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Disapproval Aversion or Inflated Inequity Acceptance? The Impact of Expressing Emotions in Ultimatum Bargaining

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Abstract: Past experimental research has shown that when rating systems are available, buyers are more generous in accepting unfair offers in ultimatum bargaining. But it at the same time suggests that sellers behave more fairly to avoid receiving negative feedbacks. This paper experimentally studies which effect is stronger with a rating system: buyers' inflated inequity acceptance or sellers' disapproval aversion. We explore this question by varying the information condition on buyers' side. Our experiment shows that in the setup where the size of pie is common knowledge to both buyers and sellers, when a rating system is present, the sellers exhibit disapproval aversion but the buyers do not raise inequity acceptance. But on the other hand, when only sellers are aware of the size of the pie, sellers behave aggressively to exploit buyers and their behaviors do not change by the presence of a rating system, but instead, buyers raise inequity acceptance significantly with the rating system present. We discuss that these results can be explained by a theoretical model with sellers' social disapproval aversion and buyers' disappointment aversion, along with the players' inequality aversion.

Keywords: experiment, ultimatum game, emotion, rating, disapproval aversion

JEL classification codes: C91, D03, D82, M21

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1. INTRODUCTION

In recent decades, economists have devoted considerable efforts to studying the impact of expressing emotions on people's behavior with complete information and have found that emotional expression may affect both the senders and recipients of the expression. On the one hand, it has been documented that people have preferences against receiving disapproval from others. Consequently they behave pro-socially so that they do not receive negative feedback.[1] On the other hand, expressing emotions has also been known to affect the behavior of the senders of those emotions. For example, in a one-shot ultimatum game, buyers (responders) are more likely to accept unfair offers when given opportunities to express emotions (e.g., Xiao and Houser 2005, Güth and Levati 2007). This finding suggests that expressing negative emotions is a substitute for punishing matched sellers (proposers) and thus increases buyers' *inequity acceptance*. But which effect is more dominant with a rating system present in ultimatum bargaining: buyers' inflated inequity acceptance or sellers' disapproval aversion? Does the relative strength of these two effects differ by information condition? This paper is the first to study how the impact of expressing emotions differs by whether the size of pie is common knowledge to all players (complete information) or is only known to sellers (incomplete information).

Although past studies used complete information setups to study the effects of expressing emotions, understanding such effects under the incomplete information setting is equally important for two particular reasons. First, the incomplete information setup is more realistic for some circumstances in which sellers are better informed than buyers about products they sell. On the one hand, for example, price settings of foods in grocery stores, or standard items, such as pens, university textbooks and music CDs, in physical stores or on the online marketplace (e.g., Amazon.com) can be described with complete information. On the other hand, some transactions

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[1] For example, see Masclet *et al.* (2003) and Dugar (2013) in public goods games, Ellingsen and Johannesson (2008) and Xiao and Houser (2009) in a dictator game, and López-Pérez and Vorsatz (2010) in a prisoner's dilemma game.

can be best described by incomplete information on buyers' side. Examples include used products, medical services, and education service, such as higher education. Users usually become aware of the quality of goods and services only after they purchase or consume them. A rating system is available for some cases (e.g., standard items or used products on the online marketplace, lectures at universities), but not for other cases (e.g., goods in grocery stores, used items in classified ads, such as Craigslist).

Second, the asymmetry of information between sellers and buyers is known to change the picture of the bargaining between them. Many experiments with complete information have demonstrated that people prefer fair outcomes in ultimatum games (see Roth (1995) for a survey). At the same time, however, past studies have shown that in incomplete information setups, (a) sellers can become greedier and their offering prices can be close to what standard theory predicts and, (b) buyers are more likely to accept unfair offers.[2] These results may extend to an environment with a rating system. Moreover, the presence of the rating system may make buyers open to even more unfair offers with incomplete information. Buyers behave conservatively to avoid disappointment that they may experience when the realized size of pies are lower than their expectation. However, with a rating system present, buyers can release such negative emotions using ratings; as such, buyers do not need to lower inequity acceptance because of disappointment.

Our experiment is built on a finitely-repeated ultimatum game. We design four treatments by varying two dimensions. The first dimension is constituted by whether buyers are given the opportunity to rate sellers or not. Sellers are informed of their own ratings after the transactions are completed. The ratings are not disclosed to other group members and are not carried over

[2] See, for example, Straub and Murnighan (1995), Rapoport *et al.* (1996), Croson (1996), Güth *et al.* (1996), and Mitzkewitz and Nagel (1993).

from period to period.[3] The second dimension is constituted by whether buyers are informed of the size of the pies or not (i.e., complete versus incomplete information). In each treatment, subjects are randomly assigned either a role of seller or of buyer. Seller j has one commodity, the value of which is randomly drawn from integers between 0 and 40, and is then randomly matched with a buyer i. Seller j submits an offering price (p_{sj}) and buyer i submits a purchase threshold (p_{bi}). If $p_{sj} \leq p_{bi}$, then the transaction between i and j is closed.

We first theoretically describe that bargaining between seller j and buyer i could result in more unequal divisions with incomplete information than with complete information conditions. We then describe how a fairer or a less fair situation could hold as an equilibrium outcome with a rating system if players are inequality averse and sellers exhibit disapproval aversion. We then show that buyers' inflated inequity acceptance could dominate sellers' disapproval aversion when the buyers are not aware of the size of the pies (incomplete information), because buyers dislike disappointment from possibly lower size of the pies than expected.

Our experiment results largely confirm the theoretical analyses with social disapproval aversion and disappointment aversion. First, the divisions of the pies were much more unequal with incomplete than with complete information. Second, sellers exhibited disapproval aversion with complete information, as is consistent with past research. Specifically, the sellers attempted to keep smaller shares of the pies when the rating system was available, compared with when it was not available. Third, by sharp contrast, with incomplete information, sellers' disapproval aversion did not affect their bargaining behavior. Whether the rating system was present, sellers aggressively attempted to take more from their buyers. The presence of rating opportunities instead raised buyers' inequity acceptance. The enhanced buyers' acceptance to unfair offers

[3] This design is employed because our aim is to measure the effects of a rating system itself without reputation effects.

increased the inequality in the divisions of the pies. In short, our paper suggests that the rating system may have opposite effects depending on the information conditions.

The rest of the paper proceeds as follows: Section 2 describes our experimental design. Section 3 provides theoretical considerations. Section 4 reports results, and Section 5 concludes.

2. EXPERIMENTAL DESIGN

Our experiment is based on a finitely-repeated ultimatum game. At the onset of the experiment, subjects are randomly assigned to an interaction unit (group) with other nine subjects. A group of ten subjects is then randomly divided into two subgroups of five subjects. Five subjects in one subgroup are assigned roles of seller (proposer) and the five in the other subgroup are assigned roles of buyer (responder).[4] The initially assigned roles do not change throughout the entire experiment. Subjects do not interact with subjects in other groups. The number of periods is 50 and there is no break between periods.

The structure of each period is identical. At the onset of a period t, each seller is randomly matched with a buyer in his group. Since there are five buyers and five sellers in a group, the probability that a seller is matched with the same buyer both in period t and period $t-1$ is 20%. In each period, every seller has one commodity whose quality is the same across all five sellers in the group. The quality (true value) of the commodity, q_t, is randomly (i.e., with a probability of 1/41) drawn from the set of integers ranging between 0 and 40 in every period. The random drawing process is independent across periods. The experimental design follows the standard ultimatum games with a strategy method. Each seller proposes a price, p_{sj}, to sell a commodity to his matched buyer. They can sell at most one commodity. p_{sj} must be an integer ranging from 0 to 40. Each buyer simultaneously submits a purchase threshold, p_{bi}, to her

[4] In the experimental sessions, two subsets of subjects are called "buyers" and "sellers" as written in the paper. The framing of buyers and sellers is often used in experiments with ultimatum games (e.g., Roth *et al.* 1991).

matched seller.[5] If $p_{sj} \leq p_{bi}$, the deal between buyer i and seller j is closed; seller j obtains a payoff of $p_{sj} - q_t/2$, and buyer i obtains a payoff of $q_t - p_{sj}$. Here, we can interpret $q_t/2$ as the production cost of a commodity or the value of it for the seller. If $p_{sj} > p_{bi}$, the deal is not closed; the payoffs of both players are zero in that period. Note that when a deal is closed but $q_t - p_{sj} < 0$, the buyer incurs a loss. Each player is informed of their own interaction outcome at the end of each period. Buyer i is then made aware of the seller's offering price. However, seller j is not informed of the matched buyer's purchase threshold; and the seller is only informed of whether the offer was accepted. Subjects are paid based on the sum of their payoffs earned during all 50 periods.[6] The number of periods, the assignment procedure of the roles, the distribution of q_t, and the interaction rules, such as the formula of payoffs, are all common knowledge to subjects.

We design four treatments by varying two dimensions in the experiment. The first dimension is whether the value of the commodity (q_t) is known to both sellers and buyers, or is only known to sellers, before transactions in each period. In the incomplete information condition, the buyers learn the realized value of q_t at the end of each period.[7] The second dimension is whether there is a rating system available to buyers or not. The four treatments are named as the "No Rating, Complete Information" (N-C) treatment, the "Rating, Complete Information" (R-C) treatment, the "No Rating, Incomplete Information" (N-IC) treatment, and the "Rating, Incomplete Information" (R-IC) treatment.

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[5] Strategy methods are widely used in experiments with ultimatum games. The benefit of using the strategy methods is to elicit the upper bound of the buyer's purchase decision (acceptance). With the standard, sequential direct-response method, we only observe a buyer's acceptance to a specific offer, not the threshold. Past studies also find that there is no difference in mean offer or mean acceptance rate between the two methods with complete information. They further indicate little difference in subjects' behavior between the two methods when used in ultimatum games with incomplete information on buyer's side (see Brandts and Charness 2011 for a survey).

[6] The participation fee is guaranteed even if a subject's accumulated payoff is negative. In the experiment, 0%, 0%, 11.25% and 18.75% of the buyers in the N-C, R-C, N-IC and R-IC treatments, respectively received only participation fees due to their negative accumulated payoffs.

[7] The setup of the incomplete information condition is similar to the experimental design such as the one used in Rapoport *et al.* (1996). For example, in Rapoport *et al.* (1996), the size of the pie in an ultimatum game is randomly distributed from a uniform distribution [a, b] and the realized size is private information of the sellers.

In the R-C and R-IC treatments, each buyer is given an opportunity to rate their matched seller on a 10-point scale in every period after learning their transaction outcome (including their own and their matched seller's payoffs). Buyers are instructed that the lowest number (0) means "very unfair;" 3 means "unfair;" 7 means "fair;" and the highest number (10) means "very fair."

At the end of each treatment, demographic information, such as gender, is collected. These responses are used as control variables in data analysis.

3. THEORETICAL CONSIDERATION AND HYPOTHESES

Each seller is randomly assigned an identification number, is then randomly paired with a buyer and interacts with each other in every period. As discussed in Section 2, the number of interactions is finite and is common knowledge to both the buyers and the sellers. The standard theory therefore predicts the same behavior of the subjects in each stage game. The standard theory predictions are the same between the N-C and R-C treatments, and also between the N-IC and R-IC treatments, because the rating opportunities held by buyers do not affect the (material) payoffs of the buyers and sellers.

Our experiment uses the standard ultimatum games with a strategy method. Thus, there are multiple equilibrium outcomes in each treatment. First, in the N-C and R-C treatments, for a given q_t, any division of the pie: $(p - q_t/2)/(q_t/2)\times100[\%]$ for the seller and $(q_t - p)/(q/2)\times100[\%]$ for the buyer, where $p \in [q_t/2, q_t]$, can be realized as an equilibrium outcome. Note that the size of pie in this experiment is $q_t/2$ $(= q_t - q_t/2)$. Under a Nash Equilibrium, the same p is offered by a seller and is also set as a purchase threshold by the buyer; and their transaction is closed. In addition, there are many equilibrium outcomes where deals are not closed, and both sellers and buyers receive nothing (see Appendix A.1).

Second, in the N-IC and R-IC treatments, while a seller can condition his strategy on q_t, the matched buyer selects a purchase threshold p_b irrespective of q_t, as the buyer is not informed of the value of q_t. We write p_{sj}: [0, 40] → [0, 40] as the strategy of seller j, and $p_{bi} \in [0, 40]$ as the strategy of buyer i.[8] As shown in Appendix A.3, we find two kinds of Bayesian Nash Equilibria (BNE). In the first kind of equilibrium, the seller has a clear advantage: the buyer obtains an expected payoff of 0 and only the seller obtains a positive payoff.[9] In other words, only extremely unequal divisions of the pies are realized as equilibrium outcomes. In the second class of BNE, the transaction is not executed. The following is an example: the seller always posts a price so that $p_s > 20$, and the buyer sets her purchase threshold at 0.

Summary 1: *Equilibrium Analysis Based on the Standard Theory.*

There are multiple equilibria in all of the four treatments. In an equilibrium where a deal is closed, both the buyer and seller can obtain positive shares of the pie in the N-C and R-C treatments. However, in the N-IC and R-IC treatments, only a very unequal division of the pie is observed in a Bayesian Nash Equilibrium where a deal is closed.

Based on Summary 1, we now have the following testable hypothesis on the impact of the information condition on subjects' divisions of the pies.

Hypothesis 1: *A more unequal division of the pies is realized in the N-IC and R-IC treatments than in the N-C and R-C treatments.*

Players' Inequality Aversion and Sellers' Disapproval Aversion:

[8] Although we use a discrete interval {0, 1, …, 40} for the choice space in the experiment, we use a continuous interval [0, 40] for simplicity in our theoretical analysis.

[9] For instance, the following is an equilibrium: the seller proposes $p_s = p_s(q_t) = c$ for $q_t \leq 2c$; and $p_s(q_t) = q_t$ for $q_t > 2c$, and the buyer submits $p_b = c$ as her purchase threshold. Here, c is any constant that is less than or equal to 20. Although there are multiple BNE of this class, the expected payoff of the seller differs by equilibrium and is maximized when the following equilibrium is realized: $p_s = p_s(q_t) = 20$ for all q_t, and $p_b = 20$. The expected payoff of the seller is then 10. This implies that the Pareto dominant BNE is that the seller always proposes to sell the commodity at a price of 20, and the buyer sets the purchase threshold at the price of 20.

Unlike Summary 1, buyers obtain some positive payoffs and thus the divisions of the pies can be less unequal in equilibrium even in the incomplete information treatments, once we assume that people have other-regarding preferences. As an illustration, assume that all subjects have inequality-averse preferences (e.g., Fehr and Schmidt 1999) and that it is common knowledge. The utility function of the inequality-averse buyer can be expressed as:

$$u_{bi}(\pi_{bi}, \pi_{sj}) = \pi_{bi} - \mu_i \cdot f(\pi_{bi} - \pi_{sj}), \tag{1}$$

where μ_i indicates the utility weight of inequality of buyer i and it differs by buyer. In our theoretical analysis, we use the following quadratic function as $f(.)$:[10]

$$f\left(\pi_{bi} - \pi_{sj}\right) = \left(\pi_{bi} - \pi_{sj}\right)^2. \tag{2}$$

The utility function of inequality-averse seller j can be defined likewise:

$$u_{sj}(\pi_{sj}, \pi_{bi}) = \pi_{sj} - \mu_j \cdot f(\pi_{sj} - \pi_{bi}). \tag{3}$$

As shown in Appendix A.2, regardless of the information condition, the seller's best response strategy (price) would depend on q_t and μ_j, and in equilibrium where a deal is closed, both the seller and the buyer always obtain positive (expected) payoffs in all the treatments.[11] As a result, for a given q_t, the degree of inequality with the division of the pies is mitigated to some degree.[12]

Next, we consider how the presence of the rating system may affect the players' behaviors using the model with inequality aversion (Eqs. (1) to (3)). As in past research, let us assume that a seller incurs a psychological loss when the seller receives a negative rating from

[10] Our choice of a quadratic function is due to its tractability, but would not lose many important implications because of this choice. Quadratic functional forms are sometimes used in theoretical analyses of subjects' behaviors. For example, see Cappelen *et al.* (2013) and Kamei (forthcoming).

[11] The seller's best offering price is increasing in q_t, but with a slope less than 1, when q_t is sufficiently smaller than the seller's belief on the buyer's purchase threshold, because the seller prefers fairer outcomes. If a realized q_t is in some range close to a given buyer's purchase threshold p_{bi}, the seller attempts to submit p_{bi} as her offering price, although the seller offers a price strictly greater than p_{bi} when q_t is sufficiently large (Appendix Figure A.2). The buyer, given p_{sj}, attempts to submit p_{sj} as his purchase threshold, so long as the buyer's utility is non-negative.

[12] Another other-regarding preference model is an intention-based social preference model such as a reciprocity model (e.g., Rabin 1993, Charness and Rabin 2002, Dufwenberg and Kirchsteiger 2004, Falk and Fischbacher 2006, Cox *et al.* 2007). In a reciprocity model, agents react hostilely to hostile acts taken toward them by their opponents. In our experiment, buyers have the opportunity to reject unfair offers proposed by sellers. Thus, such a reciprocity model would also predict a fairer division of the potential gain between the two parties.

his buyer, but the seller receives a psychological gain when the rating is positive. With this assumption, the direction of the effects of the rating system does not differ by the information condition. We use the R-C treatment to illustrate possible consequences of expressing emotions, incorporating the framework used by Cooper and Lightle (2011, 2012) into our setup. For simplicity, also assume that the psychological loss or gain of a seller is proportional to the difference from the neutral rating, 5, and is expressed as: $c \cdot (r - 5)$, where c is a positive constant and r is the rating ($\in \{0, 1, \ldots, 9, 10\}$). With this setup, the seller's payoff is re-written by π_{sj}':

$$\pi_{sj}' = \pi_{sj} + c \cdot (r - 5). \tag{4}$$

We also assume that there are no costs on the buyer's side because giving ratings are mandatory.[13] In this framework, seller j selects p_{sj} to maximize his utility $u_{sj}(\pi_{sj}', \pi_{bi})$. Buyer i selects p_{bi} and then r in the later rating stage to maximize her utility $u_{bi}(\pi_{bi}, \pi_{sj}')$. As detailed in Appendix A.5, the buyer would utilize the rating opportunity so as to shrink her disutility from inequality (i.e., $\mu_i \cdot f(\pi_{bi} - \pi_{sj}')$). This implies that when their transaction is closed ($p_{bi} \geq p_{sj}$), the buyer's rating scores are negatively correlated with the seller's offering prices (equivalently the seller's payoff).[14] This analysis is summarized as Hypothesis 2 below:

Hypothesis 2: *Buyers give positive (negative) ratings to sellers who take less (more) from the pies when their transactions are closed.*

Because the disutility the buyer incurs from material inequality diminishes by acts of expressing emotions, the buyer shows more willingness to accept a higher price (i.e., an unfair division of pie), compared with when the rating system is not available. Note that the buyer would accept an offer by matching p_{bi} with the seller's offering price whenever $u_{bi}(\pi_{bi}, \pi_{sj}') \geq 0$ in equilibrium. However, as explained in Appendix A.5, there is not only a fairer equilibrium but

[13] Adding a show-up fee in the payoff function of a player does not change the calculation. For notational simplicity we did not include the show-up fee in the payoff functions.
[14] When it is not closed, the buyer would give a rating of 5 (the neutral rating) to the seller.

also a less fair equilibrium with rating than without rating, due to psychological costs or gains associated with receiving negative or positive feedbacks. On the one hand, the disapproval-averse seller would attempt to keep less by setting a lower price in the R-C (R-IC) than in the N-C (N-IC) treatment when the seller expects to incur a psychological cost from receiving a negative feedback. On the other hand, the seller would oppositely attempt to keep more in the R-C (R-IC) than in the N-C (N-IC) treatment when he expects to receive a positive feedback. The former (latter) situation leads to an equilibrium in which fairer (less fair) divisions of the pies are realized, compared with a situation without a rating possibility.

Summary 2: *Equilibrium Analysis based on Inequality Aversion and Disapproval Aversion. (a) Given q, buyers exhibit more willingness to accept unfair offers in the R-C (R-IC) than in the N-C (N-IC) treatment. However, (b) there exists not only a fairer equilibrium but also a less fair equilibrium in the R-C (R-IC) than in the N-C (N-IC) treatment.*

Buyers' Disappointment Aversion:

Under which information condition could buyers exhibit stronger inequity acceptance: complete or incomplete information? We now explain that stronger inequity acceptance may be observed in the incomplete information setting because of buyers' disappointment aversion. A large body of literature suggests that a subject could incur a disutility from disappointment if realized outcomes are lower than his/her certainty equivalent in risky decisions (see Gul (1991) and Routledge and Zin (2010) for theoretical models). If buyers exhibit disappointment aversion in our context, their purchase thresholds would differ between the R-IC and N-IC treatments, even without disapproval aversion (see Appendix Section A.6 for an illustrative analysis in a simple setting). This results from two forces: (a) disappointment-averse buyers in the N-IC treatment would submit low purchase thresholds to avoid disappointment from possibly lower q, but (b) disappointment aversion would not affect buyers' behaviors in the R-IC treatment because of the rating opportunity.[15] In contrast to the incomplete information setup, buyers would not experience such disappointment in the R-C and N-C treatments as they are aware of q_t when making decisions. The likely impact of buyers' disappointment aversion with incomplete information suggests that the difference in buyers' inequity acceptance between with and without rating could be larger in the incomplete information than the complete information setup.

Summary 3: *Analysis based on Inequality Aversion and Buyers' Disappointment Aversion. Stronger degree of inflated inequity acceptance is observed in the incomplete information than in the complete information setup.*

We explained that the theoretical analyses do not provide a point prediction (Summary 2(b)). One may wonder to which equilibrium subjects' interactions could converge through adjustments in their strategy over the course of repetition.[16] We could provide a hypothesis to this question using past research findings and Summary 3. On the one hand, as mentioned in Section 1, people are known to prefer to avoid receiving disapproval from others and therefore behave more fairly when a rating system is available in complete information settings (e.g., Masclet *et al.* 2003, Dugar 2013, Ellingsen and Johannesson 2008, López-Pérez and Vorsatz 2010, Xiao and Houser 2009). This suggests that subjects' interactions could converge to a fairer equilibrium in the R-C treatment. In such equilibrium, sellers' disapproval aversion can dominate buyers' inflated inequity acceptance. But on the other hand, a less fair equilibrium may be instead realized with incomplete information, because of Summary 3. Due to disappointment-averse motives, buyers could exhibit lower inequity acceptance in the N-IC than in the N-C treatment. However, because of the presence of the rating system, buyers in the R-IC treatment

[15] Buyers can cancel out the negative emotions from disappointment, by releasing them through rating acts.

[16] Both buyers and sellers would change their action choices over time even if they have stable inequality-averse preferences because the design of each treatment is based on the ultimatum game with a strategy method and has multiple equilibria. As in the discussion in Cooper and Dutcher (2011), the subjects' learning process is determined by the distribution of their beliefs on others' behaviors if they hold inequality-averse or reciprocal preferences. The reinforcement learning theory may also account for learning behaviors of some subjects.

do not need to care about disutility from disappointment and might accordingly become more vulnerable to their sellers' exploitable behaviors. Reflecting buyers' vulnerability, their interactions could converge to a less fair equilibrium where sellers no longer exhibit disapproval aversion in the R-IC treatment. These considerations provide our third hypothesis:

Hypothesis 3: *(a) Sellers exhibit strong disapproval aversion in the R-C treatment. (b) By contrast, in the R-IC treatment, buyers exhibit strong inequity acceptance.*

4. RESULTS

Four sessions per treatment – two at Brown University and two at the National Taiwan University, were conducted. A total of 320 students participated in the experiment. All instructions were neutrally framed (see the Appendix for the instructions).[17] The experiment was programmed and conducted with the software in ztree (Fischbacher 2007). All participants were students at Brown University or National Taiwan University.[18] No subjects participated in more than one session. Each session contained two groups, which consisted of ten subjects each. The value of the commodity (q_t) was randomly selected in every period, and the same value was used for q_t for both groups.[19] The sessions on average lasted for one hour. No communication between subjects was permitted during sessions. Subjects had to answer several control questions to make sure their understanding of the experiment before the sessions began.

[17] We first wrote the instructions in English. Chen and her research assistant (both are native speakers of Mandarin) translated them carefully to Mandarin so that there is no wording with positive or negative connotations.

[18] They were recruited by solicitation emails via the BUSSEL (Brown University Social Science Experimental Laboratory) for the USA sessions, and via TASSEL (Taiwan Social Science Experimental Laboratory) for the Taiwan sessions. The sessions in the USA were conducted in July to September 2013 and July and August in 2016. The sessions in Taiwan were conducted in September and October 2016. The numbers of female subjects were 79 (49.38% of the subjects) for the USA sessions and 58 (36.25% of the subjects) for the Taiwan sessions. The numbers of subjects with economics majors were 28 (17.50% of the subjects) for the USA sessions and 25 (15.63% of the subjects) for the Taiwan sessions. Subjects were privately paid immediately at the end of the session. The average earnings (including show-up fee) were \$17.0 in the USA sessions and 338.3 NT dollars (around \$10.6) in Taiwan sessions. We note that the minimum hourly wage in Taiwan was 133 NT dollars as of September 2016.

[19] This feature was employed due to its simplicity. Nevertheless, this feature potentially causes subjects' behaviors within sessions to be correlated with each other (e.g., Fréchette 2012). We include session clustering or use bootstrap standard errors when we perform regression analyses in Sections 4.2 and 4.3.

Section 4 is devoted to an analysis of subjects' behaviors, linking to the hypotheses formulated in Section 3. We will first go over descriptive statistics in Section 4.1. We will next report buyers' rating behaviors in Section 4.2. Lastly, we will study the impact of each treatment factor while also considering the panel structure of data in Section 4.3.

4.1. Bargaining between Sellers and Buyers and their Interaction Outcomes

Table 1 shows key results by treatment, separately for the USA and Taiwan sessions. In this table, so as to study subjects' bargaining behaviors, we calculated the amounts attempted to be kept by a seller, which we call the "keep" of the seller in the paper, and the share of it out of the size of pie, which we call the "keep share" of the seller. As the size of pie in this experiment is $q_t/2$ (= $q_t - q_t/2$), seller j's keep value and keep share are each calculated as $(p_{sj}^t - q_t/2)$ and $(p_{sj}^t - q_t/2)/(q_t/2)$, respectively. Likewise, we calculated the payoff of a buyer based on the lowest acceptable offer specified by the buyer, i.e., $(q_t - p_{bi}^t)$; which we call the "keep" of the buyer. We also define buyer i's "keep share" as $(q_t - p_{bi}^t)/(q_t/2)$.

Among others, four clear findings, each of which holds both for the USA and Taiwan sessions, were obtained. First, as consistent with Hypothesis 1, the divisions of the pies drastically differ by the information condition (see columns (7) and (15)). The average realized shares of sellers for closed deals were around 45% to 52% in the N-C and R-C treatments. However, sellers become more selfish with incomplete information. Unlike the N-C and R-C treatments, the average keep shares of sellers were significantly higher than 1 in the N-IC and R-IC treatments (columns (4) and (12)).[20,21] As a result, the average realized shares of sellers were

[20] The null hypothesis that sellers' average keep shares are equal to 1 is rejected in each of the four comparisons, according to one-sided t tests ($p < .0001$, $p < .001$, $p < .0001$, and $p < .01$ in the Taiwan N-IC, the USA N-IC, the Taiwan R-IC, and the USA R-IC sessions, respectively).

[21] 38.0% (32.2%) and 33.3% (42.2%) of the sellers' offering prices were greater than q in the N-IC and R-IC treatments, respectively, for the USA (Taiwan) sessions. These percentages are significantly higher than the same percentages seen in the corresponding complete information treatments, which are 4.1% (1.8%) and 4.5% (7.1%), for the USA (Taiwan) sessions, according to two-sided chi-squared tests (p-value < .001). We note that the

much higher than 100% in the N-IC and R-IC treatments (columns (7) and (15)).[22] Due to the sellers' aggressive behaviors, buyers' average acceptance rates were significantly lower with incomplete than with complete information, for each comparison (columns (8) and (16)).[23,24]

RESULT 1: *Hypothesis 1 holds. This can be explained by sellers' attempts to take more from buyers with incomplete information. Because of the sellers' aggressive behaviors, buyers' acceptance rates were lower with incomplete information than with complete information.*

Second, as consistent with Hypothesis 3(a), the average sellers' keep and keep share were both lower in the R-C than in the N-C treatment (columns (3), (4), (11), and (12)).[25] This suggests that sellers exhibited disapproval aversion in the R-C treatment. However, the buyers' bargaining behaviors are almost at the same levels between the R-C and N-C treatments (columns (5), (6), (13), and (14)). Third, by clear contrast, the average sellers' keep and keep share were both *larger* with rating than without rating in the incomplete information setting. This suggests that sellers did not exhibit disapproval aversion in the R-IC treatment. However, as consistent with Hypothesis 3(b), buyers' behaviors were significantly affected by the presence of the rating system. Both buyers' keep and keep shares were by far lower in the R-IC than in the N-IC treatment (see again columns (5), (6), (13), and (14)).[26]

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percentage of events in which buyers received negative payoffs is significantly larger in the N-IC (R-IC) than in the N-C (R-C) treatment, regardless of the subject pool (*p*-value < .001, two-sided chi-squared test).

[22] The sellers' average realized shares are significantly different between the N-C and N-IC treatments in the USA ($p < .0001$) and Taiwan ($p < .0001$), according to two-sided Mann-Whitney tests. Likewise, these are significantly different between the R-C and R-IC treatments in the USA ($p < .0001$) and Taiwan ($p < .0001$).

[23] The difference in the average acceptance rate between the N-C and N-IC treatments is significant for each of the USA and Taiwan sessions, according to a Mann-Whitney test based on the average rates where sellers' offers were accepted over 50 periods (*p*-value < .001, two-sided). The same holds for a comparison between the R-C and R-IC treatments, whether the USA subjects or Taiwan subjects are used. See also Appendix Table B.1.

[24] The levels of acceptance rates were high from the onset, and they then rose from period to period at small rates in all treatments (Appendix Table B.1). This suggests that the acceptable range of buyers largely coincided with that of sellers from earlier periods and they just gradually needed to adjust action choices over time.

[25] Two sided Mann-Whitney tests, based on pooled data of sellers' average decisions, find that the difference in sellers' keep share is significant between the N-C and R-C treatments with $p = .0220$.

[26] Two sided Mann-Whitney tests, based on pooled data of buyers' average decisions, find that the difference in buyers' keep (keep share) is significant between the N-IC and R-IC treatments with $p = .0138$ ($p = .0262$).

RESULT 2: *(i) With complete information, as consistent with Hypothesis 3(a), sellers' keep values and keep shares were both lower in the R-C than in the N-C treatment. (ii) With incomplete information, as consistent with Hypothesis 3(b), buyers' keep values and keep shares were both lower in the R-IC than in the N-IC treatment.*

Fourth, the impact of the rating system on subjects' bargaining outcomes differs by the information condition (columns (7) and (15)), because of Result 2. With complete information, the presence of the rating system reduced realized shares of sellers from closed trades. With incomplete information, by contrast, it instead *increased* realized shares of sellers and accordingly the division of the pies became more unequal between sellers and buyers.

4.2. Buyers' Rating Behaviors

As explained in Section 4.1, subjects' behaviors were consistent with Hypothesis 3. However, whether sellers are disapproval averse or not, buyers became more tolerant to unfair offers with than without a rating system if buyers dislike disappointment from possibly lower q (see Section 3). To what extent does our data fit the theoretical implications obtained based on disapproval aversion? In order to address this question, we will test Hypothesis 2.

We take a regression approach in which the dependent variable is a rating score given from buyer i to seller j (Table 2). In this regression, either the matched seller j's keep (columns (1) and (2)) or keep share (columns (3) and (4)) is included as an independent variable.[27] First, the estimation shows that when their transactions are closed, these two independent variables are both negative predictors for the rating scores sellers receive from buyers, both in the R-C and R-IC treatments. This is consistent with Hypothesis 2, and in line with findings from past research (e.g., Xiao and Houser 2005, Ellingsen and Johannesson 2008, Lumeau *et al.* 2015). This

[27] The buyer's payoff or share based on the seller's keep was not included as an independent variable because it is a linear transformation of the seller's keep or keep share.

suggests that at least buyers believe that sellers would dislike receiving disapproval also with incomplete information, and Result 2(ii) may mean the impact of buyers' disappointment aversion exceeds that of sellers' disapproval aversion.

Second, Table 2 also showed that even when their transactions were not closed, sellers' keep shares (sellers' keep values) were significantly negatively correlated with the matched buyers' ratings in the R-C (R-IC) treatment. This is not consistent with the theoretical analysis we discussed based on sellers' social disapproval aversion in Section 3. This may mean that sellers' intentions to take more alone, even if it did not succeed, may affect the matched buyers' welfare and as such, buyers use the rating opportunities to deal with such psychological disutility.

RESULT 3: *Whether transactions were closed or not, buyers were more likely to give negative ratings to sellers who attempted to take more from the pies.*[28]

4.3. Treatment Effects of the Information Condition and the Rating System

We saw that the information condition have clear impact on sellers' bargaining behaviors in Section 4.1. We also found that the impact of the rating opportunity differs by the information condition, as consistent with Hypothesis 3. This section is devoted to an analysis of the treatment effects of the information condition and the rating system while controlling for the structure of panel data. We combined data of the USA and Taiwan subjects in the analysis, as the general patterns of their behaviors were similar between the two subject groups (Section 4.1, Table 1).

We first give an overview to the trends of subjects' bargaining behaviors. Figure 1 reports the trends of buyers' and sellers' keep shares in the two complete information treatments. It shows that sellers' keep shares were lower in the R-C than in the N-C treatment in most

[28] To supplement Table 2, we also estimated the Heckman two-stage selection model, with the dependent variable in the first stage being whether transactions were closed or not. This model has an advantage in that we can allow coefficients of all the independent variables in the second stage to be different by whether deals were closed or not. We used buyers' last period purchase thresholds as an instrument. Results we obtained in this additional analysis were qualitatively similar to that of Table 2. See Appendix Table B.2.

periods. By contrast, there were no specific patterns for the trends of buyers' keep shares. These results resonate with the idea that sellers are disapproval-averse agents and thus consistently attempt to keep smaller shares in the R-C treatment to avoid receiving negative feedbacks, compared with the N-C treatment. This picture dramatically changed with the incomplete information setups (Figure 2). In Figure 2, we drew the trend of p_{bi}, but not buyers' keep shares, as buyers were not aware of q in submitting p_{bi}. First, buyers' purchase thresholds were consistently higher with rating (the R-IC treatment) than without rating (the N-IC treatment). By contrast, the trends of sellers' keep shares were on average at very high levels and were similar between the N-IC and R-IC treatments. This resonates with the idea that buyers become more inequity-acceptable when they have an ex-post opportunity to rate, because the buyers do not need to care about disappointment due to possibly lower q in the incomplete information setting.

The results we obtained in Section 4.1 and the patterns seen at Figures 1 and 2 are largely confirmed by a formal analysis, where individual random-effects linear regression are used (Table 3).[29] First, as consistent with Result 1, whether the rating system is available or not, sellers attempt to take significantly more from the pies with incomplete than with complete information (variables (b) and (c), Wald test 1 in columns (1) and (2)). Second, the impact of the rating system differs clearly by the information condition. On the one hand, as consistent with Result 2(i), sellers keep less in the complete information setup when the rating system is present than otherwise. This effect is significant at the 10% level (variable (a) in columns (1) and (2)). Parallel to this result, buyers decreased inequity acceptance in the R-C treatment (variable (a) in columns (3) and (4)). On the other hand, with incomplete information, buyers attempt to keep less with rating than without rating, as consistent with Result 2(ii). This effect is significant at the

[29] We did not include the interaction terms between the period number variable and treatment dummies as independent variables because of two reasons. First, any of the interaction terms does not obtain significant coefficients even if we include them. Second, we suffer from serious colinearity problems if we add these terms. The variance inflation factors for variables (a), (b) and (c) are much larger than 5 if these interaction terms are included.

1% level (Wald test 2 in columns (3) and (4)). We thus conclude that what equilibrium outcome is realized with rating may largely depend on the information conditions.

RESULT 4: *Results 1 and 2 hold also when we test the impact of each treatment factor while controlling for the panel data structure.*

5. CONCLUSIONS

This paper investigated the effects of expressing emotions in a finitely-repeated ultimatum game. In the treatments where both sellers and buyers were aware of the value of commodity, sellers exhibited disapproval aversion with a rating system present. By contrast, buyers did not raise inequity acceptance in that condition. The picture changed drastically once buyers were uninformed of the value of commodity. With the incomplete information setup, sellers no longer exhibited disapproval aversion; and they attempted to take much larger shares from buyers regardless of the presence of the rating system. Buyers, who were put in weaker positions, became more open to accept unfair offers if the rating system is available.

As a last remark, we note that although our results are clear, there are many areas for future research. For example, details of the experimental setups might affect the direction or degree of the effects of expressing emotions. For instance, the payoffs of buyers were negative if $p_s > q$ in our design. Our setup is reasonable for a wider variety of circumstances, but it would also be a useful follow-up study to examine the same question in a setup where sellers are required to split the pie so that both sellers and buyers obtain non-negative payoffs. Second, it would also be useful to perform a robustness check using different games, such as prisoner's dilemma games, to establish the behavioral regularity of our findings. It is possible that the relative strength of disapproval aversion may differ in other games. Finally, needless to say, more replication studies would be essential as results may depend on various factors such as culture and populations, although we found similar patterns between the USA and Taiwan.

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TABLE 1: Summary of Results

(I) USA Sessions

Treatment name	Rating	Information condition	Number of subjects (Number of groups) (1)	Avg. value of commodity: $\bar{q}$[#2] (2)	Average keep and average keep share: Sellers' keep: $p_s - \frac{q}{2}$ (3)	Sellers' keep share: $\left(p_s - \frac{q}{2}\right) / \left(\frac{q}{2}\right)$ (4)	Buyers' keep: $\overline{q - p_b}$ (5)	Buyers' keep share: $(q - p_b) / \left(\frac{q}{2}\right)$ (6)	Bargaining outcomes: Avg. shares of sellers in closed deals[#1] (7)	Average acceptance rate (8)
N-C (<u>N</u>o Rating, <u>C</u>omplete Information)	No	q_t is known to both sellers and buyers	40 (4)	18.57 [12.80]	5.30 [4.22]	0.56 [0.25]	2.56 [3.54]	0.23 [2.05]	51.61%	81.60%
R-C (<u>R</u>ating, <u>C</u>omplete Information)	Yes	q_t is known to both sellers and buyers	40 (4)	18.54 [12.23]	4.85 [4.31]	0.49 [0.23]	2.56 [4.85]	0.25 [1.12]	45.52%	81.70%
N-IC (<u>N</u>o Rating, Incomplete Information)	No	q_t is known only to sellers	40 (4)	20.94 [11.64]	8.03 [5.15]	1.53 [2.26]	2.18 [13.45]	-1.03 [3.72]	176.68%	60.60%
R-IC (<u>R</u>ating, <u>I</u>n<u>c</u>omplete Information)	Yes	q_t is known only to sellers	40 (4)	22.78 [11.86]	9.04 [5.19]	2.04 [5.40]	0.23 [14.60]	-1.88 [7.55]	243.88%	64.00%
All data	---	---	160 (16)	20.21 [12.27]	6.80 [5.06]	1.16 [3.00]	1.88 [10.41]	-0.61 [4.45]	118.35%	71.98%

Notes: The numbers in squared bracket are standard errors. [#1] The average share of buyers in a given treatment is 100% minus the value in this column. [#2] The average size of the pie is $\bar{q}/2$.

(II) Taiwan Sessions

Treatment name	Rating	Information condition	Number of subjects (Numbers of groups)	Avg. value of commodity: $\bar{q}$	Average keep and average keep share				Bargaining outcomes	
					Sellers' keep: $\overline{p_s - \frac{q}{2}}$	Sellers' keep share: $\overline{\left(p_s - \frac{q}{2}\right) / \left(\frac{q}{2}\right)}$	Buyers' keep: $\overline{q - p_b}$	Buyers' keep share: $\overline{(q - p_b) / \left(\frac{q}{2}\right)}$	Avg. shares of sellers in closed deals[#1]	Average acceptanc e rate
			(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
N-C (<u>N</u>o Rating, <u>C</u>omplete Information)	No	q_t is known to both sellers and buyers	40 (4)	21.50 [12.25]	6.35 [4.65]	0.73 [2.66]	3.44 [3.41]	0.35 [0.32]	51.50%	73.20%
R-C (<u>R</u>ating, <u>C</u>omplete Information)	Yes	q_t is known to both sellers and buyers	40 (4)	19.58 [11.84]	5.76 [4.59]	0.54 [0.18]	3.54 [2.83]	0.39 [0.22]	49.74%	78.00%
N-IC (<u>N</u>o Rating, <u>I</u>n<u>c</u>omplete Information)	No	q_t is known only to sellers	40 (4)	22.51 [11.28]	8.14 [4.69]	2.06 [5.14]	3.05 [13.00]	-1.53 [6.55]	238.42%	60.60%
R-IC (<u>R</u>ating, <u>I</u>n<u>c</u>omplete Information)	Yes	q_t is known only to sellers	40 (4)	19.92 [11.97]	8.26 [4.72]	2.14 [4.50]	-0.41 [14.28]	-2.11 [7.11]	240.40%	65.10%
All data	---	---	160 (16)	20.88 [11.90]	7.13 [4.79]	1.36 [3.74]	2.41 [10.04]	-0.72 [4.94]	1.35 [3.32]	69.23%

Notes: The numbers in squared bracket are standard errors. [#1] The average share of buyers in a given treatment is 100% minus the value in this column. [#2] The average size of the pie is $\bar{q}/2$.

TABLE 2: The Determinants of the Rating Decisions by Buyers

Dependent variable: Rating that buyer i gave to the matched seller j in period $t \in \{1, 2, ..., 50\}$

Independent variables	(1)	(2)	(3)	(4)
(a) Seller's keep in period t (i.e., $p_{sj,t} - q_t/2$)	-0.575*** (0.063)	-0.525*** (0.076)	----	----
(b) $\frac{\text{Seller's keep in period } t}{q_t/2}$	----	----	-0.856*** (0.325)	-0.435 (0.662)
(c) Deal Closed Dummy {which equals 1 if the trade is closed; 0 otherwise}	1.404*** (0.576)	4.862*** (0.682)	2.697*** (0.526)	2.471*** (0.670)
(d) Complete Information dummy {which equals 1 for the N-C and R-C treatments; 0 otherwise}	0.935* (0.494)	-2.658*** (0.781)	1.119** (0.564)	5.179*** (1.011)
(e) Interaction term between variable (a) and variable (c)	----	-0.448*** (0.060)	----	----
(f) Interaction term between variable (a) and variable (d)	----	0.483*** (0.076)	----	----
(g) Interaction term between variable (b) and variable (c)	----	----	----	-0.548 (0.769)
(h) Interaction term between variable (b) and variable (d)	----	----	----	-7.603*** (1.448)
Period Number (= {1, 2, …, 50})	-0.012** (0.005)	-0.008 (0.006)	-0.014*** (0.006)	-0.012** (0.006)
Constant	7.508*** (1.202)	6.962*** (1.144)	4.209*** (1.109)	4.202*** (1.188)
# of Observations	4,000	4,000	3,800	3,800
Left-censored	688	688	584	584
Right-censored	856	856	812	812
Log likelihood	-8232.86	-7966.17	-8066.05	-7919.92
Wald χ^2	197.35	229.02	55.90	102.87
Prob > χ^2	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Two-sided p-value to the null that seller's keep or keep share is a negative predictor for a seller's rating score:				
When deals were closed:				
• R-C treatment	----	< 0.0001[#1]	----	< 0.0001[#3]
• R-IC treatment	----	< 0.0001[#2]	----	0.0448[#4]
When deals were not closed:				
• R-C treatment	----	0.3511[#5]	----	< 0.0001[#6]
• R-IC treatment	----	< 0.0001[#7]	----	0.5113[#7]

Notes: Individual random-effects tobit regressions with bootstrap standard errors (200 replications). Numbers in parenthesis are standard errors. Control variables include buyers' demographic variables: a USA dummy (=1 if sessions were conducted in the USA; 0 otherwise), a female dummy (=1 if female; 0 otherwise), number of economics courses taken, general political orientation (1 = very conservative to 7 = very liberal) and income of the subject's family. We omitted the coefficient estimates of these demographic variables to conserve space as these are not related to the hypotheses in the paper. [#1] H_0: variable (a) + variable (e) + variable (f) = 0. [#2] H_0: variable (a) + variable (e) = 0. [#3] H_0: variable (b) + variable (g) + variable (h) = 0. [#4] H_0: variable (b) + variable (g) = 0. [#5] H_0: variable (a) + variable (f) = 0. [#6] H_0: variable (b) + variable (h) = 0. [#7] p-values for the coefficient estimate of variable (a) or (b).

*, **, and *** indicate significance at the 0.10 level, at the 0.05 level and at the 0.01 level, respectively.

TABLE 3: *The Effects of Each Treatment Factor on Subjects' Bargaining Behaviors*

Dependent Variable: / Independent variables:	Seller *j*'s keep in period *t* (= (p_{sj}^{t} −q_t/2))		Buyer *i*'s keep in period *t* (= (q_t − p_{bi}^{t}))	
	(1)	(2)	(3)	(4)
(a) The R-C treatment dummy {= 1 for the R-C treatment; = 0 otherwise}	-0.373* (0.206)	-0.340* (0.202)	0.541* (0.294)	0.949** (0.428)
(b) The N-IC treatment dummy {= 1 for the N-IC treatment; = 0 otherwise}	2.103*** (0.328)	2.049*** (0.302)	-0.616 (0.618)	-1.506** (0.656)
(c) The R-IC treatment dummy {= 1 for the R-IC treatment; = 0 otherwise}	2.618*** (0.477)	2.577*** (0.445)	-3.060*** (0.543)	-3.774*** (0.479)
Value of commodity in period *t* (i.e., q_t)	----	0.033 (0.063)	----	0.566*** (0.112)
Period = {1, 2, …, 50}	----	0.002 (0.007)	----	-0.018 (0.015)
Constant	5.672*** (0.442)	4.940*** (1.292)	3.137*** (0.640)	-7.321*** (2.119)
# of Observations	8000	8000	8000	8000
Wald chi^2	443.82	951.07	147.46	330.69
Prob > chi^2	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Two-sided *p*-values (Wald Chi-square test results)				
Test 1: Ho: R-C = R-IC [i.e., variable (a) = variable (c)]	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Test 2: Ho: N-IC =R-IC [i.e., variable (b) = variable (c)]	0.2054	0.1687	0.0013	0.0017

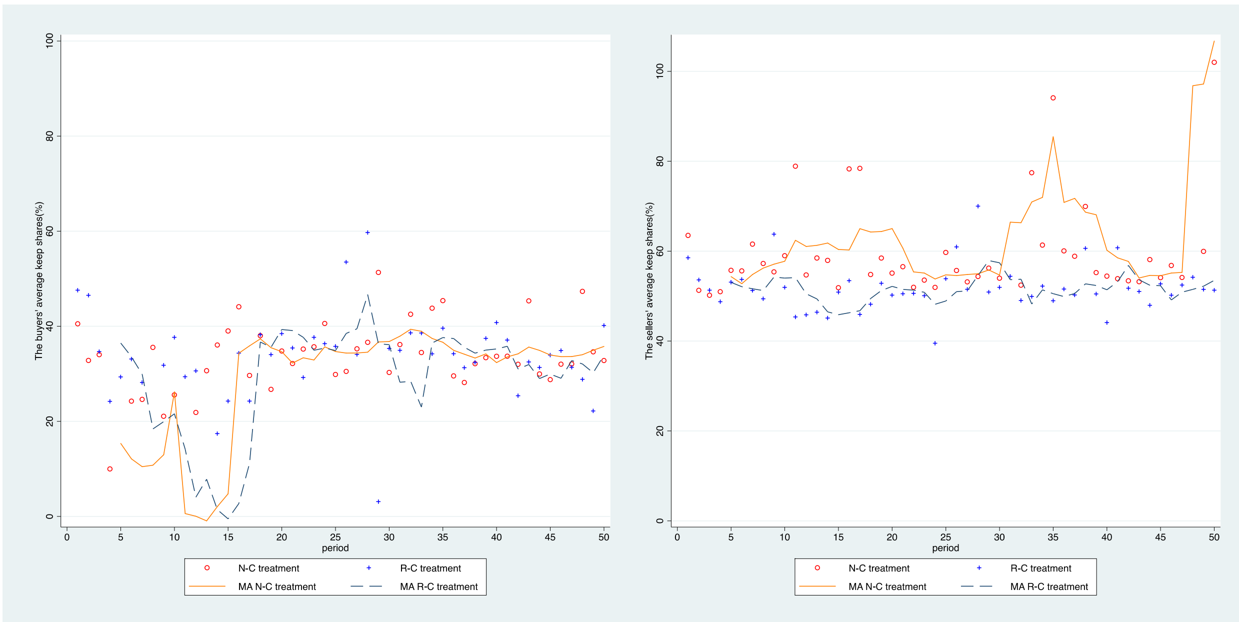
Notes: Random-effects linear regressions with robust standard errors clustered by session ID. Numbers in parenthesis are standard errors.

Control variables include a USA dummy (=1 if sessions were conducted in the USA; 0 otherwise), a female dummy (=1 if female; 0 otherwise), number of economics courses taken, general political orientation (1 = very conservative to 7 = very liberal) and income of the subject's family. We omitted the coefficient estimates of these demographic variables to conserve space since these are not related to the hypotheses in the paper.

*, **, and *** indicate significance at the 0.10 level, at the 0.05 level and at the 0.01 level, respectively.

FIGURE 1

Period-by-Period Average Keep Shares of Buyers and Sellers in the N-C and R-C Treatments

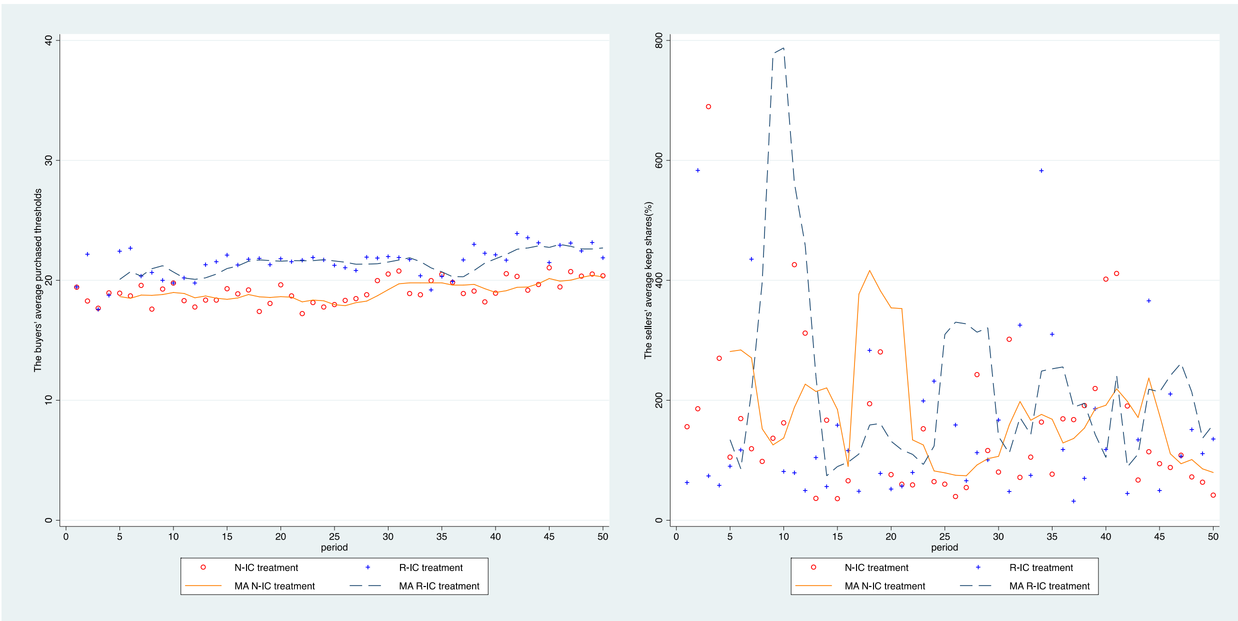


(a) Buyers' average keep shares: $(q - p_b)/(q/2)$ (b) Sellers' average keep shares: $(p_s - q/2)/(q/2)$

Note: Two observations in the N-C treatment and two observations in the R-C treatment in figure (a), and two observations in the N-C treatment in figure (b) are not shown because the values were above 110% or below 0%. The lines of MA indicate simple moving averages of the previous five observations.

FIGURE 2

Period-by-Period Buyers' Average Purchase Thresholds and Sellers' Average Keep Shares in the N-IC and R-IC Treatments



(a2) Buyers' average purchase thresholds: p_b (b2) Sellers' average keep shares: $(p_s - q/2)/(q/2)$

Note: One observation in the N-IC treatment and four observations in the R-IC treatment in figure (b2) are not shown because the values were above 800% or below 0%. The lines of MA indicate simple moving averages of the previous five observations.

Appendix A: Theoretical Analysis

A.1. *Standard Theory Predictions for the N-C and R-C Treatments*

For an assigned $q \in [0, 40]$, a seller maximizes his payoff with respect to the price p_s, given the paired buyer's purchase threshold p_b,:

$$max\left\{\left(p_s - \frac{1}{2}q\right) \cdot Prob\{p_s \leq p_b\}\right\}.$$

Likewise, the buyer maximizes her payoff with respect to the purchase threshold p_b, given the paired seller's offering price p_s:

$$max\{(q - p_s) \cdot Prob\{p_s \leq p_b\}\}.$$

Thus, the best responses of the seller and buyer are calculated as below:

Seller: $p_s = p_b$ if $p_b - \frac{1}{2}q \geq 0$; $p_s = \xi$ such that $\xi > p_b$ if $p_b - \frac{1}{2}q < 0$.

Buyer: $p_b = p_s$ if $q - p_s \geq 0$; $p_b = \nu$ such that $\nu < p_s$ if $q - p_s < 0$.

These best response correspondences are depicted as below:

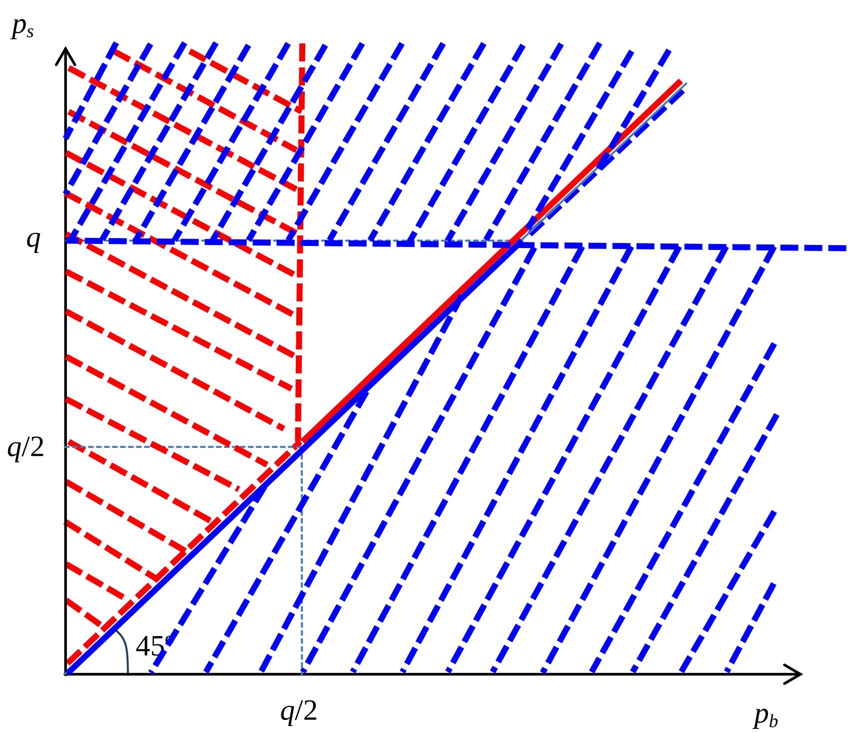


Figure A.1: The Best Response Strategies of the Seller and Buyer

In Figure A.1, the red line and the red dash region indicate the best responses of the seller, whereas the blue line and the blue dash region indicate the best responses of the buyer. From this, the set of Nash equilibria where trades between the seller and the buyer are closed is summarized as below:

$$\left\{(p_b, p_s) | p_s = p_b = x \in \left[\tfrac{1}{2}q, q\right]\right\}.$$

In each equilibrium, the payoff of the seller (π_s) is $x - q/2$ and that of the buyer (π_b) is $q - x$. The set of Nash equilibria where trades between the seller and the buyer are not closed is summarized as below:

$$\left\{(p_b, p_s) | p_s > q \text{ and } p_b < \tfrac{1}{2}q\right\}.$$

A.2. *Inequality-Averse Preferences and Best Response Strategies for the N-C and R-C Treatments*

Suppose that a seller is inequality-averse as defined in the paper: $u_{sj}(\pi_{sj}, \pi_{bi}) = \pi_{sj} - \mu_j \cdot (\pi_{sj} - \pi_{bi})^2$, where $\pi_{bi} = (q - p_{sj}) \cdot 1_{\{p_{sj} \le p_{bi}\}}$ and $\pi_{sj} = \left(p_{sj} - \frac{1}{2}q\right) \cdot 1_{\{p_{sj} \le p_{bi}\}}$. Here, $1_{\{p_{sj} \le p_{bi}\}} = 1$ when $p_{sj} \le p_{bi}$; = 0 otherwise. Then, given the matched buyer's strategy, p_{bi}, for each $q \in [0,40]$, seller j maximizes the following payoff with respect to p_{sj}:

$$\left\{\pi_{sj} - \mu_j \cdot (\pi_{sj} - \pi_{bi})^2\right\} \cdot 1_{\{p_{sj} \le p_{bi}\}}$$

$$= \left\{p_{sj} - \tfrac{1}{2}q - \mu_j \cdot \left(2p_{sj} - \tfrac{3}{2}q\right)^2\right\} \cdot 1_{\{p_{sj} \le p_{bi}\}}, \quad \text{(A1)}$$

The term within the first curly bracket is maximized at: $p_{sj} = \frac{1}{8\mu_j} + \frac{3}{4}q$, as the derivative of it with respect to p_{sj} is: $1 + 6\mu_j \cdot q - 8\mu_j \cdot p_{sj}$. The value in the first curly bracket at $p_{sj} = \frac{1}{8\mu_j} + \frac{3}{4}q$ reduces to:

$$\tfrac{1}{4}q + \tfrac{1}{16\mu_j}.$$

Thus, given p_{bi}, if q is small enough that $q \le \frac{4}{3}p_{bi} - \frac{1}{6\mu_j}$ so that $p_{sj} \le p_{bi}$, the seller's best response function is given by: $p_{sj} = \frac{1}{8\mu_j} + \frac{3}{4}q$. By contrast, if q is large enough that $q > \frac{4}{3}p_{bi} - \frac{1}{6\mu_j}$, then, $p_{sj} = p_{bi}$ is the seller's best response function if the value in the curly bracket is still positive at $p_{sj} = p_{bi}$: $p_{bi} - \frac{1}{2}q - \mu_j \cdot \left(2p_{bi} - \frac{3}{2}q\right)^2 > 0$; otherwise, $p_{sj} > p_{bi}$ becomes his best response. In short, the seller's best response function is summarized as:

$$p_{sj} = \begin{cases} \frac{3}{4}q + \frac{1}{8\mu_j}, & \text{if } q \leq \frac{4}{3}p_{bi} - \frac{1}{6\mu_j}. \\ p_{bi}, & \text{if } q > \frac{4}{3}p_{bi} - \frac{1}{6\mu_j} \text{ and } p_{bi} - \frac{1}{2}q - \mu_j \cdot \left(2p_{bi} - \frac{3}{2}q\right)^2 > 0. \\ \text{any } c, \text{s.t. } c > p_{bi}, & \text{if } q > \frac{4}{3}p_{bi} - \frac{1}{6\mu_j} \text{ and } p_{bi} - \frac{1}{2}q - \mu_j \cdot \left(2p_{bi} - \frac{3}{2}q\right)^2 < 0. \end{cases} \tag{A2}$$

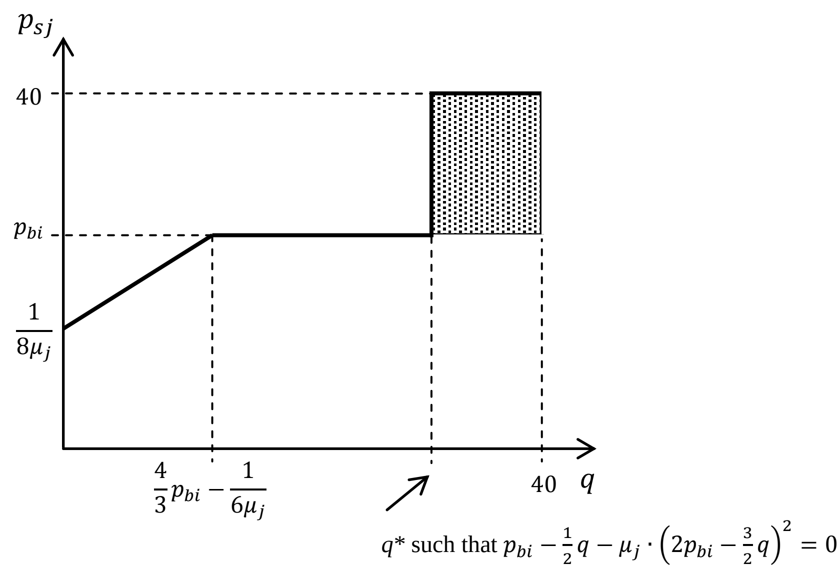


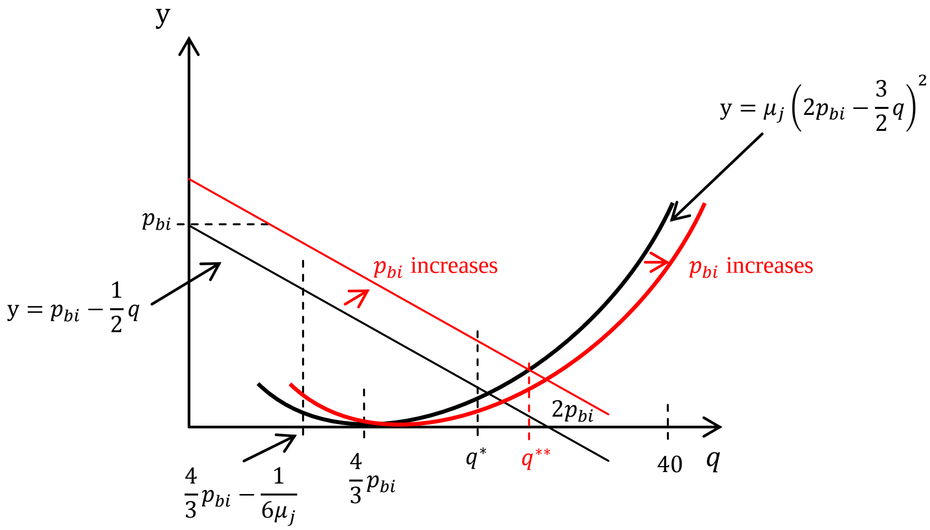
Figure A.2: The Best Response Strategy of the Seller

Here, the acceptance rate of the offering prices in the experiment would be $q^*/40$ in expectation as q is randomly drawn from the uniform distribution between 0 and 40. Note that the intercept in Figure A.2 (the seller's best response price at $q = 0$) is $\frac{1}{8\mu_j}$. This is not dependent on p_{bi}. If $p_{bi} < \frac{1}{8\mu_j}$, then the seller's best response strategy becomes as follows:

$$p_{sj} = \begin{cases} p_{bi}, & \text{if } p_{bi} - \frac{1}{2}q - \mu_j \cdot \left(2p_{bi} - \frac{3}{2}q\right)^2 > 0 \\ \text{any } c, \text{s.t. } c > p_{bi}, & \text{if } p_{bi} - \frac{1}{2}q - \mu_j \cdot \left(2p_{bi} - \frac{3}{2}q\right)^2 < 0. \end{cases} \tag{A3}$$

For simplicity, we assume that $p_{bi} > \frac{1}{8\mu_j}$ in the rest of this Appendix A.

Also, Note that $\frac{\partial q^*}{\partial p_{bi}} > 0$ since q^* is a point at which $y = p_{bi} - \frac{1}{2}q$ and $y = \mu_j \cdot \left(2p_{bi} - \frac{3}{2}q\right)^2$ intersect; and both curves shift to the right when p_{bi} increases as shown in the following figure.[2]



Thus, we find that the seller's best response strategies shift as below responding to a chance in p_{bi}.

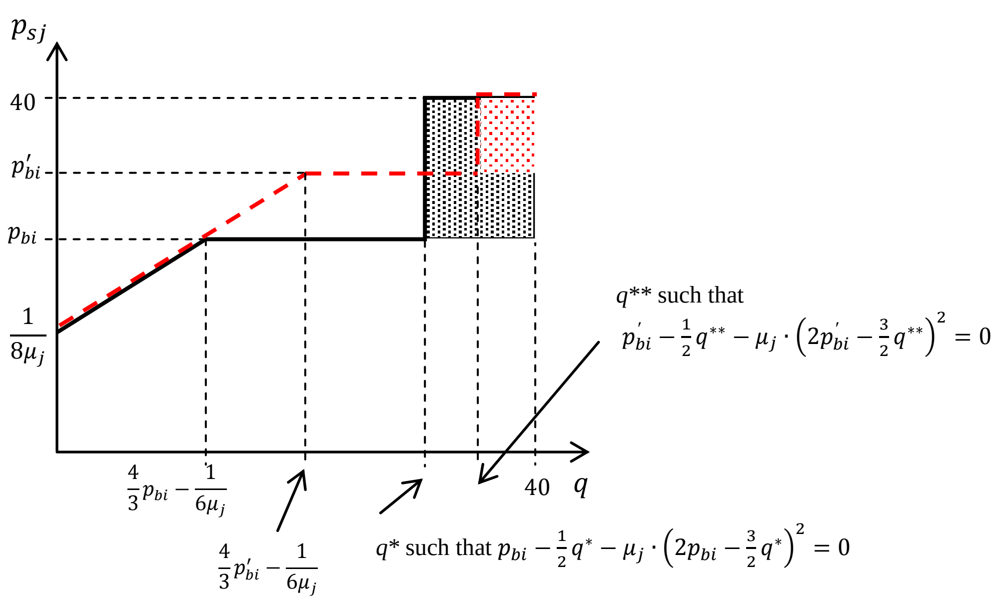


Figure A.3: The Seller's Best Response Strategies for Various p_{bi}

Note: The solid (dashed) line indicates the best response strategy of seller *j* when faced with p_{bi} (p'_{bi}).

[2] q^* can be greater than 40. In that case, the seller's best response price is less than or equal to p_{bi} for any value $q \in [0,40]$.

Suppose also that the buyer is inequality-averse as assumed in the paper: $u_{bi}(\pi_{bi}, \pi_{sj}) = \pi_{bi} - \mu_i \cdot (\pi_{sj} - \pi_{bi})^2$. Notice here that the utility weight on inequality μ_i is different from that of seller μ_j. The buyer maximizes her utility, given p_{sj}:

$$u_{bi}(\pi_{bi}, \pi_{sj}) = \left[q - p_{sj} - \mu_i \cdot \left(2p_{sj} - \tfrac{3}{2}q\right)^2\right] \cdot 1_{\{p_{sj} \le p_{bi}\}}.$$

This means that the buyer's best response strategy is: $p_{bi} \ge p_{sj}$ when $u_{bi} = q - p_{sj} - \mu_i \cdot \left(2p_{sj} - \frac{3}{2}q\right)^2 \ge 0$, but $p_{bi} = \xi$, such that $\xi < p_{sj}$ if $q - p_{sj} - \mu_i \cdot \left(2p_{sj} - \frac{3}{2}q\right)^2 < 0$. For a given q, this best response correspondences of the buyer and those of the seller described in Conditions (A2) and (A3) characterize the set of the Nash Equilibria.

A.3. *Standard Theory Predictions for the N-IC and R-IC Treatments*

For each $q \in [0, 40]$, given the buyer's purchase threshold p_b, the seller maximizes his payoff with respect to the price p_s:

$$max\left\{\left(p_s - \tfrac{1}{2}q\right) \cdot Prob\{p_s \le p_b\}\right\}.$$

We obtain, from this maximization problem, the best response function of the seller as follows:

$$b_s(q) = \begin{cases} p_b & \text{for } 2p_b \ge q. \\ \tilde{p}\ s.t. \tilde{p} > p_b & \text{for } 2p_b < q. \end{cases} \tag{A4}$$

Likewise, given the seller's strategy $p_s(q)$, the buyer maximizes her expected payoff with respect to p_b as the value of the commodity is unknown to her. This reduces to the following maximization problem:

$$max\left\{\pi_b = \int_0^{40} (q - p_s(q)) \cdot 1_{\{p_s(q) \le p_b\}} \cdot \tfrac{1}{40} dq\right\}. \tag{A5}$$

There exist Bayesian Nash Equilibria characterized by the seller's best response specified in condition (A4) and the following best response strategy of the buyer:

$$p_b \ge p_s, \text{ if } p_s \le 20; \ p_b < p_s, \text{ if } p_s > 20. \tag{A6}$$

Specifically, the following is an example of the equilibria: $p_s = c$ for q such that $q \le 2c$; and $p_s(q) = q$ for q such that $q > 2c$, while $p_b = c$. Here, c is any integer which is less than or equal to 20. With this equilibrium, the expected payoff of the seller is:

$$\pi_s = \int_0^{2c} (c - q/2) \cdot \frac{1}{40} dq = \frac{1}{40}\left[cq - \frac{1}{4}q^2\right]\Big|_{q=0}^{2c} = \frac{c^2}{40} \ (> 0),$$

and the expected payoff of the buyer is:

$$\int_0^{2c} (q - c) \cdot \frac{1}{40} dq = \left(\frac{1}{2}q^2 - cq\right) \cdot \frac{1}{40}\Big|_0^{2c} = 0.$$

There is no profitable deviation not only for the seller but also for the buyer. There are many equilibria of this kind.

There is also another kind of equilibrium in which the transaction is not exerted. The following is an example: the seller posts a price which is greater than or equal to 20 always, and the buyer sets her purchase threshold at 0.

A.4. *Inequality-Averse Preferences and Best Response Strategies for the N-IC and R-IC Treatments*

The best response of the seller is the same as the one discussed in Section A.2.

For the best response of the buyer, suppose that the buyer is also inequality-averse as the seller: $u_{bi}(\pi_{bi}, \pi_{sj}) = \pi_{bi} - \mu_i \cdot (\pi_{sj} - \pi_{bi})^2$. Then, the buyer's best response strategy is derived by maximizing the following her expected utility given the seller's strategy, $p_{sj} = p_s(q)$:

$$E_q[u_{bi}(\pi_{bi}, \pi_{sj})] = E_q\left[\left\{\pi_{bi} - \mu_i \cdot (\pi_{sj} - \pi_{bi})^2\right\} \cdot 1_{\{p_s(q) \leq p_{bi}\}}\right]. \quad \text{(A7)}$$

That is,

$$p_b(\mu_i) = argmax_x. E_q\left[\left\{\pi_{bi} - \mu_i \cdot (\pi_{sj} - \pi_{bi})^2\right\} \cdot 1_{\{p_s(q) \leq x\}}\right]. \quad \text{(A8)}$$

Here, suppose that $p_s(q)$ is non-decreasing in q. Then, (A8) reduces to the following:

$$E_q[u_{bi}(\pi_{bi}, \pi_{sj})] = \int_0^{p_s^{-1}(p_{bi})} \left[q - p_s(q) - \mu_i \cdot \left(2p_s(q) - \frac{3}{2}q\right)^2\right] \cdot \frac{1}{40} dq. \quad \text{(A9)}$$

Here, $p_s^{-1}(p_{bi})$ is the upper bound if it responds multiple values (correspondence). Since the condition of non-negative utility must be met, we have:

$$\int_0^{p_s^{-1}(p_{bi})} \left[q - p_s(q) - \mu_i \cdot \left(2p_s(q) - \frac{3}{2}q\right)^2\right] dq \geq 0. \quad \text{(A10)}$$

Although there are multiple equilibria, there is a common feature that the buyer also obtains a positive material payoff in expectation. This is because condition (A10) implies that:

$$\int_0^{p_s^{-1}(p_{bi})} [q - p_s(q)] \ \ dq \geq \int_0^{p_s^{-1}(p_{bi})} \mu_i \cdot [2p_s(q) - \tfrac{3}{2}q]^2 dq > 0.$$

The BNE is characterized by (A2) (or A3), (A8) and (A10).

From Figure A.3, we have the following features of the equilibria:

(1) The higher the buyer's equilibrium purchase threshold p_{bi}^*, the higher the acceptance rate.

(2) Regardless of which purchase threshold is realized in equilibrium, the seller's equilibrium price is increasing in q and less than p_{bi}^*, in a region where $q \leq \frac{4}{3}p_{bi}^* - \frac{1}{6\mu_j}$.

(3) No trades are closed in the region where $q > q^*$.

A.5. *Disapproval Aversion and the Transactions between the Seller and the Buyer in the R-C treatment*

In this analysis, we assume that the seller's payoff function is expressed as in *Eq*. (4) of the paper (i.e., $\pi'_{sj} = \pi_{sj} + c \cdot (r - 5)$). Then, the utility of seller j is expressed as:

$$u_{sj}(\pi_{bi}, \pi'_{sj}) = \left\{p_{sj} - \tfrac{1}{2}q + c \cdot \left(r - 5\right) - \mu_j \cdot \left(2p_{sj} - \tfrac{3}{2}q + c \cdot \left(r - 5\right)\right)^2\right\} \cdot 1_{\{p_{sj} \leq p_{bi}\}}$$

$$+ \left\{c \cdot (r - 5) - \mu_j \cdot \left(c \cdot (r - 5)\right)^2\right\} \cdot 1_{\{p_{sj} > p_{bi}\}}.$$

Likewise, the utility of buyer i is expressed as:

$$u_{bi}(\pi_{bi}, \pi'_{sj}) = \left\{q - p_{sj} - \mu_i \cdot \left(2p_{sj} - \tfrac{3}{2}q + c \cdot \left(r - 5\right)\right)^2\right\} \cdot 1_{\{p_{sj} \leq p_{bi}\}}$$

$$+ \left\{-\mu_i \cdot \left(c \cdot (r - 5)\right)^2\right\} \cdot 1_{\{p_{sj} > p_{bi}\}}.$$

We can solve this situation from the second stage (the rating stage) [backward induction].

The second stage (rating stage):

If $p_{sj} > p_{bi}$, buyer *i* receives a material payoff of 0 points. In the rating stage, the buyer minimizes the term: $\mu_i \cdot \left(c \cdot (r - 5)\right)^2$. This means that the buyer's best response rating score is: $r^* = 5$.

If $p_{sj} \leq p_{bi}$, in the rating stage, the buyer tries to minimize the term: $\mu_j \cdot \left(2p_{sj} - \frac{3}{2}q + c \cdot (r - 5)\right)^2$. From $2p_{sj} - \frac{3}{2}q + c \cdot \left(r - 5\right) = 0$, we find:

$$r = 5 + \frac{3}{2c}q - \frac{2}{c}p_{sj}.$$

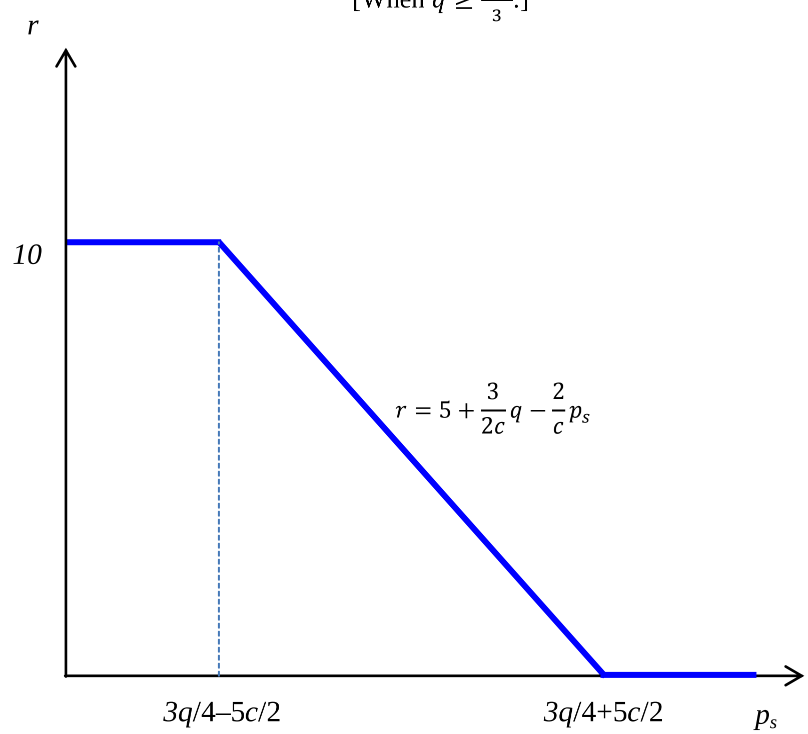
This is the condition of interior solutions. The negative slope (– 2/c) shows a negative correlation between *r* and p_{sj}. The buyer's best response correspondence differ by *q* because $0 \leq r \leq 10$. We have the following three cases, considering the size of intercept $(5 + \frac{3}{2c}q)$:

(i) If p_{sj} is small enough that $p_{sj} \leq -\frac{5}{2}c + \frac{3}{4}q$, $r^* = 10$.

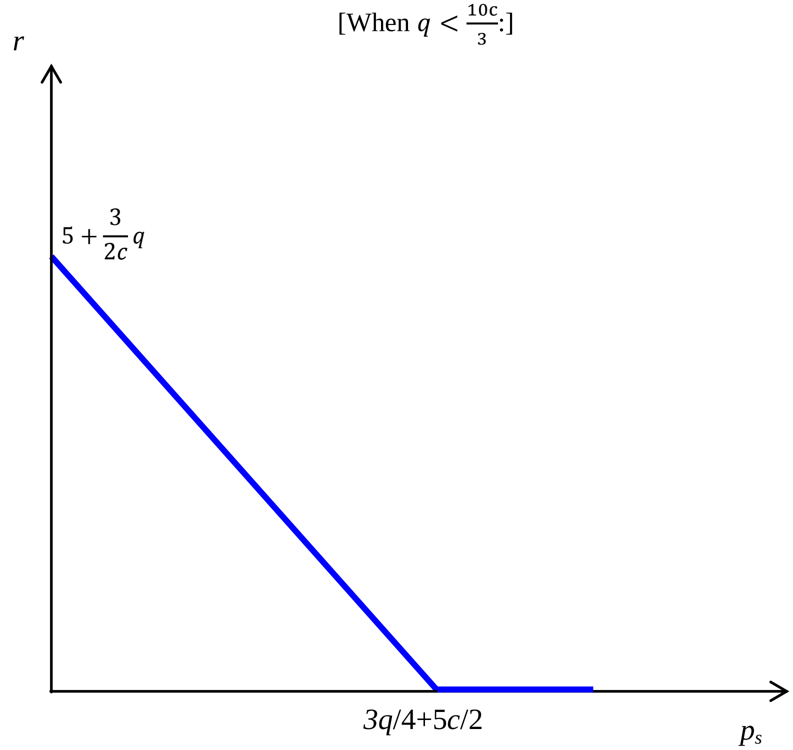
(ii) If p_{sj} is high enough that $p_{sj} > \frac{5}{2}c + \frac{3}{4}q$, $r^* = 0$.

(ii) If $p_{sj} \in [-\frac{5}{2}c + \frac{3}{4}q, \frac{5}{2}c + \frac{3}{4}q]$, $r^* = 5 + \frac{3}{2c}q - \frac{2}{c}p_{sj}$.

[When $q \geq \frac{10c}{3}$:]



[When $q < \frac{10c}{3}$:]



The optimality condition suggests a negative correlation between *r* and p_{sj}.

In the second stage, there are no real decisions to make for the sellers.

The first stage (the transaction between the seller and buyer):

The buyer's best response can be quickly derived. Given p_{sj}, if $q - p_{sj} - \mu_j \cdot \left(2p_{sj} - \frac{3}{2}q + c \cdot (r^* - 5)\right)^2 \geq 0$, she submits a purchase threshold which is higher than or equal to p_{sj}. Here, r^* is the buyer's best response strategy for rating in the following rating stage. It is clear that because of the rating opportunities, the inequality-averse term in her utility function is smaller in the R-C treatment than in the N-C treatment. Therefore, materially unequal offers by the seller are more likely to be accepted by the buyer. This is consistent with the idea that the buyer substitutes expressing emotions for rejecting offers.

As for the seller, we first consider the interior solution case in the rating stage (see the above). In this case, the seller's utility is: $\left\{p_{sj} - \frac{1}{2}q + c \cdot (r^* - 5)\right\} \cdot 1_{\{p_{sj} \leq p_{bi}\}} = \{q - p_{sj}\} \cdot$

$1_{\{p_{sj} \leq p_{bi}\}}$ whereas the buyers' utility is: $\{q - p_{sj}\} \cdot 1_{\{p_{sj} \leq p_{bi}\}}$. The seller chooses his possible minimum price to offer. The buyer's best response strategy is to submit p_{bi} so that $p_{sj} \leq p_{bi}$ whenever $p_{sj} \leq q$ (her payoff is positive). Thus, in this case, the unique equilibrium is: $p_{sj} = -\frac{5}{2}c + \frac{3}{4}q$ and $p_{bi} = x$ such that $x \geq -\frac{5}{2}c + \frac{3}{4}q$. Thus, we see that the seller chooses to offer lower prices in the R-C treatment so as to avoid receiving disapproval points or to enjoy positive psychological gains.

When r^* = 10 or 0 (corner solution), from $\partial \pi_{sj}/\partial p_{sj} = 0$, we have:

Case 1: $p_{sj} = \frac{1}{8\mu} + \frac{3}{4}q - \frac{5c}{2}$ when r^* = 10, if the seller's utility is then non-negative.

Case 2: $p_{sj} = \frac{1}{8\mu} + \frac{3}{4}q + \frac{5c}{2}$ when r^* = 0, if the seller's utility is then non-negative.

Case 1 is not a solution because the buyer sets r^* = 10 if $p_{sj} < \frac{3}{4}q - \frac{5c}{2}$. By contrast, Case 1 holds as a corner solution because $p_{sj} > \frac{5c}{2} + \frac{3}{4}q$ (see Case II in the analysis of the second stage). The buyer submits p_{bi} so that $p_{sj} \leq p_{bi}$ as long as the buyer's utility is positive. Thus, in the corner solution, the seller offers a materially less fair amount (higher price) to the buyer and the buyer selects r^* = 0 in the second stage.

A.6. *Inequality Aversion, Disappointment Aversion, and Players' Best Responses in N-IC and R-IC treatments*

In this subsection, we study how theoretical predictions may change if inequality-averse actors also exhibit disappointment aversion due to asymmetric information on q in the incomplete information treatments. For simplicity, we assume that sellers do not exhibit social disapproval aversion in this analysis. That is, we assume that buyers' rating behaviors will not affect the utilities of sellers. We note that calculations become messy if we have both disapproval aversion and disappointment aversion in the model. However, even if we incorporate both disapproval aversion and disappointment aversion into the modeling of subjects' inequality-averse preference (*Eqs*. (1) to (3)) with the assumption that buyers can cancel out negative emotions from disappointment by releasing the emotions, we obtain the same implications (the degree of inequity acceptance is stronger in the incomplete information than in the complete information settings because of disappointment aversion). In this Appendix, we show a simpler version of the analysis for an illustrative purpose.

We assume that, with incomplete information (when q is unknown to buyers), buyers select p_b based on the expected value of q. In a model with disappointment aversion (e.g., Bonomo, Garcia, Meddahi, and Tédongap 2010, Gul 1991, Routledge and Zin 2010), buyer *i* will incur a psychological disutility when realized q_t was *less than* his or her expectation (i.e., $E(q) = 20$). The absolute value of *i*'s psychological loss is assumed to be increasing in p_b. We will incorporate the model of disappointment aversion into our model with inequality aversion (*Eqs*. (1) to (3) in the paper) as follows. First, we write the payoff function of buyer *i* in the N-IC treatment as below:

$$\pi_b^N = \left\{(q_t - p_s) + p_b \alpha(\mathrm{q} - 20) \cdot 1_{\{q<20\}}\right\} \cdot 1_{\{p_s \leq p_b\}},$$

$$\text{where } 1 > \alpha > 0.$$

We further assume that buyers' loss from disappointment would be 0 once it is released (see psychological papers for this argument, such as Xiao and Houser (2005), Campbell-Sills *et al.* (2006), and Gross and John (2003)). This means that buyers strategically utilize the rating opportunity to deal with their negative emotions from disappointment (realized low q_t). In other words, buyers do not utilize rating opportunities to verbally punish or reward the behavior of their matched sellers. Based on this assumption, we can write the payoff function of buyer *i* in R-IC treatment as below.

$$\pi_b^R = (q_t - p_s) \cdot 1_{\{p_s \le p_b\}}.$$

Second, we calculate the utilities of buyer *i* and seller *j* in the incomplete information treatments based on *Eqs*. (1) to (3):

$$u_b^R = \{\pi_b - \mu_i(\pi_{sj} - \pi_{bi})^2\}.$$

$$u_b^N = \{\pi_b^N - \mu_i(\pi_{sj} - \pi_{bi}^N)^2\}.$$

$$u_s^R = \left\{\pi_s - \mu_j(\pi_{sj} - \pi_b)^2\right\}.$$

$$u_s^N = \left\{\pi_s - \mu_j(\pi_{sj} - \pi_b^N)^2\right\}.$$

Here, the superscripts *N* and *R* refer to treatments without and with rating opportunities, respectively.

In Section A.6, we denote $p_b^N = arg\ max\ E(u_b^N)$;

$p_b^R = arg\ max\ E(u_b^R)$;

$p_s^N = arg\ max\ u_s^N$;

$p_s^R = arg\ max\ u_s^R$.

Proposition 1. $p_b^N \le p_b^R$.

<u>Proof</u>.

Let $r^-(q) = \alpha(q - 20) \cdot 1_{\{q<20\}}$.

We can rewrite π_b^N as:

$$\pi_b^N = \pi_b^R + r^- p_b 1_{\{p_s \le p_b\}}.$$

Thus we have:

$$\begin{aligned} E(u_b^N) &= \frac{1}{40}\int_0^{40} \pi_b^N - \mu(\pi_s - \pi_b^N)^2 \\ &= \frac{1}{40}\int_0^{40} \pi_b^R + r^- p_b 1_{\{p_s \le p_b\}} - \mu(\pi_s - \pi_b^R)^2 + 2\mu(\pi_s - \pi_b^R) r^- p_b - \mu(r^-)^2\, p_b^2 1_{\{p_s \le p_b\}} \\ &= \ E(u_b^R) + \frac{1}{40}\int_0^{40} r^- p_b 1_{\{p_s \le p_b\}} + 2\mu(\pi_s - \pi_b^R) r^- p_b - \mu(r^-)^2\, p_b^2 1_{\{p_s \le p_b\}} \\ &= \ E(u_b^R) + \frac{1}{40}\int_0^{40} r^- p_b 1_{\{p_s \le p_b\}} \end{aligned}$$

$$+\frac{1}{40}\int_0^{40} 2\mu(\pi_s - \pi_b^R) r^- p_b 1_{\{p_s \le p_b\}}$$
$$-\frac{1}{40}\int_0^{40} \mu(r^-)^2 p_b^2 1_{\{p_s \le p_b\}}.$$

Here, we call:

$$\frac{1}{40}\int_0^{40} r^- p_b 1_{\{p_s \le p_b\}} = A(p_b),$$
$$\frac{1}{40}\int_0^{40} 2\mu(\pi_s - \pi_b^R) r^- p_b 1_{\{p_s \le p_b\}} = \mathrm{B}(p_b),$$
$$-\frac{1}{40}\int_0^{40} \mu(r^-)^2 p_b^2 1_{\{p_s \le p_b\}} = C(p_b).$$

We can show that A, B, C are non-positive decreasing functions.

First, because $(\pi_s - \pi_b) \ge 0$, $r^- \le 0$, A and B are non-positive, decreasing functions, respectively. Second, $(r^-)^2 \ge 0$ implies that C is also a non-positive decreasing function.

Now suppose that y $> p_b^R$. Then,

$$E(u_b^N)(y) = E(u_b^R)(y) + A(y) + B(y) + C(y)$$

$$< E(u_b^R)(p_b^R) + A(p_b^R) + B(p_b^R) + C(p_b^R) = E(u_b^N)(p_b^R).$$

This means that $y \ne argmax(E(u_b^N))$, which implies $p_b^N = argmax(E(u_b^N)) \le p_b^R$.

Proposition 2. When q is small enough, $p_s^N < p_s^R$

Sellers' best responses in R-IC treatment is (A2). By using the same calculation process as in (A2), we can find sellers' best response function in N-IC treatment.

$$p_s^N = \begin{cases} \frac{1}{8\mu_j} + \frac{3}{4}q + \frac{f(q)}{2}p_b, & \text{if } \frac{1}{8\mu_j} + \frac{3}{4}q + \frac{f(q)}{2}p_b \le p_b \\ p_b, & \text{if } \frac{1}{8\mu_j} + \frac{3}{4}q + \frac{f(q)}{2}p_b > p_b \text{ and } \pi_s - \mu_j(\pi_s - \pi_b^N)^2 > 0 \\ \text{any } c > p_b, & \text{if } \frac{1}{8\mu_j} + \frac{3}{4}q + \frac{f(q)}{2}p_b > p_b \text{ and } \pi_s - \mu_j(\pi_s - \pi_b^N)^2 \le 0 \\ & \text{where } f(q) = \alpha(q-20)1_{\{q<20\}} \end{cases}$$

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Appendix B: Additional Tables

TABLE B.1:

The Determinants of the Acceptance Rates of Offers

Dependent variable: Dummy which equals 1 if a transaction between buyer *i* and seller *j* was closed in period *t*

Independent variables	(1)	(2)
(a) Value of the commodity in period t (q_t) {= 0, 1, …, 39, 40}	-0.022*** (0.002)	-0.023*** (0.004)
(b) Rating dummy {which equals 1 for the R-C or R-IC treatment; 0 otherwise}	0.053 (0.052)	0.003 (0.133)
(c) Complete Information dummy {which equals 1 for the N-C and R-C treatments; 0 otherwise}	0.419*** (0.069)	0.482*** (0.074)
(d) Period = {1, 2, …, 50}	0.008*** (0.001)	0.009*** (0.002)
(a) × (b)	---	0.002 (0.005)
(b) × (d)	---	0.0002 (0.003)
(c) × (d)	---	-0.003 (0.002)
Constant	0.611*** (0.141)	0.609*** (0.156)
# of Observations	8000	8000
Log Likelihood	-4483.90	-4482.83
Wald chi^2	249.37	221.32
Prob > chi^2	< 0.0001	< 0.0001

Notes: Random-effects probit regressions with bootstrap standard errors (the number of replications is 200). Numbers in parenthesis are robust standard errors. Demographic variables of buyers and sellers are included to control for individual characteristics. Control variables include a USA dummy (=1 if sessions were conducted in the USA; 0 otherwise), a female dummy (=1 if female; and 0 otherwise), number of economics courses taken, general political orientation (1 = very conservative to 7 = very liberal) and income of the subject's family. We omitted the coefficient estimates of these demographic variables to conserve space since these are not related to the hypotheses in the paper.
*, **, and *** indicate significance at the 0.10 level, at the 0.05 level and at the 0.01 level, respectively.

TABLE B.2:

The Determinants of the Rating Decisions by Buyers (Supplementing Table 2 of the paper)

Dependent variable: Rating that buyer *i* gave to the matched seller *j* in period $t \in \{1, 2, ..., 50\}$

The following are the estimation results with the Heckman's two-stage selection model.

[Second Stage Regression]

Independent variables	When deals were closed (1)	When deals were not closed (2)	When deals were closed (3)	When deals were not closed (4)
(a) Seller's keep in period *t* (i.e., $p_{sj,t} - q_t/2$)	-0.594*** (0.014)	-0.388*** (0.022)	----	----
(b) $\frac{\text{Seller's keep in period } t}{q_t/2}$	----	----	-0.324*** (0.016)	-0.235*** (0.026)
(c) Complete Information dummy {which equals 1 for the N-C and R-C treatments; 0 otherwise}	-1.448*** (0.202)	-5.704*** (0.408)	3.268*** (0.343)	-1.603 (1.064)
(d) Interaction term between variable (a) and variable (c)	0.484*** (0.025)	0.376*** (0.034)	----	----
(e) Interaction term between variable (b) and variable (d)	----	----	-2.579*** (0.521)	-1.359 (1.413)
Period Number (= {1, 2, …, 50})	-0.001 (0.003)	-0.022*** (0.006)	-0.007* (0.004)	-0.018** (0.007)
Constant	9.292*** (0.318)	7.112*** (0.570)	5.697*** (0.344)	4.661*** (0.504)
# of Observations	3,920	3,920	3,720	3,720
Censored observations	1072	2848	1019	2701
Wald chi^2	2358.52	683.52	921.1	364.96
Prob > chi^2	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Two-sided *p*-value for the null:				
H_0: variable (a) = 0	< 0.001	< 0.0001	----	----
H_0: variable (b) = 0	----	----	< 0.0001	< 0.0001
H_0: variable (a) + variable (d) = 0	< 0.001	0.6909	----	----
H_0: variable (b) + variable (e) = 0	----	----	< 0.0001	0.2567

Notes: Numbers in parenthesis are robust standard errors. Control variables include buyers' demographic variables: a USA dummy (=1 if sessions were conducted in the USA; 0 otherwise), a female dummy (=1 if female; 0 otherwise), number of economics courses taken, general political orientation (1 = very conservative to 7 = very liberal) and income of the subject's family. We omitted the coefficient estimates of these demographic variables to conserve space as these are not related to the hypotheses in the paper.

*, **, and *** indicate significance at the 0.10 level, at the 0.05 level and at the 0.01 level, respectively.

[First Stage: Selection Equation]

Please note that the absolute values of coefficient estimates in column (1') are identical to those in column (2') with the sign being opposite. The same holds between columns (3') and (4').

Equations (1'), (2'), (3') and (4') in the table are the selection equations of columns (1), (2), (3),and (4), respectively, on the previous page.

Independent variables	When deals were closed (1')	When deals were not closed (2')	When deals were closed (3')	When deals were not closed (4')
Buyers' last period purchase threshold (i.e., p_{bi}^{t-1}) [instrument]	0.032*** (0.003)	-0.032*** (0.003)	0.035*** (0.003)	-0.035*** (0.003)
(a) Seller's keep in period t (i.e., $p_{sj,t} - q_t/2$)	-0.020*** (0.006)	0.020*** (0.006)	----	----
(b) $\frac{\text{Seller's keep in period } t}{q_t/2}$	----	----	0.025*** (0.007)	-0.025*** (0.007)
(c) Complete Information dummy {which equals 1 for the N-C and R-C treatments; 0 otherwise}	0.891*** (0.089)	-0.891*** (0.089)	3.219*** (0.160)	-3.219*** (0.160)
(d) Interaction term between variable (a) and variable (c)	-0.062*** (0.011)	0.062*** (0.011)	----	----
(e) Interaction term between variable (b) and variable (d)	----	----	-4.392*** (0.251)	4.392*** (0.251)
Period Number (= {1, 2, …, 50})	0.006*** (0.002)	-0.006*** (0.002)	0.007*** (0.002)	-0.007*** (0.002)
Constant	-0.328*** (0.116)	0.328*** (0.116)	-0.691*** (0.115)	0.691*** (0.115)

Notes: Numbers in parenthesis are robust standard errors. Control variables include buyers' demographic variables: a USA dummy (=1 if sessions were conducted in the USA; 0 otherwise), a female dummy (=1 if female; 0 otherwise), numbers of economics courses taken, general political orientation (1 = very conservative to 7 = very liberal) and income of the subject's family. We omitted the coefficient estimates of these demographic variables to conserve space as these are not related to the hypotheses in the paper.

*, **, and *** indicate significance at the 0.10 level, at the 0.05 level and at the 0.01 level, respectively.