The Next Deal in Repeated Bargaining: How ‘Getting to Yes’ Determines Equilibrium in Laboratory Markets*

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Abstract

In repeated negotiations for multiple units the opportunity cost to an agreement is potential earnings on future units. A two-person bargaining game is constructed like a double auction. Numerous units are traded in sequence within a set time. Potential earnings are measured by total available consumer and producer surplus, which determines opportunity costs to current negotiations. When surpluses are equivalent, prices converge to the intersection of supply and demand. When not equivalent, negotiations lead traders to different equilibrium. Greater buyer surplus leads to stable prices above the intersection; greater seller surplus leads to stable prices below the intersection.

Key Words: repeated negotiations; market experiments; bargaining behavior

JEL Codes: C70, C90, D40
1. Introduction

When the sale of goods is repeatedly negotiated within a set time frame, as is done for many agricultural and mineral commodities, no agreement on the current transaction means there is no agreement on future transactions. In this paper we take the position that future transactions represent an important opportunity cost of failed or slowed negotiations, and test this in laboratory markets when future transactions have different unit-by-unit values to buyers and sellers. We find that different relative values impact bargaining behavior and move the market equilibrium away from the intersection of a supply and demand schedule.

These opportunity costs and their impact on trading behavior are modeled by Muthoo (1999).1 In a repeated setting, as opposed to just a single transaction, traders are less aggressive in their present bargaining stance on current negotiations in order to make future bargains; the value of future transactions creates impatience on the part of traders. Relative degrees of impatience can work to the advantage or disadvantage of individual traders. If future trading prospects are different between negotiators, they will exhibit different degrees of impatience in the amount of and number of concessions made during the negotiation process. In this way the desire to move forward to the next “deal” influences equilibrium prices and quantities.

The unit-by-unit values of a good are private information in our laboratory markets; negotiators are completely uninformed of a counterpart’s gains. This is not to suggest traders are reaching agreement in an information void. Our experimental data indicate that traders learn a great deal from each other as they negotiate. Opening prices, the amount of a counteroffer (or concession), and the number of concessions provide signals about the importance of getting to the next unit. Traders communicate to each other via initial bids and offers and concessions

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1 Much of this discussion regarding impatience as signaled by opening bids and offers and later concessions is based on Muthoo (1999) chapter 10.
about the relative value of future transactions. These signals, a counterpart’s reaction, and subsequent reactions to reactions move prices away from the intersection of supply and demand.

The lure of future earnings, however, does not fully explain bargaining behavior in repeated negotiations; we believe the past also can be important. In the novel *Nobel House*, by James Clavell, the main character Casey Tcholok has the assignment of structuring a partnership deal for Struan and Company, a failing Asian trading house. In making the deal, Casey is looking for “drop dead money.” This is the level of wealth needed to tell her employer to drop dead -- or “I quit” -- if the occasion should arise in the future, and she never worry about financial security. It is the amount of savings required to make her tough in negotiations with her boss over salary and responsibilities. After penning the phrase “drop dead money,” Clavell is quoted as saying “I’ve got my own drop-dead money, so I write what I want at my own pace. When I finish it I let them [my potential publishers] read 200 pages.”² It is from here that negotiations begin. Hence in both fiction and fact, the value of the next deal depends on the wealth position of traders. As this brief description suggests, as wealth grows, traders become more stubborn in their current negotiation stance.

In our bargaining experiments, earnings are a measure of “drop dead money.”³ It is a variable that depends on basic market conditions, the bargaining acumen of each subject, and a subject’s preferences; it is a variable endogenous to bargaining outcomes as individuals negotiate the sale of multiple units, one at a time. As trading progresses and sellers come to the end of their inventories, the past may become more of a factor than the potential gain from future trades. Hence, in repeated bargaining traders may be conflicted by the opportunity cost of the future and

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³ Since subjects are unable to spend their earnings in the laboratory, current earnings are highly correlated with accumulated earnings.
their current earnings. The influence of the future makes traders impatient, while the influence of the past makes them patient.

1.1 Relative Consumer and Producer Surpluses in Negotiation

Imagine a two-person bargaining game constructed much like a double-sided auction; one buyer and one seller make offers and counteroffers until there is price agreement. We refer to this market institution as “negotiation” and as constructed it has a close relationship to a double auction institution. Auction theory with multiple buyers and sellers predicts, and experimental laboratory results confirm (e.g. Smith 1962 and Plott 1982), an equilibrium outcome described by simple competitive supply and demand analysis. That is, agents seeking to maximize individual gains move toward total sales and an average price that is established by the intersection of supply and demand, where total surplus is maximized. This result is robust even when the magnitudes of consumer and producer surplus differ. Smith and Williams (1982) show that the path to the intersection of supply and demand differs if there are differences in consumer and producer surplus. The path is from above the intersection if consumer surplus is greater and from below if producer surplus is greater.

When the market institution is negotiation (i.e., one buyer and one seller) and production is to demand (sellers produce after there is price agreement), we have found the intersection of supply and demand to be a good predictor of prices when consumer surplus is equal to producer surplus (Phillips and Menkhaus 2010). The flow of earnings in future repeated negotiations are equal, and therefore the level of impatience brought to a transaction is balanced. When the value of future trades is not equal, i.e. traders have different relative surpluses; the intersection of supply and demand is not a good predictor of prices. Different relative surpluses can cause stable prices above and below the intersection. If surplus is greater for sellers, prices converge
below the intersection. If it is greater for buyers price converge above the intersection of supply and demand.

Relative surplus is controlled in our laboratory market by taking a typical supply and demand schedule, for example as illustrated in figure 1, and rotating demand or supply around the intersection in order adjust consumer and producer surplus. A flatter demand schedule means less future surplus for buyers; a steeper schedule gives buyers more. Likewise, a flatter supply schedule means less future surplus for sellers; one that is steeper gives them more. When these adjustments are made as described in table 1, the side of the market with the relatively larger surplus is less aggressive on current negotiations, i.e. they have less patience, and market outcomes swing in the direction of giving more surplus to the party with relatively less surplus.

1.2 The Bargaining Environment in the Laboratory

Traders are completely uninformed about the potential and realized gains of other traders in the market. There is nothing provided in the bargaining environment that may guide these tendencies. There is no verbal communication between traders. These markets outcomes are accomplished by the party with the relatively greater future gains effectively making more generous opening bids or offers, and in concert the party who lacks earning power is making less generous opening bids and offers. Through concessions they reach a point that is about midway between the opening bid and offer. We find that opening bids and offers are very important in establishing the eventual transaction price.

Equilibrium price above or below the intersection of the supply and demand schedules effectively leads to a more equitable division of total surplus in the market. There is the appearance of traders, without common knowledge of the other party’s earnings, attempting to equalize the gains from trade. We do not believe that traders are consciously attempting to
fairly distribute gains, although this behavior has the capability to reinforce tendencies observed in other experimental bargaining games.\footnote{Past research, for example, shows that bargainers are inclined to seek equitable outcomes (Bolton, 1991; Guth, Schmittberger, and Schwarze 1982; Kahnman, Knetsch and Thaler 1986; Roth, Malouf, and Murnighan, 1981; Roth and Murnighan 1982; Roth and Schoumaker, 1983).} In a multi-product, multi-period setting there can be learning about relative gains that may induce tendencies toward equitable splits of the total. As our work is described, we cannot deny the possibility that coming forward with a generous opening bid or offer and making large concessions is self-recognition of relatively greater potential wealth. A willingness to share this wealth may be communicated by these signals. Sharing the gains on current transactions promotes quicker trading on future units and everyone benefits.

We construct a bargaining environment that mimics a double-sided auction because this is how many negotiations flow. Two traders are free to make initial offers and counteroffers, and accept proposals without waiting on the reaction of the other party to the latest offer. The buyer can raise bids and the seller can lower offers without waiting on a counter proposal from the other party. Many food commodities such as cattle, corn, and other grains are sold in a repeated negotiation setting like this for both in spot and forward trading. Minerals are sold spot and forward and contract prices are negotiated in such an open environment, in some cases anchored to a hub price as in the sale of crude oil and natural gas. Consumer durables such as automobiles and housing have negotiated prices, while one party ponders an offer the other can present a better deal in order to keep negotiations moving.

2. Experimental Design

The experimental design is based on that of Phillips and Menkhaus (2010). Eight subjects for each experimental session were recruited from business and economics university classes via
email. The request asked them to report to a computer laboratory where a session began with the experimenter reading instructions aloud. These instructions can be found in the Appendix. They describe how subjects can use the computer to negotiate a sale. This was followed by a practice period of three minutes to familiarize the participants with the software and trading rules. Afterwards, questions regarding the experimental procedures were answered and more practice time was given if needed. Subjects were not allowed to participate in more than one session.

In each experiment session, four buyers and four sellers were randomly paired in a customized trading platform. Buyers and sellers simultaneously placed bids and offers on fictitious goods referred to as units. The exchange currency was “tokens” where 1 token = $.01 U.S. Initial bids and offer were made by manually typing in the bid or offer and pressing ‘Enter.’ Bids (offers) then could be raised (lowered) by one token with a single click of the mouse or changed by more than one token by typing in new values. Buyers and sellers had one minute to negotiate trade prices, one unit at a time, for as many units as time would allow. An improvement rule was in place so that bids had to become progressively higher and offers progressively lower. Once a bid or offer was accepted, negotiation began on the next unit until the minute elapsed. After the minute expired, participants were again randomly matched for another one-minute trading round. Three one-minute trading rounds comprised a trading period or cycle. During each period, buyers and sellers could trade up to eight units. Production was effectively undertaken after the period was completed (forward trading or production to demand). Sellers did not hold inventory and unsold units did not become a sunk cost.

Each experiment went at least 20 periods. Participants were not informed of the exact number of periods to prevent any unusual behavior in the final round. After period 20, a random number was generated between one and 100. If the number fell between one and 20,
experiment was completed. If the number fell between 21 and 100 the experiment continued. At the completion of the experiment, tokens were exchanged for cash. In addition, each participant received an initial token balance of 700 ($7.00) for participating.

A unit had both a redemption value for buyers and a unit cost for sellers. The redemption value for each successive unit decreased. Thus, the redemption value for the first unit was highest, decreasing for the second unit, etc. See table 1 Baseline (B) redemption values as an example. Buyers earned tokens by purchasing units below their redemption value and then reselling to the experimenter. In the instructions profit for buyers on each unit are defined as

$$\pi_{\text{Buyer}} = R - P$$

where $$\pi_{\text{Buyer}}$$ is the profit of the buyer, $$R$$ is the redemption value, and $$P$$ is the purchase price.

Sellers earned profit by selling units to buyers above their unit costs. Unit costs successively increased. Thus, the production cost of the first unit was lowest followed by a higher cost for the second unit and so on. See table 1 Baseline (B) unit costs as an example. In the instructions sellers were told that their profit on each unit was be calculated as

$$\pi_{\text{Seller}} = P - C$$

where $$\pi_{\text{Seller}}$$ is the profit of the seller, $$P$$ is the purchase price and $$C$$ is the unit cost to the seller.

As subjects negotiated trades the computer screen reported to each subject their earnings on that unit. When the trading cycle ended, subject earnings were tallied and accumulated earnings over all the trading cycles was reported.

We report the results of five distinct treatments – reflecting alternative earning potentials for buyers and sellers. They are referred to as Baseline (B) in which both consumer and producer surpluses are equal, Increased Consumer Surplus (ICS), Decreased Consumer Surplus (DCS), Increased Producer Surplus (IPS), and Decreased Producer Surplus (DPS). Throughout each session, all buyers face the same redemption schedules and all sellers face the same unit
costs. The predicted competitive outcome for all treatments is a price of 80 tokens and a quantity traded between five and six units for the individual trader. Only the amounts of consumer and producer surplus differ.

Individual demand and supply for the baseline treatment is presented in figure 1. The unit values and unit costs for this treatment are presented in table 1. Buyer and seller surplus are the same and equal 150 tokens at the intersection of supply and demand. The redemption values and unit costs for the other treatments carry across table 1. The demand schedule for the ICS treatment is steep relative to the baseline resulting in consumer surplus of 300 tokens at the intersection of supply and demand; producer surplus remains at 150 tokens. It is useful to classify the treatments in terms of the ratio of consumer surplus to producer surplus at the intersection of supply and demand. In the baseline (B) it is 1. In the ICS treatment the ratio is 2.

The DCS treatment has a flatter demand schedule relative to the baseline; consumer surplus is 75 tokens while producer surplus remains at 150 tokens at the intersection of supply and demand. Here the ratio of consumer surplus to producer surplus is 0.5. Supply is steep relative to the baseline treatment in the IPS resulting in a producer surplus of 300 tokens. Consumer surplus remains at 150 tokens at the intersection of supply and demand. The IPS treatment is unique in that the first unit sold has a negative cost of 20 tokens. This was explained to subjects as a subsidy of 20 tokens for selling the unit. Additionally, the second unit had no cost. These special cases were covered with an example in the instructions read aloud to all participants. The ratio of consumer surplus to producer surplus is 0.5. Finally, the DPS treatment consists of a flatter supply curve resulting in a producer surplus of 75 tokens while consumer surplus is held constant at 150 tokens. The ratio of consumer surplus to producer surplus is 2.
For comparison purposes it is helpful to pair treatments by relative earning potential. In terms of the collective earning potential of buyers as a group and sellers as a group, the ICS and DPS have the same relative earning potential. In these two treatments buyers have twice the earning potential as sellers at the intersection of supply and demand. In the DCS and IPS treatments, buyers and sellers have the same relative earning potential and sellers have twice the potential as buyers. These four treatments also will be individually compared to the baseline.

Each treatment was repeated five times at different times with the exception of the baseline treatment which was repeated six times. Each repetition is referred to as a session. Twenty periods from each session are included in the data set.

3. Prices, Trades, and Efficiency

In each experimental session, data were collected on the prices of units traded, number of units traded, and the earnings of buyers and sellers. Similar to Noussaire, Plott, and Riezman (1997) and Phillips and Menkhaus (2010), we begin by describing these data using a general convergence model:

\[
Z_{it} = B_0 \left[ \left( \frac{t-1}{t} \right) \right] + B_1 \left( \frac{1}{t} \right) + \sum_{j=1}^{i-1} \alpha_j D_{jt} \left[ \left( \frac{t-1}{t} \right) \right] + \sum_{j=1}^{i-1} \beta_j D_{jt} \left( \frac{1}{t} \right) + u_{it}
\]

where \(Z_{it}\) is the variable of interest such as average sale price, number of units traded, or earnings outcome across sessions for each of \(t\) trading periods (1, ..., 20) in the treatment cross section \(i\); \(B_0\) is the predicted asymptote and \(B_1\) is the starting level of the dependent variable (e.g. price, trades, or earnings outcome) for the baseline treatment; \(\alpha\) and \(\beta\) are, respectively, adjustments to the asymptote and starting levels for each treatment’s relation to the base; \(D_{jt}\) is a dummy variable representing the \(j^{th}\) treatment (equal to zero for the base treatment and one for the compared treatment) for each of the \(t\) trading periods; and \(u_{it}\) is an error term. A variant of this model also is used to estimate convergence levels for initial bids and offers in the negotiation.
process. The Parks method (Parks 1967) was used to estimate the model to account for unique statistical properties resulting from the panel data sets. Analyses were conducted in SAS using the PANEL Procedure (SAS 1999). In the discussion that follows, we focus on the convergence or asymptote levels for the variables of interest associated with alternative treatments.

3.1 Prices: ICS and DPS

A time series graph of average trade prices for the treatments is presented in figure 2. Only the baseline treatment moves to the predicted competitive equilibrium of 80 tokens; price converges to 80.01 tokens (see table 2). In the ICS treatment average trade price tracks the baseline until about period 8 and then drifts higher; price converges to 83.20, significantly higher (by 4%) than the baseline result and the predicted equilibrium. Average price results are similar for the DPS treatment. Price in the DPS treatment begins at about 85 tokens and stays consistently high throughout the experiment. Table 2 reports an asymptote of 84.00, which is significantly different from the baseline value and 5% above the predicted equilibrium at the intersection of supply and demand.

The ICS and DPS asymptotes for price are not significantly different. Thus when consumer surplus is twice that of producer surplus at the intersection of supply and demand, but the relative surpluses are created in different ways, either by raising consumer surplus (ICS treatment) or lowering producer surplus (DPS treatment) relative to a baseline, there are very similar and stable price patterns. The average negotiated price is significantly greater by 4% to 5% than when the amount of surpluses is equal at a price of 80 tokens.

3.2 Prices: DCS and IPS

Figure 2 shows that the DCS and IPS treatments generate stable price paths below 80 tokens. Average price converges to about 72 tokens (71.85 in table 2) in the DCS market. This is
a significantly different price than 80 tokens and 10% less than the predicted equilibrium; this estimate is significantly different from all other treatments. The IPS market also generates stable prices below 80 tokens. Price converges to about 66 tokens (or 18% less). In both of these cases the seller surplus is twice that of buyers. The fact that the IPS treatment moves to a lower price than the DCS treatment may be due in part to the cost of the first two units in the IPS treatment set at -20 and 0 respectively. The target level of earnings for sellers may be relatively generous as a result of these low costs.

3.3 Trades

A time series graph of the average number of trades is presented in figure 3. The predicted competitive equilibrium number of trades for each treatment is at least 20 trades, five trades for each of the four buyer-seller pairs; see figure 1. From figure 3, we can see that the average number of trades for all treatments fall below this level. Similar to prices, we can analyze the estimated asymptotes from the convergence model to determine whether or not the number of trades in each treatment is consistent with the estimates of the baseline treatment. In the baseline treatment, the convergence level for the number of trades is 17.14 (table 2).

It is widely recognized that more trades are expected to occur when there is more total surplus available for buyers and sellers. This is because it is easier to strike a bargain at the margin if total gains are greater. We believe this is true even when just the surplus of either the buyer or seller is greater than a baseline. Indeed it reinforces our impatience argument. In a negotiation market institution the ease with which deals can be struck at any point in the repeated sales of units makes the party with relatively more to gain less patient, and so bargains are made that favor the patient party, but more bargains are struck. It is relative impatience that gets traders to the marginal unit as time expires in a trading round.
Total surplus available in the baseline treatment is 1200. In the ICS and IPS treatments total surplus available is 1800 tokens, a 50% increase; here the asymptotic convergence levels for the number of trades are 18.00 and 18.26, respectively. These quantities are significant increases from the baseline, but not significantly different values between the ICS and IPS treatments (table 2). Impatience created through increased surplus for either the buyer or seller increases trades.

In the DCS and DPS treatments where the total surplus available is 900 tokens, a 25% decrease, the asymptotic convergence levels for the number of trades are 16.44 and 16.11, respectively. These quantities are not significant decreases from the baseline and not significantly different between treatments. When surplus in decreased for the buyer or seller, we argue relative patience is created for this side of the market. More patience should lead to fewer trades, which is the direction of change in our data, although not significant. The absence of significance may be due to a smaller change from the baseline than in the ICS and IPS treatments.

We can use the results from the total earnings (total surplus) data to evaluate how efficient each treatment is compared to the baseline. Using the asymptotes from the convergence model we can calculate a level of efficiency for each treatment. The last column of table 2 estimates total actual earnings relative to total possible surplus in the market. Similar to the number of trades, the more surplus there is available the higher the percentage of earnings to total available surplus. As we can see from table 2, the decreased consumer surplus and decreased producer surplus are least efficient. Their levels of efficiency are 88.44% and 86.86%, respectively. The baseline treatment is 90.21% efficient while the increased consumer surplus and increased producer surplus treatments are 92.00% and 94.27% efficient, respectively.
3.4 Summary

To this point, we have described and compared prices, trades, and efficiencies from the alternative treatments. Price converges to the predicted supply and demand equilibrium when surpluses are equivalent. Greater buyer surplus leads to price above the supply and demand intersection, while greater seller surplus leads to price below the intersection. There is evidence from differences in trades among the treatments of impatience created by increased surpluses for either the buyer or the seller.

4. Initial Proposals and Bargaining to the Middle

In this section we begin to make our case that future surplus is a major influence in “getting to yes” in negotiation. The first part of our inquiry highlights the importance of opening bids and offers. They effectively decide final outcomes because traders have a tendency to make trades at the midpoint of the initial proposals. To give up about half of the gain after opening suggests at some level equity plays a role in the market outcomes. The second part of our investigation focuses on the determinants of opening bids and offers. We analyze initial offers and bids in each treatment averaged over the initial offers and bids proposed over the three trading rounds and all sessions in order to test for differences between their midpoint and estimated average selling price from the convergence model (table 2). Figures 4 through 8 map these average initial offers and bids for the five treatments for each period, and report estimated convergence levels for each time series.

4.1 Baseline Treatment

For the baseline treatment, figure 4 shows average initial offers and bids and respective convergence amounts. Offers to sell are converging to 106.12 and bids to buy converge to 51.46. We shall henceforth summarize initial offers to sell and bids to buy as a bargaining bracket
[51.46 106.12] defining the asymptotic lowest and highest possible final negotiated price. If agents bargained to the midpoint of these values, the average selling price would be 78.81 tokens. This is very close and not significantly different from the estimated baseline negotiated value of 80.01 tokens.\textsuperscript{5} Thus, initial offers and bids bracket the intersection of supply and demand in the experimental baseline.

\subsection*{4.2 ICS and DCS Treatments}

Figure 5 tracks initial buyer bids for the ICS and DCS. We present these data together in one figure in order to show that when the total amount of consumer surplus is increased, buyers make consistently higher bids that benefit sellers. In the ICS treatment, initial bids converge to 61.75 and are significantly different than those in the DCS treatment at 51.72. Of note is that initial bids in the DCS treatment are not significantly different from initial bids in the baseline. This observation is worth emphasizing. Increased consumer surplus results in a change and increase in buyer initial bids, but deceased consumer surplus shows no change from the baseline.

However, as figure 6 shows sellers in the DCS treatment reduce their initial offer to sell to 90.49. Bargaining toward the middle of the bracket [51.72 90.49] gives the buyer lower final prices which shifts surplus to the buyer relative to the baseline bracket of [51.46 106.12]. In the DCS treatment final negotiated prices converge to 71.85. The midpoint of the DCS bracket is 71.05 and is not significantly different from 71.85. Surplus is shifting from sellers to buyers through the relative high surplus side of the market. Sellers are the moving party in negotiations, as they lower their initial offers.

In the ICS treatment, figures 5 and 6 show that initial bids and offers have the bracket [61.75 104.67]. The initial bid asymptote is significantly different than 51.46 in the baseline.

\textsuperscript{5} Tests of statistical differences between the midpoint and the estimated convergence level from table 2 are conducted using a t-test – 95 percent confidence level.
The initial offer amount is not significantly different than 106.12 from the baseline. Hence, the moving party is once again the side of the market with the relatively larger surplus; buyers move to shift surplus toward the seller. The midpoint of the ICS bracket [61.75 104.67] is 83.20, which exactly matches the estimated asymptote reported in table 2. So the broader issue raised in these two treatments is how does ICS cause buyers to raise initial bids and sellers exhibit no change in initial offers; how does DCS cause buyers to exhibit no change in initial bids and sellers lower initial offers?

4.3 IPS and DPS Treatments

Figures 7 and 8 describe the initial bids and offers in the IPS and DPS treatments. Figure 7 further reports that the initial offers in these treatments are significantly different; figure 8 reports that initial bids from buyers are significantly different between the treatments. In the IPS treatment the bracketed initial bid-offer values converge to [49.04 90.21]. The initial bid value is not significantly different from the baseline value of 51.46, while the initial offer value is significantly different from the baseline value of 106.12. The bargaining party with the greater surplus--in this case sellers--adjusts to give surplus to the bargaining party with less surplus--in this case buyers. Buyers make no adjustment relative to the baseline. The midpoint of the IPS bracket is 69.57. The estimated final price is 66.09; these values are close but are significantly different at the 95 percent confidence level.

In the DPS treatment the initial bid-offer values are estimated at [63.53 102.30]. The initial bid amount is significantly different from the initial bid in the baseline bracket [51.46 106.12], while the offer values are not significantly different. The moving parties are buyers who have the relatively greater surplus and they increase initial bids. The midpoint of the DPS
bracket is 82.81. The estimated convergence final price is 84.00 from table 2. The difference between the midpoint and the final convergence price is not significantly different.

4.4. Summary

These results paint a consistent picture of bargaining behavior when relative gains differ. The party with relatively larger potential earnings moves toward making more generous initial bids/offers, even though potential earnings may be no different from a baseline with equal consumer and producer surplus. Once opening values become known, parties bargain near the midpoint. This brings us to the second part of our inquiry: what are the determinants of initial bids and offers?

5. The Determinants of Initial Bids and Offers

We focus on several possible determinants in the econometric models we construct below. Individuals bargain differently depending on their current and potential earnings. Differences in bargaining are largely manifested through initial bids and offers, which are the dependent variables in our models. An instrument for the wealth or “drop dead” impact on trading behavior is individual earnings, and as described earlier, this can counteract the influence of potential earnings. The impact of potential or future earnings, will be measured by a set of dummy interaction variables for treatments that increase or decrease the potential earnings of traders – reflecting differences in relative surpluses.

The only information a trader has about a counterpart is the other person’s initial bid or offer, how frequently the other negotiator makes concessions, and how much is conceded when making a counteroffer. These variables give cues to a trader about the other person’s opportunity costs, and their willingness to hurry the negotiation process along. We believe that traders take cues such that those with a relatively high earning potential will adjust their initial bid or offer to
move surplus to the weaker side of the market. Dummy variables representing different relative surpluses will help to confirm this argument. In our analysis of initial bids and offers we define the following variables:

- **Buyer mean initial price**: $bmip_{t-1}$ (lagged one round), $bmip_t$ (current round). The variable $bmip_t$ will be the dependent variable we seek to explain for buyer initial bid behavior.

- **Seller mean initial price**: $smip_{t-1}$ (lagged one round), $smip_t$ (current round). The variable $smip_t$ will be the dependent variable we seek to explain for seller initial offer behavior.

- **Buyer mean concession**: $bmc_{t-1}$ (lagged one round).

- **Seller mean concession**: $smc_{t-1}$ (lagged one round).

- **Mean number of buyer concessions**: $bn_{t-1}$ (lagged one round).

- **Mean number of seller concessions**: $sn_{t-1}$ (lagged one round).

- **Average buyer earnings per average unit traded**: $bearnuint_{t-1}$ (lagged one round).

- **Average seller earnings per average unit traded**: $searniunt_{t-1}$ (lagged one round).

- **Treatment**: Dummy variables are used to capture differences in behavior due to the change in relative surpluses as reflected in the treatments. The baseline carries a value of 0. The ICS ($t_1$) treatment takes the value of 1 and others zero. The DCS or $t_2$ treatment takes the value of 1 and others zero. DPS is described as $t_3$ and IPS is identified as $t_4$.

  A number of dummy interaction effects with other independent variable can be suggested. Most obvious is that different levels of consumer surplus can have a cross-effect with $bmip_{t-1}$, $bmc_{t-1}$, and $bn_{t-1}$ when explaining $smip_t$. Hence these variables are interacted with $t_1$ and $t_2$ in the regression model for $smip_t$. Similarly, different levels of producer surplus can

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6 A number of cross-effect combinations with the dummies and dependent variables have been tested with marginal explanatory value in the models described below in tables 5 and 6.
interact with \( \text{smip}_{t-1}, \text{smc}_{t-1}, \) and \( \text{sn}_{t-1} \) when explaining \( \text{bmip}_t \), so these variables are crossed with \( t3 \) and \( t4 \) in the regression model for \( \text{bmip}_t \). The interactions \( t2 \) and \( t3 \) are of special interest because it is in treatment DCS that sellers change their initial offers, and it is in the DPS treatment that buyers change their initial bids. In these treatments sellers and buyers, respectively, did not have their surplus change relative to the baseline.

We describe our dependent variables in more detail as follows. Four sellers and four buyers trade multiple units in trading session \( i \) for treatment \( c \). Assume a seller is designated as SI and a buyer as BI, \( I = 1, 2, 3, 4 \). They negotiate over \( J \) total units during round \( t \), trading at least \( f = \{Z - 1, Z \} \) units; the \( Z \)th unit may not be traded as time expires. For all units, and using the \( i \)th unit as typical, the seller in most cases will propose an initial prices \( \text{sip}_{ti} \). It is possible \( \text{sip}_{ti} \) is not made if the buyer’s initial bid is accepted or the seller waits as bids are raised. Similarly, the buyer proposes initial price \( \text{bip}_{ti} \) or does not make a proposal for the \( i \)th unit if the seller’s initial offer is accepted or the buyer waits for lower offers. Assume the seller proposes \( m \) number of initial prices, where \( m \leq Z \). Similarly, the buyer proposes \( n \) number of initial prices, where \( n \leq Z \). The seller mean initial price during round \( t \) is \( \text{smip}_t = \frac{\sum_{i=1}^{m} \text{sip}_{ti}}{m} \) and the buyer mean initial price during round \( t \) is \( \text{bmip}_t = \frac{\sum_{i=1}^{n} \text{bip}_{ti}}{n} \). These averages are aggregated and averaged for all buyers and sellers. That is, these are the average initial offers and initial bids for each of the three trading rounds, each of the 20 periods, and each of the five sessions for each treatment, except for the base treatment in which three sessions were used.

After the opening offer a seller can make concessions \( \text{sc}_{t1}, \text{sc}_{t2} \ldots \text{sc}_{tk} \ldots \text{sc}_{tp} \) during round \( t \) within the 60 seconds. In total, the seller proposes \( p \) number of concessions during round \( t \) (\( \text{sn}_t \)). Thus, we have seller mean concession \( \text{smc}_t = \frac{\sum_{k=1}^{p} \text{sc}_{tk}}{p} \) and \( \text{sn}_t = p \) in round \( t \). A buyer can make concessions \( \text{bc}_{c1}, \text{bc}_{c2} \ldots \text{bc}_{ck} \ldots \text{bc}_{cq} \) during round \( t \) within 60 seconds. So in
total, a buyer proposes q number of concessions during round t (bn_t). Thus, we have buyer mean concession in round t as \( bm_{ct} = \left( \sum_{k=1}^{q} b_{ctk} \right) / q \) and \( bn_t = q \). As with the initial bids and offers, these averages are aggregated and averaged for all buyers and sellers by trading round, period, and session for each treatment.

The seller and the buyer may not reach an agreement for the last unit before the clock ends; they have successfully traded \( f \) units where \( f \leq Z \). The price at which they agree to trade the typical ith unit is \( \text{aveprice}_{ti} \). Assume the buyer redemption valued (or resale price) for the ith unit is \( R_{bi} \). Buyer “BI” earnings for round t is \( \text{bearn}_{tB_i} = \sum_{i=1}^{f} (R_{bi} - \text{aveprice}_{ti}) \). Let the seller cost for the ith unit be \( C_{si} \). Seller “SI” earnings during round t is \( \text{searn}_{tS_i} = \sum_{i=1}^{f} (\text{aveprice}_{ti} - C_{si}) \). We have four buyers and four sellers, so the average buyer earnings for round t are \( \text{bearn}_{tB} = (\text{bearn}_{tB_1} + \text{bearn}_{tB_2} + \text{bearn}_{tB_3} + \text{bearn}_{tB_4})/4 \) and the average seller earnings for round t is \( \text{searn}_{tS} = (\text{searn}_{tS_1} + \text{searn}_{tS_2} + \text{searn}_{tS_3} + \text{searn}_{tS_4})/4 \). Assume on average traders make h successful trades, which is the average of the number of trades for the four trading pairs. Average buyer earnings per unit are defined as \( \text{bearnuint}_t \equiv \text{bearn}_{tB}/h \) and the average seller earnings per unit is \( \text{searnuint}_t \equiv \text{searn}_{tS}/h \).

For all the treatments, we observe from mean values of bmip and smip that average price tends toward the midpoint of bmip and smip (table 3) – a result previously discussed. Overall average price as listed for the four test treatments is lowest (highest) in the DCS (DPS) treatment, suggesting that sellers (buyers) are willing to bargain for lower (higher) prices – conceding to buyers (sellers) and confirming again that those traders with the relatively higher potential earnings for future trades are willing to concede. Notice that from the baseline, bmip and smip are highly correlated. In all treatments, when bmip rises or falls, so does smip.
Continuing with data reported in table 3, both buyer and seller mean concessions are highest for the ICS treatment followed by the IPS treatment. The numbers of buyer and seller concessions (bn and sn) are highest for the DCS and DPS treatments. Buyer average earnings per unit, as expected, are highest in the ICS treatment. On the seller side of the market, seller average earnings per unit are highest in the IPS treatment. Interestingly, the second highest average per unit earnings for buyers is in the IPS treatment, while the second highest seller average per unit earnings are in the ICS treatment. This again is evidence that the advantaged buyer or seller with regard to potential earnings gives some surplus to the trading partner in the ICS and IPS treatments.

Averages, however, do not describe the process by which current and potential earnings exert force. For example, a period of relatively small and infrequent concessions during the time allowed for negotiations can signal a weak earning potential. We believe that traders take cues such that those with relatively high earning potential will adjust their initial bid or offer to move surplus to the weaker side of the market in order to make more trades. We discuss seller and buyer behavior separately, conducting pooled OLS regressions on the determinants of bmip_t and smip_t. In each regression the data for all treatments are organized as a cross-section time series.

5.1 Determinants of Seller Initial Price (smip)

We first examine the determinants of smip. Variants of the model estimated in table 4 summarize the impact of the above defined independent variables on seller initial offers in bargaining. The four variants reported offer different scenarios of the interaction effect between buyer bargaining attributes and levels of consumer surplus. Significance of variables in
regression (1) is not impacted by the addition of the cross-effect terms in regressions (2), (3), and (4). Hence most of our focus will be on regression (1).

When making offers, sellers are significantly influenced by their past first offer; amount and number of concessions; along with the first bid in the previous round. The positive and significant coefficients on $\text{smc}_{t-1}$ and $\text{sn}_{t-1}$ suggest mean concessions and the number of concessions positively influence the initial offers from the seller. Current earnings, as measured by seller average earnings per unit in the previous round, does not significantly affect the seller’s initial offer.

Among the dummy treatment variables, DCS (t2) and IPS (t4) exhibit statistically significant estimated coefficients. The initial offer varies inversely with each of these treatment variables. Increased potential seller earnings, as measured by t2 and t4, lowers the initial offers of sellers. Future earnings matter as reflected by the negative and significant coefficient for IPS (t4). Sellers reduce initial offers to trade more units.

Importantly, the coefficient on $\text{bmip}_{t-1}$ is significant and positive in each of the four regression variants. This suggests that sellers follow a tit-for-tat bargaining strategy; when buyers increase their initial bids, sellers increase their initial offers and vice-versa. How differing levels of surplus move prices away from the intersection of demand and supply can now be explained. If relative impatience leads the way to more generous bids and offers and a counterpart follows, then impatient sellers, for example, opening lower will move market prices downward as buyers follow. Impatient buyers opening higher will move market prices upward as sellers follow.

As suggested in our discussion concerning the number of trades under each treatment, there is a complementary pull and push between relative impatience and patience. If relative
impatience induces more generous bids and offers, then relative patience reinforce the movement of prices in a direction away from the intersection of supply and demand. The impatient party is more than willing to accommodate generous openings, and could even take the lead with less than generous openings from their side of the market.

5.2 Determinants of Buyer Initial Price (bmip<sub>t</sub>)

Tit-for-tat initial bid/offer behavior could not be sustained, and the above explanation for why prices move away from the intersection of demand and supply would not have merit, unless followed by both the seller and the buyer. Table 5 shows that seller initial offers, smip<sub>t−1</sub>, have a positive and significant impact on bmip<sub>t</sub>. As for sellers, buyer history or past initial bids also matter. Further, mean concessions and number of concessions help buyers set their initial bid prices. As buyers concede more with each new bid and do it more frequently, initial bids increase.

These estimates show some differences between seller and buyer behavior. For instance, buyer earnings tend to be an important determinant of buyer initial bids. As earnings rise, initial bids fall; as buyers become wealthier they become more aggressive in their initial bargaining stance. The treatment effects show significant and increased bids in the ICS (t1) and IPS (t3) treatments. As buyer surplus increases in the ICS, initial bids increase. There is no significant change in initial bids, relative to the base, when buyer surplus is decreased (t2). Initial bids do not change significantly under the IPS treatment, although buyers tend to learn about IPS through the amount of concessions (mean and number) made by sellers, as per the results of the interaction term with t4.

5.3 Summary
Buyers and sellers tend to negotiate for prices in a way that channel relative gains toward the side of the market that has less earning potential. For both sellers and buyers, increased earning potentials (IPS and ICS) cause traders to become more generous. Low earning potential relative to a baseline does not cause less generous bargaining behavior. This observation coupled with a clear tendency to follow a counterpart’s initial bid and path leads to market outcomes that cannot be predicted by simple demand and supply analysis. Comparing seller (table 4) and buyer (table 5) initial mean prices we also see that each responds to their own previous offers and bids and their own mean and number of concessions; a person’s own history has influence on current decisions. A consistent history on the parts of both traders reinforces observed price trends.

6. Conclusion

In negotiations, in which paired buyers and sellers repeatedly bargain over a price in an unstructured format for bids, offers and counteroffers, we find that agents arrive at the predicted competitive equilibrium price when buyers and sellers each have the same available surplus. When gains from trading or surpluses are different for buyers and sellers, however, the price settles at a level different from the intersections of supply and demand. When the relative surplus favors buyers (sellers), the price is above (below) that predicted by the intersection of the supply and demand schedules.

There is evidence from our laboratory markets that initial bids and offers from previous negotiations are important in determining initial bids and offers in the current negotiation. The trade price tends to finalize midway between these initial buyer and seller offerings. It is expected that buyers and sellers pay attention to their own previous concessions, both amount and number, as they make decisions. They also, however, pay attention to opening bid or offer
of their counterpart. This is an important cue to traders. As traders follow less patient and more generous openings, working in their best interest, prices move away from the predicted equilibrium.

Sellers are responsive only to their potential earnings, while buyers are responsive to their current and potential earnings. This observation is part of a growing body of evidence that suggests buyers and sellers bargain differently. Bazerman et al., 1985; Neale and Bazerman, 1985; Huber and Neale, 1986; McAlister et al., 1986; Neale and Northcraft, 1986; Neale et al., 1987, as a group of studies, suggest that the role labels of “buyer” and “seller” induce negative and positive frames, respectively. These frames can give buyers a bargaining advantage. Our results show there are behavioral differences arising from the types of information important to buyers and sellers. The past is important to buyers, but not sellers. Earnings make buyers increasingly stubborn.

The notion of fairness or generosity is sometimes suggested to explain why agents might not be profit seeking in markets. But, given that surpluses are not known in our laboratory market experiments, how do agents learn to share a relatively favorable surplus and why don’t they behave as profit maximizers as in the double auction? The bids and offers must carry the signals for behavior. These signals carry meaning in private negotiation where there is more of a focus on the individual trader as opposed to the broader setting in a double auction where there are more sellers and buyers interacting simultaneously in price discovery. We find that concessions and frequency of concessions in counteroffers in the bargaining environment provide these signals. The impact of these signals is reinforced by the movement of past trade prices.
References


Figures

Figure 1. Induced aggregate market demand and induced market supply for four buyers and four sellers baseline treatment.
Figure 2. Average trade prices by period and treatment
Figure 3. Average trades by period and treatment

![Graph showing average trades by period and treatment]

- Baseline
- Increased CS
- Decreased CS
- Increased PS
- Decreased PS
Figure 4. Average initial offers by sellers and initial bids by buyers across three trading rounds and three sessions for each period - baseline treatment
Figure 5. Average initial bids by buyers across three trading rounds and five sessions for each period for increased consumer surplus and decreased consumer surplus.
Figure 6. Average initial offer by sellers across three trading rounds and five sessions for each period for increased consumer surplus and decreased consumer surplus treatments.

Convergence Level = 104.67

Convergence Levels Significantly Different

Convergence Level = 90.49
Figure 7. Average initial offer by sellers across three trading rounds and five sessions for each period for increased producer surplus and decreased producer surplus treatments.
Figure 8. Average initial bid by buyers across three trading rounds and five sessions for each period for increased producer surplus and decreased producer surplus treatments.
Tables

Table 1: Redemption values and costs

<table>
<thead>
<tr>
<th>Unit</th>
<th>Baseline (B) Redemption Value/Cost</th>
<th>Increased Consumer Surplus (ICS) Value/Cost</th>
<th>Decreased Consumer Surplus (DCS) Value/Cost</th>
<th>Increased Producer Surplus (IPS) Value/Cost</th>
<th>Decreased Producer Surplus (DPS) Value/Cost</th>
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<tr>
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<td>100/40</td>
<td>120/0</td>
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</tr>
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<td>140/50</td>
<td>95/50</td>
<td>110/20</td>
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Table 2. Estimated baseline convergence levels and treatment adjustment coefficients

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<tr>
<th>Treatment</th>
<th>Prices</th>
<th>Trades&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Total Earnings&lt;sup&gt;e&lt;/sup&gt;</th>
<th>Efficiency&lt;sup&gt;f&lt;/sup&gt;</th>
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<td>1082.57</td>
<td>90.21</td>
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<td>573.44</td>
<td>92.00</td>
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<td></td>
<td>(0.70)</td>
<td>(0.24)</td>
<td>(16.88)</td>
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<td>Decreased Consumer Surplus (DCS)</td>
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<td>(7.76)</td>
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<td>Increased Producer Surplus (IPS)</td>
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<td>1.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>614.23</td>
<td>94.27</td>
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<td>(0.28)</td>
<td>(12.35)</td>
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<td>(0.42)</td>
<td>(0.45)</td>
<td>(11.45)</td>
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* Convergence level is significantly different from the baseline level – 95 percent confidence level. Standard errors are in parentheses.

a, b, c – Same letter indicates no significant difference between convergence levels in the respective equations. Different letters indicate a significant difference between convergence levels – 95 percent confidence level.

<sup>d</sup> Normality of the residuals is rejected and skewness is severe. A non-parametric Wilcoxon-Mann-Whitney test was conducted using an average of the last five periods of each session for the respective treatment pairs.

<sup>c</sup> Normality of the residuals is rejected and skewness is severe. Statistical tests of significance were not conducted for total earnings. Relative magnitudes are of primary interest.

<sup>f</sup> Total Earnings/Total Surplus times 100%
Table 3. Means and [standard deviations] for variables across sessions, three trading rounds, and twenty periods for each treatment

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<tr>
<th>Treatment</th>
<th>bmip</th>
<th>smip</th>
<th>bmc</th>
<th>smc</th>
<th>bn</th>
<th>sn</th>
<th>price</th>
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<td>[8.72]</td>
<td>[5.56]</td>
<td>[3.60]</td>
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</table>

*Note:* mean [st. dev] and three sessions for the baseline treatment

bmip-buyer average initial price per round, smip-seller average initial price per round, bmc-buyer mean concessions per round, smc-seller mean concessions per round, bn-buyer mean numbers of concessions per round, sn- seller mean numbers of concessions per round, price-final price per round, searnunit-average seller earning per unit per round, bearnunit-average buyer earning per unit per round.
Table 4. Regression of smip<sub>t</sub> – seller mean initial price, current round.

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>regression (1)</th>
<th>regression (2)</th>
<th>regression (3)</th>
<th>regression (4)</th>
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<td>0.09* [0.02]</td>
<td>0.05* [0.02]</td>
<td>0.09* [0.02]</td>
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<td>-0.20 [0.16]</td>
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<td>0.13* [0.06]</td>
<td>0.14* [0.06]</td>
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<tr>
<td>bmc&lt;sub&gt;t-1&lt;/sub&gt;x t2</td>
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<td>-0.23 [0.18]</td>
<td></td>
</tr>
<tr>
<td>bn&lt;sub&gt;t-1&lt;/sub&gt;x t2</td>
<td></td>
<td>-0.26 [0.25]</td>
<td>-0.38 [0.24]</td>
<td></td>
</tr>
<tr>
<td>t1</td>
<td>1.10 [1.30]</td>
<td>10.40 [5.40]</td>
<td>1.10 [1.29]</td>
<td>11.36* [5.49]</td>
</tr>
<tr>
<td>t3</td>
<td>0.14 [0.93]</td>
<td>-0.49 [0.95]</td>
<td>0.17 [0.95]</td>
<td>-0.50 [1.02]</td>
</tr>
<tr>
<td>constant</td>
<td>81.40* [6.24]</td>
<td>79.16* [6.13]</td>
<td>80.87* [6.22]</td>
<td>78.34* [6.18]</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.27</td>
<td>0.27</td>
<td>0.27</td>
<td>0.28</td>
</tr>
<tr>
<td>No. of Obs</td>
<td>1396.00</td>
<td>1396.00</td>
<td>1396.00</td>
<td>1396.00</td>
</tr>
</tbody>
</table>

Mean[heteroskedastic-corrected standard error],*Significant at the 95 percent confidence level.
Table 5. Regression of bmip\textsubscript{t} – buyer mean initial price, current round.

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>regression (1)</th>
<th>regression (2)</th>
<th>regression (3)</th>
<th>regression (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>bmip\textsubscript{t-1}</td>
<td>0.29* [0.04]</td>
<td>0.30* [0.04]</td>
<td>0.28* [0.04]</td>
<td>0.29* [0.04]</td>
</tr>
<tr>
<td>bmc\textsubscript{t-1}</td>
<td>-0.28* [0.11]</td>
<td>-0.32* [0.11]</td>
<td>-0.30* [0.11]</td>
<td>-0.34* [0.11]</td>
</tr>
<tr>
<td>bn\textsubscript{t-1}</td>
<td>-0.74* [0.19]</td>
<td>-0.77* [0.20]</td>
<td>-0.71* [0.19]</td>
<td>-0.73* [0.19]</td>
</tr>
<tr>
<td>smip\textsubscript{t-1}</td>
<td>0.09* [0.03]</td>
<td>0.10* [0.03]</td>
<td>0.10* [0.03]</td>
<td>0.11* [0.04]</td>
</tr>
<tr>
<td>smc\textsubscript{t-1}</td>
<td>0.06 [0.07]</td>
<td>-0.03 [0.07]</td>
<td>0.13 [0.07]</td>
<td>0.06 [0.07]</td>
</tr>
<tr>
<td>sn\textsubscript{t-1}</td>
<td>0.27 [0.17]</td>
<td>-0.14 [0.21]</td>
<td>0.51* [0.19]</td>
<td>0.11* [0.28]</td>
</tr>
<tr>
<td>bearunit\textsubscript{t-1}</td>
<td>-0.22* [0.09]</td>
<td>-0.20* [0.09]</td>
<td>-0.16 [0.10]</td>
<td>-0.15 [0.10]</td>
</tr>
<tr>
<td>smip\textsubscript{t-1}x t3</td>
<td>-0.05 [0.07]</td>
<td>-0.05 [0.07]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>smc\textsubscript{t-1}x t3</td>
<td>0.44 [0.32]</td>
<td>0.36 [0.32]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sn\textsubscript{t-1}x t3</td>
<td>1.08* [0.28]</td>
<td>0.81* [0.33]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>smip\textsubscript{t-1}x t4</td>
<td>0.06 [0.07]</td>
<td>0.06 [0.08]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>smc\textsubscript{t-1}x t4</td>
<td>-0.95* [0.23]</td>
<td>-0.90* [0.23]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sn\textsubscript{t-1}x t4</td>
<td>-1.55* [0.33]</td>
<td>-1.16* [0.38]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t1</td>
<td>6.70* [1.29]</td>
<td>6.86* [1.27]</td>
<td>6.10* [1.29]</td>
<td>6.30* [1.28]</td>
</tr>
<tr>
<td>t2</td>
<td>0.37 [1.19]</td>
<td>1.01 [1.20]</td>
<td>0.18 [1.20]</td>
<td>0.76 [1.23]</td>
</tr>
<tr>
<td>t3</td>
<td>6.93* [0.99]</td>
<td>2.62 [6.68]</td>
<td>6.48* [0.99]</td>
<td>4.44 [7.01]</td>
</tr>
<tr>
<td>t4</td>
<td>1.74 [0.96]</td>
<td>2.10* [0.96]</td>
<td>10.42 [6.61]</td>
<td>8.60 [6.89]</td>
</tr>
<tr>
<td>constant</td>
<td>33.80* [4.18]</td>
<td>34.71* [4.62]</td>
<td>31.33* [4.38]</td>
<td>32.66* [5.07]</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.26</td>
<td>0.28</td>
<td>0.27</td>
<td>0.29</td>
</tr>
<tr>
<td>No. of Obs</td>
<td>1396.00</td>
<td>1396.00</td>
<td>1396.00</td>
<td>1396.00</td>
</tr>
</tbody>
</table>

Mean[heteroskedastic-corrected standard error], *Significant at the 95 percent confidence level.
Appendix A (For Online Publication)

INSTRUCTIONS

Introduction

This is an experiment in the economics of market decision making. In this experiment, we will set up a market in which some of you will be BUYERS and some of you will be SELLERS.

The commodity you are trading is referred to as a "unit". Sellers make earnings by producing units at a cost and selling these units to buyers. Buyers make earnings by purchasing units from sellers and then redeeming (or reselling) these units to the experimenter. Earnings are recorded in a fictitious currency called tokens. Tokens are exchanged for cash at the rate of 100 tokens = $1.00. Your earnings will be paid to you in CASH at the end of the experiment. To begin, every seller and buyer will be given an initial balance of 700 tokens ($7.00). You may keep this money PLUS any you earn.

Buyers and sellers will be randomly paired and will exchange units for tokens in computerized markets over a sequence of trading cycles. Each trading cycle consists of three trading sessions or rounds during which pairs of buyers and sellers negotiate trading prices. Each trading cycle consists of what is commonly referred to as a forward market. The forward market occurs before sellers have produced units. A trade in the forward market is a binding agreement between buyer and seller. In other words, the seller agrees to produce a unit for the buyer and the buyer agrees to pay the seller for that unit.

All trading is conducted over the computer network. At the end of each trading cycle or period, any unit sold is automatically produced, and the cost of production is deducted from the seller's token balance. In addition, the computer will automatically account for sales or purchases that you have made and adjust your token balance accordingly. A listing of sales or purchases you have made and your adjusted token balance will be displayed on the computer screen at the end of every trading cycle. After you have viewed this information and clicked on OK, a new trading cycle with three trading sessions will begin. This experiment will consist of
several trading cycles. We will conduct a practice cycle to familiarize you with the mechanics of the computerized market before the actual experiment begins. During the practice cycle the information you see will be different than that in the actual experiment.

**Random stop.** No one knows when the experiment will end. Decisions will be made through 20 periods in the experiment. After period 20 the computer will randomly generate a number between 1 and 100. If the number falls between 1 and 20 the experiment will end. If the number is higher than 20, it will continue. Hence, the probability of stopping in a given period after period 20 is 1 in 5 and the probability of continuing for another period is 4 in 5. Are there any questions about this procedure?

**Specific Instructions to Buyers**

During each trading cycle you are free to purchase up to 8 units. For the first unit that you buy during a trading cycle, you will receive the amount listed under UNIT VALUE for Unit 1. In this example, this amount is 80 tokens. Unit 1’s redemption value is 80 tokens. For the second unit that you buy you will receive the amount listed under UNIT VALUE for Unit 2, which is 70 tokens. The redemption values for these and subsequent units will be displayed on your computer screen.

The earnings from each unit that you purchase (which are yours to keep) are computed by taking the difference between the redemption value and purchase price of the unit bought. That is,

**Your Earnings = Redemption Value - Purchase Price**

Suppose, for example, that you buy 2 units in a trading cycle. If you pay 60 tokens for the first unit and 45 tokens for the second unit, your earnings are:

earnings for Unit 1 = 80 - 60 = 20

earnings for Unit 2 = 70 - 45 = 25

**total earnings = 20 + 25 = 45 tokens**
During the experiment this trading information will be summarized on the computer screen at the end of each trading cycle. Buyers also should be aware that they will not be allowed to spend more tokens buying units than what they have in their beginning balance in any one cycle.

Specific Instructions to Sellers

During each trading cycle you are free to sell up to 8 units. Remember, any units that you sell will automatically be produced once trading in the forward market is complete. The first unit that you sell during a trading cycle will cost you the amount listed under UNIT COST for Unit 1. In this example, this cost is 20 tokens. Unit 1’s unit cost is 20 tokens. The second unit that you sell will cost you the amount listed under UNIT COST for Unit 2, which is 30 tokens and unit 3 is 40 tokens. The unit costs for these and subsequent units will be displayed on your computer screens.

The earnings from each unit that you sell (which are yours to keep) are computed by taking the difference between the sale price and unit cost of the unit sold. That is,

\[
\text{Your Earnings} = \text{Sale Price} - \text{Unit Cost}
\]

Let's suppose that in the forward market you sell Unit 1 for 50 tokens, Unit 2 for 45 tokens and Unit 3 for 45 tokens. Your earnings would then be:

\[
\begin{align*}
\text{earnings for Unit 1} &= 50 - 20 = 30 \\
\text{earnings for Unit 2} &= 45 - 30 = 15 \\
\text{earnings for Unit 3} &= 45 - 40 = 5 \\
\text{total earnings} &= 30 + 15 + 5 = 50 \text{ tokens}
\end{align*}
\]

Sellers may have a subsidized production cost. For example, the first unit in the above example could have a cost of -20. Assuming production costs for Unit 2 and Unit 3 remain the same, your earnings would then be:

\[
\text{earnings for Unit 1} = 50 - (-20) = 70
\]
earnings for Unit 2 = 45 – 30 = 15

earnings for Unit 3 = 45 – 40 = 5

total earnings = 70 + 15 + 5 = 90 tokens

During the experiment this trading information will be summarized on the computer screen at the end of each trading cycle. Sellers also should be aware that they will not be allowed to incur a production cost greater than the amount in their beginning token balance in any one cycle.

Trading Rules for the Forward Market

Only one unit may be bought and sold at a time. A buyer makes bids to the seller to purchase a unit. A "bid" is a proposed price at which a buyer is willing to purchase a unit. Bids must become progressively higher. In other words, if the first bid for a unit is 50 tokens, then the second bid must be higher than 50. Suppose the second bid is 55 tokens, then the third bid must be higher than 55, and so on.

A seller makes offers to the buyer to sell a unit. An "offer" is a proposed price at which a seller is willing to sell a unit. Offers must become progressively lower. In other words, if the first offer to sell a unit is for 60 tokens, then the second offer must be lower than 60. Suppose the second offer is 55 tokens, then the third offer must be less than 55, and so on.

There is one further set of restrictions on bids and offers. The reason for these restrictions is just common sense. A buyer's bid cannot be higher than what is labeled on the computer screen as the SELLER’S CURRENT OFFER. In other words, a buyer cannot attempt to pay a price that is higher than that for which the seller is willing to sell. Similarly, a seller's offer cannot be lower than what is labeled as the BUYER’S CURRENT BID. In other words, a seller cannot attempt to sell at a price below that which the buyer is willing to pay. In fact, the computer will not allow such bids and offers.

A bid is made by typing the bid and pressing the ENTER key. Similarly, an offer is made by typing the offer, and pressing the ENTER key. During a market, a buyer will be making bids at the same time that a seller is making offers.
It should be apparent that the difference between the BUYER’S CURRENT BID and the SELLER’S CURRENT OFFER gradually decreases. A trade is made when the BUYER’S CURRENT BID equals the SELLER’S CURRENT OFFER. Suppose the BUYER’S CURRENT BID is 55 tokens and the SELLER’S CURRENT OFFER is 60 tokens. If a buyer decided that he or she was willing to purchase the unit for 60 tokens, he or she could type the number 60 and then press ENTER. There is, however, a quicker method to do this. As soon as the buyer saw the SELLER’S CURRENT OFFER was 60, he or she could simply click on “Accept.” Whenever a buyer "Accepts", he or she automatically makes a bid which equals the SELLER’S CURRENT OFFER or, in other words, "accepts" the SELLER’S CURRENT OFFER.

As another example for sellers, suppose again that the BUYER’S CURRENT BID is 55 and the SELLER’S CURRENT OFFER is 60. If a seller decided that he or she was willing to sell the unit for 55 tokens, he or she could type the number 55 and then press ENTER. Again, there is a quicker method to do this. As soon as the seller saw the BUYER’S CURRENT BID was 55, he or she could click on "Accept." Whenever a seller "Accepts", he or she automatically makes an offer which equals the BUYER’S CURRENT BID or, in other words, "accepts" the BUYER’S CURRENT BID.

After a seller and buyer have made a trade, the trading price will be listed on both the buyer's and seller's screens. After a trade has been made, bid and offer values are cleared from the screen. A buyer and seller pair may then resume entering bids and offers for additional units. Trades are made between buyer and seller pairs for one minute. After a minute has elapsed, buyers and sellers are again randomly paired and the next trading session begins.

Each forward market or trading cycle has a maximum time limit of 3 minutes or three one-minute trading sessions. A market will be terminated automatically if profitable trades cannot be made by the randomly matched buyer and seller.

**Your Name and Identification**

Before the practice session, the computer will ask for your name and W number which is your 9-digit student number. This information is kept confidential, but it is important to the funding agency as proof of your participation. The bids and earnings of people in the experiment
are confidential. Please do not look at someone else’s screen and do not speak to another participant once the experiment begins. You may ask the experimenter questions at any time during the experiment. Are there any questions before we conduct the practice session?