RISK BALANCING STRATEGIES IN THE FLORIDA DAIRY INDUSTRY: AN APPLICATION OF CONDITIONAL VALUE AT RISK

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Abstract

Legislation has prompted changes in milk price volatility. Milk price volatility impacts the producer's exposure to business risk which is compound by the firms financial risk. Financial risk is a function of the firms capital structure. In the short run it is difficult for the producer to significantly change the firms capital structure and therefore balance increased business risk with reduced financial risk. The producer can however reduce financial and business risk by using futures contracts to lock in a price for milk produced. The producer's risk preferences dictate the producer's hedge ratio. Using the return on equity as a profitability measure and the conditional value at risk as a risk measure the optimal hedge ratio is derived for various probabilities of negative returns on equity.

Key words: Conditional Value at Risk, cVaR, Risk Management, Futures, Dairy

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Introduction

Legislation has prompted changes in milk price volatility. Increased price volatility reduces the financial leverage that a producer can adopt. The risk balancing literature has shown that producers compensate for increased business risk by decreasing financial risk (Gabriel and Baker, 1980). Financial risk is directly related to the firm's capital structure. Furthermore lack of access to equity markets make the capital structure for closely held corporations inflexible in the short run. This study will develop strategies the producer can use to balance increased milk price risk using futures in the short run.

A number of different risk measures have been proposed in the literature. Theoretical grounding requires risk measures to rank portfolios in a manner that is consistent with expected utility theory. Direct use of expected utility requires the laborious task of ascertaining cardinal knowledge of the decision maker's utility function. This has prompted researchers to utilize simpler risk efficiency approaches, making only modest assumptions about the utility function to calculate an efficient frontier of alternatives based on risk measures.

One of the more popular risk measures is the standard deviation of returns. Perhaps the most troubling aspect of the standard deviation criterion is that it discriminates against portfolios with return distributions that have a highly volatile right tail (Turvey and Nayak, 2003). In reality, volatility in the left tail, the unprofitable portion of the tail, is what really concerns decision makers. Furthermore consistency with expected utility requires decision makers to have quadratic utility functions or returns that are normally distributed or return distributions that vary only by location and scale and scale parameters (Meyer, 1987). Quadratic utility functions are not theoretically justified because they are not monotonically increasing. When tested empirically return distributions are typically distributed log normally, not normally (Kritzman, 1992).

Furthermore the distributions of returns for the options and futures contracts considered in this study vary by more than just the location scale transformation defined by Meyer.

The Value at Risk (VaR) measure of risk was recently introduced and has become extremely popular in the credit and finance sector. VaR predicts with a given confidence level that losses will not exceed a threshold level within a given time period (Hull, 1997, 22). VaR attempts to quantify in a holistic sense all of the risks facing a firm in a single number. Despite the intuitive appeal of the VaR risk measure, models that use VaR suffer from theoretical shortcomings. The most notable of which is the possibility that portfolio diversification will increase risk (Plug, 2000). This violation of the sub additivity occurs when the VaR of the portfolio is greater than the sum of the VaRs for each individual asset. The result of this violation is a risk function that is not necessary globally convex with respect to diversification, making optimization with linear programming difficult (Uryasev, 2000).

Given that losses exceed VaR the expected loss is called the conditional Value at Risk (cVaR) (Tyrell and Uryasev, 2002). Unlike VaR, the cVaR risk measure is sub additive axiom and is a globally convex function with respect to portfolio diversification (Plug, 2000). The sub additive attribute of the cVaR risk measure enables consistency to be established with expected utility when portfolios are ranked using second order stochastic dominance, consistency under the VaR risk measure requires the additional assumption that the loss distribution has a normal distribution or the more stringent condition that the portfolios are ranked by first degree stochastic dominance (Yoshiba, 2001). First degree stochastic dominance has limited discriminatory power (Anderson, et al., 1977, 284) and the returns typically do not have normal distributions. They have returns that log normally distributed. Furthermore the globally convex nature of the cVaR function makes even large problems with many scenarios easy to optimize using linear programming software.

The total risk is the sum of both business and financial risk. Dairy producers face a number of different sources of business risk such as production risk or the risk of volatile production and price risk or the risk of volatile prices (Harwood, 1999). Financial risk is a function of business risk and refers to the increase in total risk due to the decision maker's selection of capital structure (Collins, 1985).

The management objectives of individual dairy producers dictate the optimal distribution of return on equity (ROE) for an individual dairy producer. The distribution of ROE is affected by the capital structure and business risk facing the producer. The risk balancing hypothesis explains the decrease in financial risk that takes place when business risk increases (Gabriel and Baker, 1980). Legislation frequently changes the business risk facing dairy producers thereby affecting the distribution of ROE. In the short run the capital structure of closely held family corporations and proprietorships is relatively inflexible because efficient equity markets do not exist. Therefore it is difficult for producers to balance increases in business risk with decreased financial risk in the short run. The cVaR risk measure is applied to the distribution of ROE for dairy producers. Futures on class III milk are included as a decision variable in the model. The linear program calculates the appropriate values for the decision variables maximizing ROE and molding the short run distribution of ROE subject to balancing constraints. Furthermore the constraints can be adjusted to enable the producer to mold the distribution in the short run to meet specific survival and profit maximization management goals.

Agricultural risk management has been thoroughly researched by agricultural economists. Recently several applications of VaR to agricultural operations have been documented in the economic literature. The application of cVaR to the dairy industry is sure to stimulate discussion on the feasibility of hedging formula prices based on the weighted average prices for four classes using futures and options on class III milk.

Business and Financial Risk

The profitability of a firm is frequently analyzed using ratios. One of the ratios that is typically used is the return on equity (ROE). The firm's monthly ROE can be calculated as

(0.1) $$ROE = \frac{\tilde{P}\,Q - Q\,F - K - iD}{E},$$

where $\tilde{P}$ is a stochastic variables that quantifies the distributions of the expected class I milk price per hundredweight and *Q* is a deterministic parameter identifying the quantity of hundredweights expected for a given month respectively. The cost of feed per hundredweight, fixed costs, interest rate, debt and equity are captured by the parameters *F*, *K*, *i*, *D* and *E* respectively.

A second ratio that is frequently used is the firm's return on assets (*ROA*). The monthly ROA can be calculated as

(0.2) $$ROA = \frac{\tilde{P}\,\tilde{Q} - \tilde{Q}\,F - K}{E + D},$$

where the numerator is the same as equation (0.1) except that interest costs are not included and the denominator is equal to the firm's assets instead of the firm's equity.

The relationship between the firm's *ROE* and *ROA* is defined by the duPont identity which states that

(0.3) $$R\tilde{O}E = \left(R\tilde{O}A - \frac{iD}{E + D} \right) \frac{E + D}{E}.$$

Frequently a risk operator ρ is applied to the firm's distribution of *ROA* to determine the firm's business risk exposure. For Florida dairy producers variability in *ROA* is a function of volatile prices and production. For dairy producers price volatility is a function of government programs such as the federally mandated milk price support program. Production volatility is a function of weather and facilities. Similarly a risk operator ρ can be applied to the distribution of *ROE* to determine the firm's total risk exposure. The difference between $\rho(ROE)$ and $\rho(ROA)$ reflects the firm's financial risk. This difference is a function of $\frac{E+D}{E}$, the capital structure multiplier in equation (0.3). In this study it is assumed that the firm's interest rate i is deterministic and not a function of the firm's capital structure. This is an assumption, which is not consistent with financial theory but is consistent with the lending practices of many agricultural lenders.

Risk Balancing

Modigliani and Miller (1958) showed that in perfect capital markets a firm's capital structure is irrelevant (Modigliani and Miller, 1958). However, in the real world market imperfections exist. In the United States interest is a deductible expense and therefore a tax shield. Modigliani and Miller (1963) showed that with the introduction of the corporate income tax the optimal capital structure is the capital structure that maximizes the present value of the tax shield and therefore the debt to equity ratio(Modigliani and Miller, 1963). Warner showed that bankruptcy costs were significant (Warner, 1977). As the debt to equity ratio increase so does the probability of bankruptcy. As residual stakeholders, the firm's equity holders primarily bare the costs of bankruptcy. This reduces the debt to equity ratio. The debate could continue. In the real world there is more variation in the capital structures of industries than there is in capital structures of firms in a particular industry. This fact alone suggests that an optimal capital structure does exist. Furthermore in general less debt is carried by industries that are in considered "risky" than by industries that are considered "less risky." This seems to reaffirm Gabriel and Baker's risk balancing hypothesis. The risk balancing hypothesis claims that a decline in business risk produces an increase in financial risk (Gabriel and Baker, 1980). Most of the research done on optimal debt can be found in the corporate finance literature. Agricultural firms such as dairies, are either held as proprietorships, partnerships or closely held corporations and therefore do not have access to efficient equity markets. This results in short term inflexibility of the agricultural firms debt to equity ratio and differentiates it from large publicly traded corporations. Therefore in the short run it is difficult for agricultural firms to alter their capital structure in response to changing levels of business risk.

Milk Marketing

The 1996 Farm Bill ushered in a new era for agricultural producers. Amid concerns of a growing national debt and deficit, Congress sought ways to reduce spending on costly farm programs such as price supports. The Bill required government to distance itself from direct intervention in the agricultural arena. For dairy producers this meant the gradual elimination of milk price supports. The 2002 Farm Bill reauthorized price supports. In addition Congress included the Milk Income Loss Contract Program, which compensated producers 45% of the difference between $16.94 per hundredweight and the Boston class I price. While the 1996 Farm Bill signaled a transition to a free market the 2002 Farm Bill reinstated programs and invented programs that were reminiscent of a more protectionist era.

Currently the price support for milk is maintained through government purchases of butter, non-fat dry milk (NFDM) and block or barrel cheese. Purchases of supported dairy products are intended to support the price of milk at $9.90 per hundredweight. While the milk support price has remained constant over the past few years the price of underlying supported commodities has not. The Secretary of Agriculture is charged with maintaining an effective support price of $9.90 per hundredweight for producers. Twice a year the Secretary reviews the prices of the underlying supported manufactured dairy products. The Secretary will change the relationship of support prices for manufactured dairy products, maintaining the mandated price floor, if it is determined that public expenditures on the dairy price support program can be reduced. This adjustment is called the butter powder tilt. Two such adjustments have been made since January 2001. On January 16, 2001 the Secretary dropped the support price of NFDM from $1.00 to $.90 per pound while simultaneously increasing the butter support price from $.65 to $.85 per pound. These adjustments maintained a $9.90 milk price support. The government continued to accumulate NFDM well above its ability to use the product. From October 2000 to May 2001 the Commodity Credit Corporation purchased 330 million pounds of NFDM. This represented over 40% of the NFDM produced during that time period. On June 1, 2001 the Secretary revaluated the support price for butter and NFDM. The NFDM price was decreased to $.80 per pound and the butter price was increased to $1.05 per pound. These adjustments yielded a support price of $9.90 per hundredweight as mandated.

The $9.90 per hundredweight support price is based on milk with 3.67% butterfat. This translates into roughly $9.80 per hundredweight on a 3.5% butterfat basis. Adjustments can be made using the butterfat differential, which is currently not reported. The price adjustment for 3.67% butterfat to 3.5% butterfat milk can be calculated by subtracting .17 times the price of butterfat and adding .17 times the price of skim. The support price is maintained through government purchases of storable commodities such as non-fat dry milk, butter and cheese. There is however no mandate for plants to sell to the government therefore in real terms the price producers receive for delivered milk can drop below $9.80 hundredweight. Currently plants are reluctant to sell at support prices when opportunities exist in the private sector. Plants put a premium on selling milk to the private sector because the government requires special packaging and grading. Packaging and grading fees increase the cost of selling manufactured dairy products to the government. This has resulted in class prices that are well below support prices.

The federal price support program operates independently from the Federal Milk Marketing Order System (FMMO). The FMMO administers formulas, which are used to set minimum class prices which are published based on 3.5% butterfat. The class III price is the minimum price processors manufacturing cheese are able to purchase raw milk at. The class IV price is the minimum price that butter and NFDM processors are able to purchase raw milk. Prices are calculated based on formulas. The formulas are based on component prices which are estimated using wholesale survey prices of cheese, non fat dry milk, butter and dried whey for a given period. Class I and class II milk is used for fluid milk and frozen dairy products respectively. The class I price is based on the maximum of the class III and class four formula prices plus a fixed locational differential. While the class I component prices are calculated using the same formula the survey period of wholesale dairy products differs. This intricacy is important because it complicates hedging attempts by producers in predominantly class I markets.

Changing government policies, butter powder tilts and current market conditions impact the business risk facing dairy producers. The price volatility for each of the four milk classes can be evaluated using historical class data. The price volatility σ is a measure of the milk price uncertainty. First the standard deviation of the natural logs of successive monthly milk prices is taken for each year. The result is multiplied by the square root of 12 to generate an annualized estimate of price volatility σ. Monthly class I price mover data from 1996 to 2002 were used to calculate the yearly estimates of σ presented in Table 1. The second column of Table 1 reports the estimated yearly estimates of σ. The remaining column report the F statistic used to test the null hypothesis that the σ from succeeding years were equal. F statistics greater than 3.47 indicate an attained significance level α of .05 or less. The attained significance level refers to the probability of type I error or the error that occurs when the null hypothesis is rejected when in fact the null hypothesis is true. Considering only the off diagonal it can be seen that the price volatility varied significantly from 1996-1997, 1998-1999,1999-2000 and 2001 to 2002.

Table 1. Annualized Standard Deviation of Monthly Class I Mover Price Returns and F Values to Test Yearly Differences in Annualized Standard Deviations

Year	Annualized S.D. (σ)	
1996	12.32%	*5.012
1997	27.57%	1.075
1998	26.60%	*6.197
1999	66.21%	*31.299
2000	11.84%	*10.984
2001	39.23%	*29.536
2002	7.22%	

The results illustrated statistically in Table 1 can be seen graphically in Figure 1. In Table 1 the lowest σ is 7.22% and is reported for 2002. This corresponds to a period of prices that slowly decreased in 2002.

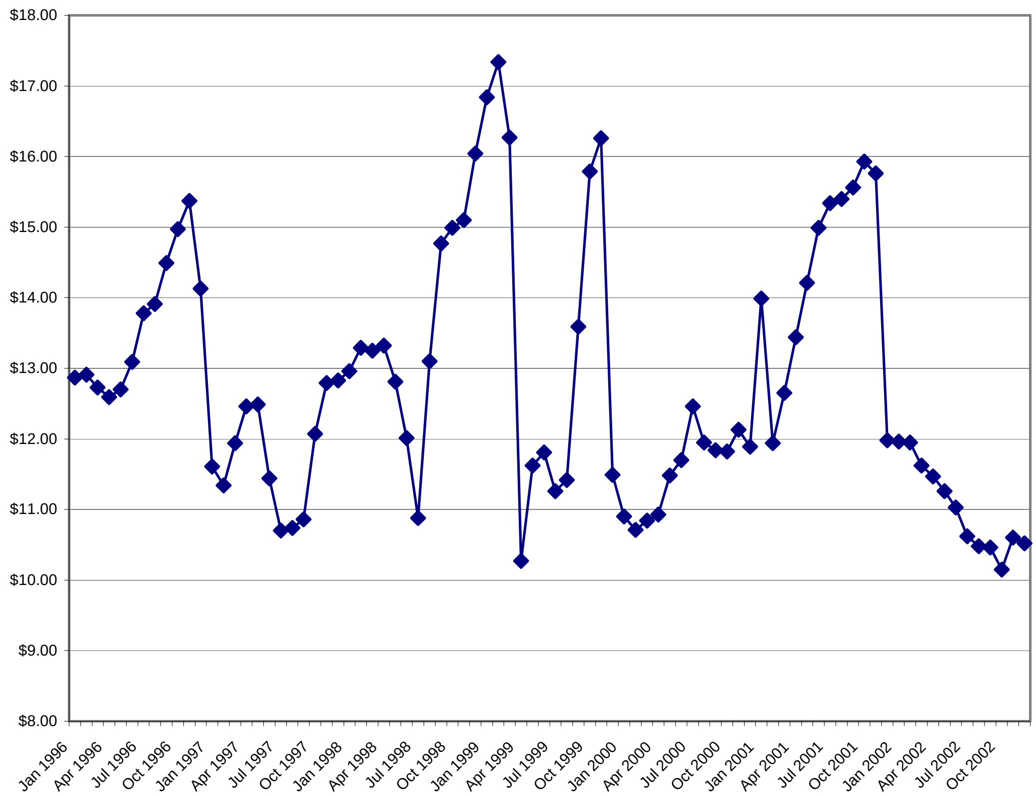

Figure 1. Class I Mover January 1996 to December 2002

Problem Statement

The Dairy Business Analysis Project (DBAP) was initiated in 1996 by the University of Florida to survey the financial performance of Florida dairy producers. DBAP summarizes the financial information of several categories of dairy producers. The information provided here is based on the 13 most profitable dairies (measured by ROA) in 2001.

Using per hundredweight revenue and cost estimates an income statement was formed. A balance sheet was also constructed based on DBAP estimates of assets and liabilities per cow. Using the net income calculated from the income statement and the equity calculated from the balance sheet the ROE was compared for various capital structures. Figure 2 illustrates the sensitivity of ROE to changes in the class I price.

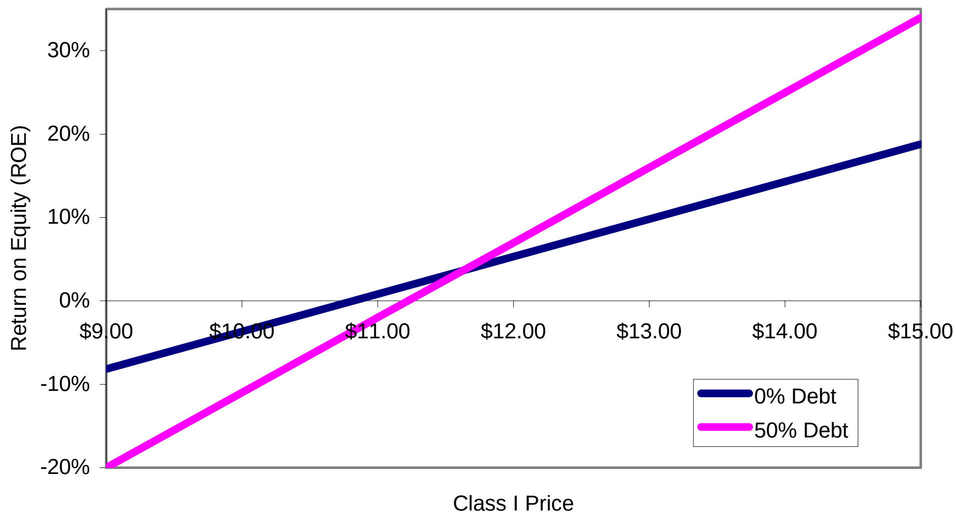

Figure 2. Comparison of Return on Equity (ROE) for 0% and 50% debt.

When prices equal $11.63 the profitability of the levered dairy equals the profitability of the unlevered dairy. The dairy producer is indifferent between these two capital structures when prices remain at this level. As prices increase the profitability increases quicker for the levered firm than for the unlevered firm. Similarly as prices fall the profitability of the prices for the levered firm decreases quicker than the profitability of the unlevered firm. If prices drop below $11.22 the levered firm will no longer cash flows. Prices need drop to $10.82 in order for the unlevered firm to no longer cash flow. The slop and intercept of the ROE for the unlevered firm are a function of the firm's business risk. The rightward shift of the intercept and increased slope of ROE for the levered firm are a function of the firm's financial risk.

The problem facing producers using leverage is that increased price volatility increases the probability of dropping below the $11.22 threshhold milk price. The risk balancing hypothesis suggests that the producer reduce financial risk in response to increased business risk. However in the short run closely held firms have a relatively inflexible capital structure. Increasing price volatility reduces the amount of debt that a dairy farm can carry. This study will analyze the impact of using class III milk futures contracts to mitigate the short run changes in price volatility.

Risk Measures

A number of different risk measures have been utilized in the academic risk management literature. Different criteria have been proposed to evaluate the legitimacy of these risk measures. One of the criteria that is frequently cited is consistency with expected utility. Consistency with expected utility requires that portfolios ranked by the risk measure have the same ordinal ranking as portfolios ranked by expected utility. Expected utility is based on the von Neumann Morgenstern axiomatic proof. Choice under uncertainty requires the independence axiom. The axiom of independence assumes that the rational choice between two portfolios should be based on how they differ. Several studies have shown the independence axiom to be violated empirically, however despite its shortcomings, expected utility remains the theoretically superior model for describing choice under uncertainty.

The standard deviation is a risk measure that is frequently used in the academic literature. The standard deviation is consistent with expected utility under the following three conditions. When the underlying utility function is quadratic, the return distribution is normally distributed or when the choice set consists of variables that differ by a location scale transformation then consistency with expected utility is achieved. The first condition poses serious theoretical shortcomings because quadratic utility functions are not monotonically increasing. The second condition is not supported empirically as return distributions are typically normally distributed.

A second risk measure that has recently become popular in the credit and finance industry is the value at risk (VaR). The VaR determines the probability of a portfolio losing a given amount in a given time period due to averse market conditions with a particular confidence level. According to Yoshiba and Yamai, VaR is consistent with expected utility maximization when the cumulative distribution of returns for portfolios can be ranked using first-degree stochastic dominance. According to Guthoff, Pfingsten and Wolf, the more lenient condition of consistency with second order stochastic dominance is all that is required when the returns have an elliptical distribution (Guthoff, January 1997).

Conditional value at risk (cVaR) is the expected value of losses given that losses exceed VaR. The conditional value at risk is consistent with expected utility under more lenient conditions than VaR because consistency with expected utility can be achieved when portfolios are ranked using second degree stochastic dominance with no distributional assumptions.

A second criteria for ranking risk measures is coherency. Artsner proposes a four properties for coherency. He defines a coherent risk measure as a risk measure that is sub additive, positively homogenous, monotonic with respect to first degree stochastic dominance, and translation invariance (Artzner).

The property of subadditivity requires that mergers not create extra risk. Therefore when the risk measure ρ is applied individually to the returns from two assets, x_1 and x_2, the combined risk must be less than or equal to the risk of the two assets. Mathematically Artzner represents this as

(0.4) $\rho(x_1 + x_2) \leq \rho(x_1) + \rho(x_2)$, where ρ is the risk measure operator. The property of subadditivity is limited by the property of positive homogeneity when there is there is no diversification effect. For example if the position is doubled for asset x_1 then there is no diversification effect and

(0.5) $\rho(\lambda x_1) = \lambda\rho(x_1)$.

The property of monotonicity assumes that if the losses of x_1 are less than the losses of x_2 for every scenario then $\rho(x_1)$ must be less than or equal to $\rho(x_2)$. The translation invariance axiom assumes that the addition of a constant deterministic variable κ affects the level of risk by the value of that constant such that

(0.6) $\rho(x_1 + \kappa) = \rho(x_1) + \kappa$.

Several of the risk measures considered in the literature are not coherent. The standard deviation violates the property of monotonicity with respect to first degree stochastic dominance in some cases. The standard deviation is monotonic with respect to first degree stochastic dominance when returns are normally distributed, however as previously discussed empirical evidence suggests that returns are not typically normally distributed. Value at risk is not a coherent risk measure because it violates the property of subadditivity when returns are not normally distributed (Plug, 2000). Conditional value at risk satisfies the subadditivity property with out making any distributional assumptions. Furthermore cVaR is positively homogenous, translation invariant and monotonic with respect to first-degree stochastic dominance and therefore coherent.

The weaker assumptions necessary to achieve consistency with expected utility and coherency prompted the selection of the cVaR risk measure for this study. Mathmatically Rockafellar and Uryasev define cVaR for discrete distributions as

(0.7) $$F_{\alpha}(x,\theta)=\theta+\frac{1}{1-\alpha}E\{\max[(f(x,\mathbf{y})-\theta),0],$$

where x is the decision variable, θ is the value at risk, α is the confidence level and **y** is a vector of stochastic variables (Rockafellar and Uryasev, 2000). The loss distribution is a function of both the decision variable and the stochastic vector and is defined as $f(x,\mathbf{y})$. For the purposes of this study the value at risk will be defined as a critical ROE. The loss function $f(x,\mathbf{y})$ generates a ROE for each particular scenario. Using equation **(0.7)** it is possible then to estimate cVaR.

Dairy Futures

The class III milk futures have been traded on the Chicago Mercantile Exchange (CME) since August of 1997. Basis defines the difference between the cash price and the futures price at a given point in time. The short hedger who seeks to hedge the sale of product produced for sale at some later time effectively trades price risk for basis risk. Basis risk is the term given to the variation in basis at a given time period. The effective price for the dairy producer trying to hedge future class III milk sales equals the entry price on the futures contract plus the basis between the local cash market price and the futures price at the time the contract expires. The entry price on the futures is always known however for most agricultural contracts closing basis is not known.

Most hedgers who assume a position on an agricultural futures contract roundturn their position by taking an equal and opposite position on the same contract. This effectively eliminates the hedger's position in the market. Making delivery on an agricultural futures contract for most hedgers is typically too cumbersome. The class III milk futures contract is differentiated from other agricultural futures in that the contract does not require delivery of the underlying physical commodity. The class III milk futures contract, cash settles to the future class III price released by the USDA. Cash settlement greatly simplifies the process of making delivery. As a result, a majority class III of milk hedgers do not offset their obligations on the futures contract by round turning their positions prior to expiration. Class III milk hedgers make "delivery." Making delivery on the cash settled class III futures contract ensures that the basis between the futures position and cash is zero and therefore for hedgers of class III milk the risk of a variable closing basis does not exist. The hedger of class III milk futures is able to effectively lock in the class III futures price.

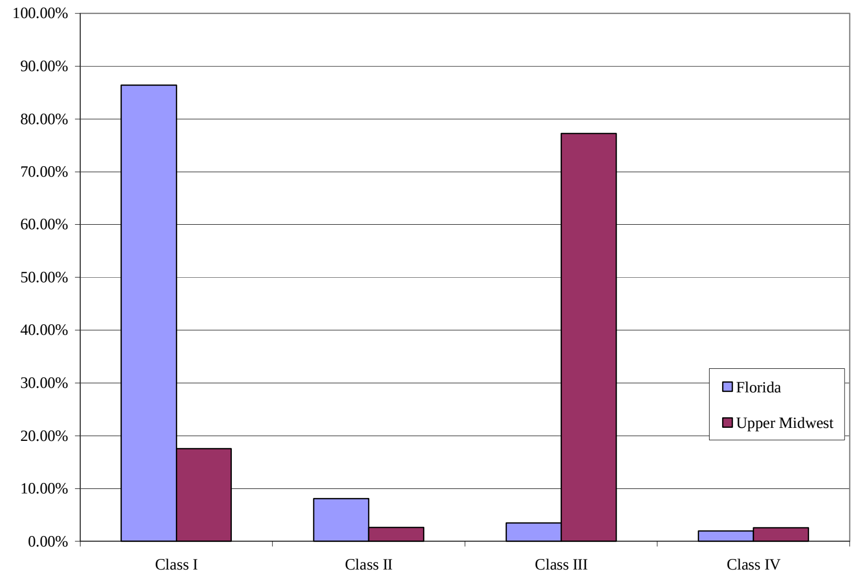

Figure 3. March 2003 A Comparison of Milk Class Utilization Between Florida and the Upper Midwest

Milk marketing in the United States is based on a complex system of formulas and surveys. Formulas are used to calculate the price of milk in each of four classes, defined early in this paper. Surveys conducted by the National Agricultural Statistics Service (NASS) are used estimate the whole sale prices of butter, NFDM, cheese and dried whey. These estimates are used to calculate the class III and class IV milk prices. Currently futures contracts based on the class III and class IV milk utilizations are listed on the CME and in reality only the class III milk contract is traded. Producers of milk that is used primarily in the class III market are able to hedge their milk production without considering basis risk. Producers from marketing orders such as Florida where a nearly 90% of the milk produced is utilized in the class I market do need to consider basis risk.

According to Hull three sources of basis risk are (1) uncertainty as to when the commodity will be marketed (2) closing the futures position before its expiration date (3) the commodity hedged is not the same as the underlying asset of the futures contract. Producers in the Upper Midwest, where class III milk dominates utilization, do not have to worry about the basis risk as much as the Florida producers. Florida producers face basis risk from two of the three sources noted by Hull. Since most of the milk produced in Florida is utilized in the class I market, Florida producers who seek to hedge their milk revenue must determine the feasibility of hedging class I sales with a class III futures contract. The class I milk price is based on the maximum of the class III and class IV milk prices and a fixed differential. The maximum of the class III and class IV milk price is called the class I mover. Effective hedging requires the ability to lock in the price of the mover, the stochastic portion of class I milk price. Some brokers have encouraged their clients to hedge with the maximum of the class III or class IV. Today this strategy is not effective because of the limited trading on the class IV futures contract. In fact at the time this article was written, the CME had stopped listing new class IV futures contracts.

Because of the thinly traded class IV future contract this paper only considered the use of the class III contract. Using the class III futures contract the producer should be able to lock in a minimum mover price. Therefore, at first glance, any basis risk encountered would work to the producers favor. This would be true if class I mover was based on the same survey periods and durations as the class III and class IV prices. In reality the class III and class IV price are calculated based on the NASS surveys during that month. The class III and class IV prices are released during the first week of the following month. The class I price for a given month is based on only first two weeks of NASS surveys from the preceding month. This exposes Florida producers to two of the causes of basis risk described by Hull. First of all, Florida producers face basis risk because they seek to hedge class I milk with a class III futures contract. This exposes producers to basis risk because the underlying asset of the class III is based on a full month of NASS surveys and not two weeks worth of NASS surveys like the class I mover. Furthermore the class I price is announced on a different date than the class III and class IV prices. Therefore producers are exposed to basis risk because they must round turn their contracts prior to the contracts expiration date.

This study determines the feasibility of hedging the class one mover for a given month by using the class III futures contract with an expiration from the previous month. The hedge was set on the first day of the month ten months prior to the first day of the “delivery” month. If milk futures were not traded on this day then the closest prior day was used. The contract was offset by roundturning the same class III futures on the day the class I price was announced. Using this strategy producers were able to lock in a minimum class I mover in all but 2 months from January 2000 to April 2003.

Figure 4 illustrates the effectiveness of locking in a minimum class I mover. On March 2002 the effective price was $.02 below the class III enter price and on November 2002 the effective price was $.05 below the class III futures enter price. Both of these incidents were caused by an accelerating component prices during the NASS survey weeks for February and October class III prices and lower prices during the survey period for March and November class I futures.

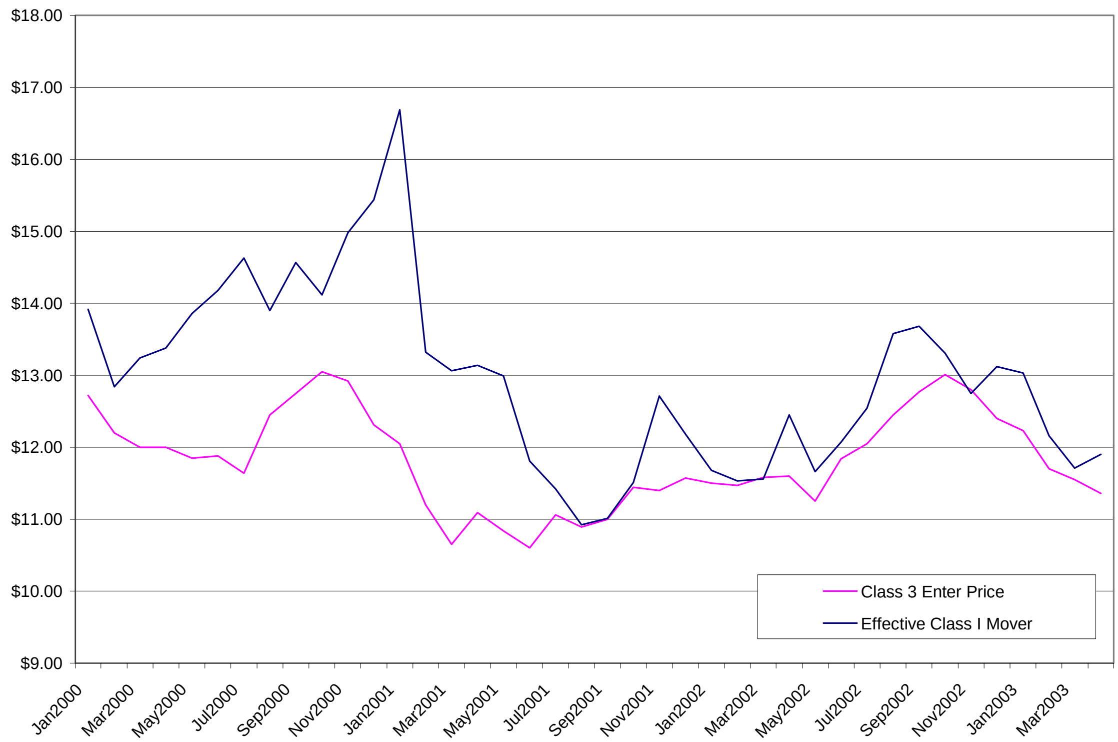

Figure 4. The Class III FuturesEnter Price Versus the Effective Class I Mover From January 2000 to April 2003

An additional concern for milk hedgers from all marketing orders is the high bid ask spread price in the class III dairy markets. The spread between the bid ask price can be used as a proxy for liquidity. The spread can also be considered as the cost of liquidity. Thinly traded markets such as dairy are characterized by a wider bid ask spread . The wider bid ask spread can be explained two ways. First of all, the higher bid ask spread is necessary to compensate market makers who have to look harder to find buyers and sellers in thin markets. Secondly thinner markets also have fewer market makers and therefore there is less competition amongst market makers. Market liquidity consists of three non mutually exclusive parts immediacy, size and price continuity. Liquidity is the “ability to transact immediately , in size with little transaction induced price changes. Consider a dairy farm with 1300 hundred cows that produced 50 pounds of milk per cow. If the producer opted to completely hedge the producer would need to take a short position on 10 class III futures contracts. If the producer tried to lock in the price of March 2004 milk on May 13, 2003 then the producer would have increased the volume for that day from 1 to 11! The far off contracts are thinly traded and therefore if this producer took a short position on 10 contracts all on the same day the price would have probably dropped significantly.

For this study it is assumed that produces are able to lock in the settle price ten months prior to the sale of class I milk. Liquidity concerns in dairy marketing threaten the reality of this assumption. However, this assumption is made for simplicity. In practice strategies using futures strategies using futures recommended in the results section of this paper should be implemented with a broker who is knowledgable about the liquidity concerns of trading far off milk futures contracts.

Empirical Model

The Cox-Rubenstein model was used to imply the volatility of class III prices in January and August of 2001. The implied volatility was used to construct a binomial tree which was used to the distribution of future class III milk prices. In this study the binomial distribution used to contruct the price tree was approximated with the normal distribution. Using Monte-Carlo simulation paths were randomly sampled through the binomial tree to generate a random sample of the possible class I mover.

The model is based on the most recently available 2001 DBAP data. Data from the thirteen most profitable dairies were used. Using these data estimates were generated for the cost of feed, personnel etc on a per hundredweight basis. The interest rate was estimated to by 7.25%. Based on these cost estimates the ROEs were generated for the capital structures ranging from 0% debt to 50% debt. The distribution of ROE for each of the capital structures was determined.

The VaR was set at 0% on the simulated ROE distribution that was based on no debt. The cVaR was calculated. The value for cVaR that was calculated was used to constrain the distributions of ROE from each of the capital structures considered. Using stochastic linear programming the expected ROE was maximized subject to the cVaR constraint. The hedge ratio, the percent of cash sales hedged with class III futures contracts, was included as the only decision variable in this model.

(0.8) $$Max\,E(ROE)\ \ sto.\ cVaR_{0\%}$$

The model considered based on the assumption that producers have lexicographic preferences for a given level of risk. Two months were considered January of 2001 and August of 2001. January contract hedged using a December 1999 class III milk futures contract and the August was hedged using the July 2001 class III milk futures contract. The short position on each of these contracts was executed on 3/1/2000 and 9/29/2000 respectively.

Results

The hedge ratio estimates for various capital structures are presented in Table 2. The estimates were determined by maximizing the expected ROE subject to a cVaR constraint. The cVaR constraint was based a VaR of 0%, 5% or 10% and on the cVaR calculated for the dairy with 0% debt.

Based on the results presented in Table 2 it is clear that as the dairy's financial risk increases the increase in financial risk can be offset by a corresponding decrease in business risk through hedging. The direct relationship between the percent debt and the hedge ratio indicates that producers are able to use class III milk futures balance financial risk. In order to earn a net profit the class III mover must be greater than $10.82 per hundred weight. The class I mover locked in for January was $12.05 and the class I mover locked in for August was $10.89. The lower the difference between the class III entry price and $10.82 the higher the hedge ratio must be for a given percent debt based on a cVaR constraint.

Table 2. Hedge Ratio Estimates for Various Capital Structures

January-01					August-01				
% Debt	cVaR	Expected ROE	Hedge Ratio	VaR	% Debt	cVaR	Expected ROE	Hedge Ratio	VaR
0%	-4.77%	5.57%	0.00%	0%	0%	-6.75%	-0.32%	0.00%	0%
10%	-4.77%	5.38%	11.00%		10%	-6.75%	-0.34%	14.55%	
20%	-4.77%	5.14%	21.80%		20%	-6.75%	-1.31%	29.61%	
30%	-4.77%	4.83%	32.86%		30%	-6.75%	-2.56%	44.76%	
40%	-4.77%	4.42%	44.08%		40%	-6.75%	-4.23%	60.95%	
50%	-4.77%	3.85%	54.82%		50%	-6.75%	-6.59%	84.98%	
% Debt	cVaR	Expected ROE	Hedge Ratio	VaR	% Debt	cVaR	Expected ROE	Hedge Ratio	VaR
0%	-1.58%	5.58%	0.00%	5%	0%	-4.27%	0.44%	0.00%	5%
10%	-1.58%	5.38%	10.88%		10%	-4.27%	-0.34%	15.80%	
20%	-1.58%	5.14%	22.17%		20%	-4.27%	-1.31%	32.53%	
30%	-1.58%	4.83%	33.27%		30%	-4.27%	-2.57%	51.33%	
40%	-1.58%	4.42%	44.53%		40%	n/a	n/a	n/a	
50%	-1.58%	3.85%	55.31%		50%	n/a	n/a	n/a	
% Debt	cVaR	Expected ROE	Hedge Ratio	VaR	% Debt	cVaR	Expected ROE	Hedge Ratio	VaR
0%	1.02%	5.58%	0.00%	10%	0%	-2.37%	0.44%	0.00%	10%
10%	1.02%	5.38%	11.31%		10%	-2.37%	-0.34%	18.98%	
20%	1.02%	5.14%	22.73%		20%	-2.37%	-1.33%	41.15%	
30%	1.02%	4.83%	34.24%		30%	n/a	n/a	n/a	
40%	1.02%	4.42%	46.16%		40%	n/a	n/a	n/a	
50%	1.02%	3.84%	58.19%		50%	n/a	n/a	n/a	

Conclusion

The model used in this paper used in this paper does not consider closing basis risk that producers were exposed too. Basis risk as illustrated early in this paper can be significant although historically variations in basis typically work to the producers advantage. Liquidity concerns are another issue discussed briefly in this paper that were not addressed by this model. The prudent hedger should be careful to set large positions over an adequate time in order to ensure price continuity. Furthermore the model only considers the producers ability to hedge the class I mover. In reality the producer needs to focus on hedging payments received by the cooperative. Although cooperative payments should be highly correlated with the class I mover this does not have to be the case. The cooperative is not required to pay minimum class prices to producers. Furthermore the cooperative has its own system of deductions and premiums that have not been accounted for by this study. Finally production risk due to inclement weather is concern for Florida producers. A worthwhile step would be to construct econometric estimates to the variable per hundred weight costs. Using these estimates in conjunction with estimates of production variable would also increase the usefulness of this model. However despite its shortcomings this model shows that theoretically (closing basis risk equals 0) producers paid the class I price based on a class III mover are able to reduce financial risk by using class III futures contracts and therefore they are able to balance increases in business risk during times of increased price uncertainty.

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