A BARGAINING FRAMEWORK TO ESTABLISH OVER-ORDER PREMIUMS IN DAIRY MARKETS

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Abstract: Given the approximate bilateral monopoly nature of Florida dairy industry (producers and processors), the monthly projected over-order premiums (i.e., the dollar amount above the Class I price) are determined by the generalized Nash bargaining model through the relevant prices, costs, bargaining power, and risk attitudes. The implications of the results are discussed.

Keywords: Cooperative, dairy, milk, bargaining, over-order-premiums, bilateral monopoly

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As a result of economies of scale, most food processors are often large and few by nature (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. In general, a cooperative of a given commodity usually negotiates with several processors (Iskow and Sexton, 1991). However, a cooperative often first bargains with a leading firm in the industry or region, and an agreement with other processors will be close to the initial outcome (Sexton, 1993). This structure indicates an approximate bilateral monopoly (Sexton, 1993). Unfortunately, the equilibrium in a bilateral monopoly cannot theoretically be determined by traditional economic tools. The supply and demand framework can define only the bargaining price range that contains the solution outcome (Helmberger and Chavas, 1996). The precise price level is defined by other non-economic factors, such as bargaining skills or their attitude toward risk.

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 the empirical works 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). On the other hand, 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. Then, Binmore, Rubinstein, and Wolinsky (1986) introduced the risk of breakdown into the Rubinstein alternative-offer bargaining model.

The 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) leads to the axiomatic Nash bargaining solution.

The Florida Milk Marketing Cooperative (MMC) and fluid milk processors reach contract agreements through a monthly bargaining process that approximates a bilateral monopoly as cited in Sexton (1993). The MMC and one processor (sometimes two processors) bargain over the dollar amount above the Class I price known as an over-order premium. The bargaining results are accepted by the other processors. This bargaining process will be analyzed in this article.

The article is organized as follows. First, a strategic bargaining model that leads to the generalized axiomatic Nash bargaining model for the Florida dairy market is introduced. Second, the model is specified for a risk averse attitude situation. Third, the projection of over-order premiums and results from the sensitivity analysis are presented. Finally, our summary, conclusions, and implications for this article are provided.

A Strategic Bargaining Model for Florida Dairy Pricing

The MCC and the processing plant bargain over a fluid milk price per hundredweight. This bargaining process is characterized using the game-theoretic alternating bargaining model originally proposed by Rubinstein (1982), and further discussed in studies by Binmore et al. (1986), Binmore (1992), Binmore et al. (1998), Coles and Wright (1998), Muthoo (1999), Coles and Hildreth (2000), Furusawa and Wen (2002). This alternating bargaining model is a game-theoretic model. Therefore, the analysis involves characterizing the unique subgame perfect equilibrium of this game-theorectic strategic bargaining model as an equilibrium point for this model (Muthoo, 1999).

At time 0, the MMC (or the processor) makes an offer p_1. The processing plant may either accept the price p_1 or reject it. If the processing plant accepts the MMC's offer, then they have reached an agreement and the MMC will sell the fluid milk to the processing plant at \$$p_1$ per hundredweight. If the processor is not satisfied with p_1, then the processor will propose (counteroffer) the price p_2 to the MMC at time Δ, where $\Delta > 0$. If the MMC agrees with this counteroffer p_2, then this negotiation process is finished. But if not, then the MMC will make a counter-counteroffer price p_3 back to the processor at time 2Δ. The alternating-offer process goes on until either party accepts a price offer proposed by the other party.

In this proposed bargaining procedure, it appears that the MMC makes offers at time 0, 2Δ, 4Δ, 6Δ…etc, while the processing plant makes offers at time Δ, 3Δ, 5Δ, 7Δ…etc. The reverse argument above is true if the processor makes the first price offer. Moreover, during a negotiation process there is a possibility that the bargaining process ends due to a random event, which once happened in the early 1980's when the bargaining process broke down. This breakdown in a bargaining process is rare but possible, and if it happens, then the MMC will sell fluid milk elsewhere and tends to receive a lower price than it should receive from the processor. Similarly, the processing plant will buy milk elsewhere with a potentially higher price than a price paid to the MMC. The breakdown results in preventing both parties from having mutual benefits from their cooperation.

Binmore et al. (1986) suggested that the time of breakdown can be modeled as an exponential distribution with parameter λ. Then, the probability that the bargaining process will terminate in each bargaining period of Δ is $p = 1\text{-}exp(\text{-}\lambda\Delta)$. Based on a property of the exponential distribution (related to the Poisson distribution), parameter λ can be interpreted as the expected number of breakdowns per unit of time (Hiller and Lieberman, 1995). The parameter λ_i could be different between parties, based on the rate of breakdown expected by the MMC and processing plant.

As proved by Binmore et. al. (1986), the perfect equilibrium point of the risk of breakdown model is reached at time t = 0. If the MMC is the one who moves first, the MMC will propose the price offer p_c^*, which is accepted by the processor. Likewise, if the processor is the one who moves first, the processor will propose the price offer p_p^*, which will be accepted by the MMC. Moreover, Muthoo (1999) views the alternating offer model with arbitrarily small Δs as the most compelling model. In the real situation, the MMC and processor are not required to move on a strict timetable (i.e., Δ, 2Δ, 3Δ…etc). Given that either the MMC or processor just rejected a price offer, the reasonable thing to do is to propose a counteroffer as soon as possible. Due to a risk of breakdown, waiting to make a counteroffer could be costly (i.e. a breakdown might occur at any time) (Binmore, 1992). Thus, the use of a small Δ is assumed in this analysis. Moreover, when Δ approaches zero, the outcome from this strategic model converges to the outcome from the generalized Nash bargaining model (Muthoo, 1999).

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

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

where U_c and U_p are the utility functions for the MMC and the processor respectively; U_{bc} and U_{bp} are the MMC's utility and the processor's utility when a breakdown occurs; α and (1-α) denote the MMC's and the processor's relative bargaining powers. Both parties have equal bargaining power if α equals 0.5. The disagreement point (d_1, d_2) in the generalized Nash model is represented by the breakdown points (U_{bc}, U_{bp}) from the strategic bargaining model (Binmore et al., 1986; and Muthoo, 1999). The Nash bargaining model is the same as the strategic model when Δ approaches zero.

A Risk Averse Generalized Axiomatic Nash Bargaining Model

Since risk aversion is the most common attitude toward risk (Pindyck and Rubinfeld, 1998), both the MMC and the processing plant are assumed to be risk-averse with a negative exponential functional form

(2) $$U(\pi) = -e^{(-\theta\pi)}$$

where θ is the Pratt-Arrow absolute risk aversion coefficient, and π is a payoff or wealth to a player. The Pratt-Arrow absolute risk aversion $\theta(\pi)$, initially developed by Pratt (1964), is defined as

(3) $$\theta(\pi) = -\frac{U''(\pi)}{U'(\pi)}.$$

The Pratt-Arrow absolute risk aversion $\theta(\pi)$ is a measurement of risk level because the feature of a risk-averse individual is a diminishing marginal utility of wealth (i.e., $U''(\pi) < 0$) (Nicholson, 2000). Higher values of θ indicate more risk aversion for an individual and θ equal zero indicates risk neutrality.

The negative exponential utility function is the most commonly used risk attitude measure in empirical studies (for example, see Rister, Skees, and Black, 1984; Raskin and Cochran, 1986; McSweeny and Kramer, 1986; Babcock, Chalfant, and Collender, 1987; Featherstone and Moss, 1990; Love and Buccola, 1991; Babcock, Choi, and Feinerman, 1993; Wang, Dorfman, McKissick, and Turner, 2001). This utility function exhibits constant absolute risk aversion (CARA), which measures the degree of risk aversion exhibited by a utility function and also has the von Neumann-Morgenstern's utility properties. A CARA decision maker requires the constant risk premium regardless of sizes of the decision maker's wealth (Robinson and Barry, 1987). A CARA decision maker has no wealth effect in the attitude toward risk (Binger and Hoffman, 1998). The CARA characteristic implies a constant level of risk aversion for a certain value of θ regardless of the size of initial wealth π. When risk aversion is concerned, both the MMC and processor are assumed to exhibit CARA because the wealth of the MMC and processor do not fluctuate from one month to the next. Furthermore, the analysis for various levels of risk aversion is done by changing θ in the utility function. Greater values of θ indicate more risk aversion for an individual.

Using the negative exponential utility function in a bargaining analysis with risk aversion, the MMC and processor's utility functions are modeled as

$$(4) \qquad U_c = -e^{[-\theta_c (p-c)]} \quad and \quad U_{bc} = -e^{[-\theta_c (p_{bc}-c)]}$$

and

$$(5) \qquad U_p = -e^{[-\theta_p (r-p)]} \quad and \quad U_{bp} = -e^{[-\theta_p (r-p_{bp})]}$$

where θ_c (θ_p) is the Pratt-Arrow absolute risk aversion coefficient for the MMC (processor); p is the price per hundredweight of fluid milk, c denotes the total cost per hundredweight faced by the cooperative, and r represents the processor's revenue minus other costs associated with milk processing per hundredweight of fluid milk; and p_{bc} (p_{bp}) is the fluid milk price per hundredweight received by the MMC (paid by the processor) if the negotiation process breaks down.

Assuming that both the MMC and processor are risk-averse where θ_c and θ_p are the Pratt-Arrow absolute risk aversion coefficients of the MMC and processor respectively, the generalized Nash bargaining model can be written as

(6) $$\underset{p}{Max}[-e^{(-\theta_c(p-c))}-(-e^{(-\theta_c(p_{bc}-c))})]^{\alpha}[-e^{(-\theta_p(r-p))}-(-e^{(-\theta_p(r-p_{bp}))})]^{1-\alpha}.$$

Differentiating equation (6) with respect to p^N and setting it equal to zero results in

(7) $$\left(\frac{\alpha}{1-\alpha}\right)\theta_c e^{(\theta_p p_{bp}-\theta_c p^N)}-\theta_p e^{(\theta_p p^N-\theta_c p_{bc})}-\left[\left(\frac{\alpha}{1-\alpha}\right)\theta_c-\theta_p\right]e^{(p^N(\theta_p-\theta_c))})=0.$$

The explicit form of p^N cannot be solved using the algebraic method. After knowing values of parameters and given other variables, p^N in equation (7) can be solved by a numerical method.

Surplus and Deficit Periods

Due to the weather conditions in Florida, there exist periods of milk shortage and surplus. The MMC is responsible for balancing the supply and demand of fluid milk. In deficit months, the MMC buys milk from out-of state producers and imports it into Florida for the Florida processors. While, in surplus months, the excess supply is shipped out of Florida as Class III and IV milk and sold to butter, cheese and/or powdered milk manufacturers.

In surplus months, the average price received by the MMC is usually less than the price received in the deficit months (Federal Milk Marketing Statistics). The bargaining model is used to analyze how the MMC and the processing plants bargain in order to establish an over order-premium at which to trade. The over-order premium plus the Class I price is the price paid by the processors (or received by the MMC).

When there is a shortage of milk in the deficit months, the MMC imports milk from out-of-state producers and sells it to the processors along with the Florida produced milk. The average cost of importing milk (*ACI*) based on the total amount of milk sold to the Florida processors is

(8) $$ACI = \frac{p_i q_{imp}}{q_{FL} + q_{imp}}$$

where p_i denotes the per hundredweight price that the MMC pays for importing milk which includes the price that the MMC pays out-of-state producers plus the transfer cost from out-of-state to the Florida processing plants; and q_{imp} and q_{Fl} represent the MMC's amount of imported milk and MMC's member milk supply in hundredweight. The price per hundredweight received by the MMC is

(9) $$p_{MMC} = p - ACI\ .$$

To account for the cost of importing, the appropriate utility function of the risk-averse MMC is modeled as

(10) $$U_c = -e^{(-\theta_c (p^N - ACI - c))}\ .$$

However, the utility functions of the processor (U_p) and the MMC's utility and the processor's utility when a breakdown occurs (i.e., U_{bc} and U_{bp}) remain unchanged.

When both the MMC and processor are risk-averse, according to equation (7), the negotiated price p^N can be computed through

(11) $$\left(\frac{\alpha}{1-\alpha}\right)\theta_c e^{(\theta_p p_{bp} - \theta_c (p^N - ACI))} - \theta_p e^{(\theta_p p^N - \theta_c p_{bc})} - \left[\left(\frac{\alpha}{1-\alpha}\right)\theta_c - \theta_p\right] e^{(\theta_p p^N - \theta_c (p^N - ACI))} = 0\ .$$

The only difference between equations (7) and (11) is the addition of variable *ACI* concerning situations in deficit periods. When *ACI* equals zero (e.g., in surplus periods), equations (7) and (11) are identical.

Data

The Federal Milk Marketing Order Administrator and Florida Milk Marketing Cooperative provided the data used in this study. The data include (1) the monthly historical over-order premiums; (2) the monthly Class I fluid milk price in the related areas; (3) the monthly hundredweights of fluid milk imported and exported during deficit and surplus periods (non-MMC producer milk); (4) costs per hundredweight paid by the MMC for fluid milk imported during deficit periods; (5) revenues per hundredweight received by the MMC for fluid milk sold to cheese, butter, and ice cream plants for surplus milk; and (6) the hauling cost per hundredweight that processors would pay if processing plants purchased their own milk. The time period for all of the data sets was from October 1998 to June 2002 (45 observations)[1]. All milk prices, premiums, and other relevant costs are in dollars per hundredweight. In the following paragraphs, a detailed accounting of the required variables is presented.

The monthly prices p^N the MMC received from the processing plants through the negotiation process equal the Class I fluid milk price in the Tampa area plus the announced over-order premium from the negotiation process. The revenues per hundredweight (p_{bc}) the MMC would receive from selling milk to manufacturing plants if

[1] Southeast Milk Inc. was created in October 1998 when the Florida Dairy Farmers Association and the Tampa Independent Dairy Farmers Association merged. The data used in this article is post merger.

the bargaining process with the processing plant broke down, are calculated by dividing monthly revenues received for fluid milk sold to cheese, butter, and ice cream plants, by the quantity. The cost per hundredweight (p_{bp}) the processing plants would pay for fluid milk if the bargaining process with the MMC broke down is assumed to be equal to the weighted average of the fluid milk price (Class I plus premiums) in the surplus areas (i.e., Baltimore, Detroit, Kansas City, and Philadelphia (the MMC's unpublished paper)) plus the per hundredweight hauling costs from those areas. Finally, The average cost of importing milk *ACI* based on the total amount of milk sold to the Florida processors is calculated by dividing costs paid by the MMC for fluid milk imported (during deficit months) by the total hundredweight of milk, which was sold to the processing plants. By definition, *ACI* equals zero in the surplus period.

Bargaining Power

The averages of α and 1-α by month (table 1) obtained from the bargaining model when both parties are moderately risk-averse, represent the estimated bargaining power for each month. On average by month, α ranges from 0.624 in September to 0.970 in April and (1-α) ranges from 0.03 in April to 0.376 in September, all for the period from October 1998 through June 2002.

Selection of the Risk Aversion Coefficient (θ)

The MMC and the bargaining processor were not surveyed to determine their level of risk averseness. This is sensitive information that could give the MMC or processor a competitive advantage. However, a selection of the suitable range for the Pratt-Arrow absolute risk aversion coefficient θ is important. If an unreasonably high level of θ is used, a firm could perform so risk-averse that this individual could not remain competitive. This might cause an unrealistic result in the model. On the other hand, if θ is too small, then the decision could be almost identical to the decision of a risk-neutral individual (Babcock, Choi, and Feinerman, 1993). The result from the decision-making model might be misunderstood to be unresponsive to the risk-attitude changes.

Babcock, Choi, and Feinerman (1993) used the risk premium to select ranges of θ. The risk premium is the difference between the expected return on the risky investment and the return on the riskless investment that leaves a firm indifferent between the two investments (Robinson and Barry, 1987). To select the appropriate range for θ, assumptions concerning the firms' risk attitude and the size of the relevant gamble are necessary. Let's consider an individual with certain (guaranteed) income w and random income z = (h, -h) with a probability of winning or losing equal to 0.5. The risk premium (i.e., R_p times h) associated with this setup is in

(12) $$0.5\left[-\exp(-\theta(w+h)\right]+0.5\left[-\exp(-\theta(w-h)\right]=-\exp[-\theta(w-(R_p)(h))].$$

By solving equation (12), the proportional risk premium is

(13) $$R_p(\theta,h)=\frac{\ln\left[0.5(\exp(-\theta h)+\exp(\theta h))\right]}{\theta h}.$$

The risk premium $R_p(\theta, h)$ is shown as a proportion of h and can be interpreted as the percentage of the h that one is willing to pay in order to eliminate the gamble or the possible loss of h. For example, an individual who is willing to pay 98% of the possible loss of h to stay out of the gamble game is classified as an extremely risk-averse person (Babcock, Choi, and Feinerman, 1993).

The size of the random income h is set to the standard deviation of a payoff to a player (Babcock, Choi, and Feinerman (1993) and Wang, Dorfman, McKissick, and Turner (2001)). Assuming that the only source of uncertainty is from the price risk, the standard deviation of the historically negotiated price (the class I price plus the over-order premium) is used to represent the size of gamble h. The size of gamble h is equal to \$1.84, the standard deviation of the negotiated price.

Risk levels ranging from $\theta = 0.001$ to $\theta = 2$ produce proportional risk premiums ranging from 0.000091 to 0.8118 (table 2). The MMC or processor with $\theta = 0.001$ is almost risk-neutral. The bargaining model with $\theta < 0.001$ provides a result virtually identical to that in a risk-neutral model. In comparison, the MMC with $\theta = 2$ is willing to pay \$1.494 (82 percent of the potential loss) for eliminating the potential gain or loss of \$1.84. This is considered strongly risk-averse.[2]

The bargaining model used to calculate p^N is where the MMC and processor are risk-averse players with risk aversion coefficients (θ_c and θ_p) equaling 0.5. A θ equal 0.5 provides the proportional risk premium of 0.4068 (i.e., pay 40.68 cents for avoiding to win or lose one dollar), implying moderate risk aversion (based on the subjective classification; Babcock, Choi and Feinerman (1993)). The use of the risk aversion coefficient θ equal to 0.5 in the bargaining model is assumed to be the benchmark in this article.

[2] Wang, Dorfman, Mckissick, and Turner (2001) consider 90 percent of the potential loss to be extremely risk-averse.

The Projection of Over-Order Premium

The price of milk for fluid use in the U.S. has the minimum price set by the Federal Milk Marketing Order and is called the Class I price (*ClassI*). Thus, the terms of bargaining between the MMC and the processing plant involves an *over-order premium* which is the dollar amount above that monthly Class I price. The negotiated price (p^N) that the MMC (processor) receives (pays) for a given month is equal to the Class I price plus the over-order premium. Hence, the over-order premium (*PM*) is

(14) $$PM = p^N - ClassI \ .$$

The projected negotiated price p^N is computed from equation (11). Based on equations (11) and (14), the over-order premium (*PM*) can be calculated from the implicit equation

(15) $$\left(\frac{\alpha}{1-\alpha}\right)\theta_c e^{(\theta_p p_{bp} - \theta_c (ClassI + PM - ACI))} - \theta_p e^{(\theta_p (ClassI + PM) - \theta_c p_{bc})}$$
$$- \left[\left(\frac{\alpha}{1-\alpha}\right)\theta_c - \theta_p\right] e^{(\theta_p p^N - \theta_c (ClassI + PM - ACI))} = 0 \ .$$

Using equation (15), the projected over-order premiums are calculated using the SIML procedure in the econometric package Time Series Processor (TSP), version 4.4. The projected and historical over-order premiums are compared from October 1998 through June 2002 (table 3).

The mean of the historical and projected premiums are not significantly different (2.543 and 2.497, table 3). The coefficient of variation indicates that the historical premium is slightly more volatile from month to month than is the projected premium (table 3).

Sensitivity Analysis

Sensitivity analysis shows how sensitive the over-order premium (*PM*) is, if a certain variable is changed, ceteris paribus. It was performed in four cases. First, the assumption on the revenues per hundredweight p_{bc} is changed. Second, the assumption on the price per hundredweight p_{bp} is altered. Third, the risk aversion degree for both the MMC and processor is changed. Finally, the bargaining power parameter is varied.

Change in p_{bc}

The price per hundredweight p_{bc} (the price that MMC would receive from selling milk if the bargaining process with the processor broke down) is one of variables used to compute the over-order premium (*PM*), ceteris paribus. Therefore, assume p_{bc} changes from the benchmark p_{bc} to the Atlanta p_{bc}[3]. The projected premiums using the Atlanta p_{bc} and using the benchmark p_{bc} are calculated using equation (15).

The Altanta p_{bc} is always higher than the benchmark p_{bc}, except in August 2000 through November 2000, August 2001, and September 2001. As a result, the projected premiums using the Altanta p_{bc} is also higher than the projected premium using the benchmark p_{bc}, except in August 2000 through November 2000, August 2001. This means that the available market is very important to the bargaining process and its final outcome.

[3]The MMC might also be able to sell its fluid milk to other fluid milk markets. One possible scenario is that the MMC is able to sell all fluid milk to the processing plants in the Atlanta area if a bargaining breakdown occurs. Then, the price per hundredweight that the MMC would receive from selling fluid milk is the Atlanta Class I price plus Atlanta's over-order premium minus a per hundredweight hauling cost.

The mean of the projected premium for using the benchmark p_{bc} is significantly smaller than the premium when using the Atlanta p_{bc} (2.497 and 2.858, table 4). Furthermore, the coefficient of variation indicates that the projected premiums from using the benchmark p_{bc} and the Atlanta p_{bc} are almost equally volatile from month to month (0.120 and 0.123, table 4).

Change in p_{bp}

The price per hundredweight p_{bp} (what the processing plant would pay for fluid milk if the bargaining process with the MMC broke down) is one variable used to compute the over-order premium (*PM*). The purpose of this section is to investigate how the projected premium (*PM*) changes with respect to more expensive p_{bp}. The projected premiums for the risk averse case ($\theta_c = \theta_p = 0.5$) along with (1) the benchmark p_{bp}, (2) a one dollar more expensive p_{bp}, and (3) a two dollar more expensive p_{bp} are calculated (table 5).

When p_{bp} increases, the projected premium increases (table 5). The means of the projected over-order premiums are 2.497, 3.166, and 3.802 dollars per hundredweight for using the benchmark p_{bp}, a one-dollar-higher p_{bp}, and a two-dollar-higher p_{bp} respectively (table 5). The difference between the projected premiums using the benchmark p_{bp} and the one-dollar-higher p_{bp} is 0.669 and between benchmark p_{bp} and two-dollars-higher p_{bp} is 1.305. This makes sense because if the price per hundredweight p_{bp} increases then the premium will rise to reflect this outside market increase.

Change in the risk aversion levels

The size of the absolute risk aversion coefficient θ_c and θ_p represents the level of risk aversion belonging to the MMC and the processor. The objective of this section is to see how the projected premium (*PM*) changes with respect to changes in the level of risk aversion for both parties, ceteris paribus.

The projected over-order premiums when (1) the MMC is almost risk-neutral (i.e., $\theta_c = 0.001$) and the processor is moderately risk-averse (i.e., $\theta_p = 0.5$) and (2) the MMC is moderately risk averse (i.e., $\theta_c = 0.5$) and the processor is almost risk-neutral (i.e., $\theta_p = 0.001$) are calculated and are compared with the projected premium obtained from the benchmark case (i.e., θ_c and $\theta_p = 0.5$).

Every value of the projected over-order premium obtained when the MMC is almost risk-neutral (i.e., $\theta_c = 0.001$) and the processor is moderately risk-averse (i.e., $\theta_p = 0.5$) is higher than that obtained from the benchmark model when both the MMC and processor are moderately risk-averse (θ_c and $\theta_p = 0.5$). The MMC receives (the processor pays) a higher over-order premium as the MMC becomes less risk-averse, ceteris paribus. The means are 3.084 and 2.497 dollars per hundredweight (table 6).

The opposite is true for the projected over-order premium when the MMC is moderately risk-averse (i.e., $\theta_c = 0.5$) and the processor is almost risk-neutral (i.e., $\theta_p = 0.001$). Every value of the projected premium is lower than that obtained from the benchmark model (figure 4). The MMC receives (the processor pays) a lower over-order premium as the processor becomes less risk-averse, ceteris paribus. The means are 2.497 and 2.331 dollars per hundredweight (table 6).

When the MMC is almost risk-neutral and the processor is moderately risk-averse (i.e., $\theta_c = 0.001$ and $\theta_p = 0.5$), the average projected premium goes up 0.587 (i.e., 3.084-2.497) dollars per hundredweight from the average benchmark premium (table 6). When the MMC is moderately risk-averse and the processor is almost risk-neutral, the average projected premium declines only 0.166 (2.331-2.497) dollars per hundredweight from the average benchmark premium (table 6). The asymmetric change in the premium results from the bargaining power for the MMC, which is higher than the power for the processor (i.e., 0.89 and 0.11 on average). Therefore, the risk aversion of the MMC has more impact on the projected premium than the risk aversion of the processor, ceteris paribus.

Change in the bargaining power

The bargaining power for the MMC and the processor should affect the projected over-order premium. The projected over-order premium when both the MMC and processor are risk-averse (θ_c and $\theta_p = 0.5$) with different levels of bargaining power is calculated using equation (15), while holding other variables constant. The means of the projected premiums when the MMC and processor are risk-averse with (1) the benchmark bargaining power, (2) α ten percent lower, (3) α twenty percent lower, and (4) α thirty percent lower are 2.497, 1.888, 1.513, and 1.214 respectively (table 7). As the bargaining power for the MMC (the processor) declines (inclines), the projected over-order premium the MMC receives (the processor pays) drops, ceteris paribus.

The difference between the projected over-order premiums with two different bargaining power parameters is smaller as the margin between the upper limit p_{bp} and the lower limit p_{bc} minus ACI (p_{bp} - p_{bc} - ACI) is smaller. For example, the difference between the projected premium for the benchmark bargaining power and the thirty-percent-lower bargaining power (for the MMC) is very narrow in October 1998, September 1999, September 2000, and September 2001 when the margin between the upper limit p_{bp} and the lower limit p_{bc} minus *ACI* reaches its trough. The smaller the margin between the upper limit p_{bp} and the lower limit p_{bc} minus *ACI*, the narrower the bargaining range and the less the impact of the bargaining power on the projected over-order premium.

Summary

The MMC negotiates with processors for the price to pay farmers by the processors. The price of milk for fluid use in Florida has a price floor set by the Milk Marketing Order called the Class I price. Therefore, the MMC and the processors bargain over the dollar amount above the Class I price in any given month. Certainly, the Florida farmers and the MMC prefer to receive high over-order premiums. Conversely, the Florida processors would like to pay low premiums. In general, a cooperative of a given commodity usually negotiates with several processors (Iskow and Sexton, 1991). However, the MMC usually negotiates for an over-order premium with a leading processor and the agreement with other processors are equal or very close to the first determined premium. This structure indicates an approximate bilateral monopoly. This structure allows us to use the bilateral bargaining model to analyze the bargaining process between the MMC and a group of processors.

The projected over-order premium is calculated by subtracting the Class I price from the negotiated price. By using the monthly average bargaining power when both the MMC and processor are moderately risk-averse ($\theta_c = \theta_p = 0.5$), the projected over-order premium ranges from \$1.82 per hundredweight in November 1999 to \$3.10 in November

2000. On average, the projected over-order premium is \$0.046 per hundredweight lower than the actual over-order premium (\$2.497 and \$2.543 per hundredweight on average). Furthermore, while holding α, the upper limit (p_{bp}), the risk levels ($\theta_c = \theta_p$), and the *ACI* constant, an increase (decrease) in p_{bc} results in a rise (decline) in the projected over-order premium. The same is true for a change in p_{bp}. An increase (decrease) in p_{bp} causes a rise (decline) in the projected over-order premium.

The empirical results from the bargaining model indicate that the MMC constantly has higher bargaining power than does the processor (table 1). There are two reasons to support the finding that MMC has higher bargaining power. First, the price for milk sold to a manufacturing plant (the lower limit) is always much lower than the price for fluid use. Therefore, the MMC receives the negotiated milk price (Class I plus over-order premium) for fluid use, which is higher than the price for manufacturing use (the lower limit p_{bc}). Second, the actual negotiated milk price is closer to the upper limit (p_{bp}) than to the lower limit. Thus, the bargaining power depends mainly on the lower limit, upper limit and the margin between them.

Finally, the projected over-order premium is higher (lower) as either p_{bc} or p_{bp}, caused by outside market forces, increases (declines), ceteris paribus. Furthermore, the projected over-order premium is higher (lower) as the MMC (processor) becomes less risk-averse, ceteris paribus. The bargaining power has an impact on the projected over-order premium as well. The projected over-order premium the MMC receives (the processor pays) drops as the bargaining power for the MMC (the processor) declines (rises), ceteris paribus.

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Table 1. The Average and Standard Deviation by Month of the Bargaining Power α and 1-α for the MMC and Processor when both the MMC and the Processor are Risk-Averse (with $\theta_c = \theta_p = 0.5$) October 1998 through June 2002[a].

Month	α	1-α	Standard Deviation	Number of Observations
January	0.965	0.035	0.011	4
February	0.967	0.033	0.017	4
March	0.956	0.044	0.028	4
April	0.970	0.030	0.017	4
May	0.951	0.049	0.029	4
June	0.937	0.063	0.034	4
July	0.945	0.055	0.018	3
August	0.655	0.345	0.224	3
September	0.624	0.376	0.278	3
October	0.758	0.242	0.084	4
November	0.902	0.098	0.098	4
December	0.937	0.063	0.083	4

[a] calculated by solving equation (11) for α and using the monthly values of p^N and the other related variables as parameters. The equation is

$$\alpha = \frac{\theta_p[e^{(\theta_p p^N - \theta_c p_{bc})} - e^{(\theta_p p^N - \theta_c (p^N - ACI))}]}{\theta_c[e^{(\theta_p p_{bp} - \theta_c (p^N - ACI))} - e^{(\theta_p p^N - \theta_c (p^N - ACI))}] + \theta_p[e^{(\theta_p p^N - \theta_c p_{bc})} - e^{(\theta_p p^N - \theta_c (p^N - ACI))}]}$$

Table 2. The Risk Aversion Coefficient θ and Implied Risk Premium $R_p(\theta, h)$ for the \$1.84 Gamble Size.

θ	Proportional Risk Premium $R_p(\theta, h)$	Premium in Dollars
0.001	0.00092	\$0.002
0.01	0.00920	\$0.017
0.1	0.09149	\$0.168
0.3	0.26303	\$0.484
0.5	0.40680	\$0.749
0.8	0.56397	\$1.038
1	0.63683	\$1.172
1.5	0.75031	\$1.381
2	0.81182	\$1.494

Table 3. The Mean, Standard Deviation, and Coefficient of Variation of the Historical Over-Order Premium and the Projected Over-Order Premium when the MMC and Processor are Risk-Averse (with $\theta_c = \theta_p = 0.5$), October 1998 through June 2002.

	The Actual Over-Order Premium	The Projected Over-Order Premium
Mean	2.543[a]	2.497[a]
Standard Deviation	0.339	0.298
Coefficient of Variation	0.133	0.120

[a]Used to test the hypothesis that the means of the premiums are not significantly different. Failed to reject the null hypothesis at the 0.05 level.

Table 4. The Mean, Standard Deviation, and Coefficient of Variation of the Projected Over-Order Premium when the MMC and Processor are Risk-Averse (with $\theta_c = \theta_p = 0.5$) with the Benchmark p_{bc} and the Atlanta p_{bc}, October 1998 through June 2002.

	The Projected Over-Order Premiums (Dollars per Hundredweight)	
	Using the Benchmark p_{bc}	Using the Atlanta p_{bc}
Mean	2.497[a]	2.858[a]
Standard Deviation	0.298	0.352
Coefficient of Variation	0.120	0.123

[a]Used to test the hypothesis that the means of the premiums are significantly different. Reject the null hypothesis at the 0.05 level.

Table 5. The Mean, Standard Deviation, and Coefficient of Variation of the Projected Over-Order Premium when the MMC and Processor are Risk-Averse (with $\theta_c = \theta_p = 0.5$) with (1) the Benchmark p_{bp}, (2) One-Dollar-Higher p_{bp}, and (3) two-Dollar-Higher p_{bp}, October 1998 through June 2002.

	The Projected Over-Order Premiums (Dollars per Hundredweight)		
	Benchmark p_{bp}	One-Dollar-Higher p_{bp}	Two-Dollars-Higher p_{bp}
Mean	2.497[a]	3.166[ab]	3.802[b]
Standard Deviation	0.298	0.315	0.335
Coefficient of Variation	0.120	0.099	0.088

[a]Used to test the hypothesis that the means of the premiums are significantly different. Reject the null hypothesis at the 0.05 level.

[b]Used to test the hypothesis that the means of the premiums are significantly different. Reject the null hypothesis at the 0.05 level.

Table 6. The Mean, Standard Deviation, and Coefficient of Variation of the Projected Over-Order Premium when (1) the MMC is Almost Risk-Neutral and the Processor is Moderately Risk-Averse (θ_c= 0.001 and θ_p = 0.5), (2) the MMC and the Processor are Moderately Risk-Averse (the Benchmark with θ_c and θ_p = 0.5), and (3) the MMC is Moderately Risk-Averse and the Processor is Almost Risk-Neutral (θ_c = 0.001 and θ_p = 0.5), October 1998 through June 2002.

	The Projected Over-Order Premiums (Dollars per Hundredweight)		
	θ_c= 0.001 and θ_p = 0.5	θ_c and θ_p = 0.5	θ_c = 0.5 and θ_p = 0.001
Mean	3.084[a]	2.497[ab]	2.331[b]
Standard Deviation	0.388	0.298	0.343
Coefficient of Variation	0.126	0.120	0.147

[a]Used to test the hypothesis that the means of the premiums are significantly different. Reject the null hypothesis at the 0.05 level.

[b]Used to test the hypothesis that the means of the premiums are significantly different. Reject the null hypothesis at the 0.05 level.

Table 7. The Mean, Standard Deviation, and Coefficient of Variation of the Projected Over-Order Premium when the MMC and Processor are Rsk-Averse (θ_c and θ_p = 0.5) with the Bargaining Power (α) for the MMC at (1) the Benchmark Level, (2) the Ten Percent Lower, (3) the Twenty Percent Lower, and (4) the Thirty Percent Lower, October 1998 through June 2002.

	The Projected Over-Order Premium (Dollars per Hundredweight)			
	Benchmark α	Ten-Percent-Lower α	Twenty-Percent-Lower α	Thirty-Percent-Lower α
Mean	2.497[a]	1.888[ab]	1.513[bc]	1.214[c]
Standard Deviation	0.298	0.411	0.531	0.626
Coefficient of Variation	0.120	0.218	0.351	0.515

[a]Used to test the hypothesis that the means of the premiums are significantly different. Reject the null hypothesis at the 0.05 level.
[b]Used to test the hypothesis that the means of the premiums are significantly different. Reject the null hypothesis at the 0.05 level.
[c]Used to test the hypothesis that the means of the premiums are significantly different. Reject the null hypothesis at the 0.05 level.