period profit and its second-period profit.*

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[4] Figures 2 and 3 are illustrated using $\beta = 1$, $\gamma = \frac{1}{3}$ and $\lambda = \frac{1}{4}$.

One may intuit that in a market with consumer fairness concerns, the manufacturer's unit sales and profit will tend to decrease since the existence of consumer fairness concerns will never increase the second-period demand but can directly reduce the second-period demand intercept (in case of a price increase). Interestingly, in a decentralized channel setting, the strategic effect of consumer fairness concerns can help the manufacturer to mitigate the double-marginalization problem in *both* periods. In the first period, knowing that the retailer has a relatively stronger cost-reduction incentive than the fairness-mitigation incentive (as explained before), the manufacturer can increase its first-period wholesale price without resulting in much increase in the first-period retail price, hence its first-period profit will increase as a result of the existence of consumers with fairness concerns. In the second period, because of fairness concerns, given that the retailer's relatively low first-period price, the manufacturer knows that the retailer will have an incentive to not charge very high prices in the second period to mitigate the demand drop due to fairness concerns. That is, the double-marginalization problem is also alleviated in the second period, making the channel more efficient (coordinated) and allowing the manufacturer to reduce its second-period wholesale price to significantly increase its second-period sales, hence improving its second-period profit. Proposition 5 shows that the above insight holds as long as the market growth rate is not too large. Note that when the market growth rate is very large, the retailer will find it optimal to set a fairly high first-period price to mitigate the fairness concerns in the second period, even taking into account its cost-reduction incentive; the high first-period retail price will significantly reduce or eliminate first-period sales, thus reducing the manufacturer's first-period profit (though its second-period profit increases).

How does the existence of consumer fairness concerns affect the retailer's profit? One might suspect that the manufacturer's benefit from consumer fairness concerns will come at the expense of the retailer. Proposition 6 shows that, interestingly, both the manufacturer and the retailer can benefit from the existence of a segment of consumers with fairness concerns.

PROPOSITION 6. *The existence of a segment of consumers with fairness concerns can benefit both the manufacturer and the retailer if the market growth rate is not too small.*

As Proposition 6 shows, the manufacturer's benefit from consumer fairness concerns does not have to come at the expense of the retailer, i.e., the retailer can also benefit from having a segment of consumers with fairness concerns in the market. The underlying reason also hinges on the fact that consumer fairness concerns can allow the retailer to decrease its first-period retail price to induce the manufacturer to lower its wholesale price in the second period. As discussed before, essentially, the retailer can commit to less incentives for charging high future prices by choosing a low first-period price, which will sacrifice some or all of its first-period profits so as to reduce its marginal cost in the second period. So, when the market growth rate is large, the retailer's benefit from reduced marginal cost in the second period can more than offset its loss in first-period profits. Thus, consumer fairness concerns, though having a negative direct effect on the second-period demand, can lead to a win-win outcome for both the manufacturer and the retailer. Furthermore, even though the existence of a segment of consumers with fairness concerns may reduce the first-period consumer surplus, the strategic cost-reduction effect in the second period can raise the second-period consumer surplus enough to more than compensate for the first-period decrease. That is, consumers' fairness concerns can be an all-win situation for the manufacturer, the retailer, and the consumers.

DISCUSSION AND CONCLUSION

When a firm experiences an increase in its product's demand, the firm has an incentive to raise its price to increase its profit. However, such price increases may lead to negative responses from some consumers. As our survey shows, a higher price increase will lead to more consumers choosing to not buy the product even though they can obtain a positive economic surplus from the purchase; many consumers indicated their reason for not buying the product was that they considered the price increase to be unfair. In this paper, we have analyzed the effects of such fairness concerns in a distribution channel. One might intuit that consumers' fairness concerns will prevent or mitigate price hikes, making firms worse off. This paper provides an analytical framework to investigate whether this intuition will always hold in a market with a segment of consumers having fairness concerns and how fairness concerns affect the dynamic pricing decisions in a channel. We have examined a decentralized channel, where a manufacturer sells its product through a retailer in two time periods in a market with a segment of consumers having fairness concerns. In our model, if the retailer raises its second-period price above its first-period price, there will be an extra demand drop due to consumers' fairness concerns. Our analysis of such a marketplace reveals several interesting findings.

First, consumer fairness concerns will, in equilibrium, make the manufacturer raise its first-period wholesale price and reduce its second-period wholesale price. Our analysis identifies a critical strategic link between the two periods when the market has a segment of consumers with fairness concerns—the lower the retailer's *first-period* retail price, the lower the manufacturer's best-response *second-period* wholesale price (i.e., the lower the retailer's second-period marginal cost). This gives the retailer an incentive to keep its first-period retail price low. Thus, anticipating the retailer's cost-reduction incentive when choosing its first-period retail price, the manufacturer will *increase* its first-period wholesale price, with less concern of causing a high retail price that would significantly reduce first-period sales. Moreover, with a segment of consumers with fairness concerns in the market, any not-too-high first-period retail price will essentially commit the retailer to not charging too high a second-period price, alleviating the double-marginalization problem in the second period, giving the manufacturer more incentive to reduce its second-period wholesale price to increase unit sales in the second period.

Second, consumer fairness concerns can reduce *both* the first-period and second-period retail prices. One might intuit that the existence of consumers with fairness concerns will induce the retailer to *raise* its first-period price so that a price increase in the second period will mitigate or eliminate the demand drop due to fairness concerns. Our analysis reveals that, with a segment of fair-minded consumers in the market, the retailer has to trade off two opposing incentives when choosing its first-period price. On one hand, the retailer has a fairness-mitigation incentive to raise its first-period price to mitigate or eliminate the second-period demand drop due to fairness concerns. On the other hand, the retailer also has a cost-reduction incentive to reduce its first-period price to induce a lower second-period wholesale price, which directly lowers the retailer's marginal cost in the second period. When the market growth rate is relatively small, the retailer's fairness-mitigation incentive will be dominated by its cost-reduction incentive, so the retailer will *lower* its first-period price.

Third, interestingly, an increase in the market demand can induce both the manufacturer and the retailer to *decrease* their prices. This occurs when the market growth rate increases from below to above a threshold such that the manufacturer will switch from a high first-period wholesale price to a low first-period wholesale price. Below the growth threshold, the manufacturer finds it optimal to exploit the retailer's strong cost-reduction incentive by charging a high wholesale price; by contrast, above the threshold, the manufacturer will find it optimal to significantly reduce its first-period wholesale price to induce a low first-period retail price so as to make the channel much more efficient in the second period. Thus, when the market growth rate increases from below the threshold to just above it, the manufacturer's strategic paradigm shift will lead to a drop in the first-period wholesale price as well as a drop in the first-period retail price and consequently, the second-period wholesale price and the second-period retail price will also decrease.

Fourth, though the direct effect of consumer fairness concerns reduces the second-period demand, its strategic effect can help the manufacturer mitigate the double-marginalization problem and improve its profits in both periods if the market growth rate is not too high. As we have shown, if the growth rate is relatively small, the retailer has a stronger cost-reduction incentive than the fairness-mitigation incentive when choosing its first-period price, so the manufacturer can increase its first-period wholesale price without inducing much increase in the first-period retail price. Thus, the manufacturer's first-period profit will increase as a result of the existence of consumers with fairness concerns. In the second period, because of fairness concerns, given the not-very-high first-period retail price, the manufacturer knows that the retailer will have an incentive to not charge very high prices in the second period in order to mitigate the demand drop due to fairness concerns. That is, the double-marginalization problem is also alleviated in the second period, making the channel more efficient and allowing the manufacturer to reduce its second-period wholesale price to significantly increase its second-period sales, hence improving its second-period profit. Thus, when the market growth rate is not very large, the manufacturer's profit can increase in both periods.

Lastly, the manufacturer's benefit from consumer fairness concerns does not have to come at the expense of the retailer or the consumer; in fact, the retailer and the consumer can also benefit from the existence of consumers with fairness concerns, because consumer fairness concerns allow the retailer to reduce its first-period price to obtain a lower wholesale price in the second period. If the market growth rate is relatively large, the retailer's benefit from the second period can more than offset its loss in first-period profit. In that parameter region, the increase in the second-period consumer surplus due to reduced double marginalization can more than offset the first-period drop in consumer surplus (due to a significant increase in the first-period wholesale price). In summary, we find that consumer fairness concerns can lead to an all-win outcome for the manufacturer, the retailer, and the consumer.

We conclude the paper with some discussions about our analysis and future research. Note that our core analysis has focused on the more representative case of $\delta \in [0, \delta^{**}]$, where in equilibrium the retailer has a positive market share in both periods. One can show that, with a market growth rate $\delta > \delta^{**}$, the retailer's first-period equilibrium price satisfies $p_1^* > \frac{1}{\beta}$, which leads to zero first-period sales; our model essentially becomes a model where the firms sell the product only in the second period but the retailer can choose the reference price (p_1) before selling starts in the second period. Our analysis reveals that, in that case, even though the retailer can costlessly choose any p_1 (e.g., infinity) to be the consumer's reference price, it actually prefers a relatively low reference price. This is because, in a decentralized channel, the retailer's optimal choice of the reference price (p_1) will have to balance its fairness-mitigation incentive and its cost-reduction incentive. This directly contrasts the finding of Zhang et al. (2014) that firms will always prefer consumers' having higher initial reference prices.

We have assumed that the market growth rate is an exogenous trend expected in the market. Future research can study how consumer fairness concerns will affect the firms' incentives to create market demand (e.g., by investing in advertising or other marketing campaigns). Moreover, it may also be interesting to study a competitive market to explore additional insights regarding consumer fairness concerns, albeit the model and analysis will be even more complex and one would have to simplify the model in other aspects to ensure analytical tractability. We leave it to future research for such exploration, which is worth its own separate study.

APPENDIX

PROOF OF LEMMA 1. Lemma 1 shows the manufacturer's and the retailer's first-period and second-period wholesale and retail prices in a decentralized channel with no consumers having fairness concerns. The results of Lemma 1 can be easily solved using backward induction. We will first find the second-period subgame equilibrium outcome and then solve for the first-period equilibrium. In the second period, for a given second-period wholesale price w_2^{NF}, the retailer chooses p_2^{NF} to maximize its second-period profit $\pi_{R2}^{NF} = D_2^{NF}(p_2^{NF} - w_2^{NF})$, where $D_2^{NF} = 1 + \delta - \beta p_2^{NF}$. One can show that the retailer's optimal second-period price is interior at $p_2^{*NF} = \frac{1+w_2^{NF}\beta+\delta}{2\beta}$. Then the second-period market demand has become $D_2^{*NF} = \frac{1+\delta-\beta w_2^{NF}}{2}$. Next, the manufacturer chooses w_2^{NF} to maximize its second-period profit $\pi_{M2}^{NF} = D_2^{*NF} w_2^{NF} = \frac{1+\delta-\beta w_2^{NF}}{2} * w_2^{NF}$. One can show that the manufacturer's optimal second-period wholesale price is $w_2^{*NF} = \frac{1+\delta}{2\beta}$. Plugging in w_2^{*NF}, we can get the retailer's second-period retail price: $p_2^{*NF} = \frac{3(1+\delta)}{4\beta}$. The retailer's and the manufacturer's second-period profits are given by: $\pi_{R2}^{*NF} = \frac{(1+\delta)^2}{16\beta}$, $\pi_{M2}^{*NF} = \frac{(1+\delta)^2}{8\beta}$.

In the first period, for a given first-period wholesale price w_1^{NF}, the retailer chooses p_1^{NF} to maximize its total profit $\pi_R^{NF} = D_1^{NF}(p_1^{NF} - w_1^{NF}) + \pi_{R2}^{*NF}$, where $D_1^{NF} = 1 - \beta p_1^{NF}$. One can show that the retailer's optimal first-period price is $p_1^{*NF} = \frac{1+\beta w_1^{NF}}{2\beta}$. Thus, the first-period market demand has become $D_1^{*NF} = \frac{1-\beta w_2^{NF}}{2}$. Then the manufacturer chooses w_1^{NF} to maximize its total profit $\pi_M^{NF} = D_1^{NF} w_1^{NF} + \pi_{M2}^{*NF}$. The manufacturer's optimal first-period wholesale price is $w_1^{*NF} = \frac{1}{2\beta}$. Plugging in w_1^{*NF}, we can get the retailer's retail price $p_1^{*NF} = \frac{3}{4\beta}$. In equilibrium, the manufacturer's and the retailer's equilibrium profits are $\pi_M^{*NF} = \frac{1+(1+\delta)^2}{8\beta}$ and $\pi_R^{*NF} = \frac{1+(1+\delta)^2}{16\beta}$, respectively. ■

PROOF OF LEMMA 2. Lemma 2 shows the centralized manufacturer's equilibrium first-period and second-period retail prices in a market with consumer fairness concerns. We solve the game by backward induction. We will first find the second-period subgame equilibrium outcome and then solve for the first-period equilibrium. In the second period, for a given first-period price $\tilde{p}_1$, the manufacturer chooses its second-period price $\tilde{p}_2^*$ to maximize its second-period profit, $\tilde{\pi}_2 = \widetilde{D}_2\, \tilde{p}_2$. The second-period demand function is as follows:

$$\widetilde{D}_2 = \begin{cases} 1+\delta-\beta\tilde{p}_2 & \text{if } 0<\tilde{p}_2\le\tilde{p}_1 \\ 1+\delta-\beta\tilde{p}_2-\lambda\gamma(\tilde{p}_2-\tilde{p}_1) & \text{if } \tilde{p}_1<\tilde{p}_2\le\dfrac{1+\delta+\gamma\tilde{p}_1}{\beta+\gamma} \\ (1-\lambda)(1+\delta-\beta\tilde{p}_2) & \text{if } \dfrac{1+\delta+\gamma\tilde{p}_1}{\beta+\gamma}<\tilde{p}_2\le\dfrac{1+\delta}{\beta} \\ 0 & \text{if } \tilde{p}_2>\dfrac{1+\delta}{\beta} \end{cases}$$

Note that the manufacturer's profit function is continuous and piecewise concave on each interval. We first obtain the optimal prices within each of the following three intervals $I_1 \equiv (0,\tilde{p}_1]$, $I_2 \equiv (\tilde{p}_1,\frac{1+\delta+\gamma\tilde{p}_1}{\beta+\gamma}]$, and $I_3 \equiv (\frac{1+\delta+\gamma\tilde{p}_1}{\beta+\gamma},\frac{1+\delta}{\beta})$; among the three, the price that yields the highest profit is the manufacturer's optimal second-period retail price. Let $\tilde{p}_2^{I_i}$ denote the manufacturer's optimal price within the interval I_i.

- Suppose that $\tilde{p}_2 \in I_1$, if $0<\tilde{p}_1\le\frac{1+\delta}{2\beta}$, then one can show that the optimal price is $\tilde{p}_2^{I_1}=\tilde{p}_1$; if $\frac{1+\delta}{2\beta}<\tilde{p}_1<\frac{1+\delta}{\beta}$, then one can show that the optimal price is $\tilde{p}_2^{I_1}=\frac{1+\delta}{2\beta}$.

- Suppose that $\tilde{p}_2 \in I_2$, if $0<\tilde{p}_1\le\frac{1+\delta}{2\beta+\gamma\lambda}$, the optimal price is $\tilde{p}_2^{I_2}=\frac{1+\delta+\lambda\gamma\tilde{p}_1}{2(\beta+\gamma)}$; if $\frac{1+\delta}{2\beta+\gamma\lambda}<\tilde{p}_1$, the optimal price is $\tilde{p}_2^{I_1}=\tilde{p}_1$.

- Suppose that $\tilde{p}_2 \in I_3$, If $0<\tilde{p}_1<\frac{1+\delta}{\beta}$, the optimal price is $\tilde{p}_2^{I_3}=\frac{1+\delta+\lambda\gamma\tilde{p}_1}{2(\beta+\gamma)}$. Comparing the profits corresponding to prices $\tilde{p}_2^{I_1}$, $\tilde{p}_2^{I_2}$ and $\tilde{p}_2^{I_3}$, one can show that the manufacturer's optimal second-period price is as follows:

$$\tilde{p}_2^* = \begin{cases} \frac{1+\delta+\lambda\gamma\tilde{p}_1}{2(\beta+\gamma)} & \text{if } 0<\tilde{p}_1\le\frac{1+\delta}{2\beta+\gamma\lambda} \\ \tilde{p}_1 & \text{if } \frac{1+\delta}{2\beta+\gamma\lambda}\le\tilde{p}_1\le\frac{1+\delta}{2\beta}. \\ \frac{1+\delta}{2\beta} & \text{if } \frac{1+\delta}{2\beta}<\tilde{p}_1<\frac{1+\delta}{\beta} \end{cases}$$

Using p_2^*, we can obtain the manufacturer's second-period subgame equilibrium profits, where $\tilde{\pi}_2^* = \tilde{D}_2\,\tilde{p}_2$.

$$\tilde{\pi}_2^* = \begin{cases} \frac{(1+\delta+\tilde{p}_1\gamma\lambda)^2}{4(\beta+\gamma\lambda)} & \text{if } \tilde{p}_1 \in (0, \frac{1+\delta}{2\beta+\gamma\lambda}] \\ \tilde{p}_1(1+\delta-\beta\tilde{p}_1) & \text{if } \tilde{p}_1 \in (\frac{1+\delta}{2\beta+\gamma\lambda}, \frac{1+\delta}{2\beta}] \\ \frac{(1+\delta)^2}{4\beta} & \text{if } \tilde{p}_1 \in (\frac{1+\delta}{2\beta}, \infty) \end{cases}$$

In the first period, the manufacturer chooses its first-period price $\tilde{p}_1$ to maximize its profit $\tilde{\pi} = \tilde{D}_1\tilde{p}_1 + \tilde{\pi}_2^*$, where

$$\tilde{D}_1 = \begin{cases} 1-\beta\tilde{p}_1 & \text{if } 0 < \tilde{p}_1 < \frac{1}{\beta} \\ 0 & \text{if } \tilde{p}_1 \geq \frac{1}{\beta} \end{cases}.$$

Denote the retailer's optimal first-period price within the interval K_i by $\tilde{p}_1^{K_i}$, where $K_1 \equiv (0, \frac{1+\delta}{2\beta+\gamma\lambda}]$, $K_2 \equiv (\frac{1+\delta}{2\beta+\gamma\lambda}, \frac{1+\delta}{2\beta}]$, and $K_3 \equiv (\frac{1+\delta}{2\beta}, \frac{1+\delta}{\beta}]$. We will first find $\tilde{p}_1^{K_i}$ for $i = 1,2,3$. Then we will compare the manufacturer's profit corresponding to each $\tilde{p}_1^{K_i}$. The prices corresponding to the highest profit will be the manufacturer's optimal (subgame equilibrium) price. We will separately analyze three cases: $\frac{1}{\beta} \in K_1$, $\frac{1}{\beta} \in K_2$ and $\frac{1}{\beta} \in K_3$. Comparing the profits corresponding to each of the prices $p_1^{K_i}$ for $i = 1,2,3$, one can show that the centralized manufacturer's equilibrium first-period and second-period prices are given by:

$$\tilde{p}_1^* = \begin{cases} \frac{2+\delta}{4\beta} & \text{if } 0 \leq \delta < \frac{2\gamma\lambda}{2\beta-\gamma\lambda} \\ \frac{2\beta+\gamma\lambda(3+\delta)}{4\beta^2+4\beta\gamma\lambda-\gamma^2\lambda^2} & \text{if } \frac{2\gamma\lambda}{2\beta-\gamma\lambda} \leq \delta < \frac{2\beta^2+\beta\gamma\lambda-\gamma^2\lambda^2}{\beta\gamma\lambda} \\ \frac{1+\delta}{2\beta} & \text{if } \delta \geq \frac{2\beta^2+\beta\gamma\lambda-\gamma^2\lambda^2}{\beta\gamma\lambda} \end{cases}, \text{ and}$$

$$\tilde{p}_2^* = \begin{cases} \frac{2+\delta}{4\beta} & \text{if } 0 \leq \delta < \frac{2\gamma\lambda}{2\beta-\gamma\lambda} \\ \frac{2\beta(1+\delta)+\gamma\lambda}{4\beta^2+4\beta\gamma\lambda-\gamma^2\lambda^2} & \text{if } \frac{2\gamma\lambda}{2\beta-\gamma\lambda} \leq \delta < \frac{2\beta^2+\beta\gamma\lambda-\gamma^2\lambda^2}{\beta\gamma\lambda} \\ \frac{1+\delta}{2\beta} & \text{if } \delta \geq \frac{2\beta^2+\beta\gamma\lambda-\gamma^2\lambda^2}{\beta\gamma\lambda} \end{cases}, \text{ respectively. } \blacksquare$$

PROOF OF LEMMA 3. The proof of Lemma 3 is similar to the proof of Lemma 2, but is more technical. Please see the Online Appendix for derivation of the full subgame perfect equilibrium.

PROOF OF PROPOSITION 1. The manufacturer's subgame wholesale price in the second period are given by:

$$w_2^* = \begin{cases} \frac{1+\delta+p_1\gamma\lambda}{2\beta+2\gamma\lambda} & \text{if } 0 < p_1 < \frac{3+3\delta}{4\beta+\gamma\lambda} \\ \frac{2p_1\beta-1-\delta+p_1\gamma\lambda}{\beta+\gamma\lambda} & \text{if } \frac{3+3\delta}{4\beta+\gamma\lambda} \le p_1 \le \hat{P} \\ \frac{1+\delta}{2\beta} & \text{if } \hat{P} \le p_1 \le \frac{1+\delta}{\beta} \end{cases}$$

where $\hat{P} = \frac{(1+\delta)(\sqrt{2\gamma\lambda(\beta+\gamma\lambda)}+6\beta+2\gamma\lambda)}{4\beta(2\beta+\gamma\lambda)}$. Taking the derivative with respect to p_1, one can easily show that in each region of $p_1 \le \hat{P}$, w_2^* is always increasing in p_1. ■

PROOF OF PROPOSITION 2. The manufacturer's equilibrium wholesale prices in two periods (w_1^* and w_2^*) are given in Lemma 3; From Lemma 1 we know that when consumers do not have fairness concerns, the manufacturer's equilibrium prices are given by: $w_1^{*NF} = \frac{1}{2\beta}$ and $w_2^{*NF} = \frac{1+\delta}{2\beta}$. Define $\Delta w_1 = w_1^* - w_1^{*NF}$ and $\Delta w_2 = w_2^* - w_2^{*NF}$. One can show that when $0 \le \delta \le \frac{3(\beta+\gamma\lambda)-2\sqrt{2\gamma\lambda(\beta+\gamma\lambda)}}{9\beta+\gamma\lambda}$, $\Delta w_1 = w_1^* - w_1^{*NF} = \frac{16\beta^2(3\delta+1)+24\beta\gamma\lambda\delta+\gamma^2\lambda^2(\delta-3)}{4\beta(2\beta+\gamma\lambda)(4\beta+\gamma\lambda)} + \frac{(1+\delta)(4\beta+3\gamma\lambda)}{4\beta(2\beta+\gamma\lambda)}\sqrt{\frac{\gamma\lambda}{2(\beta+\gamma\lambda)}} - \frac{1}{2\beta} > 0$; When $\frac{3(\beta+\gamma\lambda)-2\sqrt{2\gamma\lambda(\beta+\gamma\lambda)}}{9\beta+\gamma\lambda} < \delta \le \delta^*$, $\Delta w_1 = w_1^* - w_1^{*NF} = \frac{(1+\delta)\left(48\beta^2(3\delta-1)-8\beta\gamma\lambda(7+\delta)+\gamma^2\lambda^2(1+\delta)\right)}{16\beta(\beta(3\delta-1)-\gamma\lambda)(4\beta+\gamma\lambda)} - \frac{1}{2\beta} > 0$; When $\delta^* < \delta < \delta^{**}$, $\Delta w_1 = w_1^* - w_1^{*NF} = \frac{128\beta^4+16\beta^3\gamma(17+\delta)\lambda+8\beta^2\gamma^2(17+2\delta)\lambda^2+\beta\gamma^3(\delta-7)\lambda^3+\gamma^4\lambda^4}{32\beta^2(8\beta^3+16\beta^2\gamma\lambda+7\beta\gamma^2\lambda^2-\gamma^3\lambda^3)} - \frac{1}{2\beta} > 0$. In sum, $w_1^* > w_1^{*NF}$. Moreover, when $0 < \delta \le \delta^*$, $\Delta w_2 = w_2^* - w_2^{*NF} = \frac{2(1+\delta)}{4\beta+\gamma\lambda} - \frac{1+\delta}{2\beta} < 0$; When $\delta^* < \delta < \delta^{**}$, $\Delta w_2 = w_2^* - w_2^{*NF} = \frac{32\beta^3(1+\delta)+8\beta^2\gamma\lambda(7+4\delta)-\beta\gamma^2\lambda^2(\delta-23)-\gamma^3\lambda^3}{8\beta(8\beta^3+16\beta^2\gamma\lambda+7\beta\gamma^2\lambda^2-\gamma^3\lambda^3)} - \frac{1+\delta}{2\beta} < 0$. Thus, $w_2^* < w_2^{*NF}$. ■

PROOF OF PROPOSITION 3. The retailer's equilibrium prices in two periods are given in Lemma 3. From Lemma 1 we know that when no consumers have fairness concerns, the retailer's equilibrium prices are given by: $p_1^{*NF} = \frac{3}{4\beta}$ and $p_2^{*NF} = \frac{3(1+\delta)}{4\beta}$. Define $\Delta p_1 = p_1^* - p_1^{*NF}$ and $\Delta p_2 = p_2^* - p_2^{*NF}$. One can show that when $\delta < \frac{\gamma\lambda}{4\beta} < \delta^*$, $\Delta p_1 = p_1^* - p_1^{*NF} = \frac{3(1+\delta)}{4\beta+\gamma\lambda} - \frac{3}{4\beta} < 0$, $\Delta p_2 = p_2^* - p_2^{*NF} = \frac{3(1+\delta)}{4\beta+\gamma\lambda} - \frac{3(1+\delta)}{4\beta} < 0$. I.e., $p_1^* < p_1^{*NF}$ and $p_2^* < p_2^{*NF}$. ■

PROOF OF PROPOSITION 4. The manufacturer's and the retailer's equilibrium prices in the two periods are given in Lemma 3. To show an increase in the market growth rate can lead to a decrease in the retail and wholesale prices in both periods, we prove that there is a discrete drop in the firms' equilibrium pricing strategies at $\delta = \delta^*$, as illustrated in Figures 2 and 3. For example, to show that an increase in δ can lead to a decrease in p_1^*, we only need to show $\lim_{\delta\to\delta^{*-}} p_1^*(\delta) > \lim_{\delta\to\delta^{*+}} p_1^*(\delta)$, which automatically implies, because p_1^* is a continuous function on both the left and the right neighborhoods of δ^*, that there exist some $\delta_L < \delta^*$ and $\delta_H > \delta^*$ such that $p_1^*(\delta_L) > p_1^*(\delta)$ for all $\delta \in (\delta^*, \delta_H)$. Since $\lim_{\delta\to\delta^{*-}} p_1^*(\delta) = \frac{3(1+\delta^*)}{4\beta+\gamma\lambda}$ and $\lim_{\delta\to\delta^{*+}} p_1^*(\delta) = \frac{24\beta^2+3\beta\gamma(9+\delta^*)\lambda-\gamma^2\lambda^2}{4\beta(8\beta^2+8\beta\gamma\lambda-\gamma^2\lambda^2)}$, $\lim_{\delta\to\delta^{*-}} p_1^*(\delta) - \lim_{\delta\to\delta^{*+}} p_1^*(\delta) = \frac{3(1+\delta^*)}{4\beta+\gamma\lambda} - \frac{24\beta^2+3\beta\gamma(9+\delta^*)\lambda-\gamma^2\lambda^2}{4\beta(8\beta^2+8\beta\gamma\lambda-\gamma^2\lambda^2)} > 0$, one can show that $\lim_{\delta\to\delta^{*-}} p_1^*(\delta) > \lim_{\delta\to\delta^{*+}} p_1^*(\delta)$. Similarly, we can also prove $\lim_{\delta\to\delta^{*-}} p_2^*(\delta) > \lim_{\delta\to\delta^{*+}} p_2^*(\delta)$, and $\lim_{\delta\to\delta^{*-}} w_1^*(\delta) > \lim_{\delta\to\delta^{*+}} w_1^*(\delta)$, $\lim_{\delta\to\delta^{*-}} w_2^*(\delta) > \lim_{\delta\to\delta^{*+}} w_2^*(\delta)$. ■

PROOF OF PROPOSITION 5. Recall that when there are *no* consumers with fairness concerns in a market, the manufacturer's profits in the first period and the second period are given by $\pi_{M1}^{*NF} = \frac{1}{8\beta}$ and $\pi_{M2}^{*NF} = \frac{(1+\delta)^2}{8\beta}$. Also, when there are some consumers with fairness concerns, the manufacturer's per-period profits π_{M1}^* and π_{M2}^* are given by

$$\pi_{M1}^* = \begin{cases} \hat{\pi}_{M1} & \text{if } 0 \le \delta < \delta^* \\ \frac{(8\beta^2+\beta\gamma(5-3\delta)\lambda-3\gamma^2\lambda^2)(128\beta^4+16\beta^3\gamma\lambda(17+\delta)+8\beta^2\gamma^2\lambda^2(17+2\delta)-\beta\gamma^3\lambda^3(7-\delta)+\gamma^4\lambda^4)}{128\beta^2(\beta+\gamma\lambda)(8\beta^2+8\beta\gamma\lambda-\gamma^2\lambda^2)^2} & \text{if } \delta^* \le \delta < \delta^{**} \end{cases}$$

where $\hat{\pi}_{M1}$ is given below

$\hat{\pi}_{M1} =$

$$\begin{cases} \frac{\beta-3\beta\delta+\gamma\lambda}{8(4\beta+\gamma\lambda)}\left(\frac{(1+\delta)(4\beta+3\gamma\lambda)}{\beta(2\beta+\gamma\lambda)}\sqrt{\frac{2\gamma\lambda}{\beta+\gamma\lambda}}+\frac{2(16\beta^2(1+3\delta)+24\beta\gamma\lambda\delta+\gamma^2\lambda^2(\delta-3))}{\beta(2\beta+\gamma\lambda)(4\beta+\gamma\lambda)}\right) & \text{if } 0\leq\delta\leq\frac{3(\beta+\gamma\lambda)-2\sqrt{2\gamma\lambda(\beta+\gamma\lambda)}}{9\beta+\gamma\lambda} \\ \frac{(1+\delta)(48\beta^2(1-3\delta)+8\beta\gamma\lambda(7+\delta)-\gamma^2\lambda^2(1+\delta))}{16\beta(4\beta+\gamma\lambda)^2} & \text{if } \frac{3(\beta+\gamma\lambda)-2\sqrt{2\gamma\lambda(\beta+\gamma\lambda)}}{9\beta+\gamma\lambda}\leq\delta<\delta_2 \end{cases}$$

$$\pi_{M2}^{*} = \begin{cases} \frac{2(1+\delta)^2(\beta+\gamma\lambda)}{(4\beta+\gamma\lambda)^2} & \text{if } 0\leq\delta<\delta^{*} \\ \frac{(\gamma^3\lambda^3-32\beta^3(1+\delta)-8\beta^2\gamma\lambda(7+4\delta)+\beta\gamma^2\lambda^2(23-\delta))^2}{128\beta^2(\beta+\gamma\lambda)(8\beta^2+8\beta\gamma\lambda-\gamma^2\lambda^2)^2} & \text{if } \delta^{*}\leq\delta<\delta^{**} \end{cases}$$

We will first show that the manufacturer's profit in the first period can be higher than that when no consumers have fairness concerns. More specifically, we will show when δ is not too large, $\pi_{M1}^{*} > \pi_{M1}^{*NF}$. Define $\Delta\pi_{M1} = \pi_{M1}^{*} - \pi_{M1}^{*NF}$. If $\delta \in [0, \frac{3(\beta+\gamma\lambda)-2\sqrt{2\gamma\lambda(\beta+\gamma\lambda)}}{9\beta+\gamma\lambda}]$, then $\Delta\pi_{M1} =$ $\frac{\beta-3\beta\delta+\gamma\lambda}{8(4\beta+\gamma\lambda)}\left(\frac{(1+\delta)(4\beta+3\gamma\lambda)}{\beta(2\beta+\gamma\lambda)}\sqrt{\frac{2\gamma\lambda}{\beta+\gamma\lambda}}+\frac{2\left(16\beta^2(1+3\delta)+24\beta\gamma\lambda\delta+(\delta-3)\gamma^2\lambda^2\right)}{\beta(2\beta+\gamma\lambda)(4\beta+\gamma\lambda)}\right)-\frac{1}{8\beta}$. We can show that $\Delta\pi_{M1}|_{\delta=0} =$ $\frac{(\beta+\gamma\lambda)\left(\sqrt{\frac{2\gamma\lambda}{\beta+\gamma\lambda}}(4\beta+3\gamma\lambda)+\frac{32\beta^2-6\gamma^2\lambda^2}{4\beta+\gamma\lambda}\right)}{8\beta\,(2\beta+\gamma\lambda)(4\beta+\gamma\lambda)}-\frac{1}{8\beta} > 0$. By continuity of $\Delta\pi_{M1}$ in δ, there exists some $\bar{\delta} \in$ $(0, \frac{3(\beta+\gamma\lambda)-2\sqrt{2\gamma\lambda(\beta+\gamma\lambda)}}{9\beta+\gamma\lambda}]$ such that if $\delta \in [0, \bar{\delta})$, then $\Delta\pi_{M1} > 0$, i.e., $\pi_{M1}^{*} > \pi_{M1}^{*NF}$.

Second, let us show that the manufacturer's profit in the second period can be higher than when no consumers have fairness concerns. Let us show that when δ is sufficiently small, $\pi_{M2}^{*} > \pi_{M2}^{*NF}$. Define $\Delta\pi_{M2} = \pi_{M2}^{*} - \pi_{M2}^{*NF}$. If $\delta \in [0, \delta^{*}]$, then $\Delta\pi_{M2} = \frac{2(1+\delta)^2(\beta+\gamma\lambda)}{(4\beta+\gamma\lambda)^2} - \frac{(1+\delta)^2}{8\beta}$. One can readily show that when $\lambda\gamma < 8\beta$, $\Delta\pi_{M2} > 0$ for any δ. Therefore, if $\delta \in [0, \delta^{*}]$, then $\Delta\pi_{M2} > 0$, i.e., $\pi_{M2}^{*} > \pi_{M2}^{*NF}$.

Since $\bar{\delta} < \delta^{*}$, it follows that whenever $\delta \in [0, \bar{\delta})$, the existence of consumers with fairness concerns will lead to higher profit for the manufacturer in each time period. ■

PROOF OF PROPOSITION 6. From Lemma 1, we can easily derive, when consumers do not have fairness concerns, the retailer's profits in the first period and the second period are given by $\pi_{R1}^{*NF} = \frac{1}{16\beta}$ and $\pi_{R2}^{*NF} = \frac{(1+\delta)^2}{16\beta}$, respectively. Also, when consumers have fairness concerns, the retailer's profit in period $t \in \{1,2\}$ is given by

$$\pi_{R1}^{*}=\begin{cases}\hat{\pi}_{R1} & \text{if } 0\le\delta<\delta^{*}\\ \frac{(8\beta^2+\beta\gamma(5-3\delta)\lambda-3\gamma^2\lambda^2)(8\beta^2+\beta\gamma\lambda(9+\delta)+\gamma^2\lambda^2)}{128\beta^2(\beta+\gamma\lambda)(8\beta^2+8\beta\gamma\lambda-\gamma^2\lambda^2)} & \text{if } \delta^{*}\le\delta<\delta^{**}\end{cases}$$

where $\hat{\pi}_{R1}$ is given below

$$\hat{\pi}_{R1}=$$

$$\begin{cases}\frac{(\beta(3\delta-1)-\gamma\lambda)(8\Phi\beta^3-2\gamma^2\lambda^2(3-\delta)+\beta\gamma\lambda(24\delta+\Phi\gamma\lambda-24)+2\beta^2(24\delta+3\Phi\gamma\lambda-8))}{8\beta(2\beta+\gamma\lambda)(4\beta+\gamma\lambda)^2} & \text{if } 0<\delta\le\frac{3(\beta+\gamma\lambda)-2\sqrt{2\gamma\lambda(\beta+\gamma\lambda)}}{9\beta+\gamma\lambda}\\ \frac{\gamma(1+\delta)^2\lambda(\gamma\lambda-8\beta)}{16\beta(4\beta+\gamma\lambda)^2} & \text{if } \frac{3(\beta+\gamma\lambda)-2\sqrt{2\gamma\lambda(\beta+\gamma\lambda)}}{9\beta+\gamma\lambda}\le\delta<\frac{4\beta+3\gamma\lambda}{12\beta+\gamma\lambda}\end{cases}$$

where $\Phi\equiv\frac{(1+\delta)(4\beta+3\gamma\lambda)}{\beta(2\beta+\gamma\lambda)}\sqrt{\frac{2\gamma\lambda}{\beta+\gamma\lambda}}$.

$$\pi_{R2}^{*}=\begin{cases}\frac{(1+\delta)^2(\beta+\gamma\lambda)}{(4\beta+\gamma\lambda)^2} & \text{if } 0\le\delta\le\delta^{*}\\ \frac{(32\beta^3(1+\delta)+8\beta^2\gamma\lambda(7+4\delta)+\beta\gamma^2\lambda^2(23-\delta)-\gamma^3\lambda^3)^2}{256\beta^2(\beta+\gamma\lambda)(8\beta^2+8\beta\gamma\lambda-\gamma^2\lambda^2)^2} & \text{if } \delta^{*}<\delta<\delta^{**}\end{cases}$$

Note that, if $\delta\in(\delta^{**},\infty)$, there will be no sales in the first period, i.e., $\pi_{R1}^{*}=0$, $\pi_{R}^{*}=\pi_{R2}^{*}$ and $\pi_{M1}^{*}=0$, $\pi_{M}^{*}=\pi_{M2}^{*}$. First we will prove when the market growth rate is sufficiently large, the retailer will benefit from having a segment of consumers with fairness concerns in the market. When $\delta\in(\delta^{**},\infty)$, the retailer's total profit is given by: $\pi_{R}^{*}=\frac{(1+\delta)^2(\beta+\gamma\lambda)}{(4\beta+\gamma\lambda)^2}$. Define $\Delta\pi_{R}=\pi_{R}^{*}-\pi_{R}^{*NF}$. We can show that when $\delta>\sqrt{\frac{16\beta^2+8\beta\gamma\lambda+\gamma^2\lambda^2}{\gamma\lambda(8\beta-\gamma\lambda)}}-1$, $\Delta\pi_{R}=\pi_{R}^{*}-\pi_{R}^{*NF}=\frac{(1+\delta)^2(\beta+\gamma\lambda)}{(4\beta+\gamma\lambda)^2}-\frac{1+(1+\delta)^2}{16\beta}>0$, i.e., $\pi_{R}^{*}>\pi_{R}^{*NF}$. Next we will show the manufacturer can also be better off when the market growth rate is large enough. When $\delta\in(\delta^{**},\infty)$, the manufacturer's total profit is given by: $\pi_{M}^{*}=\frac{2(1+\delta)^2(\beta+\gamma\lambda)}{(4\beta+\gamma\lambda)^2}$; In the case without consumer fairness concerns, the manufacturer's total profit is given by: $\pi_{M}^{*NF}=\frac{1+(1+\delta^2)}{8\beta}$. Define $\Delta\pi_{M}=\pi_{M}^{*}-\pi_{M}^{*NF}$. One can show that, when $\delta>\sqrt{\frac{16\beta^2+8\beta\gamma\lambda+\gamma^2\lambda^2}{\gamma\lambda(8\beta-\gamma\lambda)}}-1$, $\Delta\pi_{M}=\frac{2(1+\delta)^2(\beta+\gamma\lambda)}{(4\beta+\gamma\lambda)^2}-\frac{1+(1+\delta^2)}{8\beta}>0$, i.e., $\pi_{M}^{*}>\pi_{M}^{*NF}$. In sum, when δ is sufficiently large, both the manufacturer and the retailer will be better off. Note that one can show that the result can also hold for $\delta<\delta^{**}$. ■

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