The Bargaining Strength of a Milk Marketing Cooperative

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As a result of economies of size, food processors are generally large and few in number. These characteristics put processors at a bargaining advantage over independent farmers. Marketing cooperatives were established to counter the uneven bargaining position of individual farmers. This article investigates the relative bargaining strength of one milk marketing cooperative and several fluid milk processors. The Nash bargaining model can be used to analyze the negotiated price in the Florida fluid milk market which acts like a bilateral monopoly. The milk marketing cooperatives have bargained well with the milk marketing processors. The monthly bargaining strength of the Southeast Dairy Cooperative, Inc. (SDC), exceeds the monthly bargaining strength of the processors in all twelve months, ranging from a low of 0.6664 in January to a high of 0.7831 in September. The monthly average bargaining strength across all months for SDC is 0.7326.

Key Words: cooperative, bargaining, bilateral monopoly, dairy, processors

As a result of economies of size, food processors are generally large and few in number (Durham and Sexton 1992). These characteristics put processors at a bargaining advantage over independent farmers. Marketing cooperatives were established to counter the uneven bargaining position of individual farmers (Jesse et al. 1992). This article investigates the relative bargaining strength of one milk marketing cooperative and several fluid milk processors.

The Southeast Dairy Cooperative, Inc. (SDC), supplies farm milk to several dairy fluid milk processors in Florida. From January 1999 through May 2002, SDC was composed of two cooperatives: Southeast Milk, Inc. (SMI), and the Southeast Council of Dairy Farmers of America, Inc. (DFA). SDC provided all of the milk to the Florida processors in 1999, 2000, 2001, and 2002, except for August 2000 and 2001 when Maryland/ Virginia producers provided some milk (USDA various issues). In 2002, there were eight processors who owned twelve fluid milk processing plants in Florida (USDA various issues). The average annual amount at each plant was 199,552,230 pounds of fluid milk for Class 1 use (USDA various issues).

The market structure is a monopoly on the supply side (SDC) and oligopsony on the processors' side. When bargaining takes place, the market environment changes to one approximating a bilateral monopoly. The bargaining environment is structured so that the price is negotiated monthly between SDC and one or two processors, with the remaining processors accepting the prices negotiated by the lead processor(s). This market structure was first identified by Iskow and Sexton (1991) in the fruit and vegetable markets and was labeled as an approximate bilateral monopoly by Sexton (1993, page 49).

Equilibrium in a bilateral monopoly cannot be determined by traditional economic tools (supply and demand) (Koutsoyiannis 1979). The supply-and-demand framework can define only the bargaining price range that contains the solution outcome (Helmberger and Chavas 1996). The precise price is determined through bargaining and will be investigated in this article.

The first section of this article describes the Florida farm milk market. The next section describes an axiomatic bargaining model found in the literature and adapts it to the Florida farm milk market. An econometric bargaining price model which contains the bargaining strength co-

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Agricultural and Resource Economics Review 37/2 (October 2008) 204–210

efficients is presented. Data for the variables and the econometric estimates of bargaining strength are analyzed. Finally, a summary and conclusions for the article are provided.

Florida Farm Milk Market

Supply contracts between SDC and Florida processors are for a one-year period and are renewed annually; however, the contract can be canceled by either party if a 60-days' notice of cancellation is given. Each Thursday, processors order daily truckloads of milk for each week, starting on Sunday and ending on Saturday. Processors can amend their orders once they are placed.

The Federal Milk Marketing Order system has four classes of milk. Class 1 milk is farm milk used for drinking purposes. Class 2 milk is farm milk used for soft dairy products, such as ice cream and cottage cheese. Class 3 milk is farm milk used for hard cheeses. Class 4 milk is farm milk used for dry milk and butter. On a monthly basis, the Federal Marketing Order system sets the minimum price paid by processors and manufacturers for farm milk used in each class. Milk revenues are pooled in each marketing order and farmers are paid the sum of the revenue from each class. The total revenue from all milk classes is divided by total farm milk pounds pooled in the Federal Order, and this figure is then multiplied by the pounds of milk from each farmer in order to arrive at the farmer's gross milk receipts before expenses are taken out (e.g., transportation costs). Also, each farmer receives a Class 1 differential which is added to the Class 1 price computed for each Federal Milk Marketing Order. The Class 1 differential is different in each order and is intended to move milk from surplus to deficit regions if needed.

A Generalized Nash Bargaining Model for the Florida Farm Milk Market

Theoretic analyses of bilateral bargaining are categorized into static axiomatic and strategic approaches (Krishna and Serrano 1996). The static axiomatic approach was first proposed by Nash (1950). The Nash axiomatic approach has been popular in empirical work as it is simple to implement and can be interpreted as a stable bargaining convention which is immune to a particular argument presented by an arbitrary player (Coles and Hildreth 2000, Muthoo 1999). The strategic approach was initially introduced by Rubinstein (1982), who suggested the alternative-offer procedure and the idea of friction (i.e., the value of time) to the bargaining process. Later, Binmore, Rubinstein, and Wolinsky (1986) introduced the risk of breakdown into the Rubinstein alternative-offer bargaining model.

The static axiomatic and strategic approaches are closely related. The results from the Rubinstein strategic model and the strategic model with the risk of breakdown approximate the solution suggested by Nash's model when the response time between the parties during the game is small (Binmore, Rubinstein, and Wolinsky 1986). Indeed, the Nash bargaining model is a special case of more elaborate strategic models that converge to the Nash model under certain assumptions (Burtraw 1993) (for more examples, see Binmore 1987a, 1987b, 1987c). Furthermore, van Damme (1986) found that all solution bargaining concepts within a large class (meta-game) lead to the axiomatic Nash bargaining solution.

The SDC and fluid milk processors reach contract agreement through a monthly bargaining process that approximates a bilateral monopoly. This bargaining process is characterized by using the generalized axiomatic Nash approach. In order to account for an asymmetric environment, the generalized Nash bargaining model is the original Nash bargaining model without the symmetry axiom (Roth 1979). This asymmetry can be used to determine the parties' relative bargaining strengths in the negotiation.

The generalized Nash bargaining model (Muthoo 1999) for the price negotiation between the SDC and a Florida processor can be shown as

$$\text{(1)} \qquad \underset{p^N}{\text{Max}} \; (U_c - U_{bc})^{\alpha} (U_p - U_{bp})^{1-\alpha},$$

where U_c and U_p are SDC's payoffs and the processor's payoffs when a bargaining agreement is reached and are a function of the negotiated price p^N; U_{bc} and U_{bp} are SDC's payoff and the processor's payoff when a bargaining breakdown occurs and are a function of the breakdown price p_{bc} and p_{bp}, respectively; and α and $(1-\alpha)$ denote SDC's

and the processor's relative bargaining strength. Both parties have equal bargaining strength if α equals 0.5. The disagreement points in the generalized Nash model are from the strategic bargaining model (Binmore, Rubinstein, and Wolinsky 1986, and Muthoo 1999) and are represented by the breakdown points (U_{bc}, U_{bp}).

Assuming that the SDC and the processing plant are risk-neutral, the payoff functions for the SDC and processor are defined as

$$(2) \qquad U_c = p^N - c; \quad U_{bc} = p_{bc} - c$$

and

$$(3) \qquad U_p = r - p^N; \quad U_{bp} = r - p_{bp},$$

where c denotes the total cost per hundredweight faced by the SDC and r represents a processor's revenue minus other costs associated with milk processing per hundredweight of fluid milk.

The generalized Nash bargaining model can now be written as

$$(4) \quad \underset{p^N}{\text{Max}} \; [p^N - c - (p_{bc} - c)]^{\alpha}[r - p^N - (r - p_{bp})]^{1-\alpha}.$$

Differentiating equation (4) with respect to p^N and setting it equal to zero, the negotiated price from the strategic-based generalized Nash bargaining model is

$$(5) \qquad p^N = (1-\alpha)(p_{bc}) + \alpha(p_{bp}).$$

Given the bargaining strength that SDC and the processor possess, as well as their respective threat points, the two organizations negotiate p^N. The negotiated price p^N and the threat point prices p_{bc} and p_{bp} make it possible to econometrically estimate the bargaining strength parameters by using a restricted regression model where the relative bargaining strength parameters α and $(1 - \alpha)$ sum to one.

Empirical Model

Due to the weather conditions in Florida, there exist periods of milk shortage and surplus. The SDC is responsible for balancing the supply and demand of fluid milk. In deficit months, the SDC buys milk from out-of-state producers and imports it into Florida for the Florida processors, whereas in surplus months the excess supply is shipped out of Florida as Class III and Class IV milk and is sold to butter, cheese, and/or powdered milk manufacturers. In surplus months, the average price received by the SDC is usually less than the price received in the deficit months (USDA various issues), which indicates the presence of seasonality. In order to determine if the surplus and deficit months in Florida have an impact on the monthly negotiated bargaining price, monthly seasonality is added to equation (5) as

$$(6) \quad p_i^N = \alpha_1 p_{bp_i} + \sum_{j=2}^{12} \alpha_j p_{bp_i} D_j + (1-\alpha_1) p_{bc_i} + \sum_{j=2}^{12} [1 - \alpha_1 - \alpha_j - (1-\alpha_1)] p_{bc_i} D_j + e_i,$$

where p_i^N is the price received by SDC from the processing plants for observation i; p_{bp_i} is the cost per hundredweight that the processing plants would pay for fluid milk if the bargaining process with SDC broke down for observation i; D_j is a binary variable where D_j equals 1 for the February (December) observation when $j = 2$ (12), but zero otherwise, in order to incorporate seasonality into the model; p_{bc_i} is the minimum price fluid milk processors can pay SDC for farm milk used in Class I products for observation i; and ε_i is the error term for observation i. In order to ensure that the bargaining strength parameters for SDC and the processors sum to one, the coefficients associated with p_{bc_i} and $p_{bc_i} D_j$ are restricted by other coefficient values contained in equation (6).

The cost per hundredweight that processing plants would pay for fluid milk if the bargaining process with SDC broke down (p_{bp}) is assumed to be equal to the weighted average of the fluid milk price (Class I plus over-order premium) in surplus areas (i.e., Baltimore, Detroit, Kansas City, and Philadelphia) plus the per hundredweight hauling costs from those areas to the Florida processors.

p_{bc} is set by the Federal Milk Marketing Order system, which is administered by the U.S. De-

partment of Agriculture.[1] Processors cannot pay producers less than the Class 1 price. Furthermore, Florida has the highest Class 1 price in the nation. If SDC were to haul Florida milk to processors outside the state of Florida, the Class 1 price received would be lower than in Florida and transportation costs would be more compared to Florida milk delivered to Florida processors. Non-Florida processors are not likely to pay a premium for Florida milk because they can go north and find less expensive milk, as the price of milk decreases as one travels north in the southeastern United States. Furthermore, if bargaining breaks down and SDC is looking for non-Florida processors to buy its milk, the non-Florida processors know that they have an advantage in the bargaining process with SDC. The processors, however, can pay more than the Class 1 price. The SDC and the processors bargain for an over-order premium which, when added to the Class 1 price, equals the negotiated price p^N.

Data

The U.S. Department of Agriculture and the Southeast Dairy Cooperative, Inc., provided the data used in this study. First, the data include the monthly prices (p^N) SDC received from the processing plants through the negotiation process, equaling the Class I fluid milk price in Tampa plus the over-order premium from the negotiation process. The monthly over-order premium is the dollars per hundredweight received by SDC in excess of the Class I price set by the Federal Milk Marketing Order. The Class 1 price (p_{bc}) is set by the Federal Milk Marketing Order system, which is administered by the U.S. Department of Agriculture. Processors cannot pay producers less than the Class 1 price; however, the processors can pay more than the Class 1 price. The time period for all of the data sets was October 1998 to May 2002 (44 observations). All milk prices, premiums, and other relevant costs are in dollars per hundredweight.

[1] There was a concern about p_{bc} and p_{bp} having endogeneity problems. p_{bc} is set by formula and is not random. p_{bp} is calculated by formula and is assumed to be non-random. As a precaution, instrumental variables were tried but the results of the analysis did not change.

Results

The regression results (Table 1) were estimated using nonlinear least squares,[2] which gives the same estimates of the parameters as the maximum likelihood estimator under the assumption of normally distributed disturbances. The nonlinear least squares estimator is asymptotically normal, asymptotically efficient, and asymptotically consistent (Greene 2000).

Equation (6) was estimated in its restricted and unrestricted forms (Table 1) without the monthly slope shifters to test the hypothesis that bargaining parameters α and $(1-\alpha)$ sum to one [H_o: $\alpha_{p_{bp}} + (1-\alpha_{p_{bp}}) = 1$ (restricted model); H_a: $\alpha_{p_{bp}} + (1-\alpha_{p_{bp}}) \neq 1$ (unrestricted model)]. We failed to reject the null hypothesis as the likelihood ratio test was insignificant at the 0.01 percent level. This indicates that we failed to reject the Nash bargaining strength theoretical restriction. The coefficients from the unrestricted model sum to 0.9693. The R^2's are 0.9576 for the unrestricted model and 0.9484 for the restricted model. This information supports the Nash bargaining assumption that the differences in bargained outcomes are attributable to variation in outside options.

The restricted equation (6) was estimated with and without the monthly slope shifters to determine if relative bargaining power varies seasonally (Table 1). We failed to reject the alternative hypothesis (the model with the monthly slope shifters) as the likelihood ratio test was significant at the 0.10 percent level (H_o: $\alpha_2 = ... = \alpha_{12} = 0$; $-\alpha_2 = ... = -\alpha_{12} = 0$; H_a: at least one α_j is not equal to zero, or at least one $-\alpha_j$ is not equal to zero).

Using functions of the coefficients from the restricted model with slope shifters [equation (6)], the relative bargaining strengths for SDC and the processors were calculated for each month (Table 2). *t* tests were run to determine if the relative bargaining strengths were different from 0.5 [H_o: $(\alpha_{p_{bp}} + \alpha_j) - 0.5 = 0$; H_a: $(\alpha_{p_{bp}} + \alpha_j) - 0.5 \neq 0$], the point at which SDC and the processors have

[2] The LSQ routine in TSP version 4.4B was used. Serial correlation was corrected using a subroutine called "formar1." The first observation was retained.

Table 1. Regression Results

	Unrestricted Model		Restricted Models			
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
p_{bp}	0.8639***	0.1304	0.7264***	0.0463	0.6664***	0.0793
$p_{bp}D_2$					0.1022**	0.0437
$p_{bp}D_3$					0.0483	0.0583
$p_{bp}D_4$					0.0977	0.0663
$p_{bp}D_5$					0.0373	0.0713
$p_{bp}D_6$					0.0464	0.0779
$p_{bp}D_7$					0.0821	0.0806
$p_{bp}D_8$					0.0680	0.0795
$p_{bp}D_9$					0.1166	0.0782
$p_{bp}D_{10}$					0.0655	0.0702
$p_{bp}D_{11}$					0.0378	0.0600
$p_{bp}D_{12}$					0.0927**	0.0451
p_{bc}	0.1054	0.1540	0.2736***	0.0463	0.3336***	0.0793
$p_{bc}D_2$					-0.1022**	0.0437
$p_{bc}D_3$					-0.0483	0.0583
$p_{bc}D_4$					-0.0977	0.0663
$p_{bc}D_5$					-0.0373	0.0713
$p_{bc}D_6$					-0.0464	0.0779
$p_{bc}D_7$					-0.0821	0.0806
$p_{bc}D_8$					-0.0680	0.0795
$p_{bc}D_9$					-0.1166	0.0782
$p_{bc}D_{10}$					-0.0655	0.0702
$p_{bc}D_{11}$					-0.0378	0.0600
$p_{bc}D_{12}$					-0.0927*	0.0451
Rho [a]	0.7896***	0.1024	0.7227***	0.1059	0.8234***	0.0990
Log likelihood	-9.7923		-10.4046		-1.2488	
R^2	0.9576		0.9484		0.9507	
Adjusted R^2	0.9565		0.9484		0.9337	
Observations	44		44		44	

[a] Serial correlation was corrected using a subroutine called "formar1" which gives maximum likelihood estimates using LSQ in TSP version 4.4B. The first observation is retained.

Notes: *** coefficients are significantly different from zero at the 0.01 level, ** at the 0.05 level, and * at the 0.1 level.

equal bargaining strength. All coefficients were statistically different from 0.5 at the .01 level, except those for January and November, which were significantly different from 0.5 at the 0.05 level (Table 2). This indicates that SDC and the processors have unequal bargaining strength. The average monthly bargaining strength for SDC and the processors was statistically different from 0.5 at the 0.01 level.

There are two reasons why the SDC has a majority of the bargaining power. First, processors are more impatient than SDC because the processors have buyers who need a continuous supply of dairy products. SDC provides the processors

Table 2. The Monthly Bargaining Strength for SDC and Processor (October 1998 through May 2002)

	SDC Bargaining Strength	Processor Bargaining Strength
January	0.6664**	0.3336**
February	0.7686***	0.2314***
March	0.7147***	0.2853***
April	0.7641***	0.2359***
May	0.7037***	0.2963***
June	0.7128***	0.2872***
July	0.7486***	0.2514***
August	0.7344***	0.2656***
September	0.7831***	0.2169***
October	0.7320***	0.2680***
November	0.7042**	0.2958**
December	0.7591***	0.2409***
Average	0.7326***	0.2674***

Notes: *** and ** coefficients are significantly different from 0.5 at the 0.01 and 0.05 levels.

with all of the milk the processors need (a full supply contract) and the processors have come to expect that reliable service from SDC. Second, there is a risk of breakdown in negotiations because alternatives do exist for the SDC to sell milk to and the processors to buy milk from. If a breakdown does occur, there are at least three consequences that would affect the processors. First, Florida processors prefer fresh milk as opposed to milk that has been in a bulk tank for several days. The older milk is before being bottled, the quicker bottled milk will spoil. If bargaining breaks down, milk will not be as fresh because it will be hauled from greater distances than milk produced in Florida. Second, if processors did not have access to Florida-produced milk, Florida fluid milk processors could purchase milk only from suppliers outside the northern border of Florida. The Florida processors would not be able to go east or south or west of Florida (there is water on three sides of Florida) to purchase milk. This increases the transportation cost for importing milk into Florida and could lead to Florida processors paying higher prices for milk. Third, when Florida processors look for milk north of the Florida border, they find that the entire southeastern United States is deficit in milk. Surplus milk is located many miles from Florida, which affects the age of milk before it can be bottled.

The SDC has a majority of the bargaining strength, although it varies from month to month. The bargaining strength of SDC ranges from a high of 0.7831 in September to a low of 0.6664 in January, for a monthly average of 0.7326 (Table 2). The months above the monthly average bargaining strength for SDC are February, April, July, August, September, and December, with October being approximately average. July, August, September, October, and December are deficit months; however, February and April are surplus months. Thus, bargaining strength for SDC is higher in most deficit months (November is a deficit month) and some surplus months, which means that high bargaining strength levels do not happen exclusively during surplus months.

Summary and Conclusions

In a bilateral monopoly, the tools of supply and demand cannot be used to analyze the negotiated price (p^N). The Nash bargaining model can be used to analyze the negotiated price in the Florida fluid milk market, which acts like a bilateral monopoly. The restricted model with monthly slope shifters accounts for 95 percent of the variation in the negotiated price. The bargaining strength of SDC and the processors sums to one, as hypothesized.

Based on the study period, the milk marketing cooperatives have bargained well with the milk marketing processors. The monthly bargaining strength of SDC exceeds the monthly bargaining strength of the processors in all twelve months, ranging from a low of 0.6664 in January to a high of 0.7831 in September. The monthly average bargaining strength across all months for SDC is 0.7326.

In conclusion, the threat points for the processor and SDC define the price range within which the negotiated price can be found. The price range is set by the Milk Marketing Order system. The negotiated price is determined by the relative bargaining strength of SDC and the processors.

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