COMMITTED PROCUREMENT IN PRIVATELY NEGOTIATED MARKETS: EVIDENCE FROM LABORATORY MARKETS

DARLINGTON M. SABASI, CHRISTOPHER T. BASTIAN, DALE J. MENKHAUS, AND OWEN R. PHILLIPS

Previous research suggests an increase in committed procurement can result in lower cash market prices for livestock. There is a paucity of research that ascertains prices received by market agents trading in a prior bargaining session via alternative marketing arrangements versus those who have not. We use laboratory market experiments to analyze the potential impacts of committed procurement on privately negotiated transactions when some traders have two windows of negotiation and others have one. Results illustrate that those who do not engage in prior trading are at a bargaining disadvantage due to matching and inventory loss risks.

Key words: alternative marketing agreements, captive supplies, inventory loss risk.

JEL codes: D1, L4.

It is well documented that there is a trend toward fewer and larger firms in both the beef and pork packing industries (Ward 2010a). Ward (2010b) further states that this trend has been driven by enhanced economic efficiency and cost management associated with operating larger plants. To realize this cost advantage, larger plants must operate at high levels of utilization (Ward 1990; Barkley and Schroeder 1996). This, in turn, has affected procurement practices and pricing behavior in these industries, which likely can be extended to other industries in the food and commodity supply chains.

Concomitant with increased concentration is the increased procurement of cattle and hogs by packers on a non-cash basis, that is, there is a trend away from spot or cash purchases to committed procurement methods (Ward et al. 2000; Koontz and Lawrence 2010). This trend is particularly evident for hogs—negotiated cash purchases in 2002 and 2008 were 15.5% and 10.3%, respectively, indicating that spot market transactions declined to an even smaller proportion of total purchases over that period (Ward 2008). Swine market formula contracts as a single category made up more than 55% of hog purchases during this period. The shift away from spot procurement toward alternative marketing arrangements by beef packers has been more gradual than in the pork industry. Marketing agreements, which are a type of committed procurement method, accounted for 28.8% of the head purchased from October 2002 to March 2005 (Muth et al. 2008), and negotiated cash trades declined from 43.8% in 2001–02 to 34.1% in 2009–10 (Ward 2010b).

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1 References to the general term committed procurement (alternatives to the cash or spot market) in the literature include alternative marketing arrangements (AMAs), captive supplies, pre-committed supplies, and non-cash transactions. These refer to livestock that is owned, procured or otherwise committed to a packer more than 14 days prior to slaughter. Committed procurement practices or AMAs include forward contracts, swine market formula contracts, marketing agreements, procurement or marketing contracts, packer ownership, custom feeding, and custom slaughter. Cash or spot market transactions include auction barn sales, sales through order buyers, dealers, and brokers, and direct sales. In addition to assuring high levels of plant utilization, both pork and beef packers also can use committed procurement methods to improve supply chain coordination to secure more consistent and higher quality hogs/cattle (Ward et al. 2000).
It is thought by some that committed procurement methods, if widely used, could have the effect of reducing competition in markets for livestock and depress not only cash market prices but prices under all procurement methods (U.S. Department of Agriculture 2011). This issue could be complicated by private negotiation as a method of exchange. Muth et al. (2008) indicate that the most common method of determining purchase price for fed cattle is individual negotiation. Concerns have been raised that producers with uncommitted inventory on hand could find their bargaining advantage with processors in negotiations for cash price reduced (Ward et al. 2000).

Accusations of depressed livestock prices have often centered on concerns related to increased concentration and the potential for processors to exert market power through committed supplies (Koontz and Lawrence 2010). We believe other factors may contribute to perceived price differentials for agents trading in markets where committed procurement is prevalent. Specifically, these factors relate to matching risk and a related inventory loss risk, both of which are faced by agents that are able to transact in the committed procurement of non-storable commodities. For example, matching risk is faced by those sellers trying to transact with a processor with few units needed to meet any remaining capacity targets. Poorly-matched livestock producers who are shut out of the trading window can experience increased costs of production caused by a potential delay of sale, or by losing part of the cost of production (inventory loss risk). These producers face the further risk of later being matched with a buyer offering lower prices.

The objective of this study is to analyze the potential market impacts of committed inventory on privately negotiated transactions when some traders have two windows of negotiation and others have just one. The first window or bargaining period represents the opportunity to enter into a marketing agreement or forward contract to precommit one’s production. A second trading window or bargaining period, in which all agents can negotiate for price, represents a spot/cash market opportunity. Naturally occurring data from individual, privately negotiated transactions are difficult to obtain and, when available, are fraught with empirical challenges such as confounding influences among alternative explanatory variables. We therefore analyze data from laboratory market experiments designed to control for these potential issues that may be prevalent in naturally occurring data. Experimental treatments increase the percentage of buyer and seller pairs (from 25%, to 50%, to 75%) that bargain in a prior bargaining period, thus resulting in committed procurement. All market participants then trade in a subsequent bargaining period.

This experimental design is intended to reflect practices in which some market agents may not have the opportunity to make prior agreements to sell or purchase (Menkhaus et al. 2007). Market outcomes from these experimental treatments are then compared to a base treatment in which no buyer-seller pairs are allowed to bargain prior to a trading cycle exactly like the second bargaining period. We also analyze trades, prices, and earnings across the two bargaining periods for the committed procurement treatments, and analyze prices received by those participants trading in the first bargaining period versus those who do not trade in the first bargaining period.

We find that average market outcomes generally are not negatively impacted by committed procurement. We do find, however, that agents unable to trade in a prior bargaining period are at a disadvantage when negotiating trades. Results reported herein suggest this is due to matching and inventory loss risks, and these can occur even in the absence of concentration.

Previous Research

Previous studies focusing on pricing and committed procurement in the livestock industry are summarized by Ward (2010a); selected studies on the effect of increased forward contracting (or captive supplies) on cash prices generally find an inverse relationship, but the magnitude is often small if it does exist (Elam 1992; Schroeder et al. 1993; Ward, Koontz, and Schroeder 1998; Schroeter and Azzam 1999 and 2003; Muth et al. 2008; Vukina, Shin, and Zheng 2009). Ward et al. (1999), however, find spot prices to be higher in a simulated fed cattle market for periods when an exclusive market agreement is in place versus periods when the agreement is not in place. Generally, the majority of the studies in the literature compare alternative marketing arrangement prices to cash prices. Given the nature of data in many of these studies, there is a paucity of research ascertaining prices received by those market agents trading in a prior bargaining session.
via alternative marketing arrangements versus those who are excluded. In their simulated fed cattle market, Ward et al. (1999) indicate that firms not participating in exclusive marketing agreements compete vigorously for remaining supplies, and thus drive up spot prices. Nevertheless, concerns over cash prices remain among producers who do not have the opportunity to pre-commit supplies. Policy makers consider this to be an issue that merits debate, and we focus upon it in this research.

**Approach**

While changes in procurement practices and pricing behavior in the beef and pork packing industries motivate this paper, we study the price effects of committed procurement and privately negotiated transactions in a general sense and without specific reference to these industries. The use of a controlled laboratory market allows us to extend much of the previous research to include the effects of alternative levels of committed procurement compared to a base treatment absent of such practices, and assess how agents not participating in alternative marketing arrangements are affected. Market outcomes with committed procurement can be compared to predicted competitive prices and quantities.

**Trading Behavior with Committed Procurement and Private Negotiation**

We assume a simple bargaining environment where some participants can be matched in a first bargaining period (BP1), with one bargaining round prior to all market participants being able to trade in a second bargaining period (BP2) with three bargaining rounds. Trades are privately negotiated one unit at a time in each bargaining period. The production decision for all producers is made prior to BP1. Those matched in the first bargaining period represent an opportunity to commit procurement or a forward contract for some or all of the supply produced.

Menkhaus et al. (2007) model production in advance of bargaining for price as follows. Each unit produced by a seller has a probability represented by \( f(N) \) that the \( n \)th unit sells at a loss, where \( N \) is the total production. Loss is represented by \( \alpha_n C_n \) and generally is a function of \( N \), where \( \alpha_n \) is the loss as some proportion of the unit’s cost \( C_n \).

When \( \alpha_n = 1 \), the full unit cost of production is lost due to the unit being unsold. For illustrative purposes, Menkhaus et al. (2007) set \( f(N) = (N - 1)/N \) and derive the first-order condition as \( P_n = C_n (1 - (\alpha_n + N(N - 1)\alpha_n')) \). The risk of inventory loss is \( -\alpha_n + N(N - 1)\alpha_n' \), where \( \alpha_n' = \partial \alpha_n / \partial N \), and \( P_n \) is the negotiated price of the \( n \)th unit. This risk causes the risk-averse seller to produce less. That is, the producer will not produce up to the point where \( P_n = C_n \). This illustrates inventory loss risk due to advance production – losing all or part of the cost of production. Thus, sellers face the risk of holding unsold units at the end of BP2, or trading units produced in advance at a loss.\(^2\)

Both buyers and sellers may generally experience matching risk in a bargaining environment. If matched in BP1, the matched buyer and seller can trade or wait until BP2. After BP1 ends, each is subsequently matched with the same or a different trading partner. If matched with a different partner, the result is that agents may be matched at different points on their respective marginal schedules—marginal benefit for buyers and marginal cost for sellers. This determines the potential surplus in a trade and impacts trade prices. In bilateral bargaining, the buyer has an incentive to understate bids given marginal values, and the seller has an incentive to overstate offer prices given unit costs (Spulber 1996). The resulting price depends on where the buyer and seller are on their respective schedules after trading (or not) in BP1.

The greater the difference in number of units traded between the two matched agents, the greater the likelihood of trade failure in private negotiation. In this environment, the price shifts toward the agent who has gained more surplus from previous trades. On their marginal benefit or cost schedule, earnings are relatively small and fewer concessions can be made as more trades occur. The greater the mismatch in units, the more restricted is the agent who is further along their marginal benefit or marginal cost schedule. Matching risks and the related risk of inventory loss when there is advance production provide the foundation for understanding trading behavior with committed procurement and private negotiation.

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\(^2\) While the loss of the entire unit cost of production may not be realistic in the livestock sector, it is a distinct possibility for highly perishable commodities such as fruits and vegetables.
We investigate the implications of these two important risks—inventory loss risk due to advance production and matching risk—in a market setting with two bargaining periods (where BP1 is not open to all traders) and production in advance of privately negotiated trading as described. Drawing from the previous discussion, agents pre-committing supplies in BP1 are expected to trade actively to reduce both matching and inventory loss risks. For those agents matched in BP1, matching risk is reduced in BP2, and those agents have a greater bargaining advantage in BP2. Moreover, inventory loss risk is reduced (increased) for sellers able (unable) to bargain in BP1. As more agents trade in BP1, the total number of units produced and traded should increase. This in turn will result in an increase in total surplus extracted. These expected outcomes, coupled with concerns expressed about captive supplies depressing prices, provide the basis for the following null hypotheses to be tested in this paper:

1) $H_{O1}$: Market outcomes (trades, prices, agent earnings, and total market earnings) are not impacted by committed procurement.

2) $H_{O2}$: Average prices and earnings received by agents matched in BP1 are not different than prices and earnings received by agents not matched in BP1.

Experimental Design and Procedures

The experiment was designed to address fundamental market impacts of committed procurements in private negotiation trading by including two bargaining periods. In BP1 some buyers and sellers were randomly matched, while some were not matched, that is, they were not allowed to trade for a single one-minute round of bargaining. In BP2, all buyers and sellers were randomly matched in each of three, one-minute bargaining rounds as in the base treatment. This design allowed us to analyze the impact of a trading environment with two bargaining periods—the first bargaining period results in committed procurements, and the second bargaining period represents a negotiated cash market in which all market participants are given the opportunity to trade.

There were four treatments in our experimental design, as depicted in table 1. The base or control treatment consisted of all buyers and sellers being randomly matched for three one-minute bargaining rounds. Thus, all buyers and sellers in the base treatment had the opportunity to trade in a market environment like that of BP2 without opportunities for committed procurement. The second treatment allowed 25% of the buyers and sellers to be matched in BP1. In the third treatment 50% of the buyers and sellers were matched in the first bargaining period, and the fourth treatment allowed 75% of the buyers and sellers to be matched in BP1 (table 1). In these committed procurement treatments, all agents were then allowed to trade in BP2, which consisted of three bargaining rounds. Three replications were conducted for each treatment.

There were four sellers and four buyers for each session. At the beginning of each trading cycle, sellers made a production decision while buyers waited. Once the sellers made their production decision, the units they produced were available for sale in BP1, which consisted of one bargaining round, and/or in BP2, consisting of three bargaining rounds. The sellers produced a homogenous good. Each seller could produce, and buyers could purchase, a maximum of eight units. No production was carried over to the next trading period, that is, the units were considered perishable. Once the production decision was made, participants

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3 We recognize that we conceivably have provided buyers with a bargaining advantage because of inventory loss risk. Buyers of inputs, for example, can face risk associated with meeting a plant’s capacity. As mentioned, the practice of utilizing plant capacity provides an incentive for the practice of committed procurement. While this buyer-related practice would have the potential to dampen the buyer’s bargaining advantage in our model and experiments, we believe the seller (producer) is generally impacted more than the buyer in our industry setting. We also avoid the confounding influences of risks faced by both buyers and sellers by considering only the seller’s risk. Nevertheless, buyers in the experiments must trade to make a profit, which can reflect the need to meet a plant capacity constraint.

4 For purposes of control, we do not change supply or demand conditions, and we do not provide information on chosen production levels in a trading period. Thus, expectations related to changing supply or demand conditions are not considered.

5 A treatment with 100% of the buyers and sellers matched in the first bargaining period essentially involves four bargaining rounds, the results of which would closely replicate previous research (Menkhaus et al. 2007). Because both matching and inventory loss risks are reduced, price converges to a level near the predicted equilibrium. We therefore use the predicted competitive price (presented later) as the comparator.

6 Previous laboratory market research has shown four sellers and/or buyers to be adequate for convergence with regularity to the competitive equilibrium under alternative trading institutions (Davis and Holt 1993; Menkhaus, Phillips, and Bastian 2003; Plott 1982; Smith and Williams 2000).
Table 1. Experimental Design—The Base Treatment and Three Treatments with Two Bargaining Periods (BP1 and BP2) Per Trading Cycle

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No. of Buyers BP1</th>
<th>No. of Sellers BP1</th>
<th>No. of Matches BP1</th>
<th>No. of Buyers BP2</th>
<th>No. of Sellers BP2</th>
<th>No. of Matches BP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>25%</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>50%</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>75%</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

negotiated for prices during the bargaining rounds to complete the trading period.

In each of the three or four bargaining rounds (one in BP1 and three in BP2), buyers and sellers were randomly matched anonymously and no information was provided to either buyers or sellers regarding partner identity. In treatments with two bargaining periods, market participants did not know during the production decision whether or not they would have the opportunity to trade in BP1, because the computer randomly chose who could trade during BP1. This generally captures relevant features of alternative marketing arrangements for this research, where not all sellers are able to enter into committed procurement with buyers prior to a marketing window in which all participants may trade, that is, some agents lack access to the forward market or marketing agreements. Both buyers and sellers gained knowledge and experience as the experiment progressed. This experience allowed them to adjust production decisions and negotiations for prices.

Our recruited subjects were mainly students majoring in business and/or economics. After arriving at the study site, participants were given instructions regarding the experiment via a PowerPoint presentation, which provided an overview of the experiment as presented in figure 1, and how profits were determined for both buyers and sellers. The specific design for the committed procurement treatments—that is, whether 25%, 50%, or 75% of the buyers and sellers would be matched in the first bargaining period, as per table 1—was not made available. For those treatments, the instructions indicated there would be two bargaining periods. Participants were told that during period one, some participants would be randomly paired and would trade for one minute, while others would remain idle. Participants were told that during BP2, all buyers and sellers would be randomly matched and allowed to trade in each of three one-minute bargaining rounds. There was no mention of bargaining periods for the control or base treatment.

For both the base and committed procurement treatments, participants were told there was a random stop in place. Participants were also told that after trading cycle 20, the computer would randomly determine if the experiment would continue, and they were told the probability of stopping was 1 in 5, while the probability of continuing was 4 in 5. This was done to mitigate possible end-period effects. A random stopping point essentially created an infinite horizon for subjects in their trading behavior. Participants were explicitly informed that their payoff at the end of the experiment would be determined by their bargaining decisions during the experiment. Also highlighted was that their participation as a buyer or seller would be assigned randomly and once assigned they would remain a buyer/seller throughout the experiment. Participants were informed that each participant’s actions during the experiment would be kept private and only aggregate data would be reported.

After the presentation, questions were invited and addressed. Following the question and answer session, participants were asked to sit at a computer station. At login it was randomly determined whether the participant was a buyer or seller for the experiment. At that point a practice session was conducted, which allowed the participants to become familiar with how to make bids and offers and make decisions during a trading cycle. The practice

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7 Subjects make choices for at least 20 trading cycles. After cycle 20 there is a 20% probability of stopping. These experimental games have an infinite time horizon in which the stopping rule effectively determines the discount rate (Rasmusen 1994). However, these games are not stationary. The class of subgame-perfect equilibria that satisfy the incentive constraints in each cycle of the stationary game also satisfy the incentive constraints in each cycle of nonstationary games such as these. Phillips and Mason (1996) created stationary duopolies and have found behavior that is no different from nonstationary results.
session continued until all participants indicated they were ready to move into the actual experiment.

The production costs and redemption values displayed for the practice session were different from the ones used for the actual experiment. Participants were instructed that the values would change in the experiment that followed the practice session, and they should not form any expectations regarding trade prices. Production costs and redemption values for the actual experiment are presented in table 2. These represent individual supply and demand curves. When summed across participants, a predicted competitive equilibrium of 80 tokens and 20–24 units is determined. This provides a competitive benchmark with which to compare results.

The currency used in the experiments was referred to as tokens, with one hundred tokens being equal to one U.S. dollar. The production cost and redemption value schedules were the same for all sellers and buyers, respectively, but participants did not know this. At the beginning of the experiment each buyer and seller was given 1,000 tokens, or $10. This was to ensure that sellers would not go bankrupt early in the experiment as they incurred costs to produce units. Buyers also were given the same amount for consistency.

Table 2. Production Costs and Redemption Values for Each Unit Traded

<table>
<thead>
<tr>
<th>Unit</th>
<th>Redemption Values for Buyers (tokens)</th>
<th>Production Costs for Sellers (tokens)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>130</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>120</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>110</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>90</td>
<td>70</td>
</tr>
<tr>
<td>6</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>7</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>8</td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>

For each bargaining round within the two bargaining periods, each randomly paired buyer and seller would make bids and offers until they reached an agreeable price. Once price was agreed upon a trade occurred. Buyers’ bids had to become progressively higher, while sellers’ offers had to become lower. The matched pair could trade as many units as possible, one at a time, for each one-minute round after which buyers and sellers were again randomly matched. At the end of each trading cycle, there was a private recap on the computer screen showing each buyer and
We summarize and analyze quantities traded, prices, buyer earnings, seller earnings and total earnings for the total market results (combined BP1 and BP2), as well as for the individual bargaining periods by treatment (table 3). Statistical tests compare the outcome data from the experiments for each committed procurement treatment to the competitive prediction and across treatments (including the base) for quantities, prices, buyer earnings, and seller earnings (for BP1, BP2, and combined BP1 and BP2). Statistical differences between buyer and seller earnings are tested and reported in table 3. We also analyze quantities produced, quantities not sold (assessing inventory loss in table 4), and compare trade price as it relates to units sold at different points on respective schedules (mismatched and matched units) for agent pairs (table 5), as well as those agents who were allowed to trade (matched) in BP1 versus those who did not trade (unmatched) in BP1 (table 6). The one-sample t-test is used in all cases for comparison across the committed procurement treatments, that is, treatments with two bargaining periods.  

### Table 3. Summary of Averages and Standard Deviations (of Averages across Replications) of Laboratory Market Outcomes, Cycles 16 through 20 by Treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Trades</th>
<th>Prices</th>
<th>Average Buyer Earnings</th>
<th>Average Seller Earnings</th>
<th>Total Earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>14.00</td>
<td>74.20</td>
<td>148.72^i</td>
<td>98.77^i</td>
<td>989.93</td>
</tr>
<tr>
<td></td>
<td>(2.57)</td>
<td>(6.16)</td>
<td>(26.47)</td>
<td>(24.56)</td>
<td>(102.79)</td>
</tr>
<tr>
<td>25% BP1 &amp; BP2</td>
<td>14.87^a</td>
<td>80.89^a</td>
<td>110.73^a,i</td>
<td>131.00^a,i</td>
<td>966.93^a</td>
</tr>
<tr>
<td></td>
<td>(1.41)</td>
<td>(7.17)</td>
<td>(24.33)</td>
<td>(23.00)</td>
<td>(82.73)</td>
</tr>
<tr>
<td>50% BP1 &amp; BP2</td>
<td>15.73^a</td>
<td>76.00^a</td>
<td>129.87^b,i</td>
<td>116.20^b,i</td>
<td>984.26^a</td>
</tr>
<tr>
<td></td>
<td>(1.03)</td>
<td>(6.13)</td>
<td>(19.82)</td>
<td>(29.70)</td>
<td>(107.20)</td>
</tr>
<tr>
<td>75% BP1 &amp; BP2</td>
<td>18.93^ab</td>
<td>76.92^a</td>
<td>144.40^b,i</td>
<td>118.93^b,i</td>
<td>1053.33^ab</td>
</tr>
<tr>
<td></td>
<td>(2.05)</td>
<td>(4.53)</td>
<td>(24.81)</td>
<td>(27.55)</td>
<td>(83.38)</td>
</tr>
<tr>
<td>25% BP1</td>
<td>2.00^f (13.45%)</td>
<td>91.90^p,c,i</td>
<td>49.60^d,i</td>
<td>105.60^c,i</td>
<td>155.20</td>
</tr>
<tr>
<td></td>
<td>(1.56)</td>
<td>(12.54)</td>
<td>(29.19)</td>
<td>(76.55)</td>
<td>(96.67)</td>
</tr>
<tr>
<td>25% BP2</td>
<td>12.87^f (86.55%)</td>
<td>80.67^d,ii</td>
<td>98.33^f,i</td>
<td>104.60^d,i</td>
<td>811.73</td>
</tr>
<tr>
<td></td>
<td>(2.13)</td>
<td>(7.58)</td>
<td>(24.40)</td>
<td>(29.50)</td>
<td>(139.46)</td>
</tr>
<tr>
<td>50% BP1</td>
<td>3.47^d (22.05%)</td>
<td>75.90^d,ii</td>
<td>79.87^d,i</td>
<td>68.00^d,i</td>
<td>295.73</td>
</tr>
<tr>
<td></td>
<td>(1.55)</td>
<td>(10.10)</td>
<td>(36.97)</td>
<td>(34.16)</td>
<td>(122.03)</td>
</tr>
<tr>
<td>50% BP2</td>
<td>12.27^f (77.95%)</td>
<td>77.67^f,i</td>
<td>89.93^f,i</td>
<td>82.20^f,i</td>
<td>688.53</td>
</tr>
<tr>
<td></td>
<td>(1.91)</td>
<td>(5.16)</td>
<td>(16.87)</td>
<td>(38.66)</td>
<td>(191.61)</td>
</tr>
<tr>
<td>75% BP1</td>
<td>5.93^c (33.33%)</td>
<td>78.00^d,ii</td>
<td>81.78^d,ii</td>
<td>78.67^d,ii</td>
<td>481.33</td>
</tr>
<tr>
<td></td>
<td>(2.61)</td>
<td>(8.77)</td>
<td>(31.68)</td>
<td>(29.79)</td>
<td>(164.00)</td>
</tr>
<tr>
<td>75% BP2</td>
<td>13.00^f (68.67%)</td>
<td>76.66^f,i</td>
<td>83.07^f,i</td>
<td>59.93^f,ii</td>
<td>572.00</td>
</tr>
<tr>
<td></td>
<td>(2.90)</td>
<td>(3.38)</td>
<td>(25.34)</td>
<td>(24.99)</td>
<td>(166.04)</td>
</tr>
</tbody>
</table>

Notes: Tests of significance were conducted using a one-tail, one-sample t-test with $\alpha = 0.10$ across all combinations of independent replications. Skewness was not severe in any case. Asterisk (*) indicates significantly different from the base, $\alpha = 0.10$ – BP1 & BP2 only.

ab Same letter indicates the combined BP1 & BP2 market outcome is not significantly different between treatments, and different letter indicates the combined BP1 & BP2 market outcome is significantly different between treatments, $\alpha = 0.10$.

cd Same letter indicates the BP1 market outcome is not significantly different between treatments, and different letter indicates the BP1 market outcome is significantly different between treatments, $\alpha = 0.10$.

df Same letter indicates the BP2 market outcome is not significantly different between treatments, and different letter indicates the BP2 market outcome is significantly different between treatments, $\alpha = 0.10$.

ia Same indicator means that BP1 or BP2 buyer earnings and seller earnings are not significantly different by treatment, and different indicators mean that BP1 or BP2 buyer earnings and seller earnings are significantly different by treatment, $\alpha = 0.10$.

Results and Discussion

We summarize and analyze quantities traded, prices, buyer earnings, seller earnings and total earnings for the total market results (combined BP1 and BP2), as well as for the individual bargaining periods by treatment (table 3). Statistical tests compare the outcome data from the experiments for each committed procurement treatment to the competitive prediction and across treatments (including the base) for quantities, prices, buyer earnings, and seller earnings (for BP1, BP2, and combined BP1 and BP2). Statistical differences between buyer and seller earnings are tested and reported in table 3. We also analyze quantities produced, quantities not sold (assessing inventory loss in table 4), and compare trade price as it relates to units sold at different points on respective schedules (mismatched and matched units) for agent pairs (table 5), as well as those agents who were allowed to trade (matched) in BP1 versus those who did not trade (unmatched) in BP1 (table 6). The one-sample t-test is used in all cases for comparison across the committed procurement treatments, that is, treatments with two bargaining periods. To assure independence for the statistical tests, averages for

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8 The average payoff per participant for a typical session lasting between 1 1/2 to 2 hours was about $36, including a $10 show-up fee.

9 The t distribution is not sensitive to moderate departures from normality (Neter, Wasserman, and Kutner 1985), the seriousness of which is measured by the severity of skewness. We follow the procedure provided by Brown (1997) to evaluate skewness severity. This is done by estimating the standard errors of skewness. Brown (1997) indicates that values equal to or greater than the absolute value of two standard errors of skewness constitutes severe skewness. We evaluated the severity of skewness based on this procedure and in each case skewness was not severe.
Table 4. Averages of Units Produced and Percentages of Units Not Sold, across the Last Five Cycles for Each Treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average Units Produced</th>
<th>Average Units Unsold</th>
<th>Average % of Units Produced and Not Sold</th>
<th>% of Unsold Units Produced by Unmatched Sellers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>14.67</td>
<td>0.73</td>
<td>4.98</td>
<td>100</td>
</tr>
<tr>
<td>25%</td>
<td>15.33</td>
<td>0.53</td>
<td>3.42</td>
<td>100</td>
</tr>
<tr>
<td>50%</td>
<td>16.27</td>
<td>0.54</td>
<td>3.32</td>
<td>100</td>
</tr>
<tr>
<td>75%</td>
<td>19.60</td>
<td>0.67</td>
<td>3.43</td>
<td>44</td>
</tr>
</tbody>
</table>

Note: Trading cycle is defined as a period in which a production decision by sellers followed by all subsequent bargaining periods in a treatment are completed.

Table 5. Analysis of Percentages and Trade Prices of “Matched” or “Mismatched” Units Traded in BP2 (Trading Cycle 20)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mismatched Units</th>
<th>Matched Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average % of Units across Replications</td>
<td>Average Price of Units across Replications</td>
</tr>
<tr>
<td>25%</td>
<td>57.22</td>
<td>$81.80</td>
</tr>
<tr>
<td>50%</td>
<td>69.05</td>
<td>$74.76</td>
</tr>
<tr>
<td>75%</td>
<td>71.21</td>
<td>$74.15</td>
</tr>
</tbody>
</table>

Notes: “Matched” units are defined as units where each party was on the same unit on their respective cost or redemption schedule for which trade occurred, and “mismatched” units are defined as units for which each party was on a different unit on their respective schedules when trade occurred. All individual transactions in the trading cycle 20 were analyzed and averages for each replication were used for the analysis.

a,b Same letter indicates that prices are not significantly different, and different letter indicates a significant difference for comparisons of columns for mismatched prices or matched prices. Tests of significance conducted using a one-tail, one-sample t-test, $\alpha = 0.10$. Skewness was not severe in any case.

i,ii Same indicator mismatched versus matched prices across each treatment percentage are not significantly different, and different indicators mismatched versus matched prices significantly different by treatment, $\alpha = 0.10$.

Table 6. Comparison of Average Prices and Earnings Across the Last Five Cycles in BP2 for Agents Matched in BP1 Against Agents Unmatched in BP1 by Treatment, $H_0 : M - UM = 0$

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Seller Matched - Unmatched Prices</th>
<th>Buyer Matched - Unmatched Earnings</th>
<th>Seller Matched - Buyer Unmatched Earnings</th>
<th>Buyer Matched - Seller Unmatched Earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>25% Prices</td>
<td>86.19 – 80.35 (0.1936)</td>
<td>76.43 – 83.48 (0.0838)*</td>
<td>86.19 – 83.48 (0.5245)</td>
<td>76.43 – 80.35 (0.3090)</td>
</tr>
<tr>
<td>50% Prices</td>
<td>77.29 – 78.72 (0.5018)</td>
<td>75.62 – 80.78 (0.0361)*</td>
<td>77.29 – 80.78 (0.0862)* –</td>
<td>75.62 – 78.72 (0.2095)</td>
</tr>
<tr>
<td>75% Prices</td>
<td>79.25 – 73.44 (0.7906)</td>
<td>76.17 – 81.15 (0.0146)*</td>
<td>79.25 – 81.15 (0.3847)</td>
<td>76.17 – 73.44 (0.1887)</td>
</tr>
<tr>
<td>25% Earnings</td>
<td>187 – 116 (0.0001)*+</td>
<td>118 – 111 (0.5817)</td>
<td>187 – 118 (0.8817)</td>
<td>118 – 116</td>
</tr>
<tr>
<td>50% Earnings</td>
<td>127 – 107 (0.0105)*+</td>
<td>144 – 117 (0.0109)*+</td>
<td>127 – 117 (0.0182)*+</td>
<td>144 – 107</td>
</tr>
<tr>
<td>75% Earnings</td>
<td>130 – 90 (0.00421)*+</td>
<td>153 – 121 (0.0149)*+</td>
<td>130 – 121 (0.4883) (0.0001)*+</td>
<td>153 – 90</td>
</tr>
</tbody>
</table>

Notes: Average prices (earnings rounded to nearest whole number) for matched agents are reported first, then unmatched and probabilities for the t-tests are reported in parentheses. Asterisk (+) indicates significance at $\alpha = 0.10$. Skewness was not severe in any case.

+/- Indicates whether difference was positive (+) or negative (-).

the last five trading cycles (to allow for convergence in latter periods) for each replication are used (Phillips, Menkhaus, and Krogmeier 2001).
compared to the base, and statistically higher in the 50% and 75% treatments. This is expected given the additional bargaining round available in the committed procurement treatments. The 75% treatment has significantly higher quantities traded than the other two committed procurement treatments. This is a function of more agents being able to trade in BP1. Comparisons across the bargaining periods provide some important initial observations. The majority of trades occur in BP2, but the percentage decreases as more agents engage in committed procurement in BP1. The trades in BP1 rise across the treatments, ranging from 25–75%, and are statistically significant increases. Nearly 87% of the total trades occur in BP2 in the 25% treatment, and this percentage drops to almost 69% in the 75% treatment. Even though the number of total trades increase, quantities traded are not statistically different across the treatments in BP2. This suggests those agents not able to trade in BP1 may be more likely to face agents who have already traded, thus exacerbating the potential for matching risk. The total number of units traded in each treatment is below the competitive level.

The proportion of trades across the last five trading cycles in BP1 (one of four bargaining rounds) is 13.45% for the 25% treatment. Comparing this to the expected proportion, assuming an equal proportion of trades across bargaining rounds and buyer-seller pairs, and with one-quarter of the buyer-seller pairs matched in the 25% treatment (\(\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}\), or 6.25%), a disproportionate number of trades occurs during the first bargaining period. Similarly, for the 50% and 75% treatments, in which an average of 22.05% and 31.33% of units are traded in BP1, the expected percentages, respectively, are (\(\frac{1}{4} \times \frac{1}{2} = \frac{1}{8}\), or 12.50%) and (\(\frac{1}{4} \times \frac{3}{4} = \frac{3}{16}\), or 18.75%). Each outcome reflects active trading in BP1 to reduce matching risk and/or inventory loss risk.

Table 4 illustrates inventory loss and matching risks. The number of units produced increases across the treatments as expected, given the additional bargaining period and increased opportunity to trade as more bargaining pairs participate. A slight increase in total unsold units is seen when comparing the 25% treatments to the 75% treatment. Proportionally, the percentage of unsold units is similar across the committed procurement treatments but slightly higher for the base treatment. It is important to note that the number of units produced is below the predicted level (20–24 units) for each treatment, suggesting that sellers cut back on production to reduce inventory loss risk but increase production as the opportunity for bargaining increases. Agents not matched in BP1 in the 25% and 50% treatments were responsible for all units not sold (table 4). That is, those matched in BP1 sold all units in these two treatments during the last five periods. In the 75% treatment, those not matched in BP1 contributed to 44% of the unsold units (rather than all units as in the other two treatments). Overall, these data point to the potential for inventory loss and matching risks.

In the scenario of increased matches in the first bargaining period, there is a higher risk that sellers get matched in BP2 with buyers who would have procured units in BP1. This was expected to result in an increase in surplus units for sellers not matched in BP1 and a loss of production costs for those units. The higher frequency of being matched in BP1 in the 75% treatment, as discussed, provided an incentive to produce additional units, which contributed to slightly more unsold units in BP2, even by those matched in BP1. This result suggests that the number of unsold units in the committed procurement treatments might be expected to decrease if the buyer-seller pairings had not been random in BP1. In the absence of random pairings in BP1, sellers would be assured of being matched, which would likely result in an increase in the probability of trading additional production units.

Matching risk is further illustrated in table 5. Table 5 reports an analysis of all individual trades in BP2 across all bargaining pairs for trading cycle 20 for each committed procurement treatment (n = 116). Specifically, we analyze whether or not a unit trade occurred at the same point of the redemption and cost schedule for each bargaining pair in BP2. For example, if for a pair of traders each were bargaining for unit three on their respective schedules, that was a matched unit, and if either the seller or buyer were on a different unit of their respective schedules, that was deemed a mismatched unit. Table 5 indicates that the percentage of mismatched units traded increases as the opportunity for committed procurement increases. The percentage of mismatched units increases from 57.22% of all trades in BP2 for the 25% treatment to 71.21% in the 75% treatment. This suggests that the nature of the available surplus to bargain over can change dramatically for one party or the other as the percentage of mismatched units increases with
committed procurement. This is discussed further in our analysis of trade prices. Overall, the results provide evidence that we reject the null hypothesis that trades are not impacted by committed procurement (H10).

Trade Prices

Average prices across the committed procurement treatments (combined BP1 and BP2) are slightly higher compared to the base but are not statistically different from each other or from the base, nor are they significantly different from the predicted equilibrium of $80 (table 3). Comparing the prices between BP1 and BP2 reveals that prices, on average, are not statistically different except in the 25% treatment. In the 25% treatment, BP1 prices average $91.90 (significantly higher than the competitive equilibrium) compared to $80.67 in BP2 (table 3). As more agents participate in committed procurement, this premium between bargaining periods dissipates. The 50% treatment indicates a BP1 average price of $75.90 compared to $77.67 in BP2, and the 75% treatment BP1 average price is $78.00 compared to $76.60 in BP2. This analysis of average trade prices suggests that as committed procurement increases, average market prices are not significantly impacted. Prices generally are not statistically different between treatments, between bargaining periods, or from the competitive and base levels. This suggests we do not find strong evidence regarding the rejection of the null hypothesis that average market prices are not impacted by committed procurement (H10).

Further price analysis relates to matched or mismatched units, that is, prices across bargaining periods that may be at different units in their respective cost and redemption schedules (table 5). As discussed, and as expected, the percentage of mismatched units increases as the amount of committed procurement increases. This is a matching risk and results in lower prices for the mismatched units. Prices are significantly lower for mismatched units in the 50% and 75% treatments compared to the 25% treatment. Prices are higher for matched units compared to mismatched units across each treatment, while prices for mismatched units are significantly lower than matched-unit prices for the 50% and 75% treatments. Even though both buyers and sellers face this matching risk, sellers yield to buyers in their negotiations for prices, perhaps due to sellers facing inventory loss risk.

An important issue related to committed procurement is whether BP2 prices received (paid) by sellers (buyers) who were not matched in BP1 differ from BP2 prices received (paid) by those who were matched in BP1. Generally, the seller(s) not matched in BP1 tends to negotiate for a lower price in BP2, although they are not significantly different in any of the treatments (table 6). In BP2, sellers not matched in BP1 are faced with the prospect of losing all or part of the cost of production if they do not trade. This inventory loss risk due to advance production, coupled with the risk of being matched with a buyer who has purchased units in BP1, contributes to sellers negotiating for and accepting lower prices in BP2 (table 6). This phenomenon seems to be consistent with the results presented in table 5, which indicates that matching risk associated with units generally puts sellers at a disadvantage. Buyers who are matched tend, on average, to negotiate for lower purchase prices in BP2. The difference is statistically different for all three treatments. This reflects the fact that if buyers do not trade, they do not make any profit. Thus, buyers are willing to pay a higher price to trade. Given the risk of being matched with a seller in BP2 who has sold most or all of his/her inventory, a buyer will be more aggressive in negotiating prices to make trades when matched with a seller with inventory and the willingness to trade. This tendency also seems to be consistent with the findings discussed by Ward et al. (1999) in their simulated fed cattle market for periods when marketing agreements were in place in their experiential setting. Overall, these results provide evidence that we generally reject the null hypothesis (H20) that average prices are the same for those agents able to trade in BP1 and those who do not trade in BP1.

Agent and Market Earnings

Average buyer earnings are significantly lower in the 25% and 50% treatments (BP1 and BP2 combined) compared to the base treatment (table 3). This is due to the combination of only slightly more trades, but at higher prices compared to the base treatment. Average buyer earnings in the 75% treatment are not significantly different from those of the base, generally reflecting the significantly

Trade Prices in Bargaining Period Two for Sellers (Buyers), Matched and Not Matched in Bargaining Period One

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higher number of trades at similar prices. Alternatively, average earnings for sellers are higher for the committed procurement treatments, and significantly higher in the 25% treatment compared to the base due to generally higher prices (table 3). Average seller earnings are statistically higher than average buyer earnings in the 25% treatment, but significantly lower in the base and 75% treatments, reflecting the price and trade results discussed above. There are also significant differences between buyer and seller earnings for 25% BP1 and 75% BP2, with buyer earnings being lower than seller earnings in the former and higher in the latter. Differences in agent earnings do seem to be present, suggesting that we reject the null hypothesis (H1O) that agent earnings are unchanged with committed procurement, but it is not clear which side of the market gains the advantage, on average.

We only find weak evidence as to whether total market earnings are impacted by committed procurement. Total market earnings, except for the 75% treatment, are similar across the committed procurement treatments compared to the base (table 3). Total earnings in the 75% treatment are statistically higher compared to the base. Overall market efficiency is not negatively impacted, and in fact, one treatment is positively impacted by committed procurement.

Comparison of Earnings for Matched Versus Unmatched Agents

As discussed above, the analysis of matched versus unmatched buyers or sellers suggests some tendency for unmatched buyers to pay higher prices, and unmatched sellers to receive lower prices, relative to prices paid and received by matched buyers and sellers, respectively (table 6). A comparison of earnings across matched and unmatched agents offers additional insights into the committed procurement question. Earnings for matched sellers are statistically higher compared to earnings for unmatched sellers in both the 25% and 75% treatments, which reflects higher prices. Moreover, this is likely exacerbated by the matching risk suggested by results reported in table 5. Unmatched agents are more likely to face mismatched units than matched agents in BP2. Overall, however, this seems to provide more of a disadvantage to sellers than buyers. Matched buyers generally pay lower prices, which results in statistically higher earnings in the 50% and 75% cases compared to unmatched buyers. When comparing earnings for matched sellers and unmatched buyers and vice versa for buyers and sellers, differences are statistically higher for matched sellers in the 25% treatment, and for matched buyers in the 50% and 75% treatments.

These results indicate that outcomes are driven largely by the dynamic created by matching and inventory loss risks in the committed procurement environment. Buyers (sellers) matched in BP1 have already traded some units before entering into BP2, and thus would not be as demanding (supplying) in BP2. Matched buyers (sellers) have already earned some revenue in BP1, and this contributes to lower bids (higher offers) in BP2. This is coupled with an increased probability of a buyer (seller) being matched with a seller (buyer) who is on a different unit on their respective schedule in BP2 of our committed procurement market environment. Sellers not previously matched in BP1 face a higher inventory loss risk and are in a weaker bargaining position when negotiating price. Buyers not previously matched in BP1 are also in a weaker bargaining position than buyers who were previously matched. We find, at least in some of our treatments, that this disadvantage creates statistically different outcomes in terms of prices and earnings for matched versus unmatched agents and supports a rejection of the null hypothesis regarding outcomes for matched versus unmatched agents (H2O).

Summary and Implications

The objective of this research was to investigate the market outcomes from privately negotiated trading associated with increased participation of market agents in a prior bargaining period in which some of the production by sellers in the market is committed, compared to outcomes in a second bargaining period in which all market actors participate. Laboratory market experiments were designed to identify potential impacts of committed procurement on negotiated transactions. In committed procurement treatments some market agents negotiated for prices in a bargaining period prior to everyone trading in a second bargaining period. This design allowed us to identify the impacts associated with those market actors not participating in committed procurement. We also compared laboratory market outcomes to the predicted competitive equilibria, as well as to results from a base
treatment in which there were no opportunities for committed procurement.

Generally, the opportunity for at least some participants to trade in a prior bargaining period (committed procurement) had a tendency to increase the number of trades and price levels compared to if all agents only met in BP2, although quite often these levels were not statistically significant. Overall, the results suggest that total surplus or market efficiency is not negatively impacted and can be improved as a result of an additional bargaining opportunity for participants. Results are somewhat consistent with previous studies that indicate a relatively small to nonexistent impact on prices (Key 2011; Muth et al. 2008; Vukina, Shin, and Zheng 2009) or directly consistent with Ward et al. (1999), who found a potentially positive impact from marketing agreements. Results reported here tend to support arguments that alternative marketing arrangements may increase efficiency in the markets for beef and pork.

Results reveal that inventory loss risk (unsold units) for sellers may increase in BP2 for agents not participating in BP1. Increased production, coupled with not being matched in BP1, resulted in slightly higher inventory loss for sellers in the 75% treatment, and was highest for the base treatment when no one was matched in the first bargaining period. Further, the results show that a seller who did not get matched and thus did not trade in BP1 generally negotiates for a lower price in BP2. Oppositely, buyers not participating in the first bargaining period tend to negotiate for higher prices.

Based on the results obtained in this study, those producers who lack access to or are not able to participate in earlier trading (committed procurement) may receive lower prices in negotiated cash market sales. However, this may not always be to the same degree that would be found to be statistically significant in terms of price, but our results indicate this can be economically significant when examining earnings. Experiment results indicate that firms purchasing units prior to trading in the negotiated cash market have a bargaining advantage relative to those firms that do not.

The decrease (increase) in negotiated cash price for producers (buyers) not participating in committed procurement, since more buyers and sellers are matched in BP1, provides evidence of how the market may be impacted when there are more buyers and sellers engaged in alternative marketing arrangements. Prices in the second bargaining period, however, approach the competitive benchmark, regardless of the level of committed procurement. An additional bargaining round contributes to reducing matching and inventory loss risks and generally moves prices toward the predicted competitive level in BP2. Thus, the bargaining dynamic created by increased matching and inventory loss risks puts some agents at a disadvantage relative to other agents but may not seriously impact overall market outcomes. Our results offer some insights that suggest the controversy over committed procurement may well continue, since those who lack access to marketing agreements are at a bargaining disadvantage and may continue to voice concerns or call for regulatory intervention. An interesting implication to note is that this controversy will likely persist even in the absence of concentration and related potential exertion of market power.

Our experimental design controls for a number of other important factors that could impact the committed procurement debate and policy relevant outcomes from such practices. For example, all units sold in our laboratory market are homogeneous and therefore lack any quality differences that may impact market outcomes related to price and profitability for firms engaged in committed procurement practices. Koontz and Lawrence (2010) indicate that cattle obtained from alternative marketing arrangements are often of higher quality, which can impact profit margins for agents engaged in committed procurement. Additionally, all agents trading in our experimental market face the same redemption and unit cost schedules. This is not the case for all agents trading in real world markets; Koontz and Lawrence (2010) point to the variability in profits for packing firms engaged in committed procurement practices. Part of what may drive this variability is differences in firm cost structures and size economies. Our results do not contribute to this part of the debate regarding committed procurement. However, differences in cost and redemption schedules in the real world suggest a matching risk dynamic, as illustrated in our results.

We believe the results of this study contribute to an increased understanding of the controversy over committed procurement practices, and also extend the matching risk concept posited by Menkhaus et al. (2007) in a market setting. Many past econometric analyses have found small to nonexistent market impacts associated with committed procurement practices, and also extend the matching risk concept posited by Menkhaus et al. (2007) in a market setting.
procurement. Results reported here are consistent with this assessment and suggest that overall market efficiency is likely not harmed or may be improved on by committed procurement practices up to a level in which 75% of the agents engage in prior bargaining. However, the major contribution of this study relative to previous research is the illustration that those who are unmatched, or do not engage in prior trade, are at a bargaining disadvantage even in the absence of concentration and potential exertion of market power due to matching and inventory loss risks.

The results of this and other studies suggest that if economic efficiency is the benchmark for legal or policy remedies, interference with committed procurement will be difficult for unmatched agents to successfully argue for, even when they may very well receive prices that are different from those of matched agents. Anderson and Hudson (2008) point out that the U.S. Department of Justice uses efficiency as a primary criterion when considering antitrust issues. Koontz and Lawrence (2010) conclude that there will be a loss of efficiency if committed procurement is curtailed in the beef industry. Our results suggest that equity issues arise because the reallocation of surplus to matched agents from unmatched agents is a likely economic outcome from committed procurement, rather than efficiency loss from market power. Thus, perhaps legal or policy questions should center on whether strategic behavior or unfair practices exist related to which agents are allowed to engage in committed procurement practices.

References


