

# Forward Contracting Specification through Collective Bargaining

Selected Paper

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***Short Summary (as on COS)***

Game-based bargaining theory is presented to evaluate the potential of and stability of cooperative coalition among producers for enhancing producer returns and managing market price and income risk. Results clarify that collective bargaining can increase and stabilize producer profits when they face a single processor.

### *Long summary (as on COS)*

Problem Statement Agricultural producers have long been concerned with low and unstable farm prices and income. These conditions have been interpreted as threatening to the feasibility of sustainable agricultural systems. Two approaches are pursued. One approach is central control or management through various forms of government intervention, such as government payments to farmers and price supports for farm products. Over the past decade, this approach has been found to be financially unsustainable for the private sector (Levins, 2001). The other approach is that the government grants farmers the right to form cooperatives to collectively bargain with the handlers and processors of their products. The general objective of cooperatives is to offer their members a number of services such as production and marketing advice to enable them to do collectively what they cannot do individually.

Many practical issues with respect to cooperative bargaining and decision making, their objectives and benefits, the actual process of negotiation, and the major problems they face, have been addressed in previous studies, see Bunje (1980), Iskow and Sexton (1992), Jermolowicz (1999), Gray and Kraenzle (2002), Hueth and Marcould (2002ab), and numerous USDA reports. However, agricultural economists have paid surprisingly little attention to the economic and market implications of such bargaining (Young and Hobbs, 2002).

The purpose of this paper is to fill this gap. Two objectives are pursued: 1) Clarification of the role cooperatives might play in providing collective bargaining for farmers to manage price risk and income level and risk. 2). Evaluation of the implications of associated changes in level and stability of producer returns that result from collective bargaining. Specifically, a) evaluate how the extent of collective bargaining may affect price, quantity and profit, and b) compare price level, quantity, and profit under collective bargaining versus the cases where farmers remain independent and face a single buyer (monopsony).

Approach We consider a market for a homogeneous agricultural good such as milk or fruit. We suppose there are two kinds of traders: a processor and some homogenous individual farmers. We also suppose a single processor exists (e.g. a spatial monopsonist) that uses the raw product as an input to produce the final products and then sells to consumers in a competitive market. We suppose that individual farmers can coalesce to form a cooperative that markets their production to maximize the aggregate profit. Each member is paid the average price received for all product of like quality delivered during the duration of the transaction. We set up a bargaining model between buyers and sellers for their contracts in which they bargain over price and/or quantity. Comparing two varieties of bargaining models with two extreme

cases, competitive equilibrium and the monopsony market, we derive implications for the value and importance of collective bargaining.

A series of cases is examined through alternative theoretical specifications. The first case is that two players bargain over both price and quantity. The results of the Rubinstein's alternating bargaining model (1982) are applied. In equilibrium, the cooperative and the processor set quantity to the level, which maximizes the total surplus, and use the price as an instrument to divide the generated surplus. The second case is that two players bargain over the price, given that quantity is predetermined. A three-stage game is set up. In the first stage, the cooperative rationally chooses its supply that is also the trade quantity. The processor and the cooperative bargain over the price in the second stage, given that quantity is predetermined in the first stage. In the third stage, the processor sells the final product to a competitive market. For comparison, monopsony and competitive markets are analyzed. In addition, two issues are considered to vary these two cases. First, an outside option is introduced such that a farmer may decide whether or not to participate in the cooperative given outside options exist. On the buyer side, outside options are also introduced allowing procurement from alternative sources, e.g. nonmember production. A second issue considered is open membership. While a tradition of cooperatives, this organization has important implications for efficiency of management. Under closed membership, procurement volume, quality, and timing can be efficiently controlled.

**Results and Implications** Our results show that bargaining increases prices paid to farmers when compared with monopsony and competitive markets, as expected. However, we also find the total surplus associated with bargaining is positive. We conclude that collective bargaining can increase producer profits when they face individual processors that might exercise monopsony power in the absence of collective bargaining. In the absence of collective bargaining, we find it likely that individual producers will receive the lowest price and zero profit. Further, we illustrate how bargaining transfers surplus from the processor to the farmer cooperative. We find collective bargaining through cooperatives enables farmers to capture margins that otherwise would go to processors.

**Abstract**

The focus of this paper is on pricing mechanisms that involve collective bargaining. Collective bargaining by farmers constitutes an institutional response to an imbalance in farmer-processor bargaining power. The economic analysis in this paper will help farmers to understand what they can realistically accomplish when they organize bargaining cooperatives. We clarify the economic conditions, such as equilibrium price, equilibrium quantity, and welfare effect, which may favor the success of collective bargaining.

The results in this paper show that bargaining does not simply increase prices paid to farmers when compared with the situations in monopsony and in the competitive market; the total surplus associated with bargaining is also positive. We conclude that collective bargaining can increase producer profits in marketplaces where they face individual processors that might exercise monopsony power in the absence of collective bargaining. In the absence of collective bargaining, we find it likely that individual producers receive the lowest price and zero profit.

## **1 Introduction**

Collective bargaining by farmers constitutes an institutional response to an imbalance in farmer-processor bargaining power that attempts to shift the equity of prices and terms-of-trade toward the collective's interests, Sexton (1990). The economic and market implications of such bargaining have received little attention, Young and Hobbs (2002). The purpose of this paper is to try to fill this gap by considering the benefits of bargaining cooperatives and their conditionality on economic conditions, such as equilibrium price, equilibrium quantity, and welfare effect, which may favor the success of collective bargaining. Two objectives are pursued: 1) Clarify the role cooperatives might play in providing collective bargaining for farmers and 2) Evaluate the producer economic outcomes that result from collective bargaining including price, quantity and profit relative to cases where farmers remain independent and face a single buyer (monopsony).

## **2 Approach**

We develop two simple bargaining games for analyzing the implications of collective bargaining. Typically, formal negotiations involve rounds where the processor and the cooperative alternate offers or where the cooperative presents offers that are either accepted or rejected by the processor until an agreement is reached (Bunje, 1980). These characteristics motivate our choice of the Rubinstein

bargaining model of alternating offers (see Rubinstein (1982)), instead of the Nash bargaining model, which has been adopted to describe other settings by von Ungern-Sternberg (1996) and Venturini (1998). At the optimum, the solution of the (noncooperative) Rubinstein model converges to the solution of the (cooperative) Nash bargaining model<sup>1</sup>. In addition, a model with a market setting characterized by the presence of cooperative bargaining is examined, as well as its consequences on bargaining outcomes and on equilibrium prices, quantities, and profits.

## **2.1 Salient features of collective bargaining in current agricultural markets**

In general, cooperatives negotiate with processors after a good estimate of product quantity and quality can be obtained, typically just prior to harvest. This implies bargaining is pursued with total supply being fixed and resulting prices are a function of a predetermined volume. In most cases, processors purchase all member production. An alternative condition is one where quantity decisions are based on processor need, and are determined prior to price negotiations. The information known during negotiations includes projections of production, consumption, costs of production and harvesting, and related prices if they are public. Four salient features of current ag markets where bargaining occurs are important to note, see Hueth and Marcoul (2000b): 1) contract production is the dominant form of coordination, 2)

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<sup>1</sup> For details, see Muthoo (1999), chapter 3.

local processing monoposony naturally exists, 3) production exhibits a high degree of geographic concentration, and 4) “outside options” for producers are limited.

## **2.2 Models of bargaining**

An extensive literature has considered bargaining methods and decision making for cooperatives, see e.g. Bunje (1980), Iskow and Sexton (1992), Jermolowicz (1999), Gray and Kraenzle (2002), or Hueth and Marcould (2002ab). Producer bargaining as a way to countervail the processors’ bargaining power has been investigated formally within the theoretical frameworks of game bargaining. von Ungern-Stenberg (1996) showed that concentration in retailing is a source of bargaining power for retailers based on a Cournot model. Dobson and Waterson (1997) considered a Bertrand Nash setting of imperfectly competitive retailers and extended the von Ungern-Stenberg (1996) results to show that competition among retailers enhances social benefits of bargaining. McDonald and Solow (1981) consider bargaining between a labor union and a firm over wages and employment. They show efficient bargaining will push the firm to hire more workers than it would prefer at the negotiated wage. Venturini (1998) examine Nash bargaining between a manufacturer and  $N$  retailers and finds that vertical competition increases retailers’ bargaining power and reduces equilibrium transfer prices. Early work about the economic effects of agricultural price bargaining by Helmberger and Hoo (1965)



treats buyers of agricultural products as a colluding monopsony. Sexton (1994) used noncooperative game theory to discuss how a bargaining mechanism works between processors and producers, but assumes that the trade quantity is independent of the bargaining outcome. Kinnucan (1995) applied an equilibrium displacement model to examine the price and quantity impacts of price bargaining, where a farm cooperative cannot control its members' supply. His results show that the cooperative's bargaining power is enhanced and a significant transfer from processors to producers results when demand is inelastic.

### **3 The model**

Consider a market for a homogeneous agricultural good such as milk or fruit. Suppose there are two kinds of traders: a processor and some homogenous individual farmers. A processor who is a spatial monopsonist uses the raw product as an input to produce the final products and then sells to consumers in a competitive market. Suppose that individual farmers can aggregate to become a cooperative. The cooperative markets their production to maximize the aggregate profit. Each member is paid the average price received for all product of like quality delivered during the duration of the transaction. The reason we consider the processor as a spatial monopsonist is as follows: Packer/processor concentration in the beef industry has received considerable attention from cattle producers. One of the recent GIPSA

packer concentration studies (Hayenga, et al. 1996) revealed that 95 percent of cattle are purchased within a 270-miles radius of the plant. In addition, their results indicate that in the Upper Midwest region packers were estimated to be paying an average of \$0.09/cwt less for cattle purchased within 100 miles and \$0.29/cwt less for cattle purchased between 100 to 300 miles of the plant. The possibility of monopsony power leading to a lower price of cattle was found.

The contract is set up after the cooperative and the processor bargain over the contract price and/or quantity of delivery. This bargaining is accomplished by an alternating-offers procedure<sup>2</sup>. Successful bargaining identifies mutual benefits and resolves conflicting interests in a way that results in both joint and individual gains from cooperation. (Muthoo, 1999, Ch.1). In the model, we assume that there is no opportunity for either player to find opportunities to bargain with other agents, i.e., no outside options<sup>3</sup> are allowed.

During a bargaining session, an offer is represented by a pair  $(p, q)$  where  $p \geq 0$  is the offered price and  $q \geq 0$  is the contract quantity. If the cooperative and the processor reach agreement on a pair  $(p, q)$ , then player  $i$ 's ( $i=C$  (cooperative) and  $P$ 's (processor)) payoff is specified as the form of  $p^i(p, q)\exp(-r_i t)$ , where  $\exp(-r_i t)$  is

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<sup>2</sup> The alternating-offers procedure is a process of making offers and counteroffers, which continues until a player accepts an offer.

<sup>3</sup> According to the alternating-offers procedure, an outside option exists when a player rejects an offer and opts out, in which case negotiations terminate in disagreement.

player  $i$ 's discount factor,  $r_i > 0$  is time preference, and  $t$  is the time length of the bargaining period. On the other hand, if the players perpetually disagree, then each player's payoff is zero. The game equilibrium determines a resulting price and quantity pair that is assumed to have been transacted instantaneously.

### **The processor's choice problem**

If the processor buys a quantity  $q$  at a price  $p$ , then the processor's profit is:

$$(1) \quad \pi^P(p, q) = R(q) - pq = p_b F(q) - pq,$$

where  $p_b$  is the wholesale price of the processed product and  $F(q)$  is the production function of the wholesale product and its byproducts.  $R(q) = p_b F(q)$  is the revenue obtained by the processor by transforming the quantity  $q$  of the input into some output and then selling the output on some competitive final market at the price  $p_b$ . Define  $F(q) = aq^2 + bq$ . Assume that  $F'(q) > 0$  and  $F''(q) < 0$ , and more specifically,  $b > 0 > 2aq$  and  $a < 0$ . The processor's demand function is derived from the corresponding first-order condition as:

$$(2) \quad q^P = \frac{p - bp_b}{2ap_b}$$

### **The cooperative's choice problem**

The cooperative serves as a seller, and its profit can be represented as follows:

$$(3) \quad \pi^C(p, q) = pq - C(q),$$

where  $C(q)$  is the cost to the cooperative of producing the quantity  $q$  of the input.

Define  $C(q) = dq^2$  and assume that  $C'(q) > 0$  and  $C''(q) > 0$ , so  $d > 0$ . The

corresponding first-order condition gives the cooperative's supply function:

$$(4) \quad q^C = \frac{p}{2d}$$

Next, we consider alternative bilateral equilibria. The first case is that two players bargain over both price and quantity. The second case is that two players bargain over the price, given that quantity is predetermined.

### 3.1 Case 1: Rubinstein Model

The processor and the cooperative are assumed to bargain over the price and quantity of trade according to an alternating-offers protocol. Bargaining, as defined by Muthoo, occurs when two players have a common interest to cooperate, but have conflicting interests over exactly how to cooperate. In the model presented here, the common interest is the gain from trade (transactions resulting from agreement). This gain is the sum of both the processor's and the cooperative's surplus. An offer is a pair  $(p, q)$ , where  $p \geq 0$  and  $q \geq 0$ . For convenience, denote  $q_i \equiv \exp(-r_i t)$ . Notice that  $0 < q_i < 1$ . The cost implied by introduction of the discount rate ( $r_i$ ) results due to the time required for bargaining and, given that this cost will reflect time value, it can be interpreted as a measure of patience. If players differ in patience, it follows that the more patient (small discount rate) agent will hold greater

bargaining power. As will be clear, a player's bargaining power can be interpreted as conditioned on patience, or the discount rate.

Using Rubinstein's results (1982), the equilibrium share  $(w^i, i = P, C)$  of gains from trade  $(S)$  for the processor and the co-op is,  $w^P = (\frac{1-q_C}{1-q_P q_C})S$  and  $w^C = (\frac{1-q_P}{1-q_P q_C})S$ , respectively. These are exactly the proportions of total gains from trade weighted by the opponent's preference. Also, within in the limit, as the time interval between two consecutive offers tends to zero  $(t \rightarrow 0)$ , the equilibrium partition converges to shares  $w^P = (\frac{r_C}{r_P + r_C})S$  and  $w^C = (\frac{r_P}{r_P + r_C})S$ . This depends on the players' relative magnitude of bargaining power (as captured by the ratio  $\frac{r_P}{r_C}$ ).

We interpret equilibrium share as an indicator. It is clear that as  $\frac{r_P}{r_C}$  increases, the processor's (cooperative's) relative patience decreases (increases),  $\frac{r_C}{r_P + r_C}$  decreases and  $\frac{r_P}{r_P + r_C}$  increases, so  $w^P$  decreases and  $w^C$  increases.

Next, we assume that both processor and cooperative have the same discount rates, i.e.,  $r_P = r_C$ . It follows that the two players (processor and cooperative) equally share the total surplus (or, gains from trade). In the unique subgame perfect equilibria (SPE), the equilibrium quantity trade  $q^e$  maximizes the total surplus.

The total surplus is: (5)  $S(p, q) = \mathbf{p}^P(p, q) + \mathbf{p}^C(p, q) = p_b(aq^2 + bq) - dq^2$

Thus,  $q^e$  is the unique solution to  $S'(q) = 0$ . That is, (6)  $q^e = \frac{bp_b}{2d - 2ap_b}$

In the Rubinstein model, the equilibrium price is a weighted combination of the equilibrium average revenue and equilibrium average cost, and the weights depend on the relative bargaining power. That is,

$$p^e = \frac{r_P}{r_P + r_C} \left( \frac{R(q^e)}{q^e} \right) + \frac{r_C}{r_P + r_C} \left( \frac{C(q^e)}{q^e} \right)$$

Since the processor and the cooperative have the same discount factor, the equilibrium trade price  $p^e$  equally divides the generated surplus  $\mathbf{p}^P(q^e) + \mathbf{p}^C(q^e)$ ,

i.e. (7) 
$$p^e = \frac{1}{2} \left( \frac{R(q^e) + C(q^e)}{q^e} \right) = \frac{bp_b(3d - ap_b)}{4(d - ap_b)}.$$

### 3.2 Case 2: Quantity is predetermined

Next, consider a three-stage game. First, the cooperative rationally chooses its supply  $q^C$ , the trade quantity. The processor and the cooperative bargain over the price  $p$  in the second stage. Third, the processor sells the final product to a competitive market. The subgame perfect equilibrium (SPE) concept characterizes the outcome of this game. Following backward induction to a solution, in the third stage, the processor sells the final product,  $F(q^C)$ , to some competitive market and receives a competitive price  $p_b$ . The processor's profit is  $\mathbf{p}^P(p, q^C) = p_b(a(q^C)^2 + bq^C) - pq^C$  which evaluated at the cooperative's optimal supply implies (8)  $\mathbf{p}^P(p, q^C = \frac{p}{2d}) = p_b(a(\frac{p}{2d})^2 + \frac{bp}{2d}) - \frac{p^2}{2d}$  In the second stage, the processor and the cooperative bargain over the price  $p$  and the quantity  $\frac{p}{2d}$ . While two players bargain, the relative bargaining power plays a role in the equilibrium partition. Denote  $\mathbf{b}_i$ , where  $i = P, C$  as the processor's and the

cooperative's bargaining power, respectively. Assume  $b_i$  is exogenously determined by some behavior parameters, such as risk aversion, or by some market conditions, such as supply or demand elasticity. For a stable equilibrium, the sharing rule that allocates total surplus requires that the equilibrium price  $p^e$  equally satisfies the conditions of both players' payoffs:  $b_p p^P(p^e, q^e) = b_c p^C(p^e, q^e)$ . A higher value of  $b_i$  means a lower bargaining power for player  $i$ .

Assume that two players have the same bargaining power, i.e.,  $b_p = b_c$ . Thus, the players' profits are equal:  $p^P(p, q = \frac{p}{2d}) = p^C(p, q = \frac{p}{2d})$  which implies a quadratic equation with the roots (9)  $p = 0$  and  $p = \frac{2bdp_b}{(3d - ap_b)}$ . The equilibrium price is the positive root: (10)  $p^e = \frac{2bdp_b}{(3d - ap_b)}$ . To solve the first stage, the cooperative's profit function (3) is evaluated at the equilibrium price, and optimized by choice of quantity yielding: (11)  $q^C = \frac{bp_b}{3d - ap_b}$ . For comparison, monopsony

and competitive markets are introduced below.

### 3.3 Case 3: Monopsony

A monopsonistic market setting occurs when individual producers do not coalesce.

The monoposonist price for each quantity purchased is given by the market supply curve for the input. We use the inverse supply function from equation (4),  $p = 2dq$ .

Hence, optimizing the processor's profit function by choice of demand  $q^M$  yields the equilibrium price  $p^M$ :

$$(12) \quad q^M = \frac{bp_b}{4d - 2ap_b}$$

$$(13) \quad p^M = \frac{bdp_b}{2d - ap_b}$$

### 3.4 Case 4: A competitive market

The competitive equilibrium serves as a benchmark results in an equilibrium price

and quantity:  $p^* = \frac{bdp_b}{d - ap_b} \quad q^* = \frac{bp_b}{2d - 2ap_b}$

## 4 Results

Table 3.1 summarizes the equilibrium quantities and the equilibrium prices.

TABLE 3.1: THE RESULTANT EQUILIBRIUM QUANTITIES AND PRICES FROM 4 CASES				
EQUILIBRIUM OUTCOME \ CASES	CASE1: RUBINSTEIN MODEL	CASE2: BARGAIN OVER PRICE ONLY	CASE3: MONOPSONY	CASE4: COMPETITIVE EQUILIBRIUM
Equilibrium quantity	$q_1 = \frac{bp_b}{2d - 2ap_b}$	$q_2 = \frac{bp_b}{3d - ap_b}$	$q_3 = \frac{bp_b}{4d - 2ap_b}$	$q_4 = \frac{bp_b}{2d - 2ap_b}$
Equilibrium price	$p_1 = \frac{bp_b(3d - ap_b)}{4(d - ap_b)}$	$p_2 = \frac{2bdp_b}{3d - ap_b}$	$p_3 = \frac{bdp_b}{2d - ap_b}$	$p_4 = \frac{bdp_b}{d - ap_b}$

First, we compare the equilibrium quantities. The monopsony (case 3) equilibrium demand for the input is clearly lower than market competition. The monopsonist is the only buyer having more market power than those individual sellers. Also, the quantity traded by the Rubinstein model is the same in competitive equilibrium. This result is straightforward: in the Rubinstein model, the processor and the cooperative set quantity to the level that maximizes the total surplus. This is exactly how a competitive equilibrium works. As for the relationships among other cases, the following calculations provide some information.



$$(16) \quad q_2 - q_4 = \frac{-bp_b(d + ap_b)}{2(3d - ap_b)(d - ap_b)}$$

In the model,  $q_2$  is derived from a bargaining equilibrium, where the cooperative rationally chooses the trade quantity and the price equals two player's profits.

Intuitively, the bargaining outcome is between the monopsony and competitive equilibrium. That is, (16) is less than zero and  $d + ap_b < 0$ . Therefore,

$$q_1 = q_4 > q_2 > q_3.$$

Next, we check the equilibrium price.

$$(17) \quad p_1 - p_2 = \frac{bp_b(d + ap_b)^2}{4(3d - ap_b)(d - ap_b)} > 0$$

$$(18) \quad p_1 - p_4 = \frac{-bp_b(d + ap_b)}{4(d - ap_b)} > 0$$

$$(19) \quad p_2 - p_4 = \frac{-bp_b(d + ap_b)}{(3d - ap_b)(d - ap_b)} > 0$$

Equations (18) and (19) show that the two bargaining equilibrium prices are higher than the competitive price. Besides, the price solved from the Rubinstein model is higher than the price from case 2, where the quantity is predetermined. In the Rubinstein model, the price is a weighted average of the processor's revenue and the cooperative's cost. The sign of (18) depends on parameterizations of the processor's final product market, his production function, and the cooperative's cost function. Thus, a positive sign might not be a general result, but provides information about what elements may affect the bargaining price.

The reason why the price in the Rubinstein model is higher than that of case 2,

where quantity is predetermined, is not straightforward. In case 2, the price is derived from equaling two player's profits, given that trade quantity is predetermined, whereas the equilibrium price of the Rubinstein model is weighted by some of two players' profits. Therefore, if the trade quantity in case 2 is large, then this large supply drives the price down, and vice versa. Further, the result shows that the cooperative's payoff may not increase as a result of being able to set the trade quantity.

In other words, the buyer dominates the seller in this model. Overall,

$$p_1 > p_2 > p_4 > p_3.$$

Next, consider the profits of the processor and the cooperative in each case.

TABLE 3.2 THE PROFITS OF THE PROCESSOR AND THE COOPERATIVE FROM 4 CASES				
PLAYER \ CASES	CASE1: RUBINSTEIN MODEL	CASE2: BARGAIN OVER PRICE ONLY	CASE3: MONOPSONY	CASE4: COMPETITIVE EQUILIBRIUM
Processor (buyer)	$p_1^P = \frac{b^2 p_b^2}{8(d - ap_b)}$	$p_2^P = \frac{b^2 dp_b^2}{(3d - ap_b)^2}$	$p_3^P = \frac{b^2 p_b^2}{4(2d - ap_b)}$	$p_4^P = \frac{-ab^2 p_b^3}{4(d - ap_b)^2}$
Co-op (seller)	$p_1^C = \frac{b^2 p_b^2}{8(d - ap_b)}$	$p_2^C = \frac{b^2 dp_b^2}{(3d - ap_b)^2}$	$p_3^C = 0$	$p_4^C = \frac{b^2 dp_b^2}{4(d - ap_b)^2}$
Total surplus	$p_1^{P+C} = \frac{b^2 p_b^2}{4(d - ap_b)}$	$p_2^{P+C} = \frac{2b^2 dp_b^2}{(3d - ap_b)^2}$	$p_3^{P+C} = \frac{b^2 p_b^2}{4(2d - ap_b)}$	$p_4^{P+C} = \frac{b^2 p_b^2}{4(d - ap_b)^2}$

Case 3 is a monopsony market. The processor appropriates all profit and leaves zero profit to the cooperative. Case 4 considers a competitive market. The profit earned by each player depends on his technology. The differential profits for each

player across cases can be written. For the processor,

$$(20) \quad \mathbf{p}_3^P - \mathbf{p}_4^P = \frac{b^2 d^2 p_b^2}{4(2d - ap_b)(d - ap_b)^2} > 0$$

$$(21) \quad \mathbf{p}_3^P - \mathbf{p}_1^P = \frac{-ab^2 p_b^3}{8(2d - ap_b)(d - ap_b)} > 0$$

$$(22) \quad \mathbf{p}_3^P - \mathbf{p}_2^P = \frac{b^2 p_b^2 (d - ap_b)^2}{4(2d - ap_b)(3d - ap_b)^2} > 0$$

$$(23) \quad \mathbf{p}_2^P - \mathbf{p}_1^P = \frac{b^2 p_b^2 (d + ap_b)^2}{8(d - ap_b)(3d - ap_b)^2} > 0$$

$$(24) \quad \mathbf{p}_4^P - \mathbf{p}_2^P = \frac{b^2 p_b^2 (4d^3 + ap_b (d - ap_b)^2)}{4(d - ap_b)^2 (3d - ap_b)^2} > 0$$

From equations (20)-(24),  $\mathbf{p}_3^P > \mathbf{p}_4^P > \mathbf{p}_2^P > \mathbf{p}_1^P$ . The processor receives the highest profit from the monopsony market, and the lowest profit from case 1. This clarifies the potential of collective bargaining to establish a balance for a single processor.

For the cooperative,

$$(25) \quad \mathbf{p}_1^C - \mathbf{p}_4^C = \frac{-b^2 p_b^2 (d + ap_b)}{8(d - ap_b)} > 0, \text{ since } d + ap_b < 0.$$

$$(26) \quad \mathbf{p}_2^C - \mathbf{p}_4^C = \frac{-b^2 dp_b^2 (5d - 3ap_b)(d + ap_b)}{4(d - ap_b)^2 (3d - ap_b)^2} > 0, \text{ since } d + ap_b < 0.$$

The result shows that  $\mathbf{p}_1^C > \mathbf{p}_2^C > \mathbf{p}_4^C > \mathbf{p}_3^C$ . The cooperative receives the lowest profit (zero) in the monopsony market, but receives the highest profit under collective bargaining, considered by the Rubinstein model. The bargaining activity transfers the processor's profit to the cooperative.

For total surplus, we have the differential between Case 2, where quantity is predetermined, and Case 3, the monopsony market.

$$(27) \quad \mathbf{p}_2^{P+C} - \mathbf{p}_3^{P+C} = \frac{b^2 p_b^2 (7d^2 - 2adp_b - a^2 p_b^2)}{4(2d - ap_b)(3d - ap_b)^2}$$

The third row of Table 3.2 shows that the competitive equilibrium supports the highest total surplus. Collective bargaining following the Rubinstein model provides the same highest total surplus. Although the trade quantity is the same with the Rubinstein model and the competitive market, the higher equilibrium price associated with collective bargaining in the Rubinstein model reduces the processor's profit at a level equal to the increases in the cooperative's profit. The sign of equation (27) depends on the sign of  $7d^2 - 2adp_b - a^2p_b^2$ . Without comparison with case 2, where quantity is predetermined, the monopsony market has the smallest total surplus. On the other hand, even though the cooperative has the right to rationally decide the trade quantity, the total surplus might be lower than it can receive in the monopsony market. Overall,  $p_1^{P+C} = p_4^{P+C} > p_2^{P+C}$  (and  $p_3^{P+C}$ ).

In sum, four cases are examined in this paper: the Rubinstein alternating-offers procedure, bargaining over price only, monopsony, and competitive equilibrium. The players trade the same quantity in the Rubinstein model as in the competitive market. In monopsony, the smallest quantity is traded. In addition, bargaining models result in a higher price, than do the competitive case. By comparison, the monopsony results in the lowest price. Moreover, we evaluated four cases from the perspective of each player. For the processor, there is no doubt that he collects all of the surplus in the monopsony market. Further, bargaining also provides greater

profit than does the competitive market. Similarly, bargaining results in greater profits for the cooperative than are available from a competitive market or from the monopsony case. Thus, the function and importance of cooperative bargaining is realized.

#### 4.1 Discussions on bargaining power

The above results for Case 1 and 2 rely on the assumption that two players have the same bargaining power, recall  $r_p = r_c$  for Case 1 and  $b_p = b_c$  for Case 2. We now relax this assumption and consider a situation where the processor has greater bargaining power than the cooperative, i.e.,  $r_p < r_c$  for Case 1 and  $b_p < b_c$  for Case 2. In Case 1, this assumption does not affect the equilibrium quantity, because, under all bargaining power scenarios, it results in a Pareto optimal total surplus. In the Rubinstein model, the equilibrium price is a weighted combination of the equilibrium average revenue and equilibrium average cost, and these weights depend on the relative bargaining power. Recall equation (7).

Plugging the equilibrium quantity (6) into (28), the equilibrium price (7) becomes:

$$(7) \Rightarrow p^e = \frac{bdp_b r_c + bp_b(2d - ap_b)r_p}{2(d - ap_b)(r_p + r_c)}$$

The comparative statistics of (7) show that  $\frac{\partial p^e}{\partial r_p} > 0$  and  $\frac{\partial p^e}{\partial r_c} < 0$ . The equilibrium price increases (decreases) as the processor (cooperative) has higher bargaining power (the small value of  $r_p$  ( $r_c$ )).

As for Case 2, where quantity is predetermined, if we relax the assumption of two players with the same bargaining power, according to the sharing rule (recall

$\mathbf{b}_p \mathbf{p}^P(p^e, q^e) = \mathbf{b}_c \mathbf{p}^C(p^e, q^e)$ ), the equilibrium price is:

$$(10) \Rightarrow p^e = \frac{2bdp_b \mathbf{b}_p}{(2d - ap_b) \mathbf{b}_p + d\mathbf{b}_c}$$

(10) shows that  $\frac{\partial p^e}{\partial \mathbf{b}_p} > 0$  and  $\frac{\partial p^e}{\partial \mathbf{b}_c} < 0$ . That is, the greater the processor's relative bargaining power (the lower value of  $\mathbf{b}_p$ ), the lower is the equilibrium price.

On the other hand, increased cooperative bargaining power will result in a greater equilibrium price. As for the equilibrium quantity, (11) becomes:

$$(11) \Rightarrow q^C = \frac{bp_b \mathbf{b}_p}{(2d - ap_b) \mathbf{b}_p + d\mathbf{b}_c}$$

(11) shows  $\frac{\partial q^C}{\partial \mathbf{b}_p} > 0$  and  $\frac{\partial q^C}{\partial \mathbf{b}_c} < 0$ , so the equilibrium quantity will change as the

bargaining power changes. The cooperative will rationally supply more as its bargaining power increases, and vice versa.

Also considering the other two cases, monopsony and competitive market, the results for the four cases with respect to equilibrium prices and quantities may change.

Assume that the bargaining power of the processor is greater than that of the cooperative. The equilibrium quantity in Case 2 decreases as the processor gains greater bargaining power, until the quantity of the monopsony is reached, and thus,  $q_1 = q_4 > q_2 \rightarrow q_3$ . In addition, the equilibrium prices of both Case 1 and 2 decrease as the processor gains greater bargaining power, and may converge to the

monopsony price if the processor has the absolute market power. The magnitudes of these decreases depend on the values of  $r_i$  and  $b_i$ . In other words, there is a possibility that the order of  $p_1 > p_2 > p_4 > p_3$  may not hold.

The above discussions consider the case where there is one processor versus some homogenous farmers. If we consider a case with more than one processor, say two processors, then the type of competition between two processors has to be considered. For example, we assume that two processors compete in a Cournot fashion in a wholesale market, as in von Ungern-Stenberg (1996). That is, one can make more profit as he can supply more in the wholesale market; in other words, he has to get more supply from the raw product market. Thus, in order to get sufficient input supply, processors may bid aggressively in the raw product market. This, in turn, decreases the relative bargaining power of processors, and increases the price of raw product. Such oligopsony situations deserve further study.

## **5 Membership Decision and Outside Option**

It is generally agreed that a key factor in a bargaining cooperative's effectiveness is its ability to control a substantial supply of the product (Helmberger and Hoo (1965) and Bunje (1980)). Member farmers who form cooperatives provide the supply of the product. Thus, supply-control by a cooperative can be enhanced by increasing the number of member-farmers. To design effective membership

structures, it is critical that cooperatives have accurate information about their membership.

While most group marketing efforts by farmers are organized as cooperatives, individual farmers must decide whether or not to participate in the cooperative. The crucial problem is to define the farmers' outside options, i.e. determine what advantages can be expected from joining the cooperative as compared to not joining. In theory, if each player's outside option is less than or equal to the share he receives from the bargaining model, then the outside options have no influence on the equilibrium sharing<sup>4</sup>.

von Ungern-Sternberg (1996) simply defines the producer's outside option as trading with other buyers. He considers a monopoly situation with one producer facing homogenous buyers where those buyers are in a Cournot type competition. If the producer does not reach an agreement with one of the buyers, then an outside option must be available from other buyers. Within the Cournot, competition a decrease in the number of buyers leads to an increase in equilibrium final product prices.

In reality, several commodities, such as potatoes and apples, do have good spot market alternatives (Iskow and Sexton, 1992). According to the USDA report in

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<sup>4</sup> See details in Muthoo (1999), chapter 5.



1997, the most common marketing techniques used by cooperatives are long-term contracts, short-term contracts, electronic marketing, and open market sales<sup>5</sup>. Long-term contracts are a year or more in length, short-term contracts are less than a year, and open market sales are made at prices and terms available at the time of sale. Electronic marketing is a transaction completed over computer auctions or satellite video.

In this section, we assume that the only marketing alternative for those individual farmers who do not join a cooperative is to trade in the spot market, a competitive market. The outside option for an individual farmer can be modeled as follows. A farmer, if he supplies to the spot market, will maximize his expected profit based on the expected spot price,  $p_s^e$ . A farmer's expected profit,  $\mathbf{p}_s^i$ , can be written as:

$$(28) \quad \mathbf{p}_s^i = p_s^e q^i - d(q^i)^2,$$

where  $d(q^i)^2$  is the quadratic production cost to the farmer, and  $d$  is a positive parameter. The first-order condition derives the optimal supply to the spot market.

$$FOC: \quad \frac{\partial \mathbf{p}_s^i}{\partial q^i} = p_s^e - 2dq^i = 0$$

$$(29) \quad q^i = \frac{p_s^e}{2d}$$

Plugging (29) into (28), the farmer's expected profit in the spot market can be written as:

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<sup>5</sup> Considering different cooperatives with different marketing techniques, see White, Jr. (1993) and Wissman (1997).

$$(28) \Rightarrow \mathbf{p}_s^i = \frac{(p_s^e)^2}{4d}$$

This establishes a reservation profit, which profits from selling to a cooperative must exceed.

By contrast, if a farmer chooses to join a cooperative where  $N$  homogenous member-farmers are assumed in the cooperative, then recall from Section 3.3.1 that the farmer's production and price received from the cooperative according to the Rubinstein (1982) model are:

$$(6) \Rightarrow q^i = \frac{bp_b}{2N(d - ap_b)}$$

$$(7) \quad p^e = \frac{bp_b(3d - ap_b)}{4(d - ap_b)}$$

Hence, the farmer's profit function for joining a cooperative is:

$$(30) \quad \mathbf{p}^i = \frac{b^2 p_b^2}{8N(d - ap_b)}$$

Intuitively, the outside option (the expected profit in the spot market) matters only if it is above the bargaining outcome payoff. That is, an individual farmer is willing to join a cooperative as long as he can get at least the same profit as what he would earn if he chooses to stay outside. That is,  $\mathbf{p}^i \geq \mathbf{p}_s^i$ . However, free entry and arbitrage between sales to the spot market and cooperatives will imply  $\mathbf{p}^i = \mathbf{p}_s^i$ . That is, the profit received from the cooperative due to bargaining will be equal to the profit received from the spot market under the assumption of homogenous farmers

and open membership<sup>6</sup>. According to this argument, the most efficient number of members for the cooperative can be derived by equating (28) and (30). That is,

$$(31) \quad N = \frac{db^2 p_b^2}{2(p_s^e)^2 (d - ap_b)}$$

From (31), it is obvious that the optimal number of members decreases as the expected spot price increases. The greater the expected spot price, the more attractive it is for a farmer to stay outside the cooperative. In addition, an increase in the processed price results in an increase in the optimal number of members. Note that the sharing rule of the Rubinstein model in case 1 is assumed to equally divide the total surplus. Increases in the processed price are expected to cause the total surplus to increase, which means that both processor's and cooperative's profits increase as well. Hence, given  $N$  members in the cooperative, every member's profit increases when the total surplus increases.

Furthermore, just as individual farmers have an outside option, processors have an alternative to obtain supply from the spot market. The most obvious alternative supply source for processors is nonmember production. In other words, processors can purchase from the spot market. Since the spot market is competitive, the price is

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<sup>6</sup>Open membership is one of the first cooperative principles, which distinguishes cooperative from non-cooperative businesses. The others include one member has one vote, political and religious neutrality, no unusual risk assumption, etc. See details in Co-op 101: An Introduction to Cooperatives, USDA, 1997.

a decreasing function of quantity. If more farmers joined the cooperative, then less production is supplied to the spot market, and, in turn, the spot price may increase. In sum, the implications of an outside option for individual farmer's decisions, and individual farmer's decisions for an outside option, are interrelated. The trade-off exists between joining a cooperative and staying outside. This is because, while a farmer decides to join the cooperative to share the collective bargaining profit, his entry will reduce the sharing profit, and the expected profit to stay outside of the cooperative increases because of increases in the expected spot price. Thus, this endogeneity of the outside option is an important issue to be kept in the model, when explicitly modeling such a situation.

## **6 Conclusions**

Economic reality is forcing farmers to manage their industry and earn more profits from the marketplace (Levins, 2001). The weakness for an individual farmer in marketing can be addressed as follows. First, few farmers who market their production to a processor can match the buyer's power and size. Despite the growth in the size of individual farmers, few can match the power of the buyer except when joining with others to achieve a measure of equity (Bunje, 1980). Second, while bargaining, the Rubinstein model has shown the need to play games with timing in order to gain an advantage. Few individual farmers have the flexibility to deny the

advantages that have been theirs by default. Third, few individual farmers have the time to analyze the market for their production. Without a skillful representative and basic information, rational and accurate marketing decisions may not be made. Therefore, by working together in collective bargaining through cooperatives, farmers gain better control of their own economic destiny.

This paper identifies the problem of whether bargaining is appropriate for a given market environment. We set up a bargaining model between buyers and sellers for their contracts in which they bargain over price and/or quantity. Comparing two varieties of bargaining models with two extreme cases, competitive equilibrium and the monopsony market, we can gain more insights into collective bargaining's value and importance. Table 3.3 summarizes the rank of effects on price, quantity, and profit across the four cases.

TABLE 3.3 RANK OF EFFECTS ACROSS CASES				
	CASE1: RUBINSTEIN MODEL	CASE2: BARGAIN PRICE ONLY	CASE3: MONOPSONY	CASE4: COMPETITIVE EQUILIBRIUM
Equilibrium price	1	2	4	3
Equilibrium quantity	1	3	4	1
Processor profit	4	3	1	2
Cooperative/farmers profit	1	2	4	3
Total profit	1	3or4	3or4	1

The results in this paper show that bargaining doesn't just increase prices paid to farmers when compared with monopsony and competitive markets; the total surplus associated with bargaining is also positive. We conclude that collective bargaining can increase producer profits in marketplaces, where they face individual processors that might exercise monopsony power in the absence of collective bargaining. In the absence of collective bargaining, we find it likely that individual producers will receive the lowest price and zero profit.

In addition, bargaining's success or effectiveness should be evaluated based on its total impact, thereby considering total surplus. As the competitive market improves total surplus, the formation of the bargaining unit serves to transfer some of the surplus from the processor to the farmer cooperative. In other words, collective bargaining through cooperatives enables farmers to capture margins from the marketplace, which otherwise would go to processors. Hence, bargaining reduces asymmetric bargaining power between two groups, while also maximizing total surplus. Also, collective bargaining through cooperatives can be an effective vehicle for farmers integrating down the market channel.

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