

**DAIRY PRICE RISK MANAGEMENT
ANALYSIS**

by

JOSH ENGELMANN

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Major Professor
Dr. Kevin Dhuyvetter

ABSTRACT

The size of our dairy operation increased from 300 milk cows to 1,700 milk cows in 2003. Once the dairy operation increased, the dependency on milk price to support the entire operation also increased. This was due to the fact that the cropping side of the operation became more devoted to growing feed for the livestock as opposed to producing cash crops. Thus, the increase in the number of milk cows led to decreased diversity in our income potentially increasing the financial risk of the operation.

The purpose of this thesis is to study different risk management tools and strategies to aid in the formulation of a risk management plan for milk sales in our operation. Risk management strategies using forward contracts, futures, put options, and cash were analyzed at different time periods and various minimum price levels. The strategies were analyzed over the last ten years (2001-2010) of available price data. Twenty-five risk management strategies were analyzed both with and without set minimum milk prices. Minimum price levels ranged from \$14/cwt to \$17/cwt in \$1 increments. The time frame for the transaction ranged from zero to twelve months prior to production in three-month increments.

Based on historical data, risk management strategies can be used to decrease the price risk faced by an operation. The risk management strategies did not affect the average price received at statistically significant levels typically considered. Different risk management opportunities are highlighted that need to be analyzed before fully implementing a risk management plan for dairy operations.

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CHAPTER 1: INTRODUCTION

The expansion of our family farming operation from 300 milk cows to 1,700 milk cows occurred on May 1, 2003. Before the expansion, the operation's income was diversified between milk sales and crop sales of corn and soybeans. Since the expansion, the operation relies heavily on milk income to support all of the daily activities. The cropping operation continues, but now is used primarily to raise feed for the dairy operation. There are still some crop sales, but in reduced amounts from what they were before the expansion. The expansion of the dairy side of the operation represents an increased specialization in milk production and hence has led to a reduction in diversification of income.

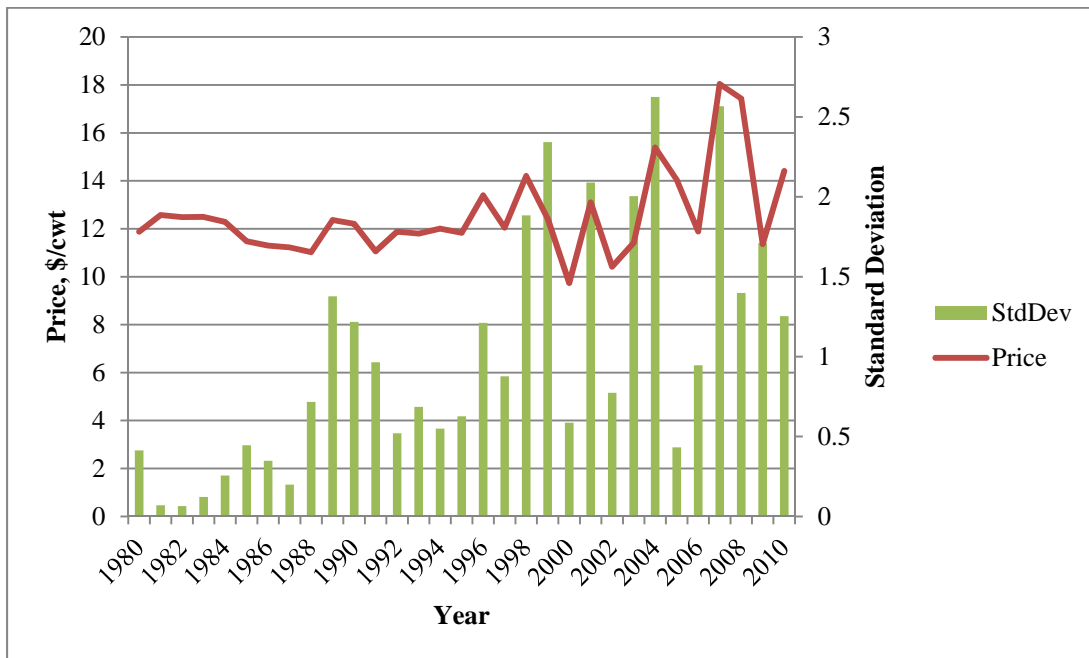
The main income source for the farming operation is milk sales. Every aspect of the operation is geared toward supporting the milking enterprise. The cropland is used to grow corn for silage and grain; alfalfa for haylage and dry hay; and soybeans as a rotational crop. Currently, the operation only sells soybeans as a cash crop with the rest of the crops used for feed. The presence of the cropping enterprise allows the operation to mitigate much of the price risk involved in supplying feed for the dairy operation.

Increased volatility in the milk markets has led to increased uncertainty in the operation's cash flow budgets from year to year. Currently, the operation sells all of its milk on a cash basis. The increased dependency on milk income has led the operation to research other tools available for milk price risk management.

1.1 Milk Price

Since 1980, the monthly announced Class III milk price has ranged from \$8.57/cwt (hundredweight) to \$21.38/cwt. The average price during that time period was \$12.55/cwt with a standard deviation of \$2.18/cwt. The annual average price has ranged from \$9.74/cwt to \$18.04/cwt and the annual standard deviation ranged from \$0.07/cwt to \$2.62/cwt. The lowest standard deviation was in 1981 and 1982 and the highest standard deviation was in 2004. Figure 1.1 displays the average annual milk price and standard deviation from 1980 through 2010.

Figure 1.1: BFP/Class III Milk Price Statistics



The volatility in the milk price has been increasing steadily since 1980. Table 1.1 reports summary statistics for milk prices by decade and for the 31-year (1980-2010) time period. The standard deviation has risen from \$0.79/cwt (1981-1990) to \$3.22/cwt (2001-2010). The range has also increased from \$4.60/cwt to \$12.81/cwt. Prior to 1999, on an

annual basis, the standard deviation of milk price was never higher than \$2.00/cwt. Since 1999, the standard deviation of milk price has been higher than \$2.00/cwt five times. Also, the standard deviation has ranged from \$0.59/cwt to \$2.62/cwt in the same time period. The data suggest that milk price volatility has increased since 1980 and has increased dramatically since 1998.

Table 1.1: Milk Price Summary Statistics

Year	Average	Standard Deviation	C.V.	Min	Max	Range
1981-1990	11.91	0.79	0.07	10.33	14.93	4.60
1991-2000	12.29	1.49	0.14	9.63	17.34	7.71
2001-2010	13.28	3.22	0.22	8.57	21.38	12.81
1980-2010	12.55	2.18	0.17	8.57	21.38	12.81

Increased milk price volatility has led to difficulty in preparing cash flow budgets for use by the operation. This has become increasingly important during expansion phases when an accurate cash flow budget was needed to determine loan repayment capabilities. Currently, lending institutions are requesting more financial information from borrowers than they have historically before extending them credit. The use of cash flow budgeting is one of the tools routinely required by lenders. Using risk management strategies can help dairy borrowers more accurately project their cash flow needs for the upcoming year.

1.2 Thesis Objective

The main objective of this thesis is to determine if using futures, put options, or forward contracts will benefit the family dairy operation. This is accomplished by studying how different milk pricing strategies would have performed had they been used in the past. The information gained from this analysis will help formulate a risk management plan for

the dairy operation to use in the future. The main client for this thesis is our family dairy operation. However, the information in this thesis will also be useful to other dairy operations and lending institutions that deal with dairy operations.

Previous research has concentrated on how different hedging scenarios affect the final price received for milk or the final price paid for inputs. These studies do not take into account how the hedging decisions affect the month-to-month financial situation of the operation. Specifically, an analysis is going to be conducted to examine how different hedging scenarios would have affected the cash flow of a dairy operation on a month-to-month basis.

To accomplish this objective, previous research was reviewed to determine what has been studied in the past and which hedging scenarios were included in the analysis. Industry professionals who actively engage in hedging were contacted to determine which hedging scenarios they use and the costs associated with hedging. Some of the hedging scenarios that have been researched in the past are modified for this analysis to expand and build upon this previous research. The defined and identified hedging scenarios are examined using historical price data. The data are used to determine the net cash flow on a month-by-month basis for each hedging strategy. It is also used to determine the final net price received per cwt of milk sold under each risk management scenario.

The results of the different pricing strategies are analyzed to determine how they affect the overall cash flow requirements of the operation, the net price received for the milk sold, and the overall risk of each risk management strategy. The results of this thesis

are used to lay the ground work for formulating a risk management strategy for milk sales for our family dairy operation.

CHAPTER 2: LITERATURE REVIEW

The prior research for this thesis falls into two categories. The first category involves risk management strategies and scenarios. The second category discusses the importance of financial analysis in the viability of a farming operation.

2.1 Risk Management Strategies

A variety of risk management strategies have been recommended by researchers over the last ten years. They range from time-based strategies to decision-based strategies. Time-based strategies rely on hedging milk at a certain time period before production. Drye and Cropp (2001) examined different time- and decision-based milk hedging strategies. They looked at time-based strategies using futures and options three, six, or ten months prior to milk production and delivery. They also looked at decision-based strategies. A futures market hedge was initiated when the milk futures price was trading in the top 30% or top 50% of historical values three, six, or ten months out. The results of their study showed that 20 of the 25 strategies considered resulted in a positive effect on net income (Drye and Cropp 2001). The results also showed that these same strategies reduced line of credit borrowing for the operations in the study. While the results of the study showed that risk management strategies can be effective, they were only examined over a three-year time period. Thus, it is important to see how a longer time frame might change the results of the study. Also, the strategies that were studied assumed that all of the milk would be hedged at one point in time. The study did not allow for a strategy that would only hedge a certain percentage of milk at any given time.

Schneider, Sanders, and Altman (2007) studied the effectiveness of producer hedging. They estimated a regression model of producer mailbox price as a function of Class III and Class IV futures prices. The results of the regression showed that a producer should hedge 85% of their production with Class III milk futures to minimize their price risk. When estimating the regression with Class IV milk futures, the results were not as promising for reducing price risk. That is, they found there is a higher correlation between producer price and Class III price than there is between producer price and Class IV price (Schneider, Sanders and Altman 2007). The results of the study point to studying more scenarios where a producer does not hedge all of their production.

Studies continue to look at decision-based risk management models. These models involve a producer hedging only when certain conditions are met. These conditions could include time and price or just price. The downfall to these strategies is that they require a producer to constantly monitor current market conditions to determine risk management strategies. While these strategies may result in higher net returns and less risk, they also increase the time and knowledge needed to implement a risk management plan. As risk management strategies get more complex, they may not be implemented correctly by producers. Jesse and Schuelke (2004) looked at the effectiveness of using absolute time and price targets to create a standing order with a broker. The results showed that standing orders did not significantly increase or decrease net price received. However, the standard deviation of price received for each strategy was less compared to simply taking the cash price. They show that risk management strategies that do not rely on constantly monitoring the market could be effective. This study also assumed that at the time of the hedge all of the milk would be hedged.

2.2 Financial Analysis

Many of the studies on risk management strategies concentrate on looking at the net price received per hundredweight (cwt) of milk. They do not examine the effects of the marketing strategy on month-to-month cash flow. The cost of the options or the margin requirements associated with a futures hedge could lead to the operation needing to borrow money to finance the risk management strategy. Van Blokland (2005) talks about the importance of profit and free cash flow when determining the viability of a firm. Profit describes the monetary resources left over after all the expenses have been taken into account. Free cash flow refers to what is left at the end of the period after all the expenses have been paid. It is the cash that is remaining to pay down principal on loans, pay owners salaries, or reinvest in the operation. It does not take into account what period the income or expenses should be applied to under accrual based accounting; it applies them to the period when the cash actually changed hands.

Most risk management studies discuss profit when determining how well the risk management strategy worked. They apply the costs associated with hedging to the same month when the milk was sold. While this helps evaluate how well the hedge ultimately worked, it does not indicate how the cash flow requirements change to support option premiums or margin calls up to the month when the hedge is lifted. The effect of the risk management strategies on cash flow needs to be measured to ensure that operations have enough cash or financing available to completely execute the hedge. One way to study how the cash flow changes on a monthly basis by individual risk management strategies is to look at partial budgets. Dalsted and Guterrez (2004) talk about partial budgeting and cash flow budgeting. When making a change to the operation, a partial budget can be used

to show how the changes will affect the cash flow. In using a partial budget, the only items that need to be included are those items that change with the scenario being studied. In this way, a partial cash flow budget can be used to determine changes to cash flow needs on a month-to-month basis when studying a risk management strategy.

CHAPTER 3: THEORY

3.1 Hedging Theory

Hedgers can either be short hedgers or long hedgers. “A short hedger is a market participant with an inherently long position in a commodity. A long hedger is a market participant with an inherently short position in a commodity” (Bittman 2001, p. 52). A short hedger has a commodity to sell in the future and is trying to protect the price they will receive for the commodity. A long hedger has a commodity they need to buy in the future and is trying to protect the price they will pay for the commodity.

This thesis is going to look at using futures and options for the purpose of a short hedge on milk prices. “A futures contract is an agreement between two parties, a buyer and a seller, to exchange a standardized good, the commodity, for an agreed-upon price at a specific date in the future, the delivery date” (Bittman 2001, p. 4). A short hedger would sell a futures contract with a delivery date closest to when they plan to sell the commodity in the cash market. In the case of milk futures, contracts are traded for every delivery month and the short hedger would use the contract for the month in which the milk will be produced. The use of a futures contract allows the producer to set the price that they are going to receive for the milk they produce in that contract month prior to when the milk is physically produced and delivered. The strategies being analyzed for price risk management are implemented with respect to the Class III milk price. They do not manage the basis risk. The basis in the milk market refers the difference between the producer’s mailbox price and the Class III milk price. (Bittman 2001) Currently, there are no risk management strategies available that allow dairy producers to protect against basis risk in the milk market.

There are two types of options – call options and put options. A call option gives the buyer of the option (i.e. the owner) the right to buy a futures contract at a set price; a put option gives the owner the right to sell a futures contract at a set price (Bittman 2001). The seller of the option has to take the opposite position on the futures contract if the option is exercised. Options are most commonly purchased to lock in a minimum sales price (put option) or a maximum purchase price (call option) for a commodity. This allows hedgers to take advantage of favorable moves in the marketplace while protecting against adverse price movement. A dairy producer would use a put option to set a floor price for their milk while still allowing them to take advantage of a rising milk market. The premium for the option is paid at time of purchase and there are not any margin calls. Options allows the hedger to identify up front what the cash flow needs are for the price risk management strategy.

In more advanced strategies, a combination of put and call options can be used to set a minimum price and a maximum price. This strategy, referred to as a fence or a window, is commonly used in a mostly sideways trading market to lock in a floor price and use a call option to defray the cost of setting the price floor. The downside is that the benefit of a rising market cannot be fully captured by the hedger.

3.2 Efficient Market Theory

The efficient market theory “says that (1) all available supply and demand information is used to determine today’s price, and that when storage and interest costs are ignored, (2) the best predictor of tomorrow’s price is today’s price, and (3) expected returns will be the same no matter when a commodity is priced” (Brosen and Anderson 2001, p.

1). The efficient market theory states that all available information is reflected in current prices and any change in price is a result of new information. Efficient market theory relies on the premise that all players in the market have access to all of the information available to determine the prices. The result of this is that abnormal profits cannot be systematically earned by any players in the market.

The implication of the efficient market theory for this thesis is that, on average, in the long run, the use of futures and options is not expected to earn a higher return than alternative marketing strategies. However, their use might be effective at reducing price and cash flow risk. The purpose behind a risk management plan using futures and options is to reduce the amount of risk that is being carried by the producer.

While the efficient market theory suggest that using futures and options is not expected to increase price, it is hard for a producer to ignore expected price when hedging. A hedging strategy with lower risk but also a lower expected price might not be viewed favorably by a producer. Each producer will have their own risk/return tradeoff with which they are comfortable.

CHAPTER 4: METHODS

4.1 Risk Management Strategies

This thesis is going to analyze different risk management strategies using futures contracts, put options, forward contracts, and cash. The risk management strategies are going to be analyzed for the production months of January 2001 through December 2010. The basis for the risk management strategies analyzed is based on previous research. Drye and Cropp (2001) examined hedging 100% of milk production at three, six, and ten months prior to production. The marketing strategies in the previous research studied generally hedged all of the milk production at one time. The analysis in this research is going to look at hedging a percentage of production at different time periods.

Table 4.1 lists the hedging strategies to be analyzed using forward contracts. The available tools for this thesis are forward contracts, futures contracts, put options, and cash. The **% Hedged** column details what percent of the milk is going to be hedged using the risk management tool identified in the title of the table. The amount of milk being hedged is based on the guidelines of the different risk management strategies and the availability of hedge tools at the time of the hedge decision. The **Time of Pricing Decision** column refers to when the risk management transaction is going to take place. The timing is listed as the number of months before the milk is produced and sold in the cash market. For example, strategy B would involve hedging all of the milk 3 months prior to production using forward contracts. Strategy F would involve hedging 25% of the milk 3 months prior to production using forward contracts, 25% of the milk 6 months prior to production using forward contracts, 25% of the milk 9 months prior to production using forward contracts, and 25% of the milk 12 months prior to production using forward contracts. The **Min**

Price column refers to whether or not a minimum price needs to be achievable in the market to proceed with the pricing strategy. With no minimum price required this simply implies that milk is priced using the forward contract strategy regardless of price level at the various times for the different strategies.

Table 4.1: Forward Contract Hedging Strategies

Code	% Hedged	Time of Pricing Decision	Min Price
B	100	3 Months	None
C	100	6 Months	None
D	100	9 Months	None
E	100	12 Months	None
F	100	25% 3 Months, 25% 6 Months, 25% 9 Months, 25% 12 Months	None

The average price received for milk hedged with forward contracts is calculated by multiplying the hundredweights (cwt) of milk contracted by the forward contract price plus the cwt of milk not contracted by the cash price. The total income from contracted milk and cash sales is divided by the total cwt of milk sold to determine the average price received for the milk for that month. The average price received for all 120 months will then be averaged to calculate the average price received over the entire time period.

Table 4.2 lists the hedging strategies to be analyzed using futures contracts. Table 4.3 lists the hedging strategies to be analyzed using put options. When using put options, the producer would purchase put options for the month that the milk is going to be produced. This allows the producer to lock in a floor price (the put option strike price minus the option premium and transaction costs) while still allowing them to take advantage of a rising market.

Table 4.2: Futures Contract Hedging Strategies

Code	% Hedged	Time of Pricing Decision	Min Price
G	100	3 Months	None
H	100	6 Months	None
I	100	9 Months	None
J	100	12 Months	None
K	100	25% 3 Months, 25% 6 Months, 25% 9 Months, 25% 12 Months	None

Table 4.3: Put Options Hedging Strategies

Code	% Hedged	Time of Pricing Decision	Min Price
L	100	3 Months	None
M	100	6 Months	None
N	100	9 Months	None
O	100	12 Months	None
P	100	25% 3 Months, 25% 6 Months, 25% 9 Months, 25% 12 Months	None

The average price received for milk hedged with futures contracts is calculated by multiplying the hundredweights (cwt) of milk hedged by the futures contract price plus the cwt of milk not hedged by the cash price. The total income from hedged milk and cash sales less transaction costs is divided by the total cwt of milk sold to determine the average price received for the milk for that month. The average price received for all 120 months will then be averaged to calculate the average price received over the entire time period.

The average price received for milk hedged with option is calculated by multiplying the hundredweights (cwt) of milk hedged by the effective price from put options. The effective price from put options is the higher of the put option strike price and the cash

price. Total income is the cwt of milk hedged times the put option effective price plus cwt of milk not hedged times the cash price. The total income from hedged milk and cash sales less put option premiums and transaction costs is divided by the total cwt of milk sold to determine the average price received for the milk for that month. The average price received for all 120 months will then be averaged to calculate the average price received over the entire time period.

Table 4.4 and Table 4.5 list the strategies that combine hedge tools. Strategies Q through U (Table 4.4) use forward contracts, futures, and options for the risk management strategy. In each scenario, one third of the milk is hedged using each tool. Strategies V through Z (Table 4.5) also use all three hedge tools. In these strategies, one fourth of the milk is hedged using each tool and one fourth of the milk is marketed at the cash price. The strategies also utilize the different time periods for executing the hedge. Analyzing these strategies will show if using a combination of hedge tools further decreases overall price risk.

Table 4.4: Hedging Strategies Using Three Pricing Methods

Code	% Hedged	Time of Pricing Decision	Min Price
Q	100	3 Months	None
R	100	6 Months	None
S	100	9 Months	None
T	100	12 Months	None
U	100	25% 3 Months, 25% 6 Months, 25% 9 Months, 25% 12 Months	None

*1/3 Forward Contracts, 1/3 Futures, and 1/3 Options

Table 4.5: Hedging Strategies Using Four Pricing Methods

Code	% Hedged	Time of Pricing Decision	Min Price
V	75	3 Months	None
W	75	6 Months	None
X	75	9 Months	None
Y	75	12 Months	None
Z	75	25% 3 Months, 25% 6 Months, 25% 9 Months, 25% 12 Months	None

*1/4 Forward Contracts, 1/4 Futures, 1/4 Options, and 1/4 Cash

As can be seen in Tables 4.1 through 4.5, none of the hedging strategies have a set minimum price. Each of the strategies will be analyzed without a minimum price and also with minimum prices. The minimum prices being analyzed in this thesis are \$12/cwt to \$17/cwt in \$1 increments. If the hedge price is below the minimum price at the timing of the hedge, that portion of the milk will not be hedged. For example, strategy B would involve selling all of the milk using forward contracts 3 months prior to production. Strategy B12 would involve selling all of the milk using forward contracts 3 months prior to production only if the forward contract price is greater than \$12/cwt. The timing of the transaction is a one-time deal. For example, using strategy F12, if the forward contract price 12 months prior to production is less than \$12/cwt, 25% of the milk will not be hedged. If at 9 months prior to production the forward contract price is greater than \$12/cwt, only 25% of the milk will be hedged. There is not a catch-up transaction to make up for the 25% of the milk that was not hedged 12 months prior to production.

It is assumed that the transactions for each strategy are executed on the first trading day of the month. If any of the hedging strategies do not have a price for that time period, that portion of milk will not be hedged. Early in the data range, some of the futures

contracts did not start trading until nine or ten months prior to the production month. Also, options prices were not always available twelve months prior to production. At twelve months prior to production, forward contracts and futures were not available 12.5% of the time, and put options were not available 35% of the time. At nine months prior to production, put options were not available 2.5% of the time.

For options, the strategy uses the closest out-of-the-money strike price that has price information. For example, if the underlying futures contract is trading at \$13.56/cwt, then the put option with a \$13.50/cwt strike price will be used. The forward contract price is equal to the futures contract trade price for that month minus \$0.10/cwt. The hedge price analyzed for the minimum price is equal to the futures price or the forward contract price for strategies utilizing those tools. For put options, the hedge price is calculated as the put option strike price minus the put option premium.

Transaction costs for hedging with futures are \$24/contract when the futures contract is sold and \$24/contract when the futures contract is settled. For options, transaction costs are \$44/option when purchased and another \$44/option if the option is exercised. While forward contracts do not have any transaction costs associated with their use, the forward contract price is always \$0.10/cwt less than the futures price. The \$0.10/cwt could be viewed as the transaction cost for forward contracting.

Expected production is based on a 1,700 cow dairy producing 78 lbs. per cow per day. The expected milk production to be hedged is 4 million lbs. of milk per month. While milk production tends to be seasonal (higher during the winter months and less during the

summer months), it will be assumed for the purpose of the thesis that milk production is stable on a month-to-month basis.

Price data for the futures and options contracts, along with historical milk prices, were obtained from the University of Wisconsin Dairy Market and Risk Management Homepage. Price data for forward contracts are from Bongards Creameries. Transaction costs are based on current information from FC Stone.

4.2 Partial Budgeting

A partial cash flow will be created for each month from January 2000 through December 2010. The partial cash flow is constructed over an eleven-year time period, even though the price data being analyzed are for a ten-year time period. The extra year allows for the hedge strategies to be fully put into place for the ten-year price data set. The partial cash flow consists of all financial activity related to risk management strategies. The partial cash flow consists of three parts: cash inflow, cash outflow, and interest. Cash inflow contains excess funds available from the margin account, gains on forward contracts, and gains on options. Cash outflow contains additional funds needed for margin account, futures commissions, options commissions, options premiums, and loss on forward contracts. Interest is calculated on the monthly ending cash balance relating to the risk management strategies. A negative balance at the end of the month incurs an interest charge, while a positive balance at the end of the month earns interest income.

The interest rate earned or charged by the hedging cash flow is the prime interest rate plus 1.5% with a minimum rate of 6%.

Several assumptions will be made to simplify the analysis. The margin account balance will be calculated on the last business day of every month. Any additional funds needed to meet maintenance requirements will be deposited at this time. Also, any excess funds beyond maintenance requirements will be pulled out of the account at this time. Initial and maintenance requirements are assumed to be the same to simplify the analysis. Margin requirements are calculated at \$600 per futures contract. The information for margin requirements comes from FC Stone.

The analysis of the partial cash flow will concentrate on cumulative cash needs throughout the entire time period. Each of the strategies will be compared to the baseline cash flow, selling all of the milk in the cash market. Each of the strategies will be analyzed to determine how they affect overall cash flow needs for the operation, as compared to the baseline. A positive cash balance will indicate the strategy generated more cash than it required. A negative cash balance will indicate the strategy required more cash than it generated. A positive interest amount indicates that the strategy earned interest while a negative interest amount indicates that the strategy was charged interest. It will be assumed that the operation needs to borrow funds to cover any losses incurred from hedging activities.

The analysis will look at the minimum and maximum values of the partial cash flow for each scenario. The minimum number will represent the largest dollar amount needed at any given time over the eleven-year period to cover the results of the risk management strategy. The analysis will also look at the amount of interest per cwt of milk

that was required for each risk management strategy. This information is helpful for operations in determining cash flow needs on a monthly and annual basis.

4.3 Analysis

The following measures will be calculated for each strategy. The first number to be calculated will be the average price received per cwt of milk. This measurement will indicate which risk management strategy earned the highest average price. The minimum, maximum, and range of price received will also be calculated. These numbers will give a quick indication of which strategy has the widest variation in price received over the ten-year time period.

The standard deviation and coefficient of variation will be calculated to measure the amount of risk for each scenario. The coefficient of variation will be used to compare the scenarios because it accounts for the different means of each scenario to give a more accurate depiction of risk.

The percentage of milk hedged will be calculated to determine how much of milk is hedged under each scenario. This will be used in the scenarios that have a minimum hedge price to determine how much of the milk is actually being hedged. The percentage of months with an average price greater than the cash price will also be calculated. This provides another measure of the effectiveness of the risk management strategy.

A paired t-test will be conducted on the monthly prices for each risk management strategy compared with the all cash sales strategy. The t-statistic and associated p-value will be calculated using a two sample t-test assuming uneven variances. The inclusion of

the p-value will help to determine if the mean for each strategy is statistically different from the mean for the all cash strategy. The F-statistic will also be calculated to determine if the amount of variance for each strategy is statistically different than the all cash strategy.

The median and skewness will also be calculated for each risk management strategy and compared to the all cash strategy. These two measures will help to determine if there is more upside risk than downside risk for each risk management strategy. A positive skewness indicates there is a greater than 50% probability that a particular outcome will be below the mean. It indicates that more of the observations are located to the left of, or below, the mean. With positive skewness, there is a greater probability of having an outcome below the mean, so there is greater downside risk. A negative skewness indicates there is a greater than 50% probability that a particular outcome will be above the mean. It indicates that more of the observations are located to the right of, or above, the mean. With negative skewness, there is a greater probability of having an outcome above the mean, so there is greater upside risk. A risk management strategy should not be viewed negatively because of higher risk if the increased risk is the result of upside risk. All statistical tests and calculations are done in Microsoft Excel.

The calculations and analysis conducted in this step of the thesis are done independent of the results of the partial cash flows for each risk management strategy.

CHAPTER 5: RESULTS

5.1 Average Price

The highest average price among all of the strategies was \$14.31/cwt for strategy E15, hedging 100% using forward contracts 12 months prior to production with a minimum price of \$15/cwt to execute the hedge, and strategy J15, hedging 100% using futures contracts 12 months prior to production with a minimum price of \$15/cwt to execute the hedge. These strategies resulted in an average price that was \$0.56/cwt higher than the average cash price. Both strategies hedged slightly less than 25% of the total milk production. The lowest average price among all strategies was \$13.32 for strategy D, hedging 100% using forward contracts 9 months prior to production without a minimum price to execute the hedge. This strategy resulted in an average price that was \$0.43/cwt less than the average cash price of \$13.75.

Among the strategies that did not have a set minimum price, marketing strategies using 100% put options had the highest average prices (Table 5.1). The strategies that used 100% forward contracts (B-F) had the lowest average prices. Of the 25 strategies analyzed, only five strategies, those using put options (L-P), had a higher average price than cash. Using put options allows producers to take advantage of rising prices while still protecting themselves from lower prices. The strategies that used 100% forward contracts or 100% futures contracts locks producers into a price regardless of whether the market rises or falls. Without setting a minimum price, producers could be locking themselves into a low price where it would be more advantageous to just wait and take the cash price for that month.

The results start to change when a minimum hedge price is introduced. With a \$12/cwt minimum, only four strategies (B12, G12, Q12, and V12) have an average price lower than cash (Table 5.2). Likewise, here are only four strategies that have an average price lower than cash with a \$13/cwt (B13, G13, Q13, and V13) or \$14/cwt (B14, G14, Q14, and V14) minimum hedge price (Tables 5.3 and 5.4). When there is a \$15/cwt minimum, only one strategy (B15) had a lower average price than cash (Table 5.5). A \$16/cwt minimum results in two strategies (B16 and G16) having a lower average price than cash (Table 5.6), while a \$17/cwt minimum results in no strategies having a lower average price than cash (Table 5.7).

When there was not a minimum set hedge price, it was evident that the strategies using 100% put options had the highest average prices. When minimum hedge prices are introduced, there does not seem to be a pattern as to which hedging tools produce the highest average prices. The only pattern seems to be that forward contracts tend to produce the lowest average prices as compared to the other hedging strategies.

The t-statistics and associated p-values were calculated for each risk management strategy as compared to the baseline (100% cash sales). None of the average prices are statistically significant until the confidence level is decreased to 85%. This means that none of the average prices for the risk management strategies are statistically different from the cash average price at typically reported levels of significance (i.e., confidence levels of 90, 95, or 99%). Based on this information, the efficient market theory that suggests that hedging will not result in a higher average price appears to hold.

5.2 Risk

The coefficient of variation (CV) is used to evaluate the relative riskiness of the various pricing strategies. A higher CV indicates that a strategy is riskier than a strategy with a lower CV. The cash price over the ten-year study period has a CV of 0.22. None of the risk management strategies studied had a higher CV (over the ten-year period) than the cash strategy. There are a number of strategies with a higher minimum hedge price that have close to the same amount of risk as cash, but there are not strategies that have more risk. The lowest overall CV was 0.13 for strategies F, K, and U (Table 5.1). The highest overall CV was 0.22 for strategies that had a \$16/cwt and \$17/cwt minimum hedge price (Tables 5.6 and 5.7).

Among the strategies without a minimum hedge price (Table 5.1), the CV ranges from 0.13 to 0.19. The strategies with the lowest risk are F, K, and U. Strategy F hedged 100% using forward contracts (25% 3 months prior, 25% 6 months prior, 25% 9 months prior, and 25% 12 months prior). Strategy K hedged 100% using futures contracts (25% 3 months prior, 25% 6 months prior, 25% 9 months prior, and 25% 12 months prior). Strategy U hedged 100% using 1/3 forward contracts, 1/3 futures contracts, and 1/3 put options (25% 3 months prior, 25% 6 months prior, 25% 9 months prior, and 25% 12 months prior). The strategy with the highest risk is strategy L, hedging 100% using put options 3 month prior to production. The time-based strategies without a minimum hedge price showed that risk can be reduced by spreading out the timing of the pricing decisions.

Similar results appear when a minimum hedge price is introduced. For each minimum price, strategies F, K, and U continue to have the lowest amount of risk. Strategy

L also continues to have the highest risk, along with the other strategies using 100% put options, at each of the minimum hedge price levels. The results tend to show that spreading out the pricing decisions among different time frames can lead to lower overall price risk.

The F-test was conducted to determine if the price variability for each risk management strategy was significantly different from the price variability of cash. At the no minimum price level and the lower minimum price levels, the F-test indicates that the majority of the risk management strategies have risk that is significantly different than the risk of always pricing in the cash market. As the minimum hedge price rises, the F-test also rises and the amount of risk for each strategy is not significantly different than the amount of risk of taking the cash price.

5.3 Hedge Percentages

The hedge percentages were calculated to help determine how much of the milk was being protected by a risk management strategy. As expected, going from no minimum price to higher minimum prices, the amount of milk that is protected by a hedge strategy decreases. At minimum prices of \$15/cwt and above (Tables 5.5 to 5.7), the amount of milk protected by a hedge strategy falls below 25 percent. At a minimum price of \$17/cwt (Table 5.7), the amount of milk hedged falls below 10 percent for all but two of the strategies (B17 and G17). As the percentage of the milk that is hedged falls, the amount of risk increases. Also, the statistical significance of the difference between the variability of the risk management strategy and the cash price decreases. At minimum hedge prices of \$14/cwt and higher, there is no statistical difference between the amount of risk for each

strategy as compared to cash at typically reported levels of significance (i.e., confidence levels of 90, 95, or 99%). As the minimum price increases, the pricing strategies start converging to the cash strategy. This would explain why the amount of risk at the higher minimum price levels is not significantly different than the amount of risk with the all cash strategy.

The other percentage that was calculated was the percentage of months that had an average price greater than the cash price. When there is no minimum hedge price (Table 5.1), the percent ranges from 19% to 49%. With a \$12/cwt minimum (Table 5.2), the percent ranges from 13% to 38%. The lower and upper portions of the percentage range continue to decrease as the minimum hedge price increases. When the minimum hedge price gets up to \$17/cwt (Table 5.7), the percent ranges from 2% to 13%. The reason for the decreased percentages can be attributed to the decreased percent of milk being hedged. At the \$17/cwt minimum hedge price, the percent of milk hedged falls below 10 percent. This means that 90% or more of the milk is sold at the cash price. This results in a lower percentage of the months being greater than cash.

The percentage of months that had an average price greater than cash does not accurately gauge the effectiveness of the put option risk management strategies. Put options are used to set a floor for the milk price. The cost of setting that floor is the option premium. Because of the option premium, when the milk price rises the average cash price received under the put option strategy will be below the cash price strategy by the option premium plus transaction costs. The strategy could still be viewed as successful because it set an acceptable floor price for the milk.

5.4 Skewness

A skewness of 0.00 would indicate that there is an equal probability of a particular month's price being either higher or lower than the mean. The skewness for the all cash strategy is 0.55. This indicates that there is a greater than 50% probability that a particular month's cash price is going to be less than the mean of \$13.75/cwt. The positive skewness indicates that a higher percentage of the monthly cash prices were lower than the mean. It also shows there is more downside risk than upside risk in the all cash strategy. The highest skewness among all the strategies was 0.92 for strategies D and E, hedging 100% using forward contracts 9 months or 12 months prior to production without a minimum price to execute the hedge. Relative to their expected prices (i.e., means), these strategies have higher downside risk than the all cash strategy. The lowest skewness among all the strategies was -0.16 for strategy F13, hedging 100% using forward contracts three, six, nine, and twelve months prior to production. The negative skewness indicates that a higher percentage of the monthly prices were higher than the mean. It also shows there is more upside risk than downside risk for this risk management strategy.

Among the strategies without a minimum hedge price (Table 5.1), the skewness ranges from 0.10 to 0.92. All of the strategies have positive skewness, which indicates greater downside risk. Only eight strategies (F, K, O, T, U, X, Y, and Z) have a skewness less than cash. The results show that the majority of the risk management strategies without a minimum hedge price have higher downside risk than the all cash strategy.

As a minimum hedge price is introduced (Tables 5.2-5.7), the skewness starts to decrease. At the \$12/cwt minimum, the skewness ranges from 0.06-0.59 with 22 strategies

having a skewness lower than cash. At the \$13/cwt to \$17cwt minimum hedge prices, all the strategies have a skewness lower than cash except for strategy P17, which is equal to the skewness for the all cash strategy. At the \$13/cwt minimum, three strategies (F13, K13, and U13) have a negative skewness. At the \$14/cwt minimum, the same three strategies (F14, K14, and U14) have either a negative or zero skewness.

Among all of the price levels, the same strategies tend to have or be among the lowest skewness levels. The strategies F, K, and U have the lowest skewness levels for all of the minimum price levels. Strategies X, Y, and Z also tend to be among the lowest skewness levels. The results suggest that either spreading out the timing of the transactions, including more than one tool in the hedging strategy, or both can result in lower downside risk than the other risk management strategies.

The skewness tends to decrease as the minimum price increases, up to \$14/cwt. Then, the skewness tends to increase for the rest of the minimum prices. The lowest skewness levels are in the \$13/cwt and \$14/cwt minimum price strategies. It would be interesting to examine this more to determine if these price levels are the most optimal minimum price levels to use when determining hedge strategies.

5.5 Cash Flow Results

The majority of the prior research focused on the average price received per cwt of milk without taking into consideration the cash flow implications of the risk management strategy. The cash flow analysis took into account the funds needed to pay transaction costs, maintain the margin account, and cover hedging losses. The cash flow analysis also took into account the amount of interest charged or earned each month.

The risk management strategies that did not have a minimum hedge price resulted in the highest maximum cash flow need and the highest interest charges as compared to the rest of the risk management strategies. This is due to the fact that as the minimum hedge price increases, the amount of milk hedged decreases, hence reducing cash flow requirements associated with hedging. The interest charges ranged from \$0.02/cwt to \$0.37/cwt. The interest charges are calculated by taking the total interest divided by the total cwt of milk sold for the entire time period. Even the risk management strategies that ended up with an average price greater than the cash price had interest charges. The risk management strategies required \$1 million to \$6.9 million at their maximum cumulative level of cash flow needs. The cash flow needs are calculated on a monthly basis for all of the milk currently being hedged. Therefore, there could possibly be months that are hedged that are earning cash (through margin gains or gains on options), and months that are hedged that require cash. The partial budget is not calculated for each individual month's milk being hedged. It is an overall look at the entire price risk management strategy.

As the minimum hedge prices come into play, the amount of interest charged and cash flow funds needed decreases. At the \$12/cwt minimum, the interest ranges from \$0.10/cwt charged to \$0.03/cwt earned. Also, the amount of funds needed at the maximum level ranges from \$628 thousand to \$4.5 million. At the \$13/cwt minimum, the interest ranges from \$0.08/cwt charged to \$0.02/cwt earned and the funds needed ranges from \$830 thousand to \$3.5 million. At the \$14/cwt minimum, the interest ranges from \$0.04/cwt charged to \$0.03/cwt earned and the funds needed ranges from \$541 thousand to \$2.9 million. At the \$15/cwt minimum, the interest ranges from \$0.01/cwt charged to \$0.05/cwt

earned and the funds needed ranges from \$454 thousand to \$2 million. At the \$16/cwt minimum, the interest ranges from \$0.00/cwt to \$0.06/cwt earned and the funds needed ranges from \$0 to \$1.1 million. At the \$17/cwt minimum, the interest ranges from \$0.00/cwt to \$0.06/cwt earned and the funds needed ranges from \$0 to \$459 thousand.

To provide some context, the total value of the milk produced during the ten-year time period is \$66 million at the average cash price. The maximum cash flow needs of \$6.9 million at the no minimum price level represents 10% of the value of the milk being produced. The information can be used to determine a guideline of cash flow needs on a yearly basis needed to implement a risk management plan.

At the start of the thesis project, it was assumed that the interest charges would be high enough to limit the feasibility of implementing a risk management strategy. The only strategies that incurred high interest charges were the strategies that did not have a minimum hedge price. The risk management strategies that employed a minimum hedge price did not result in high enough interest charges to limit the feasibility of implementing them in the risk management plan. The lower percentage of milk being hedged at the higher minimum hedge price results in lower cash flow and interest needs. Bongards Creameries allows producers to forward contract their milk at a rate of \$0.10/cwt below the futures price. This forward contracting fee is used to pay for the transaction costs and cover the margin calls. At the beginning of the thesis, it was assumed that the interest on risk management strategies would greatly exceed the \$0.10/cwt that it costs to forward contract directly with the creamery.

It was also assumed that the amount of funds needed to be borrowed to finance the risk management strategy would limit the effectiveness of any risk management plan. Again, the risk management strategies without a minimum hedge price required the most amount of funds needed to be borrowed to cover the cash flow shortfalls. As the minimum prices were introduced, the amount of funds needed to cover the cash flow shortfalls also decreased.

Table 5.1: No Minimum Price Hedge Results

	Average	Min	Max	Std Dev	C.V.	% Hedged	% Greater than Cash	Skewness	Median	P-Value	F-Test	Interest
Cash	13.75	9.11	21.38	3.04	0.22	0.00	0.00	0.55	13.76	n/a	n/a	n/a
B	13.46	9.69	20.46	2.31	0.17	100.00	44.17	0.86	13.15	0.41	0.00	-0.20
C	13.43	9.75	19.86	2.08	0.16	100.00	47.50	0.90	12.87	0.34	0.00	-0.28
D	13.32	10.50	19.31	1.99	0.15	100.00	43.33	0.92	12.72	0.20	0.00	-0.37
E	13.41	9.99	19.91	1.97	0.15	87.50	40.00	0.92	12.70	0.31	0.00	-0.23
F	13.41	10.28	17.54	1.79	0.13	96.88	45.83	0.53	12.76	0.29	0.00	-0.27
G	13.54	9.77	20.54	2.31	0.17	100.00	47.50	0.86	13.22	0.54	0.00	-0.18
H	13.51	9.83	19.94	2.08	0.15	100.00	49.17	0.90	12.94	0.47	0.00	-0.28
I	13.40	10.58	19.39	1.99	0.15	100.00	44.17	0.92	12.80	0.29	0.00	-0.39
J	13.48	9.99	19.99	1.98	0.15	87.50	40.00	0.92	12.77	0.42	0.00	-0.26
K	13.48	10.33	17.61	1.79	0.13	96.88	46.67	0.53	12.84	0.40	0.00	-0.28
L	13.78	9.49	20.81	2.71	0.20	100.00	31.67	0.74	13.45	0.94	0.21	-0.04
M	13.93	9.93	20.72	2.51	0.18	100.00	34.17	0.77	13.49	0.62	0.04	-0.02
N	13.88	9.11	20.68	2.53	0.18	97.50	30.00	0.67	13.46	0.72	0.05	-0.11
O	13.86	9.11	20.47	2.67	0.19	65.00	19.17	0.46	13.76	0.76	0.16	-0.08
P	13.86	9.85	20.67	2.48	0.18	90.63	35.00	0.71	13.63	0.76	0.03	-0.06
Q	13.59	9.76	20.05	2.33	0.17	100.00	40.83	0.73	13.29	0.65	0.00	-0.14
R	13.62	10.39	19.34	2.03	0.15	100.00	44.17	0.81	13.06	0.70	0.00	-0.20
S	13.53	10.33	18.80	1.93	0.14	99.17	40.00	0.65	12.91	0.51	0.00	-0.29
T	13.59	9.99	19.36	1.89	0.14	80.00	37.50	0.54	13.00	0.61	0.00	-0.19
U	13.58	10.19	17.36	1.83	0.13	94.79	42.50	0.36	13.33	0.61	0.00	-0.20
V	13.63	9.86	19.35	2.41	0.18	75.00	40.83	0.64	13.28	0.74	0.01	-0.11
W	13.65	10.37	18.64	2.07	0.15	75.00	44.17	0.64	13.16	0.77	0.00	-0.15
X	13.59	10.20	17.69	1.92	0.14	74.38	40.00	0.33	13.27	0.62	0.00	-0.22
Y	13.63	9.99	17.53	1.89	0.14	60.00	37.50	0.10	13.24	0.71	0.00	-0.14
Z	13.62	10.21	18.06	1.97	0.14	71.09	42.50	0.41	13.67	0.70	0.00	-0.15

Table 5.2: \$12/cwt Minimum Price Hedge Results

	Average	Min	Max	Std Dev	C.V.	% Hedged	% Greater than Cash	Skewness	Median	P-Value	F-Test	Interest
Cash	13.75	9.11	21.38	3.04	0.22	0.00	0.00	0.55	13.76	n/a	n/a	n/a
B12	13.58	9.11	20.46	2.45	0.18	70.83	28.33	0.58	13.33	0.63	0.02	-0.10
C12	13.88	9.11	20.58	2.28	0.16	69.17	36.67	0.51	13.70	0.70	0.00	0.03
D12	13.75	9.11	20.58	2.25	0.16	69.17	32.50	0.48	13.28	1.00	0.00	-0.07
E12	13.85	9.11	20.58	2.25	0.16	65.83	34.17	0.49	13.44	0.77	0.00	-0.02
F12	13.76	9.11	19.66	2.00	0.15	68.75	37.50	0.06	13.54	0.97	0.00	-0.04
G12	13.63	9.11	20.54	2.46	0.18	72.50	31.67	0.58	13.37	0.74	0.02	-0.09
H12	13.87	9.11	20.58	2.29	0.16	70.83	37.50	0.54	13.66	0.73	0.00	-0.01
I12	13.82	9.11	20.58	2.24	0.16	70.00	33.33	0.47	13.36	0.85	0.00	-0.06
J12	13.83	9.11	20.58	2.28	0.17	69.17	34.17	0.52	13.28	0.81	0.00	-0.08
K12	13.79	9.11	19.66	2.01	0.15	70.63	37.50	0.09	13.53	0.91	0.00	-0.06
L12	13.78	9.11	20.81	2.78	0.20	60.83	16.67	0.59	13.57	0.93	0.34	-0.03
M12	14.00	9.11	20.72	2.67	0.19	54.17	19.17	0.47	13.75	0.51	0.16	0.03
N12	13.98	9.11	20.68	2.74	0.20	46.67	16.67	0.36	13.85	0.54	0.26	-0.02
O12	13.96	9.11	21.38	2.81	0.20	35.83	13.33	0.35	14.06	0.57	0.41	-0.02
P12	13.93	9.11	20.90	2.63	0.19	49.38	25.83	0.48	13.87	0.62	0.12	-0.01
Q12	13.66	9.11	20.05	2.48	0.18	68.06	28.33	0.49	13.47	0.81	0.03	-0.07
R12	13.92	9.11	20.58	2.30	0.17	64.72	35.00	0.41	13.69	0.63	0.00	0.01
S12	13.85	9.11	20.58	2.24	0.16	61.94	30.83	0.28	13.54	0.78	0.00	-0.05
T12	13.88	9.11	20.58	2.23	0.16	56.94	31.67	0.29	13.78	0.70	0.00	-0.04
U12	13.83	9.11	19.66	2.11	0.15	62.92	35.83	0.05	13.83	0.82	0.00	-0.04
V12	13.69	9.11	19.66	2.55	0.19	51.04	28.33	0.46	13.54	0.86	0.06	-0.05
W12	13.87	9.11	20.58	2.34	0.17	48.54	35.00	0.37	13.77	0.72	0.00	0.01
X12	13.82	9.11	20.58	2.23	0.16	46.46	30.83	0.16	13.70	0.83	0.00	-0.04
Y12	13.85	9.11	20.58	2.23	0.16	42.71	31.67	0.12	13.66	0.77	0.00	-0.03
Z12	13.81	9.11	19.66	2.23	0.16	47.19	35.83	0.20	13.88	0.87	0.00	-0.03

Table 5.3: \$13/cwt Minimum Price Hedge Results

	Average	Min	Max	Std Dev	C.V.	% Hedged	% Greater than Cash	Skewness	Median	P-Value	F-Test	Interest
Cash	13.75	9.11	21.38	3.04	0.22	0.00	0.00	0.55	13.76	n/a	n/a	n/a
B13	13.65	9.11	20.58	2.63	0.19	51.67	20.00	0.44	13.66	0.79	0.12	-0.08
C13	13.87	9.11	20.58	2.47	0.18	47.50	24.17	0.17	14.07	0.73	0.03	0.00
D13	13.92	9.11	20.58	2.51	0.18	42.50	22.50	0.11	14.20	0.64	0.04	-0.04
E13	13.99	9.11	21.38	2.59	0.18	40.00	23.33	0.25	14.15	0.51	0.08	-0.02
F13	13.86	9.11	20.58	2.30	0.17	45.42	30.00	-0.16	14.33	0.76	0.00	-0.03
G13	13.67	9.11	20.58	2.66	0.19	53.33	22.50	0.45	13.66	0.83	0.15	-0.09
H13	13.95	9.11	20.58	2.43	0.17	50.00	26.67	0.20	14.07	0.58	0.02	0.02
I13	13.96	9.11	20.58	2.51	0.18	45.83	23.33	0.12	14.24	0.56	0.04	-0.04
J13	14.03	9.11	21.38	2.59	0.18	40.83	24.17	0.23	14.15	0.44	0.09	-0.02
K13	13.90	9.11	20.58	2.30	0.17	47.50	33.33	-0.14	14.28	0.66	0.00	-0.03
L13	13.78	9.11	20.81	2.88	0.21	37.50	10.83	0.47	13.74	0.94	0.58	-0.03
M13	13.92	9.11	20.72	2.82	0.20	35.00	10.83	0.35	13.88	0.65	0.43	-0.01
N13	14.00	9.11	21.38	2.78	0.20	33.33	11.67	0.33	14.06	0.50	0.33	0.00
O13	13.99	9.11	21.38	2.90	0.21	24.17	10.00	0.40	14.11	0.53	0.61	0.00
P13	13.92	9.11	21.07	2.73	0.20	32.50	16.67	0.40	13.98	0.64	0.25	-0.01
Q13	13.70	9.11	20.58	2.67	0.19	47.50	19.17	0.39	13.78	0.90	0.17	-0.07
R13	13.91	9.11	20.58	2.49	0.18	44.17	25.00	0.15	14.08	0.65	0.03	0.01
S13	13.96	9.11	20.58	2.50	0.18	40.56	20.83	0.03	14.16	0.56	0.04	-0.03
T13	14.00	9.11	21.38	2.55	0.18	35.00	21.67	0.16	14.33	0.48	0.06	-0.01
U13	13.90	9.11	20.58	2.38	0.17	41.81	30.00	-0.09	14.29	0.68	0.01	-0.03
V13	13.71	9.11	20.58	2.71	0.20	35.63	19.17	0.38	13.81	0.92	0.22	-0.05
W13	13.87	9.11	20.58	2.51	0.18	33.13	25.00	0.15	14.01	0.73	0.04	0.00
X13	13.91	9.11	20.58	2.47	0.18	30.42	20.83	0.01	14.10	0.66	0.03	-0.02
Y13	13.94	9.11	21.38	2.51	0.18	26.25	21.67	0.12	14.30	0.60	0.04	-0.01
Z13	13.86	9.11	20.58	2.46	0.18	31.35	30.00	0.09	14.06	0.76	0.02	-0.02

Table 5.4: \$14/cwt Minimum Price Hedge Results

	Average	Min	Max	Std Dev	C.V.	% Hedged	% Greater than Cash	Skewness	Median	P-Value	F-Test	Interest
Cash	13.75	9.11	21.38	3.04	0.22	0.00	0.00	0.55	13.76	n/a	n/a	n/a
B14	13.67	9.11	20.58	2.72	0.20	34.17	15.83	0.34	14.14	0.84	0.23	-0.04
C14	13.88	9.11	20.58	2.65	0.19	34.17	19.17	0.17	14.34	0.72	0.14	-0.01
D14	13.98	9.11	21.38	2.63	0.19	34.17	19.17	0.20	14.33	0.54	0.12	-0.02
E14	14.24	9.11	21.38	2.91	0.20	29.17	19.17	0.27	14.44	0.21	0.65	0.03
F14	13.94	9.11	20.58	2.49	0.18	32.92	25.00	-0.12	14.43	0.59	0.03	-0.01
G14	13.72	9.11	20.58	2.72	0.20	36.67	16.67	0.34	14.08	0.93	0.23	-0.04
H14	13.91	9.11	20.58	2.67	0.19	35.00	19.17	0.17	14.35	0.67	0.16	-0.01
I14	14.00	9.11	21.38	2.65	0.19	34.17	19.17	0.19	14.35	0.49	0.14	-0.02
J14	14.26	9.11	21.38	2.93	0.21	29.17	19.17	0.26	14.44	0.19	0.69	0.03
K14	13.97	9.11	20.58	2.52	0.18	33.75	27.50	-0.13	14.46	0.54	0.04	-0.01
L14	13.77	9.11	20.81	2.96	0.21	24.17	8.33	0.44	13.82	0.97	0.77	-0.01
M14	13.91	9.11	21.38	2.90	0.21	24.17	8.33	0.34	14.10	0.67	0.61	0.00
N14	14.07	9.11	21.38	2.85	0.20	20.83	9.17	0.37	14.16	0.40	0.49	0.02
O14	14.03	9.11	21.38	2.93	0.21	17.50	8.33	0.38	14.15	0.47	0.69	0.01
P14	13.94	9.11	21.24	2.77	0.20	21.67	16.67	0.43	14.02	0.61	0.32	0.00
Q14	13.72	9.11	20.58	2.75	0.20	31.67	16.67	0.31	14.08	0.93	0.28	-0.03
R14	13.90	9.11	20.58	2.68	0.19	31.11	19.17	0.14	14.19	0.69	0.17	-0.01
S14	14.02	9.11	21.38	2.64	0.19	29.72	17.50	0.11	14.32	0.47	0.13	-0.01
T14	14.17	9.11	21.38	2.87	0.20	25.28	17.50	0.29	14.33	0.27	0.54	0.02
U14	13.95	9.11	20.58	2.56	0.18	29.44	25.00	0.00	14.33	0.58	0.06	-0.01
V14	13.73	9.11	20.58	2.78	0.20	23.75	16.67	0.32	13.98	0.95	0.34	-0.02
W14	13.86	9.11	20.58	2.67	0.19	23.33	19.17	0.16	14.16	0.76	0.17	-0.01
X14	13.95	9.11	21.38	2.59	0.19	22.29	17.50	0.12	14.27	0.58	0.08	-0.01
Y14	14.07	9.11	21.38	2.79	0.20	18.96	17.50	0.33	14.30	0.40	0.36	0.02
Z14	13.90	9.11	20.58	2.61	0.19	22.08	25.00	0.18	14.11	0.68	0.10	0.00

Table 5.5: \$15/cwt Minimum Price Hedge Results

	Average	Min	Max	Std Dev	C.V.	% Hedged	% Greater than Cash	Skewness	Median	P-Value	F-Test	Interest
Cash	13.75	9.11	21.38	3.04	0.22	0.00	0.00	0.55	13.76	n/a	n/a	n/a
B15	13.74	9.11	20.58	2.88	0.21	20.00	8.33	0.36	13.82	0.97	0.56	-0.01
C15	13.86	9.11	21.38	2.80	0.20	22.50	11.67	0.30	14.11	0.76	0.39	-0.01
D15	14.15	9.11	21.38	2.89	0.20	21.67	12.50	0.31	14.17	0.30	0.59	0.03
E15	14.31	9.11	21.38	2.98	0.21	23.33	17.50	0.22	14.37	0.15	0.83	0.05
F15	14.02	9.11	20.58	2.66	0.19	21.88	23.33	0.12	14.30	0.47	0.16	0.02
G15	13.75	9.11	20.58	2.89	0.21	20.00	8.33	0.36	13.82	1.00	0.61	-0.01
H15	13.88	9.11	21.38	2.82	0.20	25.83	13.33	0.29	14.11	0.72	0.42	-0.01
I15	14.17	9.11	21.38	2.90	0.20	21.67	12.50	0.31	14.17	0.28	0.63	0.04
J15	14.31	9.11	21.38	2.97	0.21	24.17	17.50	0.22	14.37	0.15	0.80	0.05
K15	14.03	9.11	20.58	2.67	0.19	22.92	24.17	0.11	14.32	0.45	0.16	0.02
L15	13.75	9.11	21.38	3.00	0.22	15.00	5.00	0.47	13.76	1.00	0.90	0.00
M15	13.91	9.11	21.38	2.98	0.21	10.83	4.17	0.41	13.83	0.68	0.85	0.01
N15	14.05	9.11	21.38	2.97	0.21	10.00	5.83	0.41	14.06	0.44	0.80	0.03
O15	14.12	9.11	21.38	3.00	0.21	6.67	6.67	0.34	14.11	0.34	0.90	0.03
P15	13.96	9.11	21.38	2.85	0.20	10.63	12.50	0.48	13.82	0.59	0.50	0.02
Q15	13.75	9.11	20.58	2.89	0.21	18.33	8.33	0.35	13.82	0.99	0.60	-0.01
R15	13.89	9.11	21.38	2.82	0.20	19.72	13.33	0.26	14.08	0.72	0.43	0.00
S15	14.12	9.11	21.38	2.87	0.20	17.78	11.67	0.31	14.14	0.33	0.54	0.03
T15	14.25	9.11	21.38	2.93	0.21	18.06	17.50	0.24	14.33	0.20	0.71	0.04
U15	14.00	9.11	20.58	2.70	0.19	18.47	24.17	0.21	14.16	0.50	0.21	0.02
V15	13.75	9.11	20.58	2.91	0.21	13.75	8.33	0.35	13.79	0.99	0.63	0.00
W15	13.85	9.11	21.38	2.80	0.20	14.79	13.33	0.27	14.07	0.79	0.38	0.00
X15	14.03	9.11	21.38	2.80	0.20	13.33	11.67	0.35	14.08	0.46	0.38	0.02
Y15	14.12	9.11	21.38	2.85	0.20	13.54	17.50	0.30	14.30	0.33	0.49	0.03
Z15	13.94	9.11	20.61	2.74	0.20	13.85	24.17	0.33	14.06	0.62	0.27	0.01

Table 5.6: \$16/cwt Minimum Price Hedge Results

	Average	Min	Max	Std Dev	C.V.	% Hedged	% Greater than Cash	Skewness	Median	P-Value	F-Test	Interest
Cash	13.75	9.11	21.38	3.04	0.22	0.00	0.00	0.55	13.76	n/a	n/a	n/a
B16	13.74	9.11	21.38	2.98	0.22	14.17	5.83	0.47	13.76	0.98	0.85	0.00
C16	13.94	9.11	21.38	3.02	0.22	10.00	5.83	0.42	13.83	0.63	0.96	0.02
D16	14.21	9.11	21.38	3.05	0.21	11.67	8.33	0.36	14.08	0.25	0.95	0.05
E16	14.22	9.11	21.38	3.11	0.22	6.67	6.67	0.32	14.11	0.24	0.80	0.05
F16	14.03	9.11	21.38	2.83	0.20	10.63	13.33	0.36	13.99	0.46	0.45	0.03
G16	13.73	9.11	21.38	2.98	0.22	15.00	5.83	0.48	13.76	0.97	0.84	0.00
H16	13.93	9.11	21.38	3.02	0.22	10.83	5.83	0.43	13.83	0.64	0.94	0.02
I16	14.19	9.11	21.38	3.04	0.21	13.33	8.33	0.37	14.08	0.26	0.99	0.05
J16	14.23	9.11	21.38	3.11	0.22	6.67	6.67	0.33	14.11	0.23	0.79	0.06
K16	14.02	9.11	21.38	2.82	0.20	11.46	13.33	0.35	14.03	0.48	0.42	0.03
L16	13.76	9.11	21.38	3.02	0.22	11.67	4.17	0.48	13.76	0.97	0.95	0.00
M16	13.90	9.11	21.38	3.04	0.22	6.67	3.33	0.45	13.82	0.71	0.99	0.01
N16	14.09	9.11	21.38	2.99	0.21	5.00	5.00	0.39	14.06	0.39	0.88	0.03
O16	14.02	9.11	21.38	3.03	0.22	4.17	4.17	0.40	13.98	0.49	0.98	0.02
P16	13.94	9.11	21.38	2.89	0.21	6.88	12.50	0.51	13.79	0.62	0.59	0.02
Q16	13.75	9.11	21.38	2.98	0.22	13.61	5.83	0.45	13.76	0.99	0.85	0.00
R16	13.92	9.11	21.38	3.00	0.22	9.17	5.83	0.41	13.83	0.66	0.90	0.02
S16	14.16	9.11	21.38	3.01	0.21	10.00	8.33	0.37	14.08	0.29	0.93	0.05
T16	14.16	9.11	21.38	3.05	0.22	5.83	6.67	0.35	14.11	0.30	0.96	0.04
U16	14.00	9.11	21.38	2.84	0.20	9.65	14.17	0.40	13.83	0.52	0.46	0.03
V16	13.75	9.11	21.38	2.98	0.22	10.21	5.83	0.44	13.76	0.99	0.85	0.00
W16	13.88	9.11	21.38	2.96	0.21	6.88	5.83	0.41	13.82	0.74	0.78	0.01
X16	14.06	9.11	21.38	2.92	0.21	7.50	8.33	0.42	14.06	0.42	0.68	0.03
Y16	14.05	9.11	21.38	2.96	0.21	4.38	6.67	0.39	14.08	0.43	0.80	0.03
Z16	13.93	9.11	21.38	2.86	0.21	7.24	14.17	0.48	13.76	0.63	0.51	0.02

Table 5.7: \$17/cwt Minimum Price Hedge Results

	Average	Min	Max	Std Dev	C.V.	% Hedged	% Greater than Cash	Skewness	Median	P-Value	F-Test	Interest
Cash	13.75	9.11	21.38	3.04	0.22	0.00	0.00	0.55	13.76	n/a	n/a	n/a
B17	13.77	9.11	21.38	3.05	0.22	10.00	4.17	0.52	13.76	0.95	0.95	0.00
C17	13.94	9.11	21.38	3.10	0.22	6.67	5.00	0.46	13.82	0.63	0.82	0.02
D17	14.16	9.11	21.38	3.08	0.22	5.00	5.00	0.39	14.06	0.30	0.88	0.05
E17	14.14	9.11	21.38	3.11	0.22	5.00	5.00	0.38	14.06	0.33	0.79	0.04
F17	14.00	9.11	21.38	2.88	0.21	6.67	12.50	0.44	13.88	0.51	0.57	0.03
G17	13.80	9.11	21.38	3.08	0.22	10.83	5.00	0.51	13.76	0.90	0.88	0.01
H17	13.95	9.11	21.38	3.11	0.22	6.67	5.00	0.46	13.82	0.62	0.80	0.03
I17	14.18	9.11	21.38	3.09	0.22	5.83	5.83	0.38	14.06	0.28	0.84	0.06
J17	14.14	9.11	21.38	3.12	0.22	5.00	5.00	0.38	14.06	0.32	0.77	0.05
K17	14.02	9.11	21.38	2.89	0.21	7.08	13.33	0.44	13.88	0.49	0.59	0.04
L17	13.78	9.11	21.38	3.06	0.22	6.67	3.33	0.51	13.76	0.93	0.94	0.00
M17	13.85	9.11	21.38	3.09	0.22	2.50	2.50	0.49	13.79	0.79	0.85	0.01
N17	13.93	9.11	21.38	3.03	0.22	2.50	2.50	0.46	13.83	0.65	0.99	0.02
O17	13.93	9.11	21.38	3.04	0.22	2.50	2.50	0.46	13.83	0.65	0.98	0.01
P17	13.87	9.11	21.38	2.95	0.21	3.54	10.00	0.55	13.76	0.75	0.76	0.01
Q17	13.79	9.11	21.38	3.06	0.22	9.17	5.00	0.50	13.76	0.93	0.94	0.00
R17	13.91	9.11	21.38	3.07	0.22	5.28	5.00	0.46	13.82	0.68	0.91	0.02
S17	14.09	9.11	21.38	3.01	0.21	4.44	5.83	0.41	14.06	0.39	0.93	0.04
T17	14.07	9.11	21.38	3.04	0.22	4.17	5.00	0.40	14.06	0.42	0.97	0.03
U17	13.96	9.11	21.38	2.89	0.21	5.76	13.33	0.49	13.82	0.58	0.60	0.02
V17	13.78	9.11	21.38	3.04	0.22	6.88	5.00	0.49	13.76	0.95	0.98	0.00
W17	13.87	9.11	21.38	3.03	0.22	3.96	5.00	0.47	13.79	0.75	0.97	0.01
X17	14.00	9.11	21.38	2.95	0.21	3.33	5.83	0.46	13.98	0.51	0.75	0.03
Y17	13.99	9.11	21.38	2.97	0.21	3.13	5.00	0.43	14.01	0.54	0.83	0.03
Z17	13.91	9.11	21.38	2.91	0.21	4.32	13.33	0.53	13.76	0.68	0.65	0.02

CHAPTER 6: CONCLUSIONS

6.1 Risk Management Plan Implications

There were a lot of data accumulated through the different strategies that were studied. The strategies that did not have a minimum hedge price succeeded in lowering the amount of price risk being held by the dairy operation. On the other side, they also tended to lower the average price received for the milk (but not at statistically significant confidence levels). The majority of operations are going to find it hard to include risk management strategies that result in a lower average milk price. While the average price is not significantly different from the average cash price, the statistical significance of a measurement is usually lost on dairy producers. This is an educational problem, whereas producers need to be better educated about how markets act in the long run. Also, the no minimum price strategies tended to have the largest cash flow effects. They have the highest interest charges among all of the strategies studied and also the largest maximum amount of cash that needs to be borrowed over the ten year period.

As the minimum hedge price increased, the average price received for the milk increased. Also, the number of months that are greater than the cash price decreased. As the minimum hedge price increased, the amount of milk hedged decreased. The amount of risk also increases from the no minimum hedge price strategies. The risk increases to the point where the risk is not significantly different than the amount of risk for the cash price, due to the pricing strategies converging with the cash price. The cash flow needs also improve as the minimum hedge price increases. The strategies that have the highest minimum price also have the lowest interest charges and cash flow needs. The percentage

of milk being hedged plays a large part in the cash flow needs and amount of interest charged or earned for the operation. There is a tradeoff between the amount of risk that is being managed and the average price received for the milk.

Individual producers need to determine their own risk preferences when it comes to developing a risk management plan. The data show that the different strategies provide producers numerous opportunities to take advantage of different risk/return tradeoffs. Figures 6.1 to 6.5 display the average price plotted against the standard deviation for each pricing strategy. Some producers will prefer to always hedge 100% of their milk regardless of hedge price to aim for maximum price risk management. On the flip side, some producers will tend to utilize the strategies that have a higher average price without hedging a high percentage of their milk. Each producer has a different risk tolerance they are comfortable with and that determines which strategies they will utilize in their risk management plan. While the results from the thesis show that there are many strategies available for producers to choose from, the risk/return tradeoff can rule out some of the strategies. Strategies that have a lower average price and higher standard deviation are less attractive because a higher risk/return tradeoff can be achieved with other strategies. So while the results will help to eliminate some strategies, it also leaves many strategies for producers to analyze that could benefit their operation.

Figure 6.1: Risk/Return Tradeoff – Forward Contracts

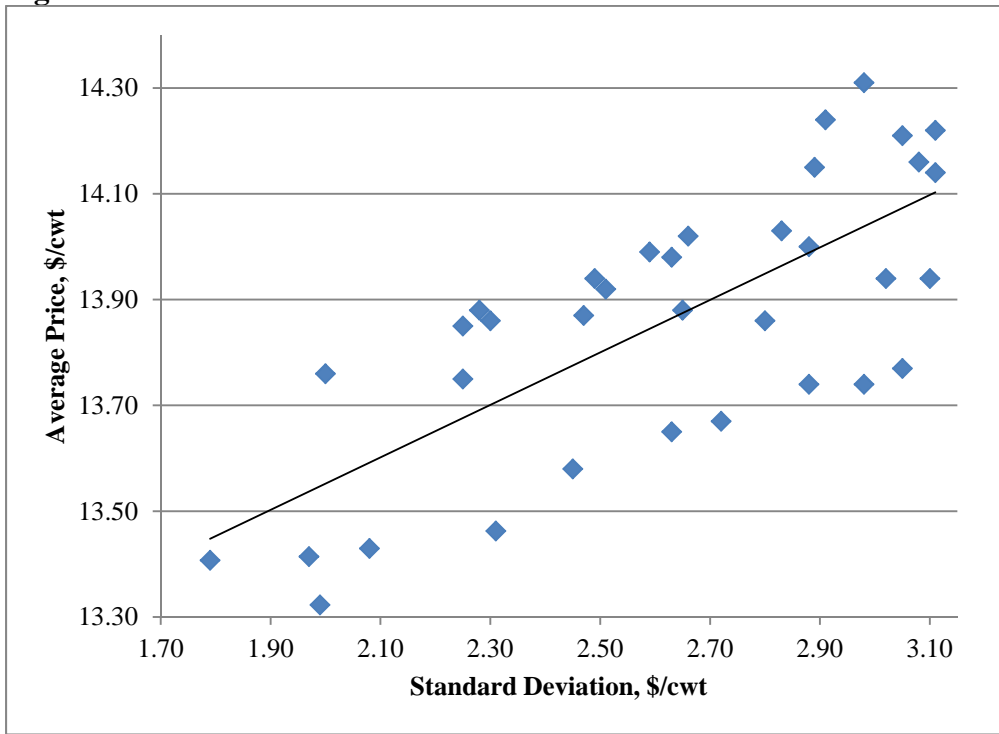


Figure 6.2: Risk/Return Tradeoff – Futures Contracts

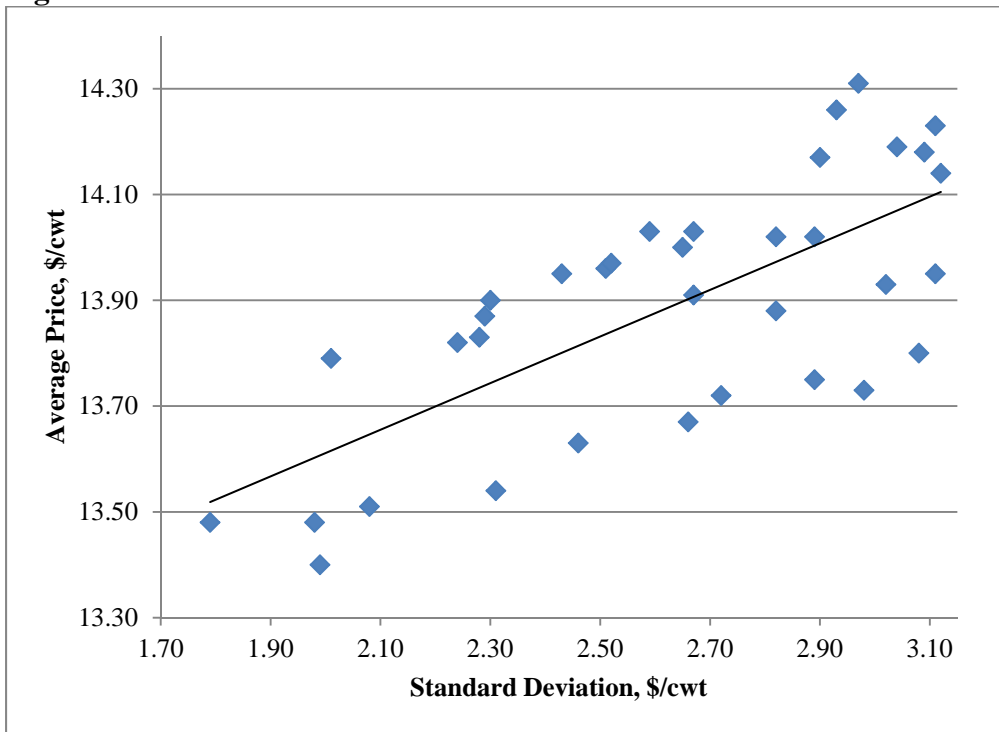


Figure 6.3: Risk/Return Tradeoff – Options

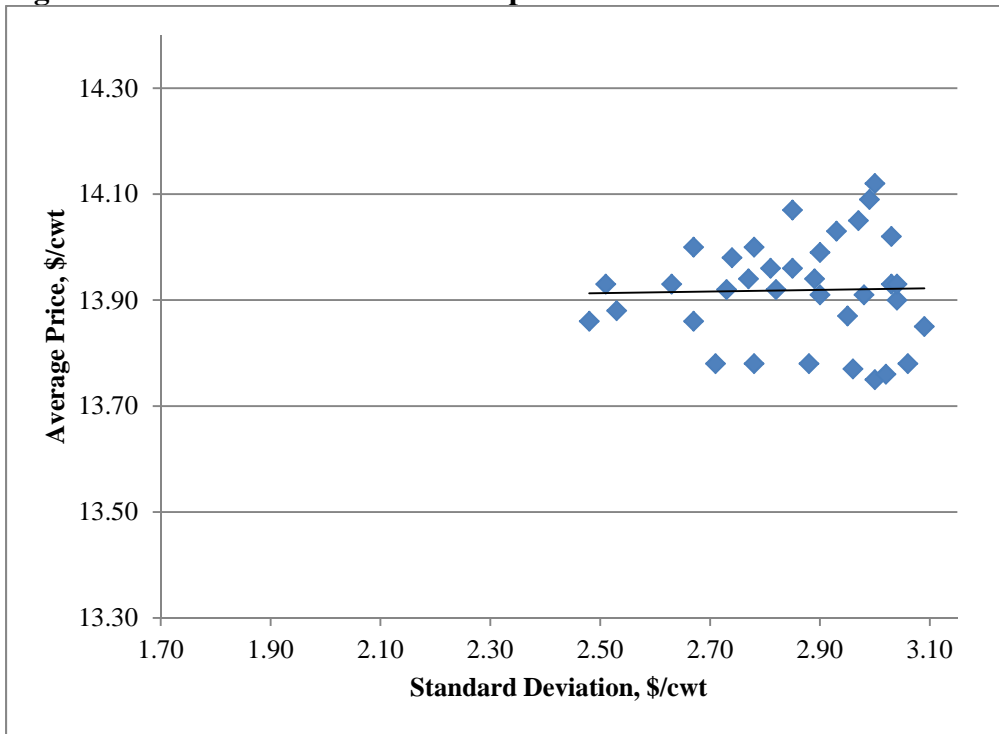


Figure 6.4: Risk/Return Tradeoff – Three Tool

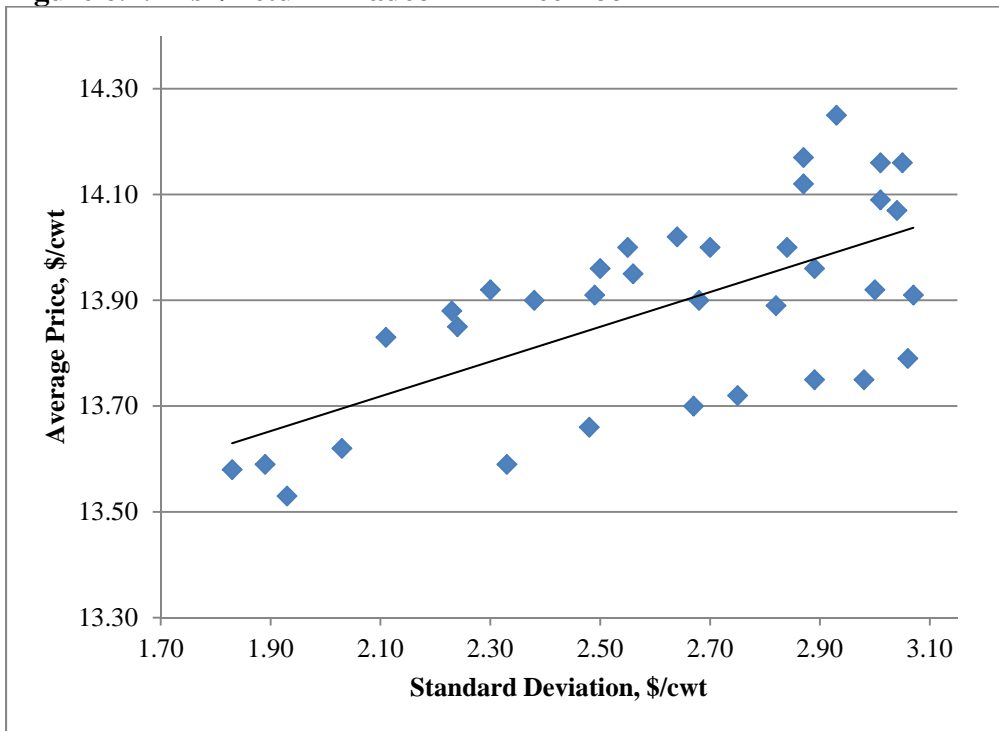
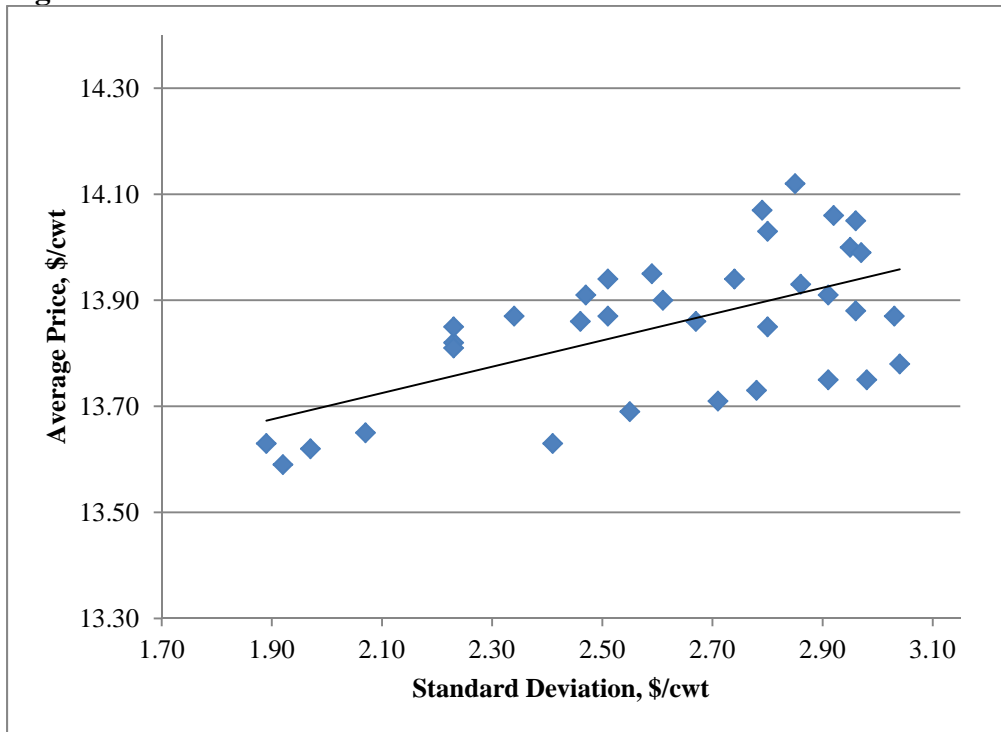


Figure 6.5: Risk/Return Tradeoff – Four Tool



The other issue that has been brought to attention with the results of this thesis is the credit implications that come along with implementing a risk management plan. Producers need to work hand in hand with their lending institution to insure that they are on board with the risk management plan. The worst case scenario would be for a producer to have their line of credit pulled because their lending institution did not fully understand the cash flow implications of the risk management plan. The efficient market theory states that using risk management tools are not expected to increase price. A producer with a risk management plan should, in theory over the long run, earn the same average price while reducing their price risk. The effect on a producer of having to divert from the risk management plan is that they are not participating in the market in the long run. This could lead to the producer increasing risk and affecting the average price received for the milk.

6.2 Additional Research Needs

The minimum hedge price scenarios highlight the need to research more hedging strategies that utilize price thresholds. One thing that could be looked at is using the top third or half of the price, over some historical periods, as the hedge minimum. Also, the minimum hedge price strategies could be implemented without a time restriction. These strategies could be implemented at any given time as long as the minimum price is met. In this thesis, the minimum price had to be met at the specific transaction time specified by the strategy. Looking at the other option of not setting a time period might lead to the minimum price strategies achieving higher hedge levels than the current strategies achieved. For example, if the minimum price level is \$15/cwt and the price on the specific transaction date is \$14.90/cwt, the hedge was not executed. The price could increase to \$15/cwt three days later, but under the scenarios in the thesis, the hedge would still not be executed. By not setting a time limit, the hedge would have been executed as soon as the price went over the \$15/cwt level. The thesis was limited in having to determine a specific time period and date to execute the transactions.

The thesis did not look at using implied volatility to determine hedging decisions. Implied volatility looks at the implied risk that is inherent in the market. Future research could look at using different risk management strategies based on the implied volatility in the marketplace at the time of the hedging decision.

The thesis also had limitations when it came to using put options in the risk management strategies. As the underlying futures prices increased, the option premiums for the strike price included in the study drastically increased. There were months where

put option premiums were as high as \$1.00/cwt or higher. At those price levels, it is hard for the risk management plan to be feasible when money needs to be borrowed to cover the cost of the option premium. Lenders set specific limits on how much money operations can borrow for operating expenses and hedging expenses. These levels are dependent on the financial viability of each operation. Having to spend upwards of \$1.00/cwt might cap out the hedging credit limit without allowing the operation to fully implement the risk management plan on the percentage of milk they want to price. One change could be to buy the highest strike price put option at a set budget. In this way, the operation could gain some risk management while not using up all of their available credit to implement the risk management plan. Also, there are more exotic risk management strategies that utilize buying and selling both put and call options to defray the cost of implementing a risk management plan. These different strategies could be studied to determine how they would have performed compared to the other strategies. When studying options, there are many different scenarios and strike prices that could be utilized making it hard to study all possible scenarios without the data becoming cumbersome and bogging down the research.

Towards the end of the research project, other tools came to prominence that had not been widely used in the past. In particular, the Livestock Gross Margin (LGM) Insurance for dairy received more attention after the federal government added additional subsidies that were not available in the past. LGM-Dairy is another risk management tool that can be added to the arsenal of a risk management plan. More research needs to be done to compare LGM-Dairy to the other tools that are currently available and have been studied in the past. There could be room in a risk management plan to utilize many different risk management tools.

The thesis did not take into account how different strategies performed in different market conditions. Different strategies could perform better when the market is rising compared to when the market is falling. Research could be done to study different risk management strategies during different market conditions. The study would have to take into account how to determine the different market conditions so that dairy operations would be able to incorporate this information into their risk management plans.

Brokers are also looking at more complex strategies where they attempt to hedge a margin. Margin refers to the difference between input costs and output prices. The brokers are using a combination of commodity and hedge tools to try and reduce the amount of risk on both the output and input side of the operation. With a margin hedge strategy, the goal is to maximize the difference between the input and output costs and does not necessarily concentrate on the costs of the individual commodities. There is an opportunity to research a margin hedge strategy to determine the effectiveness for dairy operations.

6.3 Implementation

The results of the study have generated more questions than they have answered. The risk management strategies showed that risk could be reduced while not statistically affecting the average price received for the milk over the ten-year period. The results also point to more strategies that should be analyzed before the risk management plan is fully written and implemented. Other risk management tools continue to be developed that have not been analyzed in the past. These new tools need to be analyzed alongside the current tools to determine how best to design the risk management plan. The risk management plan needs to be constantly monitored and updated to include the most up to date

information and risk management tools that are available. The research contained in this thesis is a great start to designing and implementing a risk management plan for our dairy operation.

The amount of tools and scenarios being utilized are becoming more and more complex. As the number of risk management tools increases, it becomes harder for a dairy producer to be able to effectively analyze all of them. As in other areas of the operation, it is important for a producer to enlist the help of someone knowledgeable in the use of all these tools to help with the development of a risk management plan.

WORKS CITED

- Bittman, James A. *Trading and Hedging with Agricultural Futures and Options*. McGraw-Hill, 2001.
- Brorsen, B Wade, and Kim B Anderson. "Implications of Behavioral Finance for Farmer Marketing Strategy Recommendation." *NCR-134 Conference on Applied Commodity Price Analysis, Forecastin, and Market Risk Management*. St. Louis, 2001. 8.
- Cropp, Bob, and Brian W. Gould. *Dairy Producer Use of BFP PUT Options to Reduce Price Risk: Application to USDA's Dairy Options Pilot Program*. Briefing Paper, Madison: Department of Agricultural and Applied Economics, College of Agricultural and Life Sciences, University of Wisconsin-Madison Cooperative Extension, University of Wisconsin-Extension, 1998.
- Dahlke, Jon, interview by Josh Engelmann. (March 10, 2011).
- Dalsted, Norm, and Paul Gutierrez. *Risk and Reslience in Agriculture Partial Budgeting*. Colorado State University, 2004, 5.
- Dhuyvetter, Kevin C, Martin Albright, and Joseph L Parcell. "Forecasting and Hedging Crop Input Prices." *NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management*. St. Louis, 2001. 24.
- Drye, Patrick, and Dr. Robert Cropp. *Price Risk Management Strategies for Dairy Producers: A Historical Analysis*. Madison: Department of Agricultural and Applied Economics, University of Wisconsin, 2001.
- Gould, Brian. *Understanding Dairy Markets*. <http://future.aae.wisc.edu> (accessed 01 21, 2011).
- Jesse, Ed, and Jacob Schuelke. *Effectiveness of 'Naive' Class III Hedging Strategies*. Briefing Paper, Madison: Department of Agricultural and Applied Economics, College of Agricultural and Life Sciences, University of Wisconsin-Madison Cooperative Extension, University of Wisconsin-Extension, 2004.
- Kurzawski, Dave, interview by Josh Engelmann. (March 10, 2011).
- Schneider, Jonathan, Dwight Sanders, and Ira Altman. "Producer-Level Hedging Effectiveness of Class III Milk Futures." *Southern Agricultural Economics Association Annual Meetings*. Mobile, 2007. 13.
- van Blokland, P.J. "Free Cash Flow is at Least as Important as Profit in Assessing a Farm Firm." *IMFA*. 2005. 4.