Fairness Ideals in Distribution Channels

Tony Haitao Cui

Carlson School of Management
University of Minnesota
3-150 CSOM
321-19th Avenue South
Minneapolis, MN 55455

Paola Mallucci *

Carlson School of Management
University of Minnesota
3-150 CSOM
321-19th Avenue South
Minneapolis, MN 55455

March 2012

* We thank the seminar participants at 2011 MSI Young Scholars Program, 8th triennial Invitational Choice Symposium, Annual Haring Symposium 2011, HKUST, Marketing Science Conference 2010, Tsinghua University, and Universita’ Bocconi for their helpful comments. We also would like to thank Wilfred Amaldoss and Teck-Hua Ho for their constructive comments. Support for this work was provided to Tony Haitao Cui through a 3M Non-Tenured Faculty Award and Carlson Dean’s Small Research Grant, University of Minnesota. Tony Haitao Cui is an Assistant Professor of Marketing at the Carlson School of Management, University of Minnesota. Paola Mallucci is a Ph.D. candidate at the Department of Marketing, Carlson School of Management, University of Minnesota. Email correspondence: tcui@umn.edu and mallu004@umn.edu. The usual disclaimer applies.
Fairness Ideals in Distribution Channels

Abstract

Existing research suggests that concerns for fairness may significantly affect the interactions between firms in a distribution channel. We analytically and experimentally evaluate how firms make decisions in a two-stage dyadic channel, in which firms decide on investments in the first stage and then on prices in the second stage. We find that firms’ behaviors differ significantly from the predictions of the standard economic model.

We explain the results by allowing the retailer to concern distributive fairness with the manufacturer. Using a Quantal Response Equilibrium (QRE) model, in which both the manufacturer and retailer make noisy best responses, we show significant concerns exist regarding fairness between channel members. Additionally, we propose a new principle of distributive fairness—the sequence-aligned ideal, that is studied first time in literature, and compare the new fairness ideal with several existing ideals in literature. Surprisingly, the new ideal, according to which the sequence of moving determines the formation of equitable payoff for players, significantly outperforms other fairness ideals, including strict egalitarianism, liberal egalitarianism, and libertarianism.

Key words: fairness ideals; distribution channels; quantal response equilibrium; experimental economics
Research in behavioral and experimental economics suggests that concerns for fairness impact a wide range of agents’ behaviors. Subjects in various versions of the ultimatum and dictator games routinely offer higher than optimal shares of the initial endowment, and responders virtually always turn down low offers that are significantly higher than predicted by standard economic models (Camerer 2003).

Researchers have surveyed consumers and companies to investigate what is considered fair in circumstances ranging from price increases to renting contracts, and have found that people largely agree on what is fair and what is not fair, suggesting that fairness is a widely understood concept (Güth, Schmittberger, and Schwarze 1982; Kahneman, Knetsch, and Thaler 1986a, 1986b; Olmstead and Rhode 1985). In addition, there is empirical evidence indicating that fairness/equity plays an important role in certain business contexts (Kumar, Scheer, and Steenkamp 1995; Olmsted and Rhode 1985; Scheer, Kumar, and Steenkamp 2003, etc.). For instance, in a study that surveyed 417 American auto dealers and 289 Dutch auto dealers, Scheer, Kumar, and Steenkamp (2003) found that auto dealers have concerns for distributive fairness with their business partners. Furthermore, they also found that inequity plays a very different role for dealers across cultures, with American dealers reacting only to disadvantageous inequity and Dutch dealers reacting to both disadvantageous and advantageous inequity.

There is also strong experimental support for fairness concerns from contracting agents (Fehr, Klein, and Schmidt 2007; Hackett 1994; Loch and Wu 2008). For example, Fehr, Klein, and Schmidt (2007) show that bonus contracts that offer a voluntary and unenforceable bonus for satisfactory performance provide powerful incentives and are superior to explicit incentive contracts when there are some fair-minded players.
Given the widely documented importance of fairness in various business contexts, theorists and practitioners have called attention to the issue of understanding fairness as one of the priorities for developing and maintaining healthy relations with business partners in distribution channels. For instance, Cui, Raju, and Zhang (2007) model the effect of fairness concerns on the interactions between the manufacturers and the retailer in a dyadic channel with linear demand. They find that the manufacturer can use a single wholesale price to coordinate the channel so long as the retailer has strong concerns for fairness. That is, the double marginalization problem can be avoided in such a fair channel. Caliskan-Demirag, Chen, and Li (2010) extend Cui, Raju, and Zhang (2007) to consider non-linear demand functions and find that a linear wholesale price can coordinate the channel at a wider range when the retailer is fair-minded. Pavlov and Katok (2011) find that a linear pricing contract can still maximize the channel profit when there is information asymmetry between channel members. The importance of fairness to a healthy relationship between channel members is also documented and analyzed in many other research studies.2

Although previous research has generated extensive useful insights on how fairness affects channel interactions, several important questions remain unanswered. How strong are the concerns of fairness in a channel? What principle is guiding the determination of the equitable payoff (i.e., what is considered as a fair deal by a player)? If a firm’s decision is deviating from the prediction of the standard economic model, is it because the decision maker cares about fairness or is it because the decision maker cannot always make optimal decisions due to bounded rationality?

In order to better understand these issues, we experimentally investigate the theoretical predictions on prices in a dyadic channel where the manufacturer acts as a Stackelberg leader in
choosing prices and the retailer acts as a follower, and build a Quantal Response Equilibrium (QRE) model (McKelvey and Palfrey 1995) that incorporates both retailer’s concerns for fairness and the bounded rationality by both firms to explain the discrepancy between the theoretical predictions and empirical regularities. The behavioral model nests the standard economic model as a special case. Through such an enriched model, we are able to investigate how equitable payoffs are determined in a fair channel. We estimate the behavioral model from experimental data using maximum likelihood methods.

Our research makes the following contributions to the literature. 1). We provide an estimation of fairness parameters in a channel context. The estimation results suggest that there are significant fairness concerns in distribution channels. 2). We propose a new principle of fairness that is studied the first time in literature, i.e., a sequence-aligned ideal, and compare our new fairness ideal with the fairness ideals that are commonly adopted in the literature, i.e., strict egalitarianism, liberal egalitarianism, and libertarianism (Cappelen et al. 2007). The new fairness ideal better reflects the power structure in the dyadic channel and proposes that the equitable payoff should be consonant with the ratio of players’ profits in the standard Stackelberg game. Our research contributes to the understanding of the determinants of equitable payoffs between fair-minded agents. Our research is also the first study in the literature to empirically study fairness ideals in the pricing game of a distribution channel. 3). We use a two sided QRE specification to study the bounded rationality of both the manufacturer and retailer. To the best of our knowledge, this is also the first research that analyzes the bounded rationality of both players in a dyadic channel. With both bounded rationality of players and the fairness concerns by the retailer incorporated in the behavioral model, the results of the estimated behavioral model quantify both effects using experimental data from incentive aligned experimental studies.
We show that fairness concerns identify well entrenched preferences, instead of simply an artifact of bounded rationality. 4). We provide managers with indications of how the power structure affects the interactions between channel members who may care about fairness in the channel. Based on our results, the power structure does affect the impact of fairness concerns on the dynamics between firms in a channel. In this case, it is perceived as “fair” for the more powerful firm, i.e., the manufacturer as a Stackelberg leader in our model, to obtain a higher payoff than the less powerful firm, i.e., the retailer as a follower.

Our paper is closely related to Cappelen et al. (2007), who studied three fairness ideals: strict egalitarianism, liberal egalitarianism, and libertarianism, in a dictator distribution game where the outputs of a production stage may determine the equitable payoff. However, our paper differs from Cappelen et al. (2007) in three ways. 1) In our paper, players in a dyadic channel make pricing decisions in the second stage of the game, while in Cappelen et al. (2007), the dictator is deciding the amount of currency to give the passive receiver in the second stage. The setting in our paper is closely related to the dyadic channel structure that is widely studied in marketing. 2) We propose a new fairness ideal, the sequence-aligned ideal, that is studied the first time in the literature. We show that the newly proposed fairness ideal outperforms other fairness ideals in our experimental studies. 3) Our paper presents a behavioral model that incorporates both bounded rationality and fairness concerns, while Cappelen et al. (2007) only consider fairness concerns.

Our research also contributes to the literature on incorporating behavioral theories into quantitative marketing models to better understand how firms’ decisions may be affected by certain behavioral factors. This includes cognitive hierarchy (Camerer, Ho, and Chong 2004; Goldfarb and Xiao 2010; Goldfarb and Yang 2009), fairness concerns (Chen and Cui 2012; Cui,
Raju, and Shi 2012; Cui, Raju, and Zhang 2007; Feinberg, Krishna, and Zhang 2002), bounded rationality (Che, Sudhir, and Seetharaman 2007; Chen, Iyer, and Pazgal 2010), loss and/or risk aversion (Hardie, Johnson, and Fader 1993; Kalra and Shi 2010), regret or counterfactual consideration (Lim and Ho 2007; Syam, Krishnamurthy, and Hess 2008), reference dependency (Amaldoss and Jain 2010; Ho and Zhang 2008; Orhun 2009), and learning (Amaldoss and Jain 2005; Amaldoss, Bettman, and Payne 2008; Bradlow, Hu, and Ho 2004).

The rest of this paper is organized as follows. In the next section, we outline the standard economic model with theoretical predictions on prices and investments. In subsequent sections, we describe the experimental design and report experimental results. Then, we outline a behavioral model that incorporates bounded rationality and fairness concerns by channel members. The results of the estimated model are also described in the section. We conclude with main findings from our analysis and directions for future research.

**STANDARD ECONOMIC MODEL**

In this section we present the standard economic model. The model provides the theoretical predictions of the investments and prices that channel members choose when they are rational profit maximizers.

Consider the standard dyadic channel where a single manufacturer sells its product to consumers through a single retailer. There are two stages. Each firm has an initial endowment of $E$ at the beginning of the first stage. In stage one, both manufacturer and retailer simultaneously decide on the amount of investment out of their initial endowment $E$ they would like to invest to increase the demand of the product. We denote $I_M \leq E$ as the manufacturer’s investment and $I_R \leq E$ as the retailer’s investment. Given their investments, the manufacturer moves first and charges a constant wholesale price $w$. Taking the wholesale price $w$ as given, the retailer sets the retail
price $p$. Without loss of generality, we assume that production cost $c$ is given by zero. The market demand is given by $D(p) = BD - b \cdot p = a + I_M R_M + I_R R_R - b \cdot p$, where $BD = a + I_M R_M + I_R R_R$ refers to the base demand of the product, $R_M > 0$ ($R_R > 0$) represents the rate of return for the manufacturer’s (retailer’s) investment, and $b > 0$. We denote $\pi_M = w \cdot D(p)$ as the manufacturer’s profit from sales of products and $\pi_R = (p - w) \cdot D(p)$ as the retailer’s profit from sales of products. Thus, the manufacturer’s total profit is given by $\Pi_M(I_M, w) = E - I_M + \pi_M = E - I_M + w \cdot D(p)$ and the retailer’s total profit is given by $\Pi_R(I_R, p) = E - I_R + \pi_R = E - I_R + (p - w) \cdot D(p)$.

We solved the model using backward induction. Detailed proofs and solutions of prices are given in Appendix A. We first solve the sequential pricing game given any investments by the manufacturer and retailer. Firms’ investments are then solved given firms’ price decisions each as a function of firms’ investments. Given investments $I_M$ and $I_R$, the optimal wholesale price is given by $w(I_M, I_R) = \frac{a + I_M R_M + I_R R_R}{2b}$, and the optimal retail price is given by $p(I_M, I_R) = \frac{3(a + I_M R_M + I_R R_R)}{4b}$. Given firms’ best-response prices and the other firm’s investment, a firm’s profit is a convex function of its investment, and the optimal investments are given by

$$
(I_M^*, I_R^*) = \begin{cases} 
(0, 0) & \text{if } 0 < R_M < R_{M1} \text{ and } 0 < R_R < R_{R1} \\
(0, E) & \text{if } 0 < R_M < R_{M2} \text{ and } R_R \geq R_{R1} \\
(E, 0) & \text{if } R_M \geq R_{M1} \text{ and } 0 < R_R < R_{R2} \\
(E, E) & \text{if } R_M \geq R_{M3} \text{ and } R_R \geq R_{R3}
\end{cases}
$$

The threshold values of return rates are defined as $R_{M1} = \frac{1}{E}(\sqrt{a^2 + 8bE} - a)$, $R_{R1} = \frac{1}{E}(\sqrt{a^2 + 16bE} - a)$, $R_{M2}$ solved from $\Phi_M(R_{M2}, R_R) = 0$, $R_{R2}$ solved from $\Phi_R(R_M, R_{R2}) = 0$, and $R_{R3}$ solved from $\Phi_R(R_{R3}, R_R) = 0$. 


and $R_{M3}$ and $R_{R3}$ simultaneously solved from $\Phi_M(R_{M3}, R_{R3}) = 0$ and $\Phi_R(R_{M3}, R_{R3}) = 0$, where the functions $\Phi_M$ and $\Phi_R$ are given by

$$
\begin{cases}
\Phi_M(x, y) = E \cdot x^2 + 2(a + E \cdot y)x - 8b \\
\Phi_R(x, y) = E \cdot y^2 + 2(a + E \cdot x)y - 16b
\end{cases}
$$

THE EXPERIMENT

Human subjects were recruited to act as the role of either the manufacturer or the retailer in each round. Subjects were randomly assigned to one of four treatment conditions shown in Table 1. Each player was matched in each round with a different player playing the opposite role, and played half of the rounds in the role of the manufacturer and half in the role of the retailer. In the first stage of each round, the two players in the same channel simultaneously decided on the investments out of their initial endowment of $E = 10$ pesos. As we are interested in understanding how players determine an equitable payoff, the return rates were varied across conditions so that the return rate for the investments could be either .2 or 1.2. The variation in return rates allows us to differentiate between the effect of the contribution to the channel that is under the agents’ control, i.e., the investments, and the effect of the contribution that is outside the agent’s control, i.e., the effective return to investments that is affected by the exogenously given return rates.

In the second stage, the player acting as the manufacturer decided on the wholesale price first. The player acting as the retailer was a follower and set the retail price after seeing the wholesale price. We ran three experiments. In experiment 1, the available investment levels were integers from zero to 10 pesos. In experiment 2 and 3, the available investment levels were 0, 5, and 10 pesos. We have $a = b = 1$. Table 1 shows the theoretical predictions of both investments and prices for the treatment conditions.
A total of 236 undergraduate students from a large public university in the Midwest took part in the experiments in exchange for cash payments that are contingent on their performance in the experiments. Each session consisted of approximately 20 subjects, with the largest session having 24 subjects and the smallest session having 18 subjects. Each session lasted for 75 minutes.

The experimental procedure was as follows. At the beginning of a session, subjects were given a copy of the instructions and the researcher read the instructions aloud to subjects. The researcher then answered any questions raised by subjects. At the beginning of each round, each participant was informed of her role for that round. Then, players simultaneously decided how much of the endowment to invest in the channel. As discussed above, players can choose any integer level of investment between 0 and 10 in experiment 1, but only 0, 5, or 10 in experiment 2 and 3. We ran analysis separately for these three experiments, and observed very similar results for both experiments. Hence, in the interest of brevity, we report the analysis for the collapsed discrete and continuous investment experiments. After investments were decided, players were informed about the amount of the investments, $I_M$ and $I_R$, and the amount of baseline demand, $a + I_M R_M + I_R R_R$.

In the pricing stage, the manufacturer in the channel acted as a Stackelberg leader. Hence, the manufacturer moved first to decide on a wholesale price, $w$, based on investments and baseline demand. The retailer moved second to decide on retail price, $p$, based on investments, baseline demand and wholesale price. The quantity sold was determined based on the demand function $D(p) = a + I_M R_M + I_R R_R - b \cdot p$. For each unit sold, the manufacturer earned $w$ pesos and the retailer earned $p - w$ pesos. After the quantity sold was determined, both firms’ profits were
calculated and communicated to both players. If any firm invested less than the initial endowment, the residual endowment was also added to the firm’s final profit.

Payoffs from the experiments were converted at a fixed rate and resulted in a payment between $15 and $25 for each subject. The average payment to subjects was approximately $20. Subjects were paid in cash at the end of each session. The experiments were programmed and conducted using z-Tree (Fischbacher 2007).

**EXPERIMENTAL RESULTS**

Given our experimental setup, it is easy to compute equilibrium investments and equilibrium prices for profit maximizing agents. Table 2 reports the investments predicted by the standard economic model and the actual investments observed in the experiments. The table indicates that subjects’ decisions systematically deviate from the equilibrium predictions by over-investing with respect to the equilibrium prediction of no investment, and under-investing with respect to the prediction of full investment. The $t$-test between actual and theoretically optimal investments suggests that they are significantly different from each other in all treatment conditions.

— INSERT TABLE 2 ABOUT HERE —

Similarly, Table 3 compares the prices predicted by the standard economic model to the average of the actual prices observed in the experiments given the actual investments. Again, we find that observed prices are different from the optimal prices based on actual investments. The $t$-tests indicate a significant difference ($p$-value < .01) between the optimal prices and the actual prices. This suggests that, when the actual investments are taken into consideration, the prices set by players are significantly larger than the optimal prices.

— INSERT TABLE 3 ABOUT HERE —
CAPTURING EMPIRICAL REGULARITIES

The experimental data shows that both wholesale and retail prices are significantly different from the predictions of the standard economic model. We explain these results by generalizing the standard economic model to incorporate fairness concerns that can affect the interactions between channel members significantly (Kumar 1996; Kumar, Scheer, and Steenkamp 1995; Loch and Wu 2008). Besides fairness concerns, another possible reason for players to set prices different from predictions of the standard economic model may be due to bounded rationality in their pricing decisions. In order to identify the bounded rationality in price decision making, we employ the Quantal Response Equilibrium (QRE) model (McKelvey and Palfrey 1995). We start with a discussion of fairness ideals which will determine the equitable payoff for a fair-minded firm. Next we analyze the QRE model that incorporates fairness concerns monitored by fairness ideals, and estimate the QRE model with fairness concerns using the experimental data.

**Fairness Ideals**

We use the model of distributive fairness (Fehr and Schmidt 1999) to conceptualize fairness concerns between channel members (Kumar, Scheer, and Steenkamp 1995; Cui, Raju, and Zhang 2007). A firm with concerns for distributive fairness experiences disutility from inequity in the allocation of payoffs. The negative effect of inequity is stronger when the firm has a lower payoff compared with its equitable payoff (i.e., when a disadvantageous inequity occurs) than when the firm has a higher payoff (i.e., when an advantageous inequity occurs). The equitable payoff refers to the amount of monetary payoff a firm considers a fair deal.

We follow Cui, Raju, and Zhang (2007) to assume that the retailer in the channel displays concerns for fairness, while the manufacturer is a profit maximizer. The manufacturer’s and
retailer’s payoffs from sales of product are denoted, respectively, as \( \pi_M \) and \( \pi_R \), the retailer’s utility is given by

\[
U_R = \Pi_R - \alpha \cdot \max\{\tau \pi_M - \pi_R, 0\} - \beta \cdot \max\{\pi_R - \frac{\tau}{1 - \tau} \pi_M, 0\},
\]

for \( \alpha \geq \beta \), and \( 0 < \beta < 1 \). The term in parentheses is used to distinguish between advantageous and disadvantageous inequity. To express an agent is more adverse to disadvantageous inequity than advantageous inequity, it is further assumed \( \alpha \geq \beta \).

In the utility function, different values of \( \frac{\tau}{1 - \tau} \) represent different fairness ideals. The fairness ideal captures how a player’s equitable payoff is determined. What is considered fair by players can vary as a result of social norms and power structure, as well as to the contributions of the players to the final payoff. Our experimental setup, in which the investments of different players affect both the base demand of the product and firms’ profits, is similar to an economy with investment-dependent market demands. In such a context, what is considered as a fair profit allocation depends on the concept we use to define fairness, the so called fairness ideal. The three most prominent fairness ideals studied in literature thus far are: strict libertarianism, strict egalitarianism, and liberal egalitarianism (Cappelen et al. 2007).

Strict egalitarianism claims that agents should get the same share of the final outcome, disregarding their respective contributions. Strict libertarianism argues that agents’ payoffs should be in agreement with their total contributions, including the factors under their control, i.e., investments, and the factors outside of their control, i.e., return rates on investments. Liberal egalitarianism takes a middle ground position, arguing that agents’ final profits should be divided in proportion to their contributions that are under their control, i.e., in this case, investments.
In addition, we propose a fourth fairness ideal, termed the sequence-aligned ideal. With such a fairness ideal, players believe their equitable payoffs should be proportional to their profits from product sales in the standard Stackelberg pricing game. According to this ideal, the retailer’s payoff $\pi_R$ should be consonant with the share of channel profit it would obtain in the standard Stackelberg pricing model, in which the manufacturer and the retailer sequentially set prices to maximize respective profits. Therefore, when the manufacturer is the Stackelberg leader in a pricing game, the equitable payoff for the retailer would equal one-third of the total channel profit, or one-half of the manufacturer’s profit. This ideal indicates the equitable payoffs for the firms should be consistent with the power structure in the channel.

All four fairness ideals can be represented by different values of $\tau$. A value of $\tau = \frac{1}{2}$ corresponds to the strict egalitarian ideal. This is because the retailer’s equitable payoff is equal to the manufacturer’s profit from sales of product, i.e., $\frac{\tau}{1 - \tau} \pi_M = \pi_M$, when $\tau = \frac{1}{2}$. A value of $\tau = \frac{1}{3}$ will successfully represent the sequence-aligned ideal, since $\frac{\tau}{1 - \tau} \pi_M = \frac{\pi_M}{2}$ for $\tau = \frac{1}{3}$, i.e., the retailer’s equitable payoff is proportional to its payoff in a standard Stackelberg pricing game. In a similar fashion, we can show that the value of $\tau$ with the liberal egalitarian ideal is given by

$$\tau = \begin{cases} 
\frac{1}{2} & \text{if } I_M = I_R = 0 \\
\frac{I_R}{I_M + I_R} & \text{otherwise}
\end{cases}$$

and the value of $\tau$ with the strict libertarian ideal is given by
\[
\tau = \begin{cases} 
\frac{1}{2} & \text{if } I_M = I_R = 0 \\
\frac{I_R \cdot R_R}{I_M \cdot R_M + I_R \cdot R_R} & \text{otherwise}
\end{cases}
\]

In Table 4, we summarize these four fairness ideals for ease of reference. Note that both the strict egalitarian ideal and the sequence-aligned ideal generate equitable payoffs that are independent of firms’ investments, while the retailer’s equitable payoffs under both the liberal egalitarian ideal and the strict egalitarian ideal depend on both firms’ payoffs that are affected by their investments.

| Insert Table 4 About Here |

**Quantal Response Equilibrium (QRE) Model with Fairness Ideals**

It is worthy of pointing out the importance of considering bounded rationality in our behavioral model of fairness. Both bounded rationality and fairness concerns may induce players to deviate from the optimal decisions predicted by the standard economic model. To discover whether fairness is simply an artifact of a deviation from perfect rationality, or whether it is an intrinsic preference by the players, we need to figure out whether fairness concerns survive after we control for bounded rationality. The questions we seek to answer are the following. 1) What is the driving force for deviations in players’ decisions? Is it due to fairness concerns, bounded rationality, or both? 2) Can we differentiate fairness concerns and bounded rationality from each other and quantify them? 3) Are the manufacturer and retailer both equally boundedly rational in the game?

In order to answer the preceding questions, we use the QRE model to capture the deviations from perfect rationality by channel members (McKelvey and Palfrey 1995; Ho and Zhang 2008). The key idea of the QRE framework is that decision makers will not always make the optimal
decision but they will make better decisions more often. This idea can be operationalized using a logit model. If we assume that decision makers make suboptimal choices that are subject to random errors that are \textit{i.i.d.} as an extreme value distribution, then the probability of choosing any given option can be computed using a logit specification. More specifically, the probability for the retailer to choose a retail price at level $p_j$ is given by

$$prob(p = p_j) = \frac{e^{\lambda_R U_R(p_j)}}{\sum_k e^{\lambda_R U_R(p_k)}},$$

where the parameter $\lambda_R$ refers to the degree of Nash rationality of the retailer and increases as the retailer becomes more rational. When $\lambda_R = 0$, the probabilities for the retailer to choose different price levels are the same, and the retailer is randomly choosing a price level. When $\lambda_R = \infty$, the retailer will choose the optimal price level with a probability of one.

\textit{Estimation and Results}

We develop a series of models to estimate fairness and QRE parameters using the data from the pricing stage. We can group the models in two categories: 1) the base model, in which the manufacturer is perfectly rational and the retailer is boundedly rational; and 2) the full pricing stage model, in which both agents are boundedly rational.

Since using a QRE specification requires discrete data and the prices in our model are continuous, we separated the data into three intervals.\textsuperscript{5} We elected to cut the data in equally sized bins and use the central value of each bin to compute profits and utility. For example, since the feasible range for the retail price is between $w$ and $BD$, the three available bins for the retail price were chosen as: 1) $w$ to $\frac{BD-w}{3}$; 2) $\frac{BD-w}{3}$ to $\frac{2(BD-w)}{3}$; and 3) $\frac{2(BD-w)}{3}$ to $BD$. If the retailer chose a price in the first interval we used $p = \frac{BD-w}{6}$; the second bin, $p = \frac{BD-w}{2}$;
the third bin, \( p = \frac{5(BD - w)}{6} \). We opted to divide the intervals in equally sized bins instead of using distributional characteristics (e.g., percentiles) because each observation has a different pricing space, making it difficult to determine valid cutoff points for the whole sample. We summarize the notation used for the parameters in Table 5.

--- INSERT TABLE 5 ABOUT HERE ---

**Base model**

First, we estimated a base model using data from the pricing stage, assuming that the manufacturer is perfectly rational while the retailer is boundedly rational. These assumptions have two important implications: 1) at the time of the decision, the retailer already knows the investments and the wholesale price; and 2) QRE applies only to the retailer.

Using these assumptions we are able to determine the log-likelihood for the estimation as follows,

\[
LL = \sum_{n} \sum_{j} y^{p=p_j} \log(\text{prob}(p = p_j)) = \sum_{n} \sum_{j} y^{p=p_j} \log\left(\frac{e^{\lambda R U_R(p_j)}}{\sum_k e^{\lambda R U_R(p_k)}}\right),
\]

where \( U_R \) is the utility given by Equation 3 and \( \lambda_R \) is the QRE parameter for the retailer.

Note that this log-likelihood function is a simple logit model, so estimating the parameters is sufficient in running a logit regression using any statistical software. 7

We estimated different variants of this base model. First, a model was run with no concerns for fairness. This model served as a baseline to check whether adding fairness concerns improves the explanatory power of our model. Four other variants of the base model were checked for which we assumed that the retailer cares about fairness, and we varied the fairness ideal used to determine the equitable payoff. These models give an insight into how the equitable payoff is
determined by subjects. Finally, a model was run to freely estimate and clearly establish the fairness ideal used by subjects, to determine the equitable payoff.

Estimation Results

The estimation results of the base model are presented in Table 6. The parameters for the five models are estimated, and the $\chi^2$ values for the likelihood-ratio tests are reported at the bottom of the table. All models accounting for fairness have a significantly better fit than the baseline model, where no fairness is considered. The log-likelihood of the sequence-aligned model is the highest among the four models of fairness ideals considered. This suggests that the fairness ideal that best captures subjects’ behavior is the sequence-aligned ideal. In the following discussion, we focus on the model of the sequence-aligned ideal.

--- INSERT TABLE 6 ABOUT HERE ---

The parameter of disadvantageous inequity $\alpha$ is equal to .43 and is significantly different from zero in the sequence-aligned model ($p$-value < .01). The parameter of advantageous inequity $\beta$ is given by .36, also significantly different from zero ($p$-value < .05). Since both $\alpha$ and $\beta$ are positive, the data suggests that an increase in inequity decreases retailer’s utility (see Equation 3) and players care about disadvantageous and advantageous inequity. That is, concerns exist regarding distributive fairness in the channel. In addition, since $\alpha > \beta$, the estimation confirms that players are more dissatisfied with experiencing disadvantageous than advantageous inequity.

Note that the estimated values of $\alpha$ and $\beta$ are not always significant or consistent with intuition. For instance, the value of $\alpha$ is smaller than the value of $\beta$ in the second best model—the strict egalitarian ideal. This suggests the importance of the fairness ideal in studying pricing
games in a channel. Choosing an incorrect fairness ideal may bring inappropriate conclusions about fairness concerns among channel members in a distribution channel.

The estimation results also show that the bounded rationality parameter of the retailer is given by $\lambda_R = .08$, which is significantly larger than zero and smaller than the value of $\infty$ in the rational model. Interestingly and different from the dramatic changes in the values of $\alpha$ and $\beta$ across different fairness ideal models, the estimated bounded rationality parameter $\lambda_R$ is very constant across models. This suggests that the estimation of bounded rationality is consistent and survives the choices of different fairness ideals, and can be attributed to the players’ capability to make the optimal decision given their utilities from optimal and suboptimal decisions. Such capability should in fact be relatively stable, independent of how the equitable payoff is determined. Fairness ideals, on the other hand, influence the way players form equitable payoffs, with the result that different fairness ideals significantly affect the values of inequity aversion parameters.

**Full model**

In the base model previously discussed, only the retailer is considered boundedly rational. Additionally, retailed price is used only to estimate the behavioral model. In this section, we will consider a full model in which the manufacturer and retailer are both boundedly rational. Besides studying the bounded rationality of the manufacturer, an additional benefit of studying the full model compared with the base model is that we will be able to use both wholesale prices and retail prices to estimate the behavioral parameters. Using both types of prices provides more information to estimate the parameters than the information used for the estimation of our base model.
When the manufacturer decides on the wholesale price $w$, it does not know for sure what retail price, $p$, will be chosen by the boundedly rational retailer. As a result, the manufacturer must make a decision based on the expected profit it would get from each level of wholesale prices available. This suggests that the manufacturer is facing a more complicated decision when setting wholesale prices than the retailer, who decides on the retail price $p$ only after observing the wholesale price $w$. Under this framework, the log-likelihood for the estimation can be represented as follows,

\begin{equation}
LL = LLM + LLR
\end{equation}

where

\begin{align}
LLM &= \sum_n \sum_i y^{w=w_i} \log(\text{prob}(w = w_i)) = \sum_n \sum_i y^{w=w_i} \log\left(\sum_k e^{\lambda_M \pi_M(w_i|p_j)}\right) \\
&= \sum_n \sum_i y^{w=w_i} \log\left(\frac{e^{\lambda_M \sum_j \text{prob}(p=p_j) \pi_M(w_i|p_j)}}{\sum_k e^{\lambda_M \sum_j \text{prob}(p=p_j) \pi_M(w_i|p_j)}}\right)
\end{align}

and

\begin{align}
LLR &= \sum_n \sum_j y^{p=p_j} \log(\text{prob}(p = p_j)) = \sum_n \sum_j y^{p=p_j} \log\left(\frac{e^{\lambda_R U_R(p_j)}}{\sum_k e^{\lambda_R U_R(p_k)}}\right).
\end{align}

Here $U_R$ is the utility given by Equation 3, $\pi_M = D(p)w$, and $\lambda_M$ and $\lambda_R$ are, respectively, the QRE parameters for the manufacturer and the retailer. Note that this log-likelihood function is more complicated than the one in the base model, as the probabilities of different retail prices affect the probabilities for the manufacturer to choose different wholesale prices. This requires simultaneously estimating the log-likelihoods for both manufacturer and retailer, i.e., $LLM$ and $LLR$.

In a similar fashion as for the estimation of the base model, we estimated several different versions of the full model. First, a model was run with no concerns for fairness and used as a
baseline to check whether considering fairness concerns improves the explanatory power of the model. Next, we ran the four models corresponding to the four different fairness ideals.

The estimation results are presented in Table 7. As we can see from the table, all the models that account for fairness have a significantly better fit than the baseline model where no fairness is considered. Again, the LL values suggest that the fairness ideal best capturing subjects’ behaviors is the sequence-aligned ideal. In addition, the $\chi^2$ value versus the model with no fairness concern also suggests that there are significant concerns for distributive fairness in the channel, where both players are boundedly rational. All these findings in the full model further confirm the insights obtained in the base model.

--- INSERT TABLE 7 ABOUT HERE ---

The only substantial difference between the two models is that the advantageous inequality parameter, $\beta$, is insignificant in the full model. This might be due to the fact that in this model the manufacturers’ beliefs on retailers’ preference play a role in the estimated parameters. If manufacturers believe that retailers do not care about advantageous inequality, that will be reflected in the estimation and produce the results we observe.

The full model also provides the following additional insights. First, notice that the QRE parameter for the retailer in the full model is given by .09, which is very consistent with the value in the base model. Additionally, the QRE parameter for the manufacturer is $\lambda_M = .02$, which is much smaller than the one for the retailer, $\lambda_R = .09$. Intuitively, the manufacturer faces a more complicated decision, since the manufacturer has to take into account the boundedly rational responses by the retailer to its wholesale price when deciding on the wholesale price $w$. The retailer, on the other hand, sets retail price $p$ after seeing the wholesale price $w$. Since a lower QRE parameter implies a higher rate of mistakes and $\lambda_M < \lambda_R$ in the full model, the
estimated results do confirm that the manufacturer is more prone to mistakes in its decision making than the retailer.

DISCUSSION AND CONCLUSION

In the paper, we experimentally investigated the theoretical predictions on prices in a dyadic channel, where the manufacturer acts as a Stackelberg leader in setting prices, and the retailer acts as a follower. A behavioral model that incorporates both retailer’s concerns for fairness and the bounded rationality by both firms is proposed to explain the discrepancy between the theoretical predictions and empirical regularities. Through such an enriched model, we investigate how equitable payoffs are determined in the fair channel, and propose a new principle of fairness (i.e., fairness ideal) that has never been investigated in literature. Our research makes the following several contributions to the literature.

First, we provide an estimation of fairness parameters in a channel context. The estimation results suggest that there are significant fairness concerns in distribution channels. In particular, we find that players are adverse to both advantageous and disadvantageous inequities, and they display a greater aversion for disadvantageous inequity than for advantageous inequity.

Second, we propose a new principle of fairness that is studied the first time in literature—the sequence-aligned ideal. The comparison between the new fairness ideal with several existing fairness ideals proposed in literature (Cappelen et al. 2007) suggests that the sequence-aligned ideal significantly outperforms other ideals in describing subjects’ behaviors in our experiments. The newly established ideal reflects the concept that the equitable payoff for the retailer is consonant with the ratio of players’ profits in the standard Stackelberg game. To the best of our knowledge, our research is also the first to empirically study fairness ideals in the pricing game of a distribution channel.
Third, using a two-sided QRE specification, we show that both agents in our game are boundedly rational. Since the manufacturer moves first to set its wholesale price before the retailer decides on the retail price in a Stackelberg game, the manufacturer faces a more complex task than the retailer. This is confirmed by our estimation: the QRE parameter for the manufacturer is significantly smaller than that for the retailer, indicating that the manufacturer is more irrational than the retailer in such a game.

Fourth, our study suggests that both inclinations for social preferences and bounded rationality affect firms’ pricing decisions, and we differentiate and quantify both effects through incentive aligned experimental studies. This implies that deviations in players’ pricing decisions from predictions of the standard economic model are not entirely due to errors in their decision making. Concerns for fairness do significantly affect firms’ decisions, even after bounded rationality is considered.

Finally, we provide managers with indications of how the power structure affects the interactions between channel members who may care about fairness in the channel. Based on our results, the power structure does affect the impact of fairness concerns on the dynamics between firms in a channel. It is perceived as “fair” for the more powerful firm, i.e., the manufacturer as a Stackelberg leader in our model, to obtain a higher payoff than the less powerful firm, i.e., the retailer as a follower.
REFERENCES


FOOTNOTES


3 See Appendix B for the instructions used in experiment 2 with \( R_M = .2 \) and \( R_R = .2 \). The instructions for other conditions are available from the authors upon request.

4 We assume the retailer compares profit from sales of product \( \pi_R \) with equitable payoff \( \frac{\tau}{1-\tau} \pi_M \), which is a function of the manufacturer’s profit from sales of products as well. The reason for such a specification is that firms’ pricing decisions in the pricing stage will affect only their profits from sales of product, given their investment amounts. The residual of endowment, \( E - I_j \) (\( j = M, R \)), on the other hand, is independent of firms’ pricing decisions.

5 We also varied the number of intervals used to discretize our variables by using 3, 5, 7, and 9 intervals to discretize the retail price. We did not see significant differences between the models.

6 We obtained estimates for \( \lambda_R, \alpha \lambda_R, \) and \( \beta \lambda_R \) because the QRE multiplier multiplies the entire \( U_R \) function. We recovered parameters \( \alpha \) and \( \beta \) using the delta method and assuming that the coefficient obtained for \( \pi_R \) is equal to \( \lambda \).
Table 1: Predictions of the Standard Economic Model

<table>
<thead>
<tr>
<th>Investments</th>
<th>Retailer</th>
<th>( R_R = 1.2 )</th>
<th>( R_R = .2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer</strong></td>
<td>( R_M = 1.2 )</td>
<td>10.00, 10.00</td>
<td>10.00, 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.50, 18.75</td>
<td>7.50, 10.75</td>
</tr>
<tr>
<td></td>
<td>( R_M = .2 )</td>
<td>0, 10.00</td>
<td>0, 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.50, 10.75</td>
<td>.50, .75</td>
</tr>
</tbody>
</table>

Note: the first (second) number in each row in a cell refers to the decision by the manufacturer (retailer). The first row shows investments and the second row shows prices.
<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>$R_M = 1.2$</th>
<th>$R_M = 0.2$</th>
<th>Retailer</th>
<th>$R_R = 1.2$</th>
<th>$R_R = 0.2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IM</td>
<td>IR</td>
<td>IM</td>
<td>IR</td>
</tr>
<tr>
<td><strong>Optimal Investment</strong></td>
<td></td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td><strong>Actual Investment</strong></td>
<td></td>
<td>7.59</td>
<td>6.39</td>
<td>6.87</td>
<td>2.76</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td></td>
<td>3.29</td>
<td>3.81</td>
<td>3.77</td>
<td>3.32</td>
</tr>
</tbody>
</table>

*** indicates that the t-test between actual and optimal values is significant at .001 confidence level (a negative t-test indicates that the actual investment is lower than the optimal investment, and a positive t-test indicates the opposite).
Table 3: OPTIMAL AND ACTUAL PRICES GIVEN ACTUAL INVESTMENTS

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>$R_M = 1.2$</th>
<th>$R_M = .2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Retailer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_R = 1.2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Optimal Price</strong></td>
<td>8.89</td>
<td>13.34</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>2.98</td>
<td>4.47</td>
</tr>
<tr>
<td><strong>Actual Price</strong></td>
<td>9.93</td>
<td>14.28</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>3.87</td>
<td>4.82</td>
</tr>
<tr>
<td><strong>t-test</strong></td>
<td>-7.44***</td>
<td>-8.29***</td>
</tr>
<tr>
<td>$R_R = .2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Optimal Price</strong></td>
<td>3.72</td>
<td>5.59</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>2.38</td>
<td>3.58</td>
</tr>
<tr>
<td><strong>Actual Price</strong></td>
<td>4.28</td>
<td>5.98</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>3.22</td>
<td>3.93</td>
</tr>
<tr>
<td><strong>t-test</strong></td>
<td>-7.01***</td>
<td>-6.96***</td>
</tr>
</tbody>
</table>

** indicates that the $t$-test between actual and optimal values is significant at .01 confidence level.
Table 4: FAIRNESS IDEALS

<table>
<thead>
<tr>
<th>Fairness Ideals</th>
<th>$\tau$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence-Aligned</td>
<td>$\frac{1}{3}$</td>
</tr>
<tr>
<td>Strict Egalitarian</td>
<td>$\frac{1}{2}$</td>
</tr>
<tr>
<td>Liberal Egalitarian</td>
<td>$\frac{1}{2}$, if $I_M = I_R = 0$; $\frac{I_R}{I_M + I_R}$, otherwise</td>
</tr>
<tr>
<td>Strict Libertarian</td>
<td>$\frac{1}{2}$, if $I_M = I_R = 0$; $\frac{I_R \cdot R_R}{I_M \cdot R_M + I_R \cdot R_R}$, otherwise</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>$\lambda_R$</td>
<td>QRE parameter of the retailer</td>
</tr>
<tr>
<td>$\lambda_M$</td>
<td>QRE parameter of the manufacturer</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Parameter of disadvantageous inequity</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Parameter of advantageous inequity</td>
</tr>
<tr>
<td>$\tau$</td>
<td>Parameter of fairness ideal</td>
</tr>
</tbody>
</table>
### Table 6: Estimation Results of the Base Model

<table>
<thead>
<tr>
<th></th>
<th>Sequence-Aligned</th>
<th>Strict Egalitarian</th>
<th>Liberal Egalitarian</th>
<th>Strict Libertarian</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>$\beta$=0</td>
<td>$\lambda_R$</td>
<td>.09 (0.01)**</td>
<td>.08 (0.01)**</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>-</td>
<td>.43 (0.09)**</td>
<td>.14 (0.03)**</td>
<td>.05 (0.02)**</td>
</tr>
<tr>
<td>$\beta$</td>
<td>-</td>
<td>.36 (0.12)**</td>
<td>.59 (0.20)**</td>
<td>-.15 (0.21)</td>
</tr>
<tr>
<td>Observations</td>
<td>6780</td>
<td>6780</td>
<td>6780</td>
<td>6780</td>
</tr>
<tr>
<td>LL</td>
<td>-2401.72</td>
<td>-2380.82</td>
<td>-2386.96</td>
<td>-2398.82</td>
</tr>
<tr>
<td>vs. $\alpha=\beta=0$</td>
<td>-</td>
<td>41.80***</td>
<td>29.52***</td>
<td>5.8*</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%
### Table 7: Estimation Results of the Full Model

<table>
<thead>
<tr>
<th></th>
<th>Sequence-Aligned</th>
<th>Strict Egalitarian</th>
<th>Liberal Egalitarian</th>
<th>Strictly Libertarian</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda$ Retailer</td>
<td>.12 (.01)***</td>
<td>.09 (.01)***</td>
<td>.10 (.01)***</td>
<td>.10 (.01)***</td>
</tr>
<tr>
<td>$\lambda$ Manufacturer</td>
<td>.02 (.00)***</td>
<td>.02 (.00)***</td>
<td>.03 (.00)***</td>
<td>.03 (.00)***</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>.48 (.08)***</td>
<td>.16 (.03)***</td>
<td>.07 (.02)***</td>
<td>.01 (.00)**</td>
</tr>
<tr>
<td>$\beta$</td>
<td>.08 (.12)</td>
<td>-.35 (.17)**</td>
<td>-.62 (.19)***</td>
<td>-.56 (.17)***</td>
</tr>
<tr>
<td>Observations</td>
<td>6780</td>
<td>6780</td>
<td>6780</td>
<td>6780</td>
</tr>
<tr>
<td>LL</td>
<td>-4783.23</td>
<td>-4750.05</td>
<td>-4756.11</td>
<td>-4767.97</td>
</tr>
<tr>
<td>vs. $\alpha=\beta=0$</td>
<td>-</td>
<td>66.36***</td>
<td>54.24***</td>
<td>30.52***</td>
</tr>
</tbody>
</table>

Note: Standard errors are shown in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%
APPENDIX: A

Solving Optimal Prices and Investment of the Standard Economic Model. Assume base line demand, \( BD \), is given by \( BD = a + I_M \cdot R_M + I_R \cdot R_R \), and market demand, \( D(p) \) is given by \( D(p) = BD - b \cdot p \) with \( b > 0 \). Further assume that manufacturer's and retailer's profits are given by the sum of the residual endowment and the profit from product sale so that \( \Pi_M = E - I_M + w \cdot D(p) \) and \( \Pi_R = E - I_R + (p - w) \cdot D(p) \).

First the retailer maximizes its profit with respect to \( p \), \( \max_p \Pi_R = E - I_R + (p - w) \cdot D(p) \).

From first order condition we get \( p^*(w,I_M,I_R) = \frac{a + I_M \cdot R_M + I_R \cdot R_R + w}{2b} \). Given \( p^* \), The manufacturer maximizes its profits with respect to \( w \), \( \max_w \Pi_M = E - I_M + w \cdot D(p^*) \).

From first order condition, we then have \( w^*(I_M,I_R) = \frac{a + I_M \cdot R_M + I_R \cdot R_R}{2b} \) and \( p^*(I_M,I_R) = \frac{3(a + I_M \cdot R_M + I_R \cdot R_R)}{4b} \).

Substituting optimal prices into profits, the manufacturers' total profit is given by \( \Pi_M(I_M,I_R) = E - I_M + \frac{(a + I_M \cdot R_M + I_R \cdot R_R)^2}{8b} \) and the retailers' total profit is given by \( \Pi_R(I_M,I_R) = E - I_R + \frac{(a + I_M \cdot R_M + I_R \cdot R_R)^2}{16b} \).

Because the profit function is convex in investments, \( D^2 \left( \begin{bmatrix} \Pi_M(I_M,I_R) \\ \Pi_R(I_M,I_R) \end{bmatrix} \right) = \begin{bmatrix} R_M^2 & R_M \cdot R_R \\ R_M \cdot R_R & R_R^2 \end{bmatrix} \) is positive semidefinite, we will always have corner solutions to the maximization problem. Hence for \( i=M,R \), either \( I_i = 0 \) or \( I_i = E \) so that
\( (I^*_M, I^*_R) = \begin{cases} (0,0) & \text{if} \ 0 < R_M < R_{M1} \quad \text{and} \quad 0 < R_R < R_{R1} \\ (0,E) & \text{if} \ 0 < R_M < R_{M2} \quad \text{and} \quad R_R \geq R_{R1} \\ (E,0) & \text{if} \ R_M \geq R_{M1} \quad \text{and} \quad 0 < R_R < R_{R2} \\ (E,E) & \text{if} \ R_M \geq R_{M3} \quad \text{and} \quad R_R \geq R_{R3} \end{cases} \)

We can compute the threshold values by comparing profits for different investment strategies. In order for \((0,0)\) to be an equilibrium, we must have \(\Pi_M(0,0) > \Pi_M(E,0)\) and \(\Pi_R(0,0) > \Pi_R(0,E)\). This leads to
\[
\frac{a^2}{8b} + E > \frac{(a + E \cdot R_M)^2}{8b} \quad \text{and} \quad \frac{a^2}{16b} + E > \frac{(a + E \cdot R_R)^2}{16b}.
\]

Defining \(R_{M1} = \frac{1}{E}(\sqrt{a^2 + 8bE} - a)\) and \(R_{R1} = \frac{1}{E}(\sqrt{a^2 + 16bE} - a)\), it is easy to show that the conditions are equivalent to \(0 < R_M < R_{M1}\) and \(0 < R_R < R_{R1}\).

Similarly, for \((E,E)\) to be an equilibrium, we have \(\Pi_M(E,E) \geq \Pi_M(0,E)\) and \(\Pi_R(E,E) \geq \Pi_R(E,0)\), which leads to
\[
(A1) \quad \frac{(a + E \cdot R_M + E \cdot R_R)^2}{8b} \geq \frac{(a + E \cdot R_R)^2}{8b} + E
\]
and
\[
(A2) \quad \frac{(a + E \cdot R_M + E \cdot R_R)^2}{16b} \geq \frac{(a + E \cdot R_M)^2}{16b} - E.
\]

Denote \(R_M\) by \(x\) and \(R_R\) by \(y\), so equation A1 becomes \(\Phi_M(x,y) = E x^2 + 2x(a + Ey) - 8b \geq 0\) and equation A2 becomes \(\Phi_R(x,y) = E y^2 + 2y(a + Ex) - 16b \geq 0\).

For \((0,E)\) to be an equilibrium, the conditions are \(\Pi_M(0,E) > \Pi_M(E,E)\) and \(\Pi_R(0,E) \geq \Pi_R(0,0)\), which implies that \(\Phi_M < 0\) and \(R_R \geq R_{R1}\). Similarly, the conditions for \((E,0)\) to be an equilibrium are given by \(\Phi_R < 0\) and \(R_M \geq R_{M1}\).
Hence, to solve for $R_{M2}$, $R_{R2}$, $R_{M3}$, and $R_{R3}$, it is sufficient to solve $\Phi_{M}(R_{M2}, R_{R}) = 0$ for $R_{M2}$, $\Phi_{R}(R_{M}, R_{R2}) = 0$ for $R_{R2}$, and to simultaneously solve $\Phi_{M}(R_{M3}, R_{R3}) = 0$ and $\Phi_{R}(R_{M3}, R_{R3}) = 0$ for $R_{M3}$ and $R_{R3}$.

**Solving Optimal Prices of the Behavioral Model.** Given the baseline demand $BD = a + I_{M} R_{M} + I_{R} R_{R}$, the manufacturer’s profit is given by $\pi_{M} = w(BD - bp)$ and the retailers’ utility is given by $U_{R} = \pi_{R} - \alpha \cdot \max\{\frac{\tau}{1-\tau} \pi_{M} - \pi_{R}, 0\} - \beta \cdot \max\{\pi_{R} - \frac{\tau}{1-\tau} \pi_{M}, 0\}$.

Because the utility function is not continuously differentiable, we need to distinguish between the cases in which the retailer experiences disadvantageous and advantageous inequity. The retailer experiences disadvantageous inequity when $\pi_{R} - \frac{\tau}{1-\tau} \pi_{M} \leq 0$ or equivalently $p \leq (1 + \frac{\tau}{1-\tau})w$. Hence, the retailer faces the following maximization problem

$$\max_{p} (p - w)(BD - bp) - \alpha \left[\frac{\tau}{1-\tau} w - (p - w)\right](BD - bp)$$

s.t. $p \leq (1 + \frac{\tau}{1-\tau})w$.

Similarly, the retailer experiences advantageous inequity when $\pi_{R} - \frac{\tau}{1-\tau} \pi_{M} \geq 0$ or equivalently $p \geq (1 + \frac{\tau}{1-\tau})w$. Hence, the retailer faces the following maximization problem

$$\max_{p} (p - w)(BD - bp) - \beta \left[(p - w) - \frac{\tau}{1-\tau} w\right](BD - bp)$$

s.t. $p \leq (1 + \frac{\tau}{1-\tau})w$. 
Following Cui, Raju and Zhang (2007), the optimal retail prices are given by

\[
p^*(w, I_M, I_R) = \begin{cases} 
BD + w - \frac{\beta w}{1 - \tau} \frac{\tau}{2(1 - \beta)} & \text{if } w \leq w_2 \\
\frac{BD + w}{2b} - \frac{\alpha w}{1 - \tau} \frac{\tau}{2(1 + \alpha)} & \text{if } w > w_i \\
w + \frac{\tau}{1 - \tau} w & \text{if } w_2 < w \leq w_i \\
\end{cases}
\]

where 
\[
w_i = \frac{a(1 - \alpha)}{1 + \alpha + (2 + \alpha) \frac{\tau}{1 - \tau}} \quad \text{and} \quad w_2 = \frac{a(1 - \beta)}{1 - \beta - (2 + \beta) \frac{\tau}{1 - \tau}}.
\]

If the manufacturer chooses a price in the range \( w \leq w_2 \), then the manufacturer’s maximization problem is given by \( \max_w w(BD - bp) \), s.t. 
\[
p = \frac{BD + w}{2} - \frac{\beta w}{1 - \tau} \frac{\tau}{2(1 - \beta)} \quad \text{and} \quad w \leq w_2.
\]

If the manufacturer chooses a price from the range \( w_2 < w \leq w_1 \), then the manufacturer’s maximization problem is given by \( \max_w w(BD - bp) \), s.t. 
\[
p = w + \gamma \cdot w, \quad w > w_2, \quad \text{and} \quad w \leq w_1.
\]

If the manufacturer chooses a price in the range \( w > w_1 \), then the manufacturer’s maximization problem is given by \( \max_w w(BD - bp) \), s.t. 
\[
p = \frac{BD + w}{2b} - \frac{\alpha \gamma \cdot w}{2(1 + \alpha)} \quad \text{and} \quad w > w_1.
\]

The optimal wholesale prices can be solved accordingly and are given by

\[
w^*(I_M, I_R) = \begin{cases} 
w_{w_1} & \text{if } 0 < \beta \leq 1 - 3\tau \quad \text{and} \quad \alpha \leq \beta \\
w_{w_2} & \text{if } 1 - 3\tau < \beta \leq 1 - \tau \quad \text{and} \quad \beta \leq \alpha < \frac{1}{\alpha} \\
w_{w_3} & \text{if } 1 - \tau < \beta < 1 \quad \text{and} \quad \beta \leq \alpha < 2\tau - 1 \\
w_{w_1} & \text{if } \beta = 1 - \tau \quad \text{and} \quad \beta \leq \alpha < 2\tau - 1 \\
w_{w_2} & \text{if } \beta = 1 - \tau \quad \text{and} \quad \alpha \geq \max\{\alpha, \beta\} \\
w_{w_3} & \text{if } 1 - \tau < \beta < 1 \quad \text{and} \quad \beta \leq \alpha < 2\tau - 1 \\
w_{w_1} & \text{if } 1 - \tau < \beta < 1 \quad \text{and} \quad \alpha \geq \max\{2\tau - 1, \beta\}
\end{cases}
\]
where \( w_I = \frac{BD(1-\beta)}{2b(1-\beta-\beta\frac{\tau}{1-\tau})} \), \( w_{II} = \frac{BD}{2b(1+\frac{\tau}{1-\tau})} \), \( w_{III} = \frac{BD(1+\alpha)}{2b(1+\alpha+\alpha\gamma)} \), and

\[
\alpha = \frac{(1-\beta-3\tau)^2 - 8\beta\tau^2}{8\tau^2 - (1-\beta-3\tau)^2}.
\]
APPENDIX B: INSTRUCTIONS

Instructions

You are about to participate in a decision-making experiment. By following these instructions you can earn a considerable amount of money which will be paid to you in cash before you leave today. Your earnings depend on your decisions as well as on the decisions of other participants. It is important that you do not look at the decisions of others, and that you do not talk, laugh, or make noises during the experiment. You will be warned if you violate this rule the first time. If you violate this rule twice, you will be asked to leave the room immediately and your cash earnings will be $0. The experiment is designed in a way that the anonymity of all the participants is protected.

In this experiment, there will be a total of 20 decision rounds. In each round, you will earn point earnings measured in pesos. The more pesos points you earn, the more cash earnings you make. The decision steps and how you earn pesos points in every round are described as follows:

In each round, you will be randomly matched with another person in the room. You will be acting as either a retailer or a manufacturer. The other person who is matched with you will be acting as a manufacturer if you are acting as a retailer, or will be acting as a retailer if you are acting as a manufacturer. You will act as a manufacturer in 10 out of the 20 rounds and will act as a retailer in the other 10 rounds. In each round, both you and the person you are matched with will make decisions in two phases – an investment phase and a pricing phase. In the investment phase, both the manufacturer and the retailer will each be assigned with 10 pesos and they decide how much to invest to increase the base demand of the product that the retailer is buying from the manufacturer and selling to consumers. In the pricing phase, the manufacturer will decide on the wholesale price and the retailer will decide on the retail price of the product. Consumer
demands, the manufacturer’s profit, and the retailer’s profit will be determined as described below. A manufacturer will not meet with the same retailer for more than once, and a retailer will not meet with the same manufacturer for more than once.

**Experimental Procedure**

The following procedural steps will be repeated in each of the 20 decision rounds:

*Step 1: Determining your role*

Your computer screen will show whether you are a manufacturer or a retailer in each round. Every subject will be a retailer for 10 rounds and a manufacturer for the other 10 rounds.

*Step 2: Determining each member's investment amount*

At the beginning of each round both the manufacturer and the retailer will each start with 10 pesos. You will decide how much of the 10 pesos to invest. You can choose to invest 0 pesos, 5 pesos or 10 pesos. After both the manufacturer and retailer decide on their investments, their investment amounts will be shown to each other. Each investment is going to affect the total demand for the product in the way below.

*Step 3: Determination of total demand*

After both the manufacturer and retailer make investments (denoted as IM for manufacturer and IR for retailer in pesos), the total demand \( D \) in unit is determined as follows.

\[
D = 1 + 0.2*IM + 0.2*IR - P
\]

That is, whenever you make an investment, the investment is going to increase the base demand of the product by 0.2 times of your investments if you are acting as the manufacturer or by 0.2
times of your investments if you are acting as the retailer. Here \( P \) refers to the retail price that will be chosen by the retailer later.

**Step 4: Manufacturer decides on wholesale price \( W \)**

After investment amounts IM and IR are chosen, the manufacturer decides on wholesale price \( W \) at which the manufacturer sells the product to the retailer.

**Step 5: Retailer decides on retail price \( P \)**

After the wholesale price \( W \) is set by the manufacturer, the retailer decides on retail price \( P \).

**Step 6: Profits to the manufacturer and retailer**

After the manufacturer chooses wholesale price \( W \) and the retailer decides on the retail price \( P \), the manufacturer’s total profit \( \Pi_M \) is given by:

\[
\Pi_M = 10 - IM + W \times D
\]

The retailer’s total profit \( \Pi_R \) is given by:

\[
\Pi_R = 10 - IR + (P - W) \times D
\]

Here \( D \) is the demand, 10 is the amount of pesos you start with, and IM or IR is the investment amount you made before.

You will play a test game of 2 rounds before the formal game starts.

**Example**

Suppose the manufacturer invests 5 pesos and the retailer invests 5 pesos. The manufacturer charges a wholesale price of 1.5 pesos and the retailer charges a retail price of 2.25 pesos. Then total demand \( D \) is going to be given by

\[
D = 1 + 0.2 \times 5 + 0.2 \times 5 - 2.25 = 0.75
\]

\[
\Pi_M = 10 - IM + W \times D = 10 - 5 + 1.5 \times 0.75 = 6.125
\]
PiR = 10 - IR + (P - W) * D = 10 - 5 + (2.25 - 1.5) * 0.75 = 5.5625

**Your Payoffs**

Your dollar earnings for the experiment are determined as follows. First, we will sum up your pesos earnings for each of the 20 rounds in which you participated. The profit is going to be converted at a fix rate of dollars per pesos. On top of these earnings you will get a $5 participation fee. We will pay you this amount when you leave the experiment. Note the more pesos you earn, the more money you will receive.