Price Risk Management Strategies for Virginia Dairy Farmers

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Case Study Submitted to
Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Master of Science
In
Agricultural and Applied Economics

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December 15, 2004

Blacksburg, Virginia

Keywords: Risk Management Strategies, Dairy Producers, Basis, Target Price, Moving Averages.

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Abstract

The 1996 and 2002 Farm Bill changes in milk support price legislation deregulated the market and milk prices are more volatile than ever. The use of a mechanism to reduce farmers' exposure to volatile milk prices has therefore become essential. This study evaluates the impact of two hedging strategies, one conservative and the other an intermediate one (more sophisticated). Optimal parameters for the two strategies are searched over a period of 5 years. Then, the performance, in terms of increased profitability and reduced variation, is assessed and the best performer is chosen and applied to an out-of-sample dataset.

With the in-sample data, both strategies generate higher mean monthly profits than with the no-hedging option. Comparison of both strategies indicates that the intermediate strategy outperforms the conservative one in terms of higher profitability and lower variance. Out-of-sample results confirm the findings of the in-sample results. The additional profits and the reduction in volatility can make the difference between keeping a farm profitable and bankruptcy.

To God, for giving me so many opportunities to be better each day, to my beloved parents Ramon Andino and Maria Eufrasia de Andino for their constant love and for making me believe in myself and to my dearly loved husband Christian Rojas for all his support, patience, and love.

Acknowledgements

I would like to express my sincere gratitude to Dr. Wayne Purcell for his constant encouragement and support throughout the program. His experienced feedback and valuable comments have enriched the content of this study. I am grateful to him for all the time he granted me and for the inspiration that he has been for me.

I would like to thank Dr. Dixie Reaves for her insightful comments and for all the support provided these years during which I had the opportunity to work together.

I would also like to thank Dr. Gordon Groover for his interest, thoughtful comments and suggestions to improve this work.

I am grateful to Dr. Robert James, who made possible the acquisition of the data. In addition, I would like to thank Kunal Sarda for his technical input and contribution to this work.

Finally, I would specially like to thank my beloved husband Christian for all his encouragement, love, support, and patience during these years.

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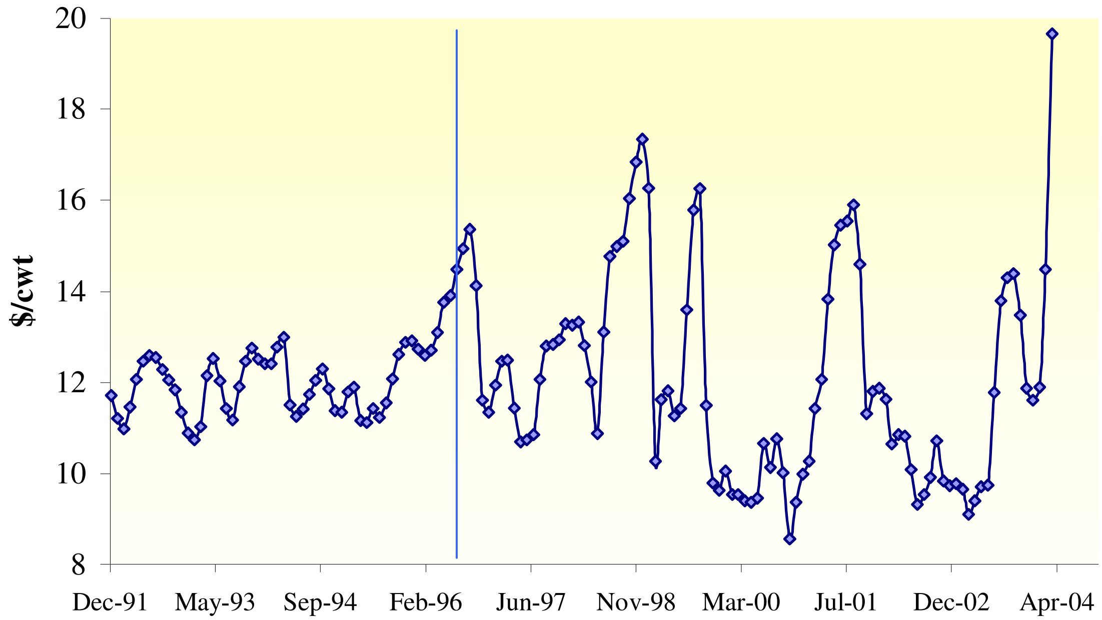
1 Introduction

1.1 Background

Virginia dairy farmers received milk price support for decades, which generally guaranteed them a positive return. This situation changed in 1996 with Farm Bill legislation that effectively eliminated milk price supports at prices above market-clearing prices. Since then, Virginia dairy farmers have had to confront new managerial challenges as milk prices have been very volatile over the years. This volatility can be seen in figure 1.1, which shows the Minnesota-Wisconsin milk price from January 1992 to April 2004. [1]

Figure 1.1: Monthly Minnesota-Wisconsin (BFP or Class III) Milk Prices ($/cwt), January 1992 – April 2004



Source: U.S. Department of Agriculture, Economic Research Service

[1] The Minnesota-Wisconsin milk price is later known as the Basic Formula Price (BFP) and recently as the Class III (cheese) milk price formula.

As the figure indicates milk prices were more stable before 1996 with monthly prices as low as $10/cwt. From January 1992 until December 1996 milk prices ranged from $10.74 to $15.37 per cwt., with the lowest value in February 1993. Subsequent to the 1996 Farm Bill prices vary over a wider range with some values below $9 per cwt. The price range from January 1997 until April 2004 fluctuates from $8.57 in November 2000 to $19.66 per cwt. in April 2004

This observed price variability represents a serious challenge to the typical dairy farmer since very low cash prices may not allow farmers the cash flow to cover short run financial obligations and production costs. For instance, in March 2003, the cash price for Class III milk was $9.11 per cwt, well below the $13.91/cwt estimated Virginia variable cost, a loss of $4.80 per cwt. A similar loss was observed during the early months of 2003. Without government support and the level of price fluctuations and subsequent short run losses, farmers may face a financial crisis that can challenge the long-term survival of their business. Therefore, developing tools to manage price volatility (price risk) is a necessary condition to improve dairy farm profitability and long-term survival.

1.2 Objectives

The purpose of this study is to develop and evaluate price risk management strategies for Virginia milk producers. The objectives of this study are to:

- Describe cash forward contracts, the advantages and disadvantages of their use and the characteristics of farmers who would benefit from this use.

- Compare the effectiveness of two management strategies for farmers to reduce their exposure to price risk: (1) target price hedging, and (2) a moving average selective hedging approach.
- Recommend and describe the tools and strategies to implement an effective price risk management program for Virginia dairy farmers.

2 Literature Review

Risk management can be applied to the farm's input costs as well as to its output prices. There have been few attempts at analyzing the performance of different risk management strategies for dairy farms' output prices. Some studies have focused on managing the risk of dairy farms' input costs. Bosch and Johnson (1992) evaluate risk management strategies for dairy farms' input costs, while Frechette (2000) analyzes how changing the assumptions on which traditional hedging relies affects the optimal choice of input management strategies in the dairy industry.

On the output side, there are two relevant studies that have addressed the operational and descriptive aspects of managing the risk of output prices in the dairy industry. Burkhart, Sink and Purcell (1999) provide a comprehensive review of futures and options markets for Virginia dairymen that includes details on contract specifications and implementation of such strategies. Furthermore, this guide contains examples and recommendations on hedging strategies both for input and output prices.

Bailey (2001) presents a similar guide on the fundamentals of forward contracting and options for dairy producers in the Northeast. Although similar in spirit to that of Burkhart, Sink and Purcell, this manuscript places more emphasis on the operational and descriptive aspects of forward contracts and options. In addition, it provides farmers with recommendations on how to develop a marketing plan.

Another study that is relevant to this investigation is that of Purcell (2002). Purcell analyzes how moving averages techniques can be used to monitor trend changes in prices. Purcell argues that the key to farmers' success, when making hedging decisions, is to know when action should be taken. Moving averages can provide the necessary information on trend changes that allow farmers to know when to take action. Moving averages techniques can be applied to different hedging strategies such as cash forward contracts, futures and options. Purcell estimates the optimal set of moving averages to guide hedging decisions and illustrates its successful applicability to the corn market.

Finally, Brown, Crabb and Haushalter (2003) analyze the success in 'selective' hedging of firms from three different sectors: gold producers, dairy farms and durables producers. The authors analyze whether firms' hedging strategies reflect the theoretical predictions (i.e. hedging ratios vary by firm characteristics) and suggest that the variation in hedging strategies is due to 'selective' hedging, defined as the hedging activity derived from managers' views of future market conditions. Further, the authors evaluate whether firms have been able to successfully profit from selective hedging and find that only the gold producers have benefited from it. However, this last study only considers the percentage of production hedged and does not assess the performance of each of the hedging mechanisms used by the farms (e.g., futures or options).

3 Theoretical Framework

Agricultural producers face many risks that can be managed in different ways. For instance, farmers can manage the risk of variation in input costs, the risk of variation in output prices, and the risk of uncertain yields of their crops. Producers' choice will depend on the risk they want to manage (probably the one that has more influence on net revenue) and their utility (objective) functions. The types of instruments producers can use to manage risk are classified into: a) spot-market strategies, b) cash forward contracts, and c) future and option contracts.

According to Tomek et al. (2001), farmers are assumed to select a combination (a portfolio) of marketing strategies that, for example, maximize net expected returns (profits) subject to the degree of risk they are willing to accept. The idea is to identify an optimal portfolio of enterprises that determines the best risk-return opportunities available. The framework in which one is able to determine this optimal portfolio is called portfolio theory. The basic portfolio theory includes the following principles:[2]

Investors' attitudes towards risks;

Trade offs between risk and expected return in order to maximize utility functions; and

The risk of an asset cannot be evaluated apart from the portfolio.

In this context, risk means that more than one outcome is possible, which creates uncertainty about the future. In general, when making economic decisions people tend to prefer a certain outcome rather than an uncertain one, and, in order to accept an uncertain outcome most people will require a premium as compensation for risk, which is called

[2] Bodie, Kane and Marcus (2002)

risk premium.[3] If an outcome has zero risk premium (i.e. there is no compensation for taking the risk) this is called a fair game. Risk averse investors are those who reject investments portfolios that are fair games. That is, they prefer certain income to risky income that has the same expected returns.[4] Furthermore, risk averse investors are willing to pay something in order not to accept a fair game. On the other hand, risk neutral investors are those who are indifferent between a certain income level and an uncertain one that has the same expected value (i.e. those who judge risk portfolios only by their expected returns). Risk loving investors are individuals who are willing to play fair games and prefer risky income levels over a certain one that has the same expected value (i.e. they want to gain utility and increase profit by engaging in risky bets).

If one assumes that an investor can allocate utility (satisfaction according to preferences and tastes) to different portfolios based on the expected return and risk of these portfolios, this utility can be viewed as a measure of ranking portfolios since the investor will maximize total utility and will find the best portfolio. Assuming that individuals evaluate portfolios based on expected return E(r) and risk (variance of return distributions σ^2). Then, equation 1 shows this relationship:

$$U = E\,(r) - 0.5\,A\,\sigma^2, \qquad (1)$$

where U is the utility value, E (r) is the expected return, A is the risk aversion coefficient and σ^2 is the variance of returns. This implies that utility increases as expected returns E(r) increase (i.e., individuals prefer more to less) and diminishes as risk increases (i.e., individuals dislike risk). The reduction of utility, when variance increases, will in turn,

[3] According to Hussein (2003) risk premium is the excess return required from an investment in a risky asset over that required from a risk-free asset.

[4] According to Bodie et. all. (2002) an expected return or mean of an asset is a probability-weighted average of its return in all scenarios. $E\,(r) = \sum Pr\,(s)\, r(s)$, where Pr(s) is the probability of scenario s, r(s) the return in scenario s and E (r) is the expected return.

depend on the risk aversion coefficient (A). A larger value of A will have greater negative impact on utility than a lower value for A. As risk aversion increases the magnitude of A increases. A takes on negative values for risk loving investors and for risk neutral investors A is zero. Consequently, investors choosing among different portfolios will choose the one offering the highest utility function subject to their risk aversion.

Figure 3.1 shows five different portfolios A, B, C, D, and MVP. Given an investor's risk preference, his or her decision about what portfolio to choose depends on the utility generated by each one. Thus, one can say that portfolio A is always dominated[5] by portfolio B since for the same variance ($\sigma_A=\sigma_B$), B offers a higher return than A does ($E(r_B) \geq E(r_A)$). The MVP (minimum variance portfolio) is the one with the minimum variance and the line from MVP to portfolio D is called the *efficient frontier*. The efficient frontier contains all portfolios that are efficient. This means that the selection between them only depends on the risk aversion coefficient of the investor since for all the portfolios that lie on the other section of the line there will always be a portfolio with the same standard deviation and a greater expected return positioned directly above it on the efficient frontier.

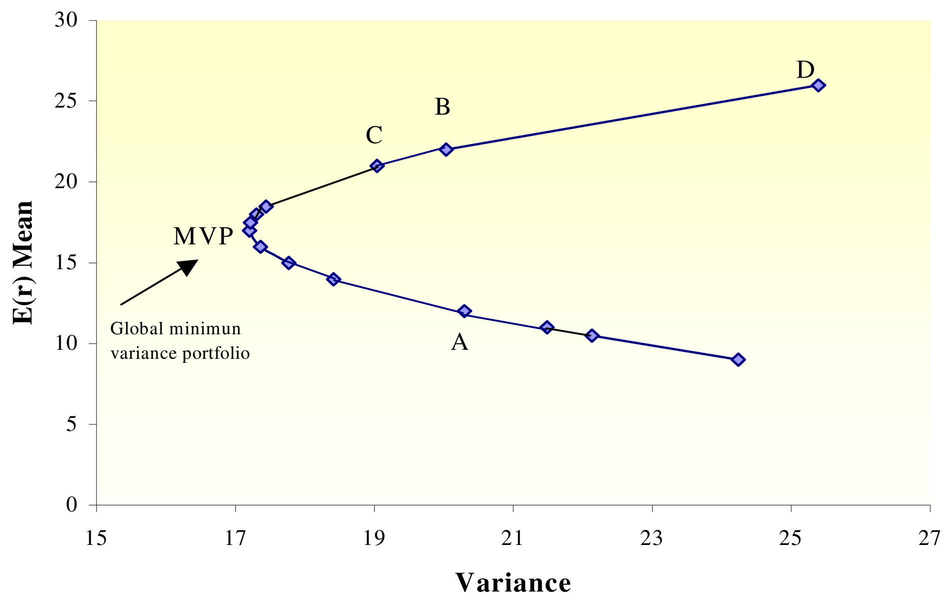
To illustrate how different investors choose different portfolios on the efficient frontier, notice that portfolio MVP has low risk and low return, portfolio D has high risk and high return, and portfolios C and B lie between MVP and D. Then, the selection of the portfolio will depend on the investor's risk preference. If an investor is more risk averse, he may select portfolio C since he is willing to sacrifice returns for a safer

[5] A portfolio X dominates portfolio Y if either: a) both have the same risk (variance) but X offers a higher return, or b) both have the same return but X has lower variance. The reason for this is that according to the utility function presented, people like higher expected return and dislike risk.

investment. On the other hand a less risk averse investor may choose D since he is willing to take more variance in order to have a greater return.

Neither MVP, B, C or D dominates the other for all risk averse investors. The Mean –Variance (M-V) condition states that for a given level of risk the M-V portfolio offers the higher expected return or for a given expected return the portfolio offers the lower risk. In the literature Markowitz (1952) proposes a concept that is similar to the M-V condition that he calls the expected returns-variance of returns (E-V) rule. However, he does not consider the risk aversion coefficient (A) that it is included here.

Figure 3.1: Efficient Frontier Mean-Variance Tradeoffs



The mean-variance condition can also be interpreted as investors being indifferent between portfolios with high risks and high expected returns and portfolios with lower risk but lower expected returns that generate the same utility. These indifferent portfolios will lie in the M-V plane on a curve that connects all portfolios points that generate the same utility value, called the indifference curve[6]. Consequently, the primary objective of the mean-variance framework is to find an optimal portfolio that maximizes utility given the expected returns and risk. Thus, analyzing hedging mechanisms designated to decrease the variability of net returns to help stabilize revenue for Virginia dairy farms is the goal of this study.[7]

4 Methodology

The following procedures were developed to accomplish the objectives of this study. First, the data are separated into two periods: the first period contains data from January 1999 to May 2003 while the second period contains data from June 2003 to May 2004. This division is made with the purpose of having five years of historical 'in the sample' data from which the best strategy is derived and one year of 'out of the sample' data in which the out-of-sample effectiveness of the best strategy obtained from the historical data is tested.

Second, a basis table for milk prices in Virginia is developed using the cash (or mailbox) prices and the futures prices.[8] This information is crucial in order to assess which price risk management strategy best suits the needs of Virginia dairy farmers. Third, the role of costs is analyzed and some assumptions are made. Using one representative cost budget for Virginia dairy farms, costs are divided in two categories.

Fourth, using mailbox prices and variable costs, profits are calculated with no risk management program in place (i.e., profit that farmer receives when remaining in the

[6] In Markovitz framework this indifference curve is called the E-V frontier.
[7] According to Purcell and Koontz (1999) trading in commodity futures contracts provides a mechanism that can be used to reduce or eliminate the risk of fluctuating cash prices faced by those dealing in the physical commodity and that the process of transfer risk is called *hedging*.
[8] Sections 4.1 and 4.2 explain in detail all the steps followed to develop the basis table.

cash market vulnerable to volatile milk prices). These results will serve as a baseline for further comparison with the two hedging strategies proposed.

Fifth, target price and moving averages strategies are developed.[9] For the target price strategy, milk futures prices, 'average' basis and different margins over variable costs are first used to compute different target prices. Then, the optimal target price is selected based on its mean profit as well as its variance. For the moving averages strategy, milk futures prices and different values of a parameter called "penetration requirement" are used to search for the profit maximizing pair of moving averages. Five different pairs of moving averages are obtained for each month, one for each penetration requirement. Then, for each month the pair of moving averages and its corresponding penetration requirement are chosen on the basis of highest profit. Thus, twelve optimal different pairs of moving averages are computed.

Target price and moving averages strategies are then compared in terms of mean profit and its variance and the better performer is used for the 'out of sample' period to test its effectiveness. In addition, some graphs are presented to illustrate the comparison between both strategies.

Finally, an alternative (simpler) version of the moving average strategy is explored and compared with the other two strategies. The procedure is similar to the moving averages described above, however, only one pair of moving averages (the one with highest mean) is obtained for the entire 'in sample' period.

[9] Details on these procedures are contained in section 4.4.2.

4.1 Data

This study uses three different data sets, one for each of three dairy farms in Virginia. The first farm is located in southwest Virginia, the second in northwest Virginia and the third in south-central Virginia. The names of the farms cannot be disclosed since the producers expressed their desire to remain as anonymous contributors to this study.

All three data sets have the same variables and number of observations. The data consists of monthly gross payments, hauling costs, and milk production (in pounds) from January of 1999 to May of 2004. This study requires developing basis patterns, for which futures market data is required. Hence, the chosen period (1999-2004) reflects the initial date in which milk futures market data for class III milk (the type of milk that has most of the trading volume) became available: October of 1998.

4.1.1 Futures data

It is necessary to describe in more detail the role of the futures market and its importance in this study. According to Purcell and Koontz (1999): "*the futures market is an anticipatory or forward pricing market. It is attempting to 'discover' what the price of a commodity should be at some time in the future*". The futures market incorporates available information regarding the underlying supply and demand as well as individuals' expectations about the future price of a given commodity (in this case milk). Thus, the futures market plays a key role in the 'price discovery process' of future milk prices that dairy farmers will receive at the moment of selling their milk.

The futures market for milk uses formalized and standardized types of contracts traded at the Chicago Mercantile Exchange (CME) through a broker. There are two kinds of standardized contracts for milk: Class III and Class IV milk futures contracts.

These contracts are cash settled (there is not delivery of milk), and the amount of milk required per contract is 200,000 pounds or 2,000 cwt.[10] For this study, Class III milk future contracts are employed because gross milk prices received by farmers depend almost entirely (80%-90%) on the milk total component value (i.e. butterfat, protein and other solids), which, is best captured by Class III milk prices.[11]

Milk contracts at the CME follow the following procedures. Each month, a new contract, with a maturity date of 24 months in the future[12], becomes available for trading at the CME. Once a contract becomes available, it can be traded by farmers at any time up to its maturity. Farmers at any point in time have opportunities to sell and buy several futures contracts that will meet their risk management needs. For example, in January of 2005 a farmer can decide to sell both his January 2006 (12 months ahead) and October 2006 (20 months ahead) milk by using contracts that became available in January of 2004 and October of 2004 (24 month prior to maturity), respectively. Therefore, farmers will face pricing decisions for each future month. For instance, suppose a farmer has negotiated on October 31, 2004 a cash forward contract to deliver milk in one month (November 30, 2004) at a price of $14/cwt. This means that the farmer is entitled to receive $14/cwt at the time of milk delivery, November 30, 2004. This is the traditional and widely used forward cash contract that sets a price for product to be delivered later. The cooperative or processor (the buyer) sells futures contracts after the cash contract is signed to protect against declining value of the milk to be delivered at the later date.

[10] http://www.cme.com/trading/prd/contract_spec_DA656.html contains all the specifications of a Class III milk futures contracts.
[11] Bailey (2000a) manuscript shows a clear definition and examples of the total component value (Class III)
[12] Maturities vary from 18 - 24 months. 24 months is used for illustrative purposes.

The futures market works in a different, but equivalent, fashion. First, the farmer opens a margin account with a broker. The normal procedure requires that the farmer has an initial balance of $2,000 per contract and must maintain a minimum balance of $1,500 (maintenance margin).[13] After a farmer has sold or is "short" a contract, say the $14/cwt above, his account is adjusted (credited or debited) on a daily basis according to the closing or settlement price of this contract. When the price change is positive (today's price is higher than yesterday's), the account is debited. If prices are increasing any buy back would be at a loss and this potential loss is reflected in the futures account. On the contrary, if the price change is negative (today's price is lower than yesterday's), the account is credited and excess money is accumulated in the account. The amount that is credited (debited) is equal to the price change (in $/cwt) times 2,000 (the number of cwt in a contract). If the account balance per contract drops below the maintenance margin ($1,500), the farmer is asked to deposit more money into the account (such deposit is referred to as 'margin call') to restore the initial margin of $2,000 per contract.

At the chosen date, in this example, November 30, 2004, the farmer has to buy back his contract in the futures market. To continue with the example, suppose that on November 30, 2004, the buy back price of the futures contract is $12/cwt. This means that the farmer benefited from a contract that allows him to establish a milk price at a higher price than $12/cwt. Therefore, the farmer receives $2/cwt more than he would have received if he had only sold the milk in the cash market. The net price is the cash price net of gains or losses in the futures market.

[13] These initial and maintenance margins are usually set by the broker and can change at any time, so it is important to update this information before trading a futures contract.

The action of selling a contract and then buying it back later is called a 'round turn'. Selling at $14/cwt and buying back and closing the contract at $12/cwt means a gain of $2.00/cwt.[14] The farmer sells milk to the processor or cooperative, as he would normally have done without participating in the futures market. Thus, the farmer will receive the cash price of $12/cwt by the cooperative (assume for a moment that the cash price received by the farmer is equal to the settlement price of the contract), plus the $2/cwt in his futures account. Recall that the farmer expected a price of $14/cwt for his milk and this is exactly what the farmer receives: $12/cwt by the cooperative + $2/cwt for the round turn in the futures market. The forward price being offered by the futures market on any particular day is futures plus basis, where basis is the expected difference between cash and futures on the date the milk is sold and futures are bought back.

Milk futures data have been available since October 1998. The futures data used in this study were obtained through PROPHET, a provider of prices in the commodities futures markets. The data acquired from Prophet provided daily data from October 1998 to May 2004 including: date of trade, open price, low price, high price, closing price, settlement price, volume traded and outstanding contracts traded for each day. This study will use the closing or settlement prices in order to test each strategy.[15] Volume traded is used to determine an adequate timeframe for testing each strategy. For each of the strategies analyzed, only the last 6 months of trades before maturity are considered (specifically the last 130 observations, discounting weekends and holidays). Most of the

[14] In this example only one round turn is considered for illustrative purposes. It is also possible for the farmer to execute multiple round turns between the first time the contract was sold and the expiration of the contract. In fact, the 'moving averages' strategy considered in this study allows for multiple round turns.

[15] Certain software packages allow to place hedges the day in which the price desired or signal is generated. This is the reason why this study uses the closing price. However, it is important to note that when using spreadsheets and prices are available after the market is closed, the farmer will place the hedge at the next day's open price.

traded volume (81%, on average) takes place within 6 months before a contract expires, and trade is thin or does not exist more than 130 days prior to contract maturity.

4.1.2 Cash data (Mailbox price)

It is known that there are many factors which influence the price of milk and the so-called mailbox price, i.e. the price received by dairy farmers after taking into account premiums, discounts, and costs. These factors include Federal and State orders, class prices (I, II, III, IV), class uses (which affects the Federal Order blend price(s)), over-order premiums, premiums for fat, volume, quality, and deductions for hauling, promotion, coop retains, etc.[16] In order to obtain a generic consistent price variable for the three regions, i.e. a price variable that allows comparison of the three data sets, the following factors were considered: monthly milk production in pounds, gross monthly payments, and hauling costs.

The cash price measure was calculated as follows. First, for each farm, the average monthly total hauling costs were calculated over the last five years. This monthly average was then subtracted from the gross payments for each month. This was done in order to maintain the variability of prices, which is of great importance in this study. Next, total production in pounds of milk per month was divided by 100 in order to obtain the total production in hundred weights (cwt. henceforth) per month. Then, the monthly gross payment minus the monthly average hauling cost was divided by the total per cwt production of milk, the resulting is the "*mailbox price*" in $ per cwt.

[16] Bailey (2000b) presents a detail explanation of these calculations.

4.2 Basis

Once the mailbox price is computed, the next step is to calculate the basis with the objective of having a better insight of the "forward" price that the producer can expect in the future. The forward price being offered to each producer on a day-to-day basis is a very important piece of information, and understanding of the basis is necessary to the calculation of the forward price being offered by the futures complex.

4.2.1 Basis Table Development

According to Purcell and Koontz (1999) basis is always defined as cash minus futures where cash prices are for a particular local market. The *closing basis* is then "the expected difference between the future price and the producer's local market price where the cash product will be sold", i.e. the difference between the future price and the mailbox price (mailbox price minus future price) for each producer. It is important to observe that for many farm commodities such as corn or slaughter cattle, the basis is typically negative given the fact that local cash prices are often lower than futures prices. This customary relationship will not hold for milk in Virginia, however. Located close to the middle Atlantic and Northeast population centers, cash prices in Virginia will normally be above the futures price which is essentially the discovering price for the Wisconsin producing area.

The basis for each farm is calculated by subtracting, for each month, the average future price of the last month traded (i.e. the month the contract expires) from the mailbox price for each Class III milk contract.[17] Then, for each month, the average of this basis over the period 1999-2003 is calculated. As a result, there are 12 'average' basis estimates, one for each month.

To illustrate this procedure, consider farm B's January 'average' basis. Since there are five January contracts, one for each year ('99-'03), there are five basis calculations as indicated in table 4.1 below.

Table 4.1: Farm B Calculated January Closing Basis by Year, and Average (1999-2003) in $/cwt

Jan Contract	Basis
Jan-99	3.09
Jan-00	4.10
Jan-01	5.56
Jan-02	3.46
Jan-03	4.20
Average	**4.08**

Each entry in table 4.1 is obtained by subtracting the average futures (closing) price from the mailbox price. For example, the basis in January 1999 (3.09) is computed by subtracting the average futures closing price over January 1999 ($15.75/cwt) from the January 1999 mailbox price ($18.84/cwt). This procedure is repeated for January 2000, 2001, 2002, and 2003. The resulting values are averaged over the 5 years. The resulting 'average' January basis for farm B is $4.08/cwt. The 'average' basis for all months and the best and worst basis for each are presented in Table 4.2.

Table 4.2 shows that the highest value of 'average' basis ($6.81/cwt) corresponds to farm A and it is registered in November. Conversely, the lowest value ($1.33/cwt) is recorded in August and corresponds to farm C. The value of the worst basis during the

[17] Remember that each data set was separated into two groups the 'in-sample' and the 'out of the sample' periods. The first one contains mailbox prices from January 1999 until May 2003 while the second one contains mailbox prices from June 2003 until May 2004.

whole period ($-2.00/cwt) corresponds to farm C and it is also registered in the month of August. On the other hand, the value of the best basis during the entire period ($8.37/cwt) corresponds to farm A and it is registered in November. The three farms show that basis is positive for almost all months within the period of study, contrary to the usual finding of negative basis for other farm products. These results confirm what was suggested earlier that Virginia is a deficit milk producing area, which is reflected in higher prices for the state than the futures market discovered prices in the Midwest would suggest.

Table 4.2: Closing Basis Measures for Class III Milk by Farm, 1999-2003, Mean and Range[18]

Contract Month	FARM A	FARM B	FARM C
Jan	4.79 (3.83 to 6.72)	4.08 (3.09 to 5.56)	3.67 (2.02 to 5.65)
Feb	5.56 (4.24 to 8.58)	4.63 (3.17 to 7.65)	4.07 (2.58 to 5.94)
Mar	5.36 (4.21 to 7.38)	4.42 (3.75 to 6.21)	4.04 (3.41 to 5.11)
Apr	4.11 (1.92 to 5.20)	3.32 (0.80 to 4.63)	2.91 (0.38 to 4.62)
May	4.08 (3.26 to 5.16)	3.65 (2.80 to 5.19)	3.01 (1.74 to 4.60)
Jun	4.06 (3.18 to 5.34)	3.79 (3.13 to 5.46)	3.15 (2.25 to 4.78)
Jul	3.60 (1.89 to 4.78)	3.48 (1.91 to 4.69)	2.64 (1.08 to 3.76)
Aug	3.10 (-0.64 to 5.17)	2.96 (-0.92 to 5.20)	1.33 (-2.00 to 3.56)
Sept	3.28 (1.08 to 4.69)	3.02 (-0.01 to 4.65)	2.23 (-0.31 to 3.69)
Octob	4.77 (3.79 to 6.16)	4.35 (3.54 to 5.38)	3.64 (2.45 to 4.85)
Nov	6.81 (4.92 to 8.37)	6.41 (4.85 to 7.53)	5.39 (3.40 to 6.36)
Dec	4.81 (3.46 to 6.85)	4.36 (3.18 to 5.90)	3.91 (3.28 to 5.52)

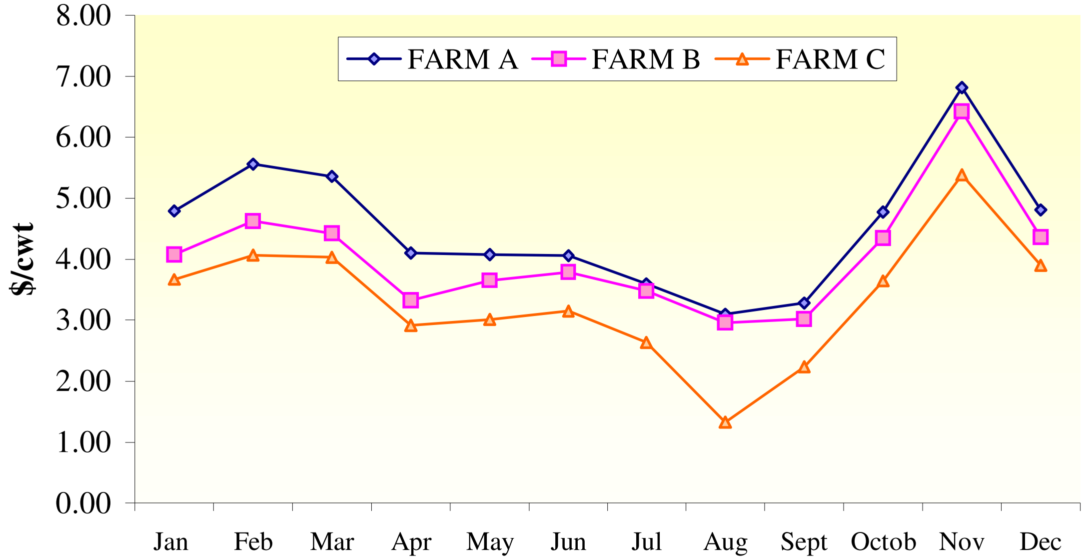
Note: each cell contains two rows: the first row represents the 'average' basis for that month, while the second row, in the parentheses, contains the worst and best basis recorded during the period.

Figure 4.1 shows the basis pattern for the three farms. From this figure it is important to highlight that the basis seems to be higher during fall months (especially November) and lower during summer months (particularly August). This pattern may be due to production changes influenced by weather and grazing conditions, as well as, demand changes. From this basis pattern one may conclude that cash milk prices in Virginia are

[18] It is important to notice that for the first five entries (i.e. January, February, March, April and May) there are five observations: January 1999 to May 2003, while for the remaining months there are only four observations: June 1999 to December 2002.

higher relative to futures prices during fall and winter months and lower relative to futures prices during spring and summer months.[19]

Figure 4.1: Calculated 'Average' Cash-Futures Basis Farm A, B and C from 1999-2003



It is essential to mention at this point that the study uses the "average" basis (reported in table 4.2) as the expected basis in the future period. Although this *expected basis* may differ from the actual closing basis for future years, it is the best available proxy and hence it is used for the calculation of forward prices being offered by the futures market. The risk of having an actual closing basis that is different from the expected one is known as *basis risk*. It is the decision maker's responsibility to choose which basis level within the range to use. A more conservative decision maker might choose the worst of the historical basis, while others, less conservative, would likely prefer to use the "average" basis.

[19] For more details on milk seasonality aspects see Groover (2000).

4.2.2 Basis Risk

Basis risk represents the risk of experiencing an actual closing basis that is different from the expected level. This concept is best illustrated with an example. In table 4.2, the values of the mean and range of Farm B's January basis are as follows: 'average' basis is \$4.08/cwt, worst basis \$3.09/cwt, and best basis \$5.56/cwt.[20] Suppose farmer B decides to use January's 'average' basis as the 'expected' basis for next January. This implies that the farmer expects that at the end of January the difference between the mailbox price received and the futures price will be \$4.08/cwt. Suppose that on July 25, 2003 he observes that the futures market price for the January 2004 is \$12/cwt. Then, the farmer would expect to receive at the end of January 2004 a mailbox price of \$16.08/cwt. (\$12+\$4.08). Six months later, January 30, 2004, the farmer receives a mailbox price of \$15.69, and the price offered in the futures market is equal to \$11.61/cwt. Thus, the 'actual' basis is \$4.08/cwt (\$15.69-\$11.61) as the farmer expected as illustrated in Table 4.3.

Table 4.3: Demonstration of Basis Risk for January 2004 Milk Futures Contract

ACTUAL BASIS = EXPECTED BASIS

Date	Cash market	Futures Market
25-Jul-03	Farmer expects that mailbox price will be \$16.08/cwt on January 30,2004 **Expected basis**: Mailbox price - futures = **\$4.08/cwt**	\$12/cwt
30-Jan-04	Mailbox price \$15.69/cwt **Actual Basis**: Malbox price - futures = **\$4.08/cwt**	\$11.61/cwt
	Difference: \$0.00/cwt	

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[20] According to Purcell and Koontz (1999) worst basis, also called 'weak basis', is the basis level that are negative and large in absolute terms, while the best basis or 'strong' basis is the small negative, or positive, basis. In the case of milk in Virginia, the worst basis turns out to be a small negative value and the best basis a positive value.

Since actual basis and expected basis are the same, there is *no basis risk* involved and the price expected is equal to the price received. However, this is not always the case, and most of the times the 'actual' basis differs from the expected basis. Table 4.4 shows two cases when this difference occurs.

Table 4.4: Demonstration of Basis Risk for January 2004 Milk Futures Contract

ACTUAL BASIS ≠ EXPECTED BASIS

CASE 1 (Worst Basis)		
Date	**Cash market**	**Futures Market**
25-Jul-03	Farmer expects that mailbox price will be $16.08/cwt on January 30,2004 **Expected basis**: Mailbox price - futures = **$4.08/cwt**	$12/cwt
30-Jan-04	Cash price $14.70/cwt **Actual Basis**: Mailbox price - futures= **$3.09/cwt**	$11.61/cwt
	Difference: - $0.99/cwt	
CASE 2 (Best Basis)		
Date	**Cash market**	**Futures Market**
25-Jul-03	Farmer expects that mailbox price will be $16.08/cwt on January 30,2004 **Expected basis**: Mailbox price - futures = **$4.08/cwt**	$12/cwt
30-Jan-04	Cash price $17.17/cwt **Actual Basis**: Mailbox price - futures = **$5.56/cwt**	$11.61/cwt
	Difference: + $1.48/cwt	

For each of the two cases, Table 4.4 presents different mailbox prices on the expiration date of the futures contract (January 30, 2004). In case 1, the mailbox price received on January 30, 2004 is $14.70/cwt not the expected $16.08/cwt. Consequently, the 'actual' basis is $3.09/cwt instead of the $4.08/cwt 'expected' basis. Since actual basis and expected basis are different, *basis risk* is present. The expected price or forward price was higher than the price realized. That is, the farmer is receiving $0.99/cwt less than anticipated. In case 2, the mailbox price received is $17.17/cwt producing an 'actual' basis of $5.56/cwt instead of the 'expected' $4.08/cwt. Again, since actual and expected basis differs, *basis risk* is present. This time, the price expected was lower than the price received and the farmer experienced a bonus to the expected price of $1.48/cwt.

In summary, the farmer is exposed to basis risk whenever the actual basis is or can be different from the expected basis. Table 4.4 was constructed so that the actual basis of each case is equal to the 'worst' and 'best' basis of this farmer. However, the 'actual' basis level could lie inside or outside the range of the basis obtained from the historical data.

In the above example the farmer chose the 'average' basis as the 'expected' basis. However, a more conservative farmer may choose a lower basis, while a more aggressive farmer may go for a higher one. Regardless of which metric is used as the expected basis (e.g. best, average or worst), basis risk cannot be eliminated. There will always be uncertainty about the 'actual' closing basis for the pricing process and therefore uncertainty about the exact level of the net price across both the cash and the futures markets.

4.3 Costs

In order to develop an effective risk management program, it is also necessary to analyze the role of costs. As it was mentioned earlier, price risk management can be utilized to reduce the risk of rising costs (the inputs) as well as to reduce the risk of falling milk prices (the output).

This study focuses on the latter since milk prices have experienced substantial variability since 1996, whereas production costs have remained relatively stable.[21] To facilitate the study on volatile milk prices some assumptions about costs have been made.

[21] Bosch and Johnson (1992) offer an insight on managing risk from an input perspective.

First, only one representative cost budget of a Virginia dairy farm is used for all farms. Second, it is assumed that these costs remain constant (in $/cwt) across farms and time (1999-2004). Third, only variable cost is considered (i.e. allocated overhead is not included) and the reason for this will be explained below.

The cost budget is obtained from the USDA website "Virginia, monthly dairy costs of production per cwt of milk sold, 2003", which contains a compilation of surveys to milk producers in the state. Appendix 9.1 shows the monthly budget of a representative Virginia dairy farm ($/cwt) for 2003, as it appears on the USDA website.[22]

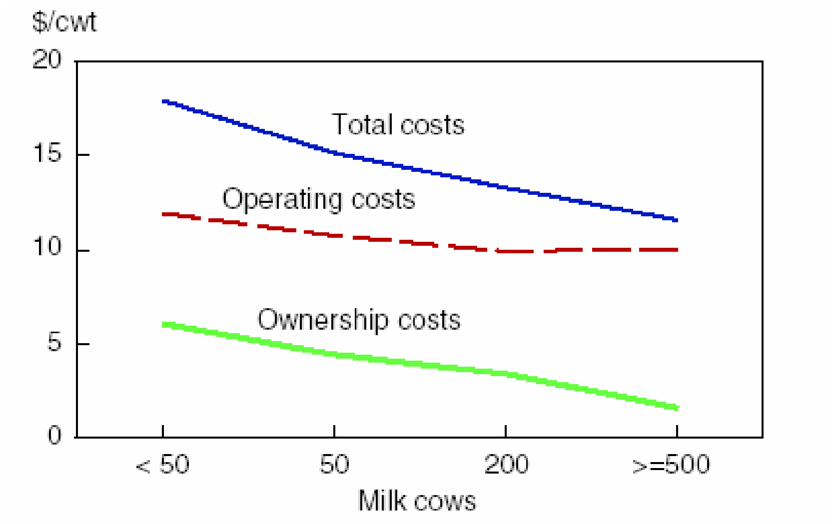
Costs are divided into two main categories: operating costs and allocated overhead. As the name suggests, operating costs include the necessary expenses to operate a farm such as feed, veterinary services and medicine, bedding and litter, marketing, customer services, fuel, lube, electricity, repairs and interest on operating inputs. In general, these costs cannot be paid in a later period or put aside (short term obligations). On the other hand, allocated overhead costs reflect a rate of return to management, labor, land, capital and equipment, which represent obligations in the long term (can be delayed to later periods).

The original USDA table was modified in the following way. Hired labor was removed from allocated overhead and placed in operating costs. The reason for this is that farmers incur variable labor costs on a monthly basis and these expenses are needed to keep the production process active. The table in appendix 9.2 reflects this modification. Henceforth, operating costs, as they appear in appendix 9.2, will be referred to as variable costs and allocated overhead as fixed costs.

[22] http://www.ers.usda.gov/Data/CostsAndReturns/testpick.htm#milkproduction.

Although the assumption made is of constant variable costs across farms and time, it should be noted that costs actually vary by region, size of farm (small, medium, large, industrial), animal productivity, and efficiency of labor and feed.[23] Since the per unit variable cost component varies by farm size and time[24], the assumption of constant marginal cost may be too strict; hence, further analysis of the sensitivity of the results obtained in this study may be appropriate in later studies.

Figure 4.2: Cost Structure by Farm Size[25]



Source: Agricultural Resource Management Survey (2000), U.S. Department of Agriculture, Economic Research Service

According to Short (2004) total operating costs for a representative small farm size (fewer than 50 cows) is $11.92/cwt, while for a representative industrial scale farm size (more than 500 cows) the total operating cost is $10.03/cwt. Figure 4.2 depicts this variable cost and also the total per unit cost for different farm sizes. From this it can be observed that as farm size increases the per unit total cost decreases. This reduction is due to lower per unit fixed costs that large farms have, a widely observed phenomenon in

[23] The work of Short (2004) analyzes how costs of production vary among U.S. producers.
[24] In the case of Virginia dairy farms, it accounts for 65% of total costs (see appendix 1.A)
[25] Figure reproduced from Short (2004)

farming labeled “economies of size”. Consequently, as it was mentioned earlier, the study only takes into account the portion of costs that varies by level of production for further calculations and results.

4.4 Risk Management Program

Once costs and basis are determined, the risk management strategies are developed and analyzed. *Farm B* will be used to illustrate the management strategies used in the study.

4.4.1 Baseline (No Hedge)

Farms with no risk management in the last 5 years were exposed to volatile milk prices, which ultimately determined whether farms were able to remain profitable or lose money. The majority of dairy farms are very specialized and obtain most of their revenue from the sale of their milk. Hence, this study will consider only revenue from milk sales.

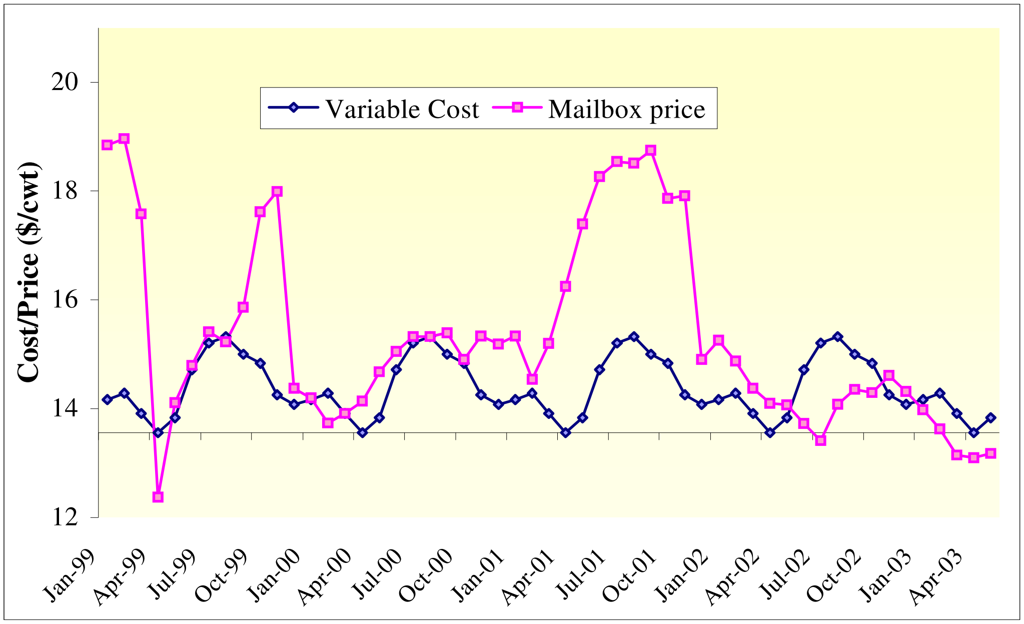
Given that variable costs are relatively similar for all farm sizes, and that in Virginia 65% of total cost are variable cost, this study, will consider variable costs as the essential portion of cost to be recovered. At least in the short run, this is the necessary condition for the survival of dairy farms.[26] It should be noted, however, that this study could be modified in a straightforward fashion to include farm-specific fixed costs (allocated overhead).

In the context of this study, each farm’s *profit*, in $/cwt, during the 1999-2003 period is defined as the monthly mailbox price ($/cwt) received by the farm minus the

[26] According to Bailey (2001) other objectives of a dairy farmer can be to protect the milk margin (Milk Margin $/cwt = Milk price – Feed costs) or hedge if the price offered at least cover your ‘breakeven’ milk price (Milk price that is needed to pay all milk production expenses, to contribute to debt reduction and capital replacement, and to realize dollars for family living).

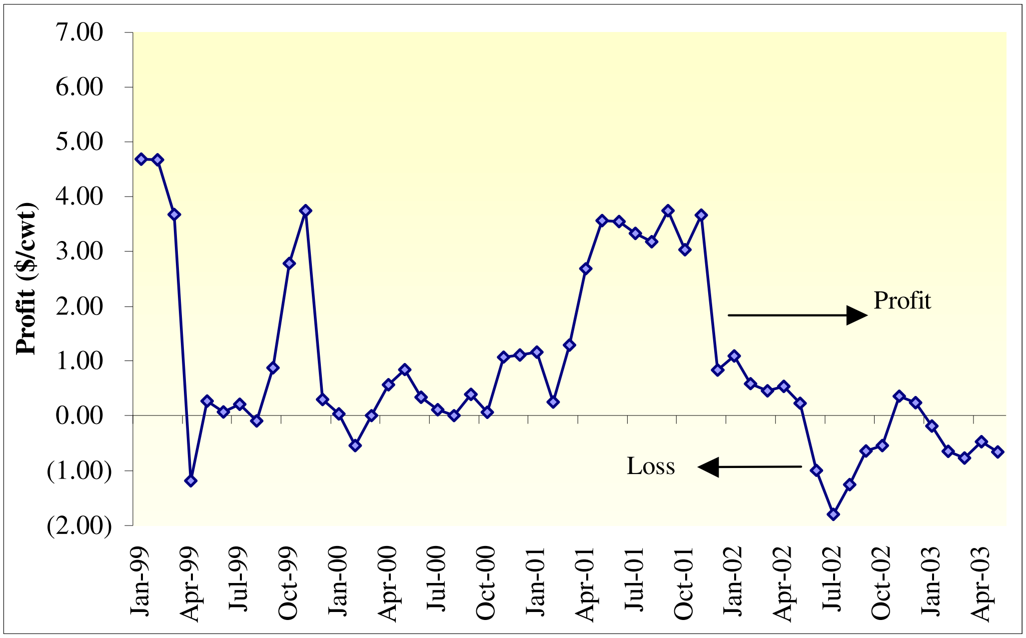
monthly per unit variable cost ($/cwt). Figures 4.3 and 4.4 show monthly mailbox prices, variable costs, and profits (in $/cwt) for farm B during 1999-2003.[27]

Figure 4.3: Farm B's Mailbox Price and Variable Costs ($/cwt) 1999-2003 Without Risk Management Program (Baseline)



[27] Remember that 1999-2003 is used as a historical "in the sample" data from which the optimum strategy will be derived.

Figure 4.4: Farm B Profit and Loss ($/cwt) 1999-2003 (Baseline)



Farm B's profit will serve as a baseline in order to compare the profitability of a farm with and without a risk management program. This baseline indicates the profit that is attained without any forward contracting or hedging activity.

In figure 4.3, whenever the mailbox price is above variable cost (positive returns to variable costs), a profit is registered. Conversely, if the mailbox price is below variable cost, a loss is recorded. The resulting profit/loss is reported in figure 4.4. As figure 4.4 shows, there are several months in which the farm incurs losses. In fact, in 13 months out of 53 months between January of 1999 and May of 2003 the farm registers negative profits. Losses as measured here indicate that the farmer was not even able to cover the operating costs (variable costs). The worst loss of $1.79/cwt occurs in July 2002, while the best profit of $4.68/cwt happens in January 1999.

It is necessary to clarify that losses may be misinterpreted as relatively small losses when looking at the number in dollars per hundred weight ($1.79/cwt in the case of

July 2002); however, when taking into account the amount of milk produced by the farmer, the total loss in dollars can be very high. For example, if the farmer produced 300,000 pounds of milk in July 2002, then the total loss will be $ 5,370 ($1.79/cwt times 3,000 cwt).

Given the fact that farmers are periodically not able to cover variable costs, it is impossible to cover fixed costs or, even worse, replace equipment or repay debt. If this situation persists for several months, the farmer will face bankruptcy and exit the market. To avoid these problems, management strategies are needed to guarantee a price that assures economic viability of the farm. The strategies developed in this study will compare the baseline profit to alternative pricing strategies designed to reduce risk and to improve profitability over the baseline.

4.4.2 Risk Management Strategies

There are several strategies that a farmer can use for a risk management program. These strategies include cash forward contracts, futures contracts and options. The choice of each strategy depends on three important factors, which will, in turn, have an effect on the success or failure of the chosen strategy. Some factors are more important than others and can impose several restrictions in the way a farmer decides to hedge his milk prices. These factors are discussed below.

4.4.2.1 Factors that Influence the Risk Management Strategy

To develop a risk management strategies three factors must be understood.

The attitude of the decision maker, in this case the farmer, toward risk: risk averse, risk neutral or risk lover.

The financial position of the farm: large debt load with high debt repayments and expansion plans (or low debt level and more flexibility).

The decision maker's level of knowledge, skill, and time allocated to manage risk.

According to Purcell and Koontz (1999), attitude towards risk in an agricultural producer can be inferred from the farmer's degree of diversification or specialization of production. A more diversified producer will be categorized as a more risk averse producer than a specialized producer. In general, a more risk averse producer would not like the idea of being exposed to price volatility (risk). Thus, this type of farmer is willing to trade off the possibility of an unexpected increase in price for protection against falling prices. Connecting this idea to the theoretical framework described earlier, this willingness to give up the opportunity of higher prices can be interpreted as being equivalent to risk averse individuals' willingness to pay a premium to ensure a certain return. A risk averse investor will hence tend to choose a more conservative strategy. On the other hand, a less risk averse producer is less likely to sacrifice the possibility of higher prices and will be willing to incur risk exposure in an effort to increase revenues.

Second, the financial position of the farm is of great importance in the strategy selection. If the farm has a high load of debt then the farm must have the necessary revenues to be able to service and reduce debt over time. For instance, when prices fall drastically, the revenues generated may not be high enough to cover variable costs, which would leave the farm in a stressed financial situation and facing the possibility of exiting the market. In order to avoid this scenario, the producer can use a strategy that guarantees protection against falling prices. It should be noted that, regardless of the farmer's attitude towards risk, if there is a highly leveraged situation in the farm's finances, this becomes the most important factor when analyzing price risk management strategies. This means that even though the producer is by nature a risk taker, a conservative strategy must be followed in order to guarantee the survival of the farm. Conversely, if the farm has a low debt load, a less conservative strategy can be employed.

Finally, the decision maker's knowledge and ability to manage risk is critical for the success of the strategy. It may be the case that the recommended strategy best fits the financial situation and the decision maker's attitude towards risk, yet the strategy involves a series of very sophisticated procedures. Therefore, for the strategies to be followed producers should be familiar with fundamental analysis[28], and to know the mechanism and consequences of each strategy. Without sufficient knowledge of mechanisms, strategies are not effective in reducing risk.

4.4.2.2 Types of Risk Management Strategies

This study presents two risk management strategies, based on the assumption that the average Virginia dairy producer is risk averse: First a conservative strategy, and second an intermediate, or less conservative, strategy.

4.4.2.2.1 Conservative Strategy

A conservative strategy is best suited for a risk averse farmer with limited analytical abilities to handle risk and restricted financial freedom (i.e. a highly leveraged farm).

[28] According to Purcell (1999) fundamental analysis is the analysis of the underlying supply and demand forces that will help the producer to project the price direction and a probable price range for the commodity in the future.

The conservative strategy utilized in this study is called a '*target price'* strategy. The target price strategy can be carried out in both the forward cash market and/or the futures market.

A target price approach in the forward cash market is considered the most conservative, in that it is easier to use. Thus, if two farmers are risk averse but one does not have any knowledge about this type of risk management, it is advisable for this farmer to price his milk in the forward cash market. Once knowledge and understanding of the procedures in the futures market are acquired, target price strategy in the futures market can be used by the farmer. A detailed explanation of the target price strategy is provided below.

a) Target Price Strategy

A target price is the price of milk that a producer may want in order to cover the costs of production, living expenses, debt services, and return on investments. Therefore, a producer will choose the target price that best suits his situation with the objective of assuring the economic viability of the farm's operations. Same producer may desire a target price that covers short-run cash flows (cash costs plus debt services plus family living expenses needs), while another may desire a price that covers total costs of production.

The selection of an adequate target price is of great importance, and the producer should be aware of the reality about setting high target prices. In general, the higher the target price selected is, the lower the probability that the price will be offered by the forward cash market or the futures market. Once a farmer has chosen a target price, he can try to lock into the specified target price through two channels. The first channel is the processor or cooperative (cash forward delivery contract), and the second channel is via a broker (futures market directly). A detailed explanation of the two channels is provided below.

a.1 Cooperative or Processor (Cash Forward Delivery Contract)

The processor or cooperative (henceforth both terms will be used interchangeably), who is more suited to manage risk, serves as an intermediary for the farmer. The cooperative guarantees a specific price in a specific future date to the farmer through a *cash forward contract*.[29] The contract can be arranged for different future delivery periods (one month, six months, or twelve months) since the farmer may not prefer to protect his milk price with just one contract in one date, but rather with several contracts for different dates and different prices.

Cash forward contracts are tied to the Class III milk futures prices. Premiums and discounts are incorporated in the mailbox price received by the farmer. That is, basis is always taken into account at the moment of calculating the net prices and any premium and discounts over time become part of basis levels. Once basis is separated from the chosen target price, the farmer has to decide the percentage of production he is going to forward price. Usually a farmer knows how much milk is *normally* produced each month, and, depending on this, the farmer will make a decision of what fraction of expected production will be forward priced.[30]

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[29] A *cash contract for forward delivery* is a contract between a farmer and a processor by which the farmer agrees to sell and *deliver* milk production on a future date and at a specified price.
[30] Dairy farmers, whose production is affected by grazing conditions, have to make sure that this production variability is taken into consideration when deciding the amount of production to forward price.

After a farmer has determined the expected price and the amount of production to be forward priced, the farmer will contact the cooperative and ask for a cash bid (a cash forward contract price) for the specific month. The cooperative then provides a price for the cash forward contract and the farmer evaluates it, calculating the 'forward price' being offered in the futures market (this is explained below) to see if the cooperative's price is acceptable, competitive and complies with the farmer's objective.[31] If this is the case, then the farmer will sign the contract.

If the farmer decides to sign a contract, the cooperative hedges the amount received by the farmer in the futures market in order to guarantee a price. In a cash forward contract, then, the producer has a specific price and the cooperative, who sells futures after offering the cash contract, faces any basis risk. The cooperative has to also deal with the margin accounts and margin calls that the position may cause in the futures market.

The hedging process conducted by the cooperative is transparent to the farmer's since the farmer only has to deal with the cooperative, and is guaranteed a specific price. When the contract expires, the farmer delivers his milk to the cooperative as usual (just as he would without cash forward contract) and receives the specified price contracted plus any appropriate premiums and discounts.

The cash forward contract presents some advantages. First, a cash forward contract can be made for small amounts of milk compared to futures (a future contract uses a fixed quantity of 200,000 pounds of milk). Cash forward contracts may be made

[31] It should be noted that the cash bid offered by the cooperative does not equal the price offered in the futures market after adjusting for basis, there is an implicit commission charged by the cooperative. Basis risk is the main reason why the processor will usually offer less than futures price plus basis in an attempt to impose the basis risk on the producer.

for 10,000, 20,000 or 25,000 pounds of milk. Indeed, this is a significant advantage to small producers that cannot use the futures markets because of their limited production. Second, a cash forward contract is very simple to use. The farmer only needs to know the bid price from the cooperative and, if the farmer finds the price acceptable, sign the contract. A farmer executing a cash forward contract has no need for a broker, nor margin accounts, thus, eliminating margin calls.

On the other hand, cash forward contracts present some disadvantages. Farmers are not usually allowed to buy the contracts back. That is, once the farmer has signed a cash forward contract he is obligated to deliver the milk in the future at the specified price and he cannot get out of the contract. This is considered as a disadvantage by some, especially when the Class III milk future prices are rising above the contracted price and the farmer could benefit from a higher price than the one contracted with the cooperative. In addition, the cash forward contracts do not necessarily eliminate basis risk for the farmer. According to Purcell and Koontz (1999), the transferability of price and basis risks from the producer to the buyer (cooperative in this case) is not complete since the cooperative will tend to offer cash price contracts that transfer part or all the basis risk to the producer. Thus, cash forward contracts could be much lower than price less basis.

Testing this strategy directly for Virginia dairy farms was not possible in this study since these data were difficult to access. This strategy is one of the most conservative ones and it is employed by individuals with high risk aversion, limited financing or restricted management abilities to handle risk.

a.2 Broker (Futures Market Directly)

If the farmer has the ability, knowledge, and sufficient financial conditions to manage risk, margin accounts and margin calls, then the farmer may prefer to contact a broker (who will charge a pre-specified commission for each round turn) and trade in the futures market.

As mentioned earlier the target price sought by the farmer will be affected by basis. The price that the farmer will expect to receive in the future can be estimated through the 'forward price'[32] (FP), which is equal to futures price (FUT) plus basis:

$$FP = FUT + BASIS$$

where futures price (FUT) is the price offered by the futures market, and BASIS is equal to the 'average' or expected basis for the specific month for which 'forward price' is being computed. This forward price can, in turn, be used to compare to target prices.

Suppose that for a given contract, say January 2000, Class III milk futures show a price of (FUT) $12/cwt. The first question that a farmer has is whether the price offered by the futures market is a good or a bad one, and, at the same time, whether his target price will be reached. In order to answer these questions, the first step is to introduce basis and then to calculate the forward price.

From the basis analysis presented in section 4.2.1, it is known that expected or 'average' basis for January is $4.08/cwt. Hence, the forward price (FP) for January 2000 is equal to $16.08/cwt ($12 + $4.08). Therefore, the farmer expects to receive a forward price of $16.08/cwt at the end of January 2000. Now, the farmer can compare the forward price he expects from the hedge with his January target price. The expected forward price should be greater or equal to the target price before a hedge is placed.

[32] This should not be confused with the forward cash market described above.

Another way to compare the target price with the future markets is by taking the specific target price, subtracting the 'average' basis and then comparing with the futures market price. The futures price must be equal to or greater than the producer's target price. For example, if the farmer wants a target price of $15.16/cwt (that covers variable costs of $14.16, plus a margin of $1/cwt) he should subtract the positive January expected basis from this price to see what price would be required in the future market. Therefore, the farmer will look for a price of $11.08/cwt ($15.16/cwt - $4.08/cwt) or higher in the futures market.

For simplicity, the example above has assumed that expected basis equals actual basis. This is not always the case because basis risk is maybe present and the actual results can be different from the expected. The difference between forward pricing with a cash forward delivery contract and hedging in the futures market is that, in the latter, the farmer must have a better financial position and the ability to manage margin accounts and margin calls.

The futures market offers these advantages. First, hedging directly in the futures market provides more flexibility to the farmer who wants to buy back the contract. A farmer trading in the futures market has to buy the contract back at or before expiration of the contract. In this case, no milk is delivered. The milk is delivered in the cash market as usual. Another advantage of hedging directly in the futures market is that the farmer can sometimes obtain better prices than when forward pricing his milk through the cooperative if the cooperative tends to discount contract offers because of basis risk.

On the down side, hedging directly in the futures market has disadvantages. As mentioned earlier, the futures contract uses a fixed quantity of 200,000 pounds of milk.

Monthly production of 200,000 pounds would require about 100 cows providing 24,000 pounds per year. Hence only producers with 100 cows or more will use this market. Second, the farmer needs to understand thoroughly the mechanism of the futures markets. Third, the farmer requires financial reserves or access to loans if margin calls are made, requiring commitment of the financial provider.

The following example illustrates how different target prices may affect farmers. Suppose there are two farmers who have decided to use target price as a price risk management strategy, and that both have the same costs and basis (variable costs $14.16/cwt, total costs $21.65/cwt, and basis $4.08/cwt). Assume that today is July 27, 1999 and the first farmer (farmer 'A') sets a target price, for milk produced 6 months from today (January 2000), that covers *variable cost plus a margin* over variable costs.[33] If variable cost is $14.16/cwt and the margin is $1/cwt over the costs, then farmer 'A' will lock into a price if the milk cooperative or the futures market offers a contract for the target price discounted basis of *$15.16/cwt* or higher, in the cash contract market, or *$11.08/cwt* ($14.16 +$1.00 -$4.08) in the futures market.

On the other hand, farmer 'B' decides to set a target price for milk produced 6 months from today that covers *total costs* with no margin; that is, the target price equals total cost (*$21.65/cwt*). Therefore, if the processor offers $21.65/cwt or higher, or the futures price is $17.57/cwt (or $21.65/cwt less $4.08/cwt basis) or higher, then farmer 'B' will sign the contract or sell the futures.[34]

[33] This margin over variable costs can be interpreted as a return over management, land, labor or equipment.

[34] Delivery of milk will only take place in the case of a cash forward contract, but not when a target price strategy is used in the futures market (i.e. the future contract is a cash settled contract).

At a quick glance it seems straightforward that farmer 'B' will receive a higher price than farmer 'A' if both can sign a contract with the processor or sell futures at their target-basis levels. However, the price that farmer 'B' is hoping for is very high and, given the market conditions, this price may never be offered by the processor.

If the highest price that the processor offers is, say, $15.50/cwt, only farmer 'A' will sign a contract and secure a price that covers the variable cost of production plus an extra $1.34/cwt. Farmer 'B', on the other hand, will not sign a contract and will depend on the cash price that is offered when the milk is sold, meaning that farmer 'B' is carrying all the low cash prices risk.

Suppose now, that when the time comes for milk to be sold (January 31, 2000), the cash price in the market is $10.00/cwt. Clearly, farmer 'A' will not suffer the negative impact of such a low price, since farmer 'A' will receive his contracted price of $15.50/cwt, while farmer 'B' will be significantly affected because even variable costs will not be covered.

As illustrated, in order to set a good strategy, the target price should be chosen in a way that reflects the farm's costs, the market conditions, and the farmer's capacity to carry risk. However, a *tremendous disadvantage* of a target price strategy (even one that uses an "adequate" [35] target price) is that if the market suffers an unexpected change in supply or demand, such that prices fall drastically beyond the expected range, the farmer will be vulnerable to the volatile cash price offered.

For example, suppose that farmer 'B' above has chosen an acceptable target price and expects the market conditions to be such that he is able to sign a contract at the expected price. However, if there is a sudden positive supply shock (e.g. more milk

[35] An adequate target price is one that assures economic viability of operations.

produced in the market than initially expected) prices may fall to such low levels that the target price may never be offered and farmer 'B' may be exposed to losses that threaten the financial viability of the farm.

Given this weakness of the target price strategy, a safety net is needed for the purpose of covering the downside price when target prices can not be met in the market (either by the cooperative or directly in the futures market). Moving averages as described in the next section can guide a selective hedging program and, at the same time, serve as a safety net.

4.4.2.2.2 Intermediate Strategy

An intermediate strategy is adequate for a less risk averse farmer who is willing to accept higher return variability if there is the possibility of obtaining higher returns and the farmer has sufficient financial resources to answer margin calls when hedging. Lastly and very important is the management ability and understanding of fundamental and technical analysis. The use of '*moving averages'* will be considered as an intermediate strategy since it allows the farmer the opportunity of taking advantage of higher cash prices while covering the risk of declining prices.

b) Moving Averages Strategy

As its name suggests, moving averages are based on arithmetic averages that move according to specific criteria. In this case, the moving average of futures milk price at any point in time is defined as the average of past futures milk closing prices up to a certain number of days in the past. For instance a 5-day moving average for today's futures price of milk is calculated as the average of the futures closing prices of milk for the past five days. To obtain a series of moving averages, this calculation is done at every point in time. Appendix 9.3 shows how to calculate a 5-day and a 12-day moving average with data obtained from the November 1999 class III milk futures contract.

Moving averages are used to extract information from the market with the intent of identifying when the trend of a market changes. These signals are then used to make decisions on selling or buying contracts in the futures market. Thus, moving averages permit the farmer to become a selective hedger, who wants to have a short hedge in place when prices are trending down and to be in the cash market (without short hedges) and benefiting when prices are trending up.

One advantage of the moving averages is that they provide clear and objective guides for trading. A single moving average can be used as a complement of other technical tools such as bar charts. However, different numbers of moving averages with different numbers of days can be used as a substitute of such analytical tools. The number of moving averages used depends on the objective of the user. In this study a pair of moving averages is employed. One moving average is for a shorter number of days than the other, for example 7 and 13 days. When these moving averages cross, a sell or a buy signal is produced. The type of signal (buy or sell) depends on the direction of the crossover action.

To illustrate, suppose that the shorter moving average (MA) is 7-days and the larger MA is 13. It is intuitive that the shorter MA reflects the movements in prices faster than the larger one (i.e. if there is a sudden price increase today it will move the average up by a larger amount if less days are included in the MA). Therefore, in what follows the shorter MA is referred to as the fast MA and the longer MA is referred to as the slow MA. The way the moving averages crossover operates as a signaling device is best illustrated with an example. Table 4.5 shows a set of closing prices for October 2001 milk futures contract. Using a 7-day fast MA and a 13-day slow MA, two trades are generated.

On August 1st, the closing price for the October 2001 class III milk futures contract reaches its peak price $14.8/cwt and starts decreasing the following days, and on August 8, the 7-day MA drops below the 13-day moving average at a $13.9/cwt closing price, confirming that the price has reached its peak. Intuitively, when the fast MA drops below the slow MA, it gives an indication that the trend is reversing and lower prices are expected.[36] Thus, if the trend is going down, it is advantageous for the farmer to sell the contract in order to get protection against declining prices.

[36] A sell signal is produced when the 'fast' moving average drops below the 'slow' moving average. On the other hand, a buy signal is produced when the 'fast' moving average raises above the 'slow' moving average. This is from the producer's perspective (short hedge only).

Table 4.5: 7-Day and 13-Day Moving Averages for a Set of Closing Prices for October 2001 Class III Milk Futures Contract and Generated Buy-Sell Signals

Date	Closing Price	7-day MA	13-day MA	Signal
17-Jul-01	13.79			
18-Jul-01	13.8			
19-Jul-01	13.9			
20-Jul-01	14.1			
23-Jul-01	14.69			
24-Jul-01	14.6	14.10		
25-Jul-01	14.7	14.23		
26-Jul-01	14.68	14.35		
27-Jul-01	14.68	14.48		
30-Jul-01	14.76	14.60		
31-Jul-01	14.75	14.69		
01-Aug-01	14.8	14.71		
02-Aug-01	14.73	14.73	14.46	
03-Aug-01	14.7	14.73	14.53	
06-Aug-01	14.55	14.71	14.59	
07-Aug-01	14.32	14.66	14.62	
08-Aug-01	13.9	**14.54**	**14.60**	**Sell**
09-Aug-01	14.15	14.45	14.56	
10-Aug-01	14.9	14.46	14.59	
13-Aug-01	14.76	14.47	14.59	
14-Aug-01	14.74	14.47	14.60	
15-Aug-01	15	14.54	14.62	
16-Aug-01	14.91	14.62	14.63	
17-Aug-01	14.65	**14.73**	**14.62**	**Buy**
20-Aug-01	14.9	14.84	14.63	
21-Aug-01	14.75	14.82	14.63	

Later in the month, on August 17, the fast MA (7-day) raises above the slow MA (13-day) confirming that a bottom has been reached and the trend has reversed upwards. Hence, it is convenient for the farmer to buy the contract back in order to be in the cash market and take advantage of higher prices. Summarizing, for a producer who wants to cover the downside risk of low prices and to take advantage of high prices (short hedging program) the following should be done when using moving averages:

Fast MA < Slow MA = SELL; and

Fast MA > Slow MA = BUY Back

The above round turn selected (sell plus buy back) generates a negative gain since the contract was sold at a price of $13.9/cwt and bought back at $14.65/cwt. This is a loss of -$0.75/cwt without commissions and once commissions are taken into account ($0.025/cwt per round turn), the loss is -$0.775/cwt. There are reasons for this loss and losses will be encountered on occasion. These reasons are presented below.

First, moving averages signals are not produced at the highest or lowest prices recorded since some days are needed for the averages to incorporate and confirm trend reversals; the longer the moving average, the lower the possibility to realize prices near the top or bottom. In addition, short moving averages do not perform well in fluctuating markets because the frequent trades that they generate are inefficient. Thus, the correct pair of moving averages is critical and it will depend on the type of market and commodity studied.

Some actions can be taken in order to lessen the effect of frequent losing trades. For instance, a requirement could be imposed such that a contract should be sold if the slow MA crosses the fast MA by at least a specific value, for example 10 cents. Similarly, this 10 cent requirement can be imposed to a buying signal. Such thresholds (e.g. 1, 5, 10, etc. cents) are called 'penetration requirements'.[37]

Again, using table 4.5 if for example a $0.10/cwt penetration requirement is incorporated to generate sell and buy signals, the first sell signal would not have been recorded on August 8. The 7-day MA drops below the 13-day MA only by *$0.06/cwt* ($14.60-$14.54) not meeting the criteria of the $0.10/cwt penetration requirement.

[37] There can be several penetration requirements. These may vary by commodity and its contract size. In this study, five penetration requirements were tested and a search for the profit maximizing one was performed. Details of this optimization procedure can be found in section 5.1.

Instead, the sell signal would have been produced on August 9, since the 7-day drops below the 13-day MA by $0.11/cwt ($14.56-$14.45) meeting the penetration requirement chosen.

In contrast, the buy signal would have been generated on the same day (August 17) as shown in table 4.5, since the 7-day MA raises above the 13-day MA by $0.11/cwt ($14.73-$14.62), meeting the requirement. Therefore, the round turn (sell plus buy back) that uses the penetration requirement generates a smaller loss than the original one. The contract would have been sold at a price of $14.15/cwt (instead of $13.9/cwt) and bought back at $14.65/cwt. This is a loss of -$0.50/cwt (instead of $0.75/cwt) without commission and a loss of -$0.525/cwt net from commission. In this case, the introduction of a penetration requirement improved the result.

Table 4.6 shows the dates, prices and gains (losses) from the round turns using the last 130 trading closing prices before the expiration date of the October 2001 Class III milk futures contract. The 7-day and 13-day MA with a $0.10/cwt penetration requirement are used.

Table 4.6: Dates, Prices, and Gains (Losses) from a Short Hedging Program for the October 2001 Class III Milk Futures using a 7-Day and 13-Day MA with a $0.10/cwt penetration requirement

Oct-01			
Date	**Action**	**Price $/cwt**	**Net Trade $/cwt**
13-Jun-01	Sell	$13.64	
28-Jun-01	Buy back	$13.32	0.32
9-Aug-01	Sell	$14.15	
17-Aug-01	Buy back	$14.65	-0.50
28-Sep-01	Sell	$15.02	
22-Oct-01	Buy back	$14.40	0.62
Total Gain/Loss:			**$0.44**
Commission:			**$0.075**
Gain/Loss net from commission ($/cwt):			**$0.365**

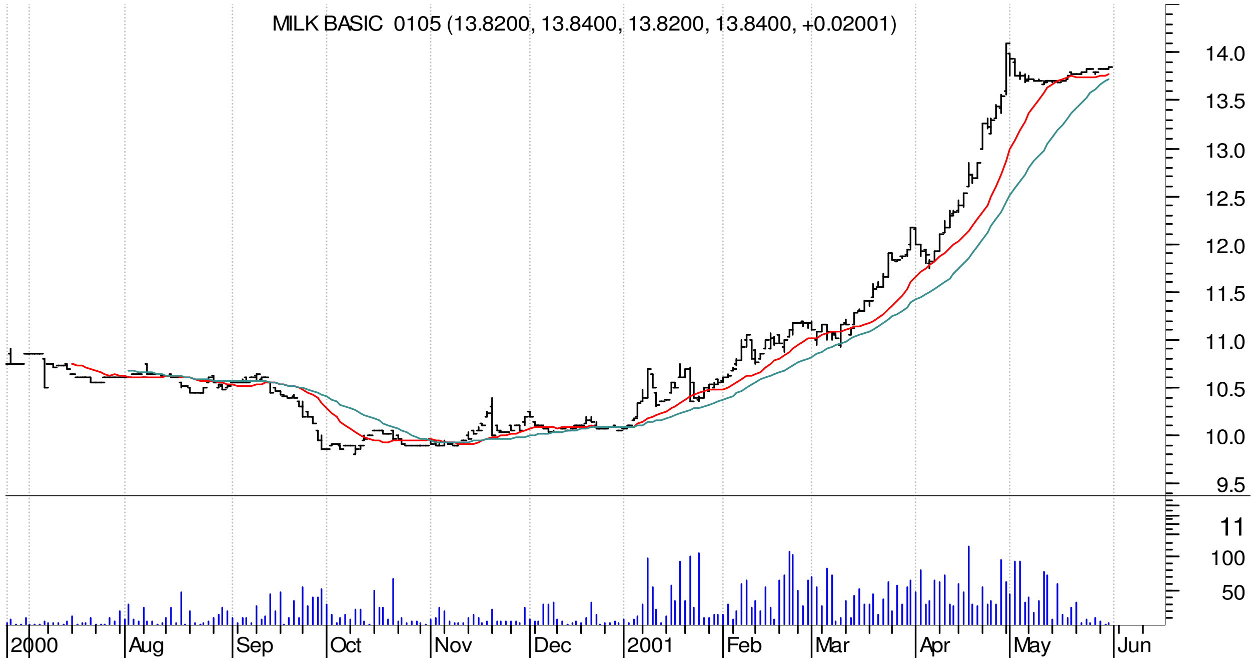
The short hedging program for the October 2001 futures contract yields a $0.365/cwt net gain in the futures market. The first sell signal is generated on June 13 and it is executed at a closing price of $13.64/cwt. Fifteen days later, a buy signal is generated and the contract is bought back at $13.32/cwt given a positive gain of $0.32/cwt before commission.

Almost a month and a half later, another sell signal is recorded and executed at a $14.15/cwt closing price. The round turn is completed on August 17, at $14.65/cwt producing a loss of $0.50/cwt. The last round turn creates a positive gain of $0.62/cwt before commission. As a result, the net overall gain is positive. Appendix 9.4 shows the chart of the October 2001 milk contract, the 7-day and 13-day MA and where the sell and buy back signals were generated and executed (this was a choppy market). Charts of May 2003 and August 2001 milk futures contracts which show a downward and upward trend are presented in appendix 9.5 and 9.6, respectively.

There are contracts in which no trade is carried out since there are strong upward trends and thus, the moving averages system does not produce sell signals. To illustrate this case, May 2001 milk futures contract are displayed in figure 4.5. May 2001 contract prices, the 15-day MA (in red) and the 27-day MA (in green) are plotted. In the figure, a sustained upward trend can be observed.

An effective pair of moving averages that uses an adequate penetration requirement is expected to keep the farmer as a cash market speculator in this upward trend market, preventing him from placing short hedges. This is exactly the case when using the 15-day and 27-day MA with a $0.025/cwt penetration requirement.

Figure 4.5: May 2001 Class III Milk Futures, 15-Day and 27-Day Moving Averages



Although the two moving averages cross over, the penetration requirement is never met and no trades are conducted. The farmer therefore takes advantage of the higher cash prices. The results using the risk management strategies described in section 4.4.2 are presented next.

5. Results

This section shows the results of the two strategies considered for hedging with futures contracts: the target price strategy and the moving averages strategy. First, the results of the performance of each strategy are presented and then both sets of results are compared.

5.1 Results from the Moving Averages Strategy

This strategy makes use of moving averages as signals for selling and buying back futures. The main objective of the producer is to price milk (short hedge) when the price trend is going down and to lift the short hedge (buy back) when the price trend turns up.

Given the nature of the farm, the milk producer should never buy milk futures, unless a short hedge (sell) has been already made, the trend is turning up, and the buying action is to offset the short position in futures.[38] Since buying milk is not in the 'natural' profit maximizing interest of the farmer, long futures positions would imply that the farmer is becoming a futures market speculator.

As it was mentioned earlier in the study (figure 3, which shows basis patterns), milk production and prices have a seasonal pattern: relatively high prices during fall and winter months, and relatively low prices during spring and summer months. If the profit analysis is done by aggregating the data on a yearly basis, the importance of these seasonalities is ignored and less efficient results may be produced. It is for this reason that the optimal moving averages calculation is conducted month by month.[39]

The results of this strategy are calculated using Metastock, a specialized software for commodities trading, and are presented below. For each round turn trade, a commission of $50 per future milk contract of 2,000 cwt is considered. Therefore, a $0.025/cwt commission is subtracted for each round turn.

For each of the 12 months (January through December), the two moving averages (fast and slow) that provide the sell and buy back signals that *maximize gains* (in the futures market)[40] over the period 1999-2003 is computed for five different penetration requirements: 0, 0.01, 0.025, 0.05, and 0.10 dollars per cwt.[41] The range of moving averages over which this maximization procedure was carried out was between 2 and 70

[38] In other words, the farmer should never be in a long speculative position in the futures.
[39] As with basis calculations, for the first five months of optimal moving averages (January through May) there were 5 years of data, while, for the last 7 months (June through December) there were only 4 years of data.
[40] Instead of profit, the term 'gains' is used here. As it was mentioned earlier, profit includes variable costs in its calculation. Gains only depict the dollar gains (or losses) due to trading in the futures market.
[41] The maximum penetration requirement chosen is $0.10/cwt since larger penetration requirements reduced the number of trades to levels that the objective of following market trends will no longer be met.

days for each of the averages. Therefore, in order to arrive to the maximizing pair of moving averages, and a given penetration requirement, say for January, a search over all the combinations of slow and fast moving averages (between 2 and 70 days) that maximized total gains for the combined months of January 1999, 2000, 2001, 2002, and 2003 was performed.

This procedure was done five times, one for each penetration requirement. After obtaining the results for the five optimizations, the one showing the highest gains is chosen as the optimal pair of moving averages with its respective penetration requirement. The procedure is carried out for the other eleven months. This optimization procedure requires significant computer power. To find the profit maximizing pair of moving averages and the corresponding penetration requirement for one month took approximately 3 hours.

To illustrate, for the month of *May*, table 5.1 displays the results of the optimization for the different penetration requirements considered.

Table 5.1: Gains Maximizing Moving Averages for each Penetration Requirement May Futures

Penetration Requirement ($)/cwt	Fast M.Average (days)	Slow M.Average (days)	Gains ($/cwt)
0.00	25	28	1.09
0.01	22	25	1.14
0.025	**15**	**27**	**1.15**
0.05	11	26	1.05
0.1	15	33	0.9

Note: The results of this table display the moving averages that yielded the maximum gains for the month of May, over the 1999-2003 period, for different penetration requirements.

For example, for a *zero penetration requirement*, the moving averages that maximize gains over the five May months (May 1999, May 2000, May 2001, May 2002 and May

2003) are 25 days and 28 days. These moving averages yield average gains, over the five Mays, of $1.09/cwt. Finally, table 5.1 shows that the penetration requirement and the pair of moving averages that maximize average gains ($1.15/cwt) over the five May futures contracts are $0.025/cwt and 15-days and 27-days respectively.

The same procedure depicted above is applied to each of the twelve months. Table 5.2 shows the monthly gain maximizing penetration requirement, the corresponding pair of moving averages, and average gains in $/cwt.

Table 5.2: Gains-Maximizing Penetration Requirements with corresponding Moving Averages (fast/slow) and Average Gains in $/cwt

Month	Penetration Requirement ($)/cwt	Fast M.Average (days)	Slow M.Average (days)	Average Gains ($/cwt)
January	0.01	22	25	1.27
February	0.01	22	25	1.27
March	0.05	6	7	1.84
April	0.025	19	22	1.16
May	0.025	15	27	1.15
June	0	7	9	0.99
July	0	49	51	0.97
August	0	32	43	1.23
September	0.1	20	26	0.72
October	0.1	7	13	1.23
November	0	8	27	2.05
December	0.025	3	4	1.32

Note: For each month, moving averages that maximize gains over the 1999-2003 were found for different penetration requirements. The results of this table display the penetration requirement that yielded the maximum gains with its corresponding moving averages and average gains

After these results are obtained, each of the 53 monthly gains (or losses) for future contracts, from January 1999 to May 2003, are calculated using the corresponding optimal penetration requirement and moving averages. For example, for the specific futures contract of February 1999 the gain from using February's optimal moving averages and penetration requirement, 22-day, 25-day and $0.01/cwt, respectively, is $3.27cwt. The same optimal moving averages 22-day, 25-day and penetration requirement ($0.01/cwt) are used for other February's contracts (i.e. February 2000, February 2001, February 2002 and February 2003). Table 5.3 shows the dates, prices and gains (losses) from the trades that result from applying February's optimal moving averages and penetration requirement to the February 1999 contract and February 2002 contract. These results were selected to show that the returns from the hedging program can be positive or negative.

Table 5.3: Example of Dates, Prices, and Gains (Losses) from a Short Hedging Program for Class III Milk Futures, February 1999 and February 2002

Feb-99			
Date	**Action**	**Price $/cwt**	**Net Trade $/cwt**
4-Jan-99	Sell	$14.09	
26-Feb-99	Buy back	$10.80	$3.29
Total Gain/Loss:			**$3.29**
Commission:			**$0.025**
Gain/Loss net from commission ($/cwt):			**$3.265**
Feb-02			
Date	**Action**	**Price $/cwt**	**Net Trade $/cwt**
11-Oct-01	Sell	$11.50	
06-Nov-01	Buy back	$11.85	-0.35
24-Dec-01	Sell	$11.85	
10-Jan-02	Buy back	$11.85	0.00
24-Jan-02	Sell	$12.25	
30-Jan-02	Buy back	$11.85	0.40
20-Feb-02	Sell	$11.63	
28-Feb-02	Buy back	$11.70	-0.07
Total Gain/Loss:			**-$0.02**
Commission:			**$0.10**
Gain/Loss net from commission ($/cwt):			**-$0.12**

For the February 1999 contract, only one round turn is made. The sell takes place on January 4, 1999 and the contract is bought back February 26, 1999. This means that on January 4, 1999 the 22-day moving average was below the 25-day moving average by at least $0.01/cwt, which provided the sell signal.[42] The contract is therefore sold in the futures market at $14.09/cwt. Given that the milk future contract is cash settled, there is no reason to be concerned about holding short positions until the last day of trading for each contract. There was no buy signal offered by the moving averages prior to the expiration of the contract, and the producers close the position by buying back the contract at the expiration date February 26, 1999 at the corresponding price, $10.80/cwt. This transaction results in a gain of $3.29/cwt (i.e. $14.09-$10.80). From this, the broker commission is subtracted giving a net gain of $3.265/cwt.

Conversely, in February 2002, there are four round turns recorded. On October 11, 2001 a sell signal is generated and executed at the closing price of $11.50/cwt. Almost one month later, the 22-day moving average is above the 25-day moving average by at least $0.01/cwt, which generates a buying signal on November 6, 2001. At a price of $11.85/cwt, a loss of $0.35/cwt is registered. Then, on December 24, 2001 a sell signal is generated again and executed at $11.85/cwt. This position is bought back on January 10, 2002, coincidentally, at the same price. Consequently, no gain or loss is registered. There are two more round turns. The sale on short position is closed by buying back the contract at its expiration date, February 28, 2002. In this particular example, all combined trades generate a loss (instead of a gain) of $0.02/cwt. However, taking into account the commissions paid to the broker for the four round turns ($0.10/cwt), the net loss adds up to only $0.12/cwt for the February 2002 milk future contract.

[42] Recall that the future data considered for the hedging strategies for each contract is only the last 6 months of trading, specifically the last 130 observations before the contract expires. A six month period contains 180 days. However, after discounting weekends, and holidays, the last 130 observations (business days) are an adequate approximation.

The producer was protected when price trend turned down in the event prices did decline significantly. It is not unusual for a "short position only" selective hedging program to lose money when the market is flat with no major trend. Losses can be larger when the trend is up and short hedges are placed on periodic price dips. What farmers will want to see in markets that trend higher is for the system to be off short hedges most of the time so producers will get the benefit of most of the windfall increase in prices.

As can be seen from the examples above, the optimal moving averages with their respective penetration requirement do not guarantee gains in all months. Rather, they reflect the maximum *average gain* possible for that month's future contract given its historical prices (1999-2003). Furthermore, there were months in which no trades were executed (months without trades). This may be explained either by the fact that the use of penetration requirements eliminates unnecessary trades in variable markets[43], or because there was a strong upward trend in the market as demonstrated in Figure 4.5.

Table 5.4 shows the number of months when short hedges took place, and the number of months without trades.[44]

Table 5.4: Summary of Trades and Gains with the Moving Averages Strategy Across all Months, January 1999 - May 2003

Total Number of Months	53
# of Months without Trades	7
# of Months with Short Hedges	46
Mean of Net Gain/Loss ($/cwt)	**1.17**
SD of Net Gain/Loss	1.10
Coefficient of Variation	0.94

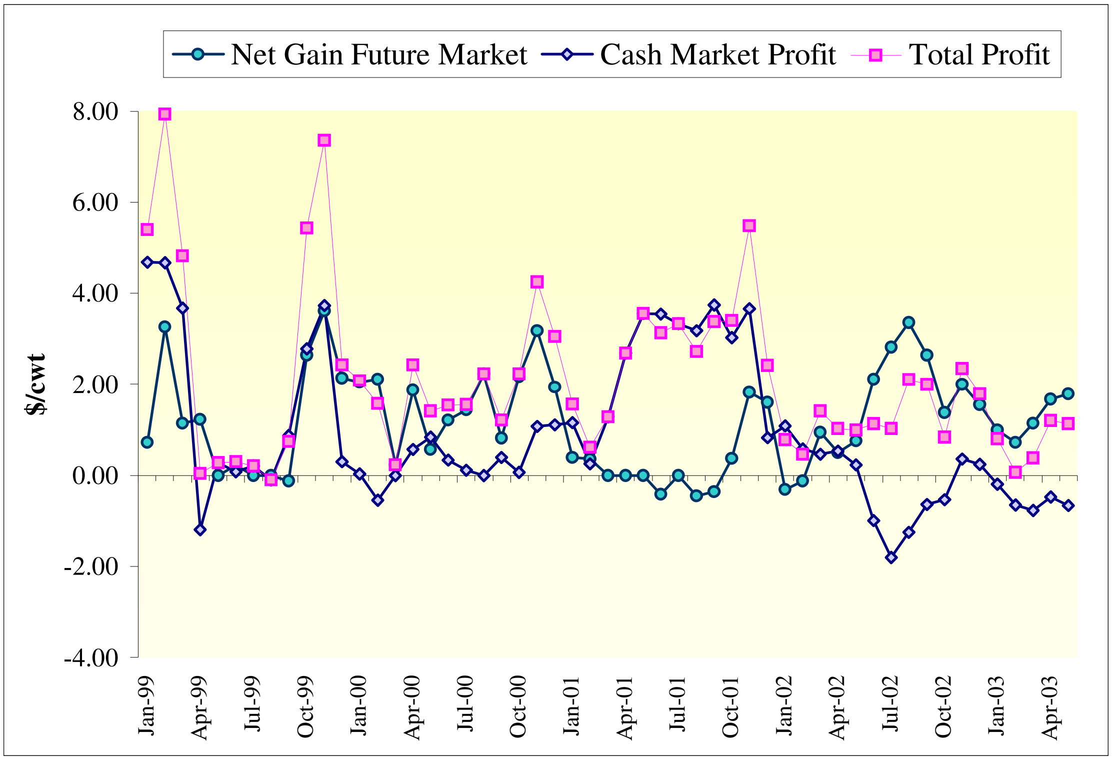
[43] According to Purcell (1999) "…..Using the penetration rule will eliminate some of the mistakes the moving averages make by calling a consolidation pattern a market top", pp 203.
[44] For the months without trades, the gains are zero.

This table also contains the average of net gains (losses) over the period January 1999 – May 2003, $1.17/cwt. These gains have a standard deviation of 1.10 and a coefficient of variation of 0.94.[45]

The last step is to compute the *total profit*. For this purpose, the *gains* from the future contracts, explained above, have to be added to the *profit* from the cash market (baseline). *Total profit* for each month (January 1999 to May 2003) is equal to *profit* from the cash market (mailbox price minus variable costs)[46] plus net *gains* or losses from the futures market: *Total profit = profit from cash market + net gains from future markets,* where "gains" can possibly be negative in the calculation. Figure 5.1 displays a graph of the three variables for the entire period 1999-2003.

[45] The coefficient of variation shows how large one standard deviation is with respect to the mean.
[46] Cash market profits are the same as the ones depicted in section 4.4.1 called baseline or profit with no hedge involved.

Figure 5.1: Cash Market Profit, Net Gains from Futures market and Total Profit ($/cwt) with Moving Averages Strategy. January 1999 - May 2003



In general, the net gains from the futures market is positive, which makes the total profit almost always higher than the profit from the cash market alone. In addition, the farmer benefits greatly from the gains in the futures market when the profits in the cash market are poor.[47] This can be more clearly seen in the last months of the graph, where the cash market profits are the lowest, net gains from futures in the downward trend market are largest, and total profits are turned from negative to positive across the last 12 months shown.

Table 5.5 shows summary statistics of monthly total profit, gains from the futures market and profit from the cash market. The average monthly gains from the futures market are higher than the average monthly profits from the cash market. Moreover, the

[47] This result is a consequence of the dynamics of the future and cash markets. Every time a short hedge is in place, whenever the price goes up, the farmer will receive margin calls (is losing in the future market), but at the same time is making money in the cash market. When the price goes down the contrary is true.

gains from the futures market is less variable both in absolute terms and around the mean, with a standard deviation and a coefficient of variation that are 34% and 50%, respectively, smaller than those of the profit from the cash market. As a result from using the moving averages strategy, the total profit is $2.11/cwt, 124% higher than without the hedging strategy. In addition, the variation around the mean is only 48% (coefficient of variation=0.85) of that attained without the strategy (coefficient of variation=1.76).

Table 5.5: Summary Statistics of Monthly Total Profit ($/cwt), Gains in Futures Market and Profit from Cash Market. Moving Averages Strategy, January 1999-May 2003

	Total Profit	Futures Market	Cash Market
Mean of Total Profit ($/cwt)	**2.11**	**1.17**	**0.94**
SD of Total Profit	1.80	1.10	1.66
Coefficient of Variation	0.85	0.94	1.76

Total profits generated by this strategy, both in terms of its mean and coefficient of variance will be compared to those obtained with the target price strategy. This will allow the assessment of the most profitable strategy.

5.2 Results from the Target Price Strategy

In this strategy, the producer sets a 'target price' with which the viability of the farm can be guaranteed. Using this target price a *priori*, the general strategy is to sell a contract once a price in the futures market is equal or greater than the futures price needed to generate the target price is observed. The short hedge is maintained until the milk is sold and the futures are then bought back.

As it was mentioned earlier, this strategy is tested using the futures market and not using forward contracts. This strategy is significantly simpler than moving averages. As opposed to the moving averages strategy, the idea here is to sell a future contract only once after the target price is observed in the futures market. The sold futures contract is then bought back at maturity, as it was done with the moving averages strategy.[48]

Fourteen target prices are evaluated, each based on a different margin over variable costs, taking into account expected or 'average' basis (see section 4.4.2.2 a for an explanation). Henceforth, the term 'margin over variable costs' will be used to denote such margins. The margins considered are: \$0.50, \$0.75, \$1, \$1.25, \$1.50, \$1.75, \$2, \$3, \$4, \$5, \$6, \$7, \$8 and \$9 dollars per cwt. For a margin of \$9 and above no hedging took place since the futures market did not offer such high prices. Gains, profit and total profit are defined in the same way as in the moving averages strategy.[49]

As it was explained in section 4.1.1, the gains from hedging in the futures market also depend on the margin calls made on the account that the farmer has with the broker. However, as opposed to the moving averages strategy, margin calls can be significantly larger with the target pricing strategy because the farmer remains in a short position for the whole period (between the date of hedging and the maturity of the contract) and there can be a sustained rise in price for which margin calls may be large. Hence, with the target pricing strategy, margin calls were at first considered in the computation of gains. However, after some calculations, the losses due to margin calls were not sufficiently large to alter the analysis. As a consequence, the results presented are simplified and do not consider margin calls.

Table 5.6 contains the summary of trades and mean monthly *total profit* using the target price strategy for the fourteen different margins considered.

[48] Futures data used in the analysis starts 6 months prior to the expiration date of the contract as with the moving averages strategy.
[49] The difference here is that the gains in the futures market are always the result of a single round trip (if there are trades at all) instead of possibly several round turns.

Table 5.6: Summary of Results for Target Price Strategy. January 1999 - May 2003

Margin over VC ($/cwt)	# of Months without Hedges*	# of Months with Short Hedges	Short Hedges: Placed on First Day**	Short Hedges: Placed on a Different Day	Mean Monthly Total Profit ($/cwt)***	SD Monthly Total Profit	Coefficient of Variation
Baseline	53	**0**	0	0	**0.94**	1.66	1.76
0.5	1	**52**	44	8	**1.78**	1.75	0.98
0.75	3	**50**	39	11	**1.78**	1.72	0.97
1	7	**46**	36	10	**1.68**	1.76	1.05
1.25	8	**45**	35	10	**1.72**	1.73	1.01
1.5	10	**43**	31	12	**1.69**	1.74	1.03
1.75	15	**38**	25	13	**1.49**	1.85	1.24
2	21	**32**	21	11	**1.40**	1.91	1.36
3	34	**19**	8	11	**1.22**	2.00	1.64
4	40	**13**	3	10	**1.39**	2.18	1.57
5	46	**7**	2	5	**1.25**	2.19	1.75
6	48	**5**	0	5	**1.24**	2.19	1.76
7	51	**2**	0	2	**1.12**	2.12	1.88
8	52	**1**	0	1	**1.04**	1.98	1.90
9	53	**0**	0	0	**0.94**	1.66	1.76

* The total number of months is 53
** Hedge made on the first day of period of analysis (i.e., six months prior to expiration of the contract)
*** The monthly profit presented here was calculated using the 'actual', and not the 'expected' basis

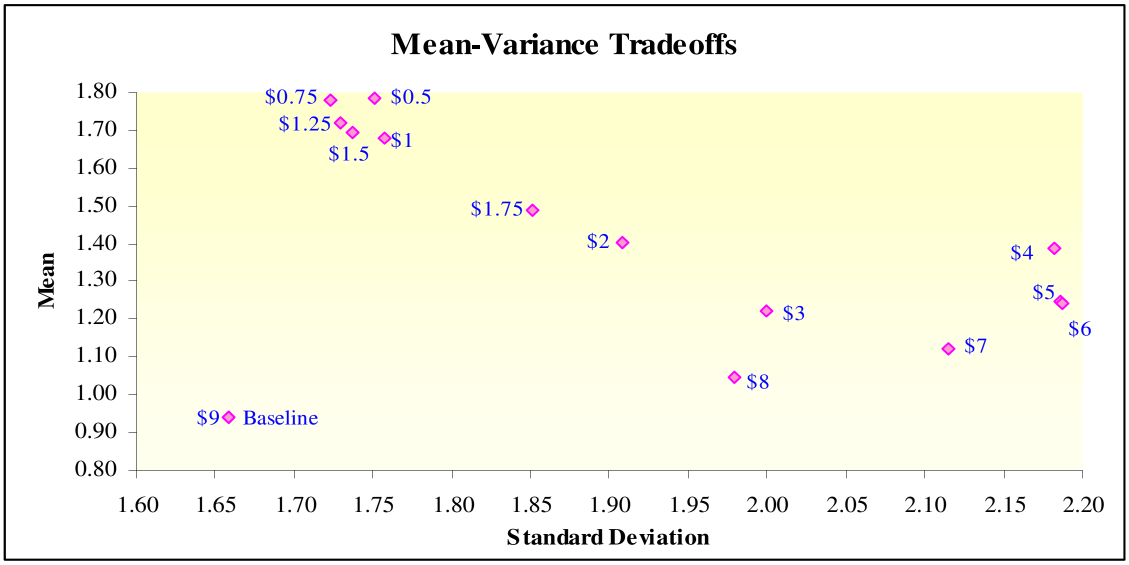
There are several features of this table that are worth highlighting. First, the number of months in which a hedge takes place declines as the margin increases. This is due to the fact that it is less likely to observe a higher target price in the futures market. For instance, with a $0.50/cwt margin the farmer almost always hedges (52 out of 53 months), while with a $8/cwt margin the farmer only hedges once in 53 months. The same patterns can be observed for whether hedging takes place on the first day (i.e. six months prior to expiration).

In addition, mean monthly total profit decreases as the margin increases. Although hedges become more profitable when target prices are higher, the reduction in the number of months in which hedging takes place more than offsets the gains per hedge. Moreover, the reduction in hedging frequency increases both the standard deviation (i.e. variability) and the coefficient of variation, indicating the farmer is often carrying risk, is speculating in the cash market and is facing a riskier environment.

In order to help understand the tradeoffs between mean and variance (risk) for the different margins over variable cost used in the target price strategy, the results are presented in a mean-variance framework as it was introduced in section 3. Figure 5.2 shows these tradeoffs, which will help to visualize more clearly the performance of the different margins.

From the figure one can see that the best performers margins are located at the upper left part of the graph. Margins of \$0.75, \$0.50, \$1.25, \$1.50 and \$1.0 generate a large increase in monthly mean total profits compared with the baseline (profits without hedge), or the \$9 margin, while their variances do not increase considerably. On the other hand, margins of \$5 and \$6, for example, present a large increase in variance compare to the baseline, but the increase in mean is not as good as the five margins mentioned above.

Figure 5.2: Mean Monthly Profit in \$/cwt and Variance using the Target Price Strategy for Different Margins over Variable Costs 1999-2003



Note: Each point in the graph represents the mean and standard deviation of monthly total profit for each margin over variable costs. These margins are display in the graph with the numbers besides each point.

The baseline and $9 margin present the lowest variance and lowest mean compared with all other margins. However, when leaving the baseline aside, the $0.75 margin outperforms all other points in the graph since it represents the highest mean and the lowest variance. This means that the $0.75 margin dominates all other points in the graph (except the baseline) in a mean-variance sense. Therefore, an individual will have to choose between the baseline or the $0.75 margin depending on his risk preference.

In this application, the main objective is to help the farmer cover the risks of future low prices and a hedging strategy should be preferred to the baseline. With a target price strategy, a lower margin implies a better chance of finding the target price in the futures market and thus hedge. With the lowest margin considered, $ 0.50, the profit generated is the same as with the optimal $0.75 margin ($1.78) and has a slightly higher standard deviation (1.75 vs. 1.72).[50] Moreover, their coefficient of variation is basically the same, 0.98 and 0.97, respectively. Hence, the $0.50 margin is also considered as a possible optimal margin.

To illustrate how annual total profits with the no-hedge option (or baseline) compares with the profit that results from hedging with the target prices strategy, several figures are presented below.[51] Each figure displays the annual total profit for one of the different margins considered, together with the annual profit from the no-hedge option.

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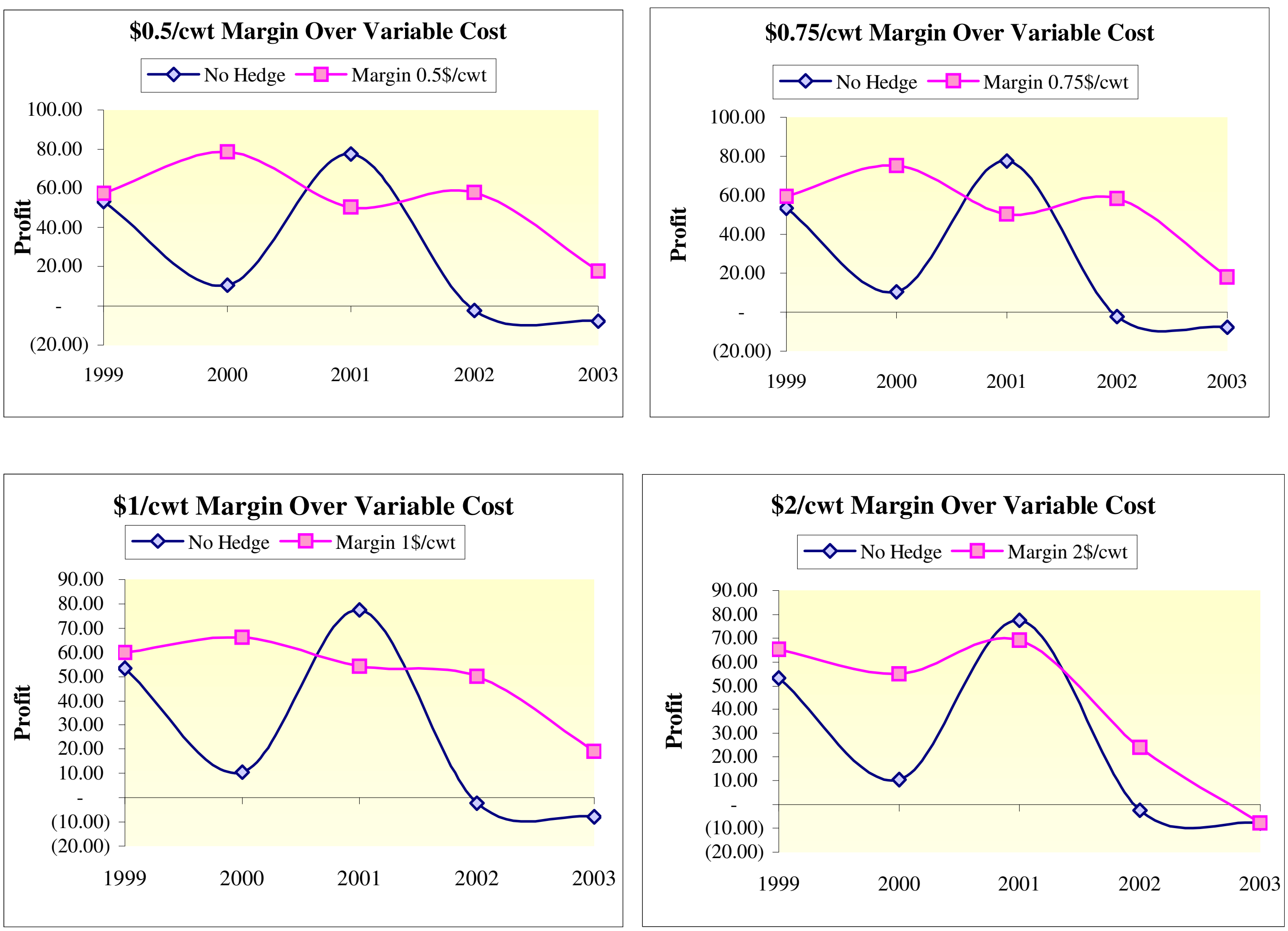
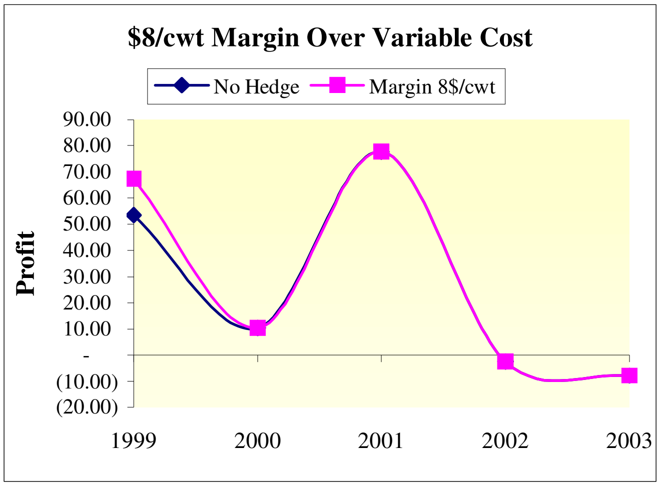
[50] On the other hand, the $8/cwt margin seems to be the poorest performer with the highest coefficient of variation ($1.90/cwt) and the second to lowest profit (i.e. it only improves the baseline profit by $0.10/cwt).

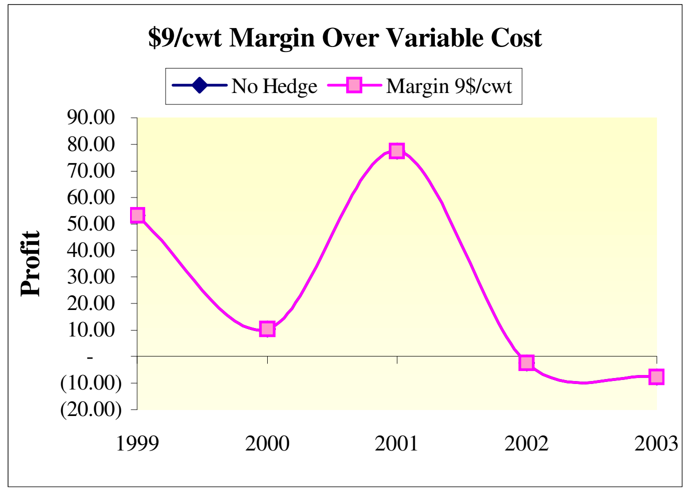
[51] In order to compute annual total profits (in $), first monthly total profits (in $/cwt) were multiplied by the quantity of milk produced each month (in hundred weights, cwt) to obtain total monthly profit. Then, monthly profits were accumulated by year.

The figures for the $0.50 and $0.75 margins present smoother shapes than the figures for other margins, confirming the results of table 5.6. In addition, the $1 margin presents a similar smoothness. However, the mean monthly profit with the $1 margin is smaller than the mean obtained with the $0.75 and $0.50 margins, and also has a larger variance.

Figures 5.3 - 5.8: Cumulative Profit by Years (thousands of $). Baseline (No Hedge) vs. Different Margins over Variable Costs (1999-2003)







For the purpose of assessing the performance of the two strategies considered in this study, $0.50 is used as the optimal margin for the target price strategy. The reason for choosing this margin over $0.75 is that the lower the target price, the higher the probability that the farmer will observe such a price in the futures market and hence be able to cover his risks by selling a contract. The $0.50 margin, when compared with the $0.75 margin, achieves this purpose. This is confirmed by the fact that with the $0.50 strategy the number of months in which a hedge took place was higher (52 out 53) than with the $0.75 strategy (50 out of 53).

The summary statistics of the monthly total profit, gains from the futures market and profit from the cash market (baseline) for the optimal target price are displayed in Table 5.7.

Table 5.7: Monthly Summary Statistics for the $0.5/cwt Margin as the Optimal Target Price Strategy. January 1999 - May 2003

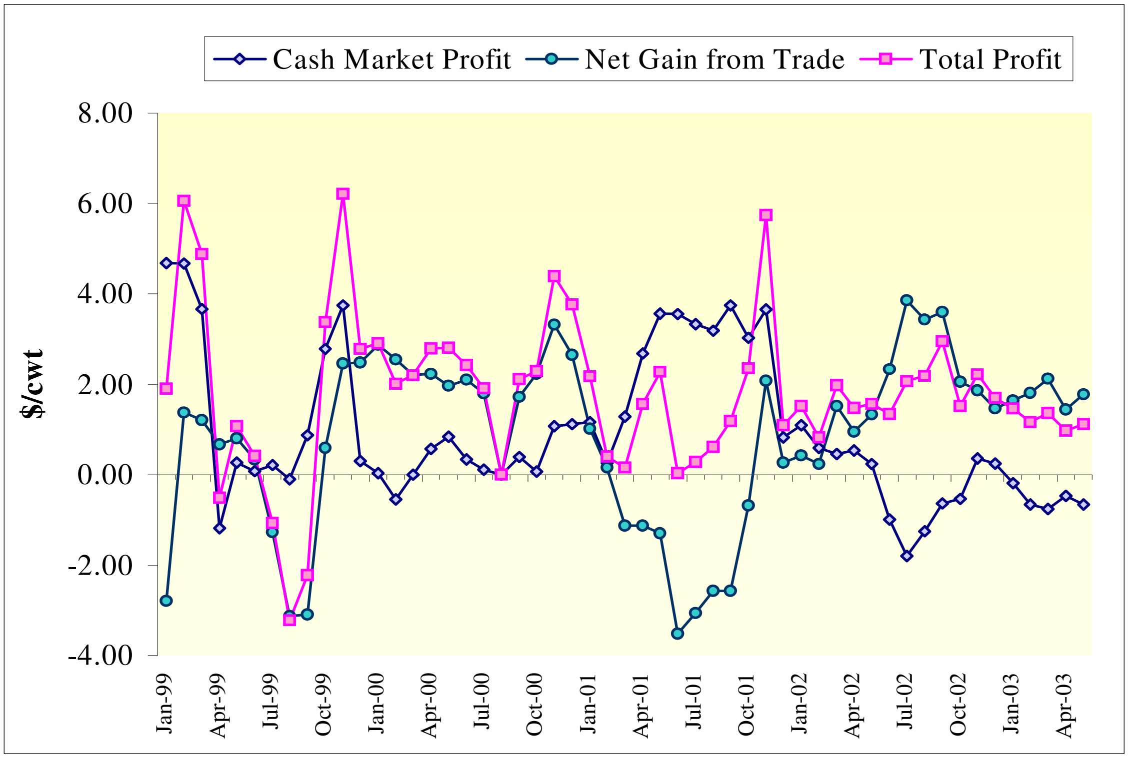
	Total Profit	Futures Market	Cash Market
Mean of Total Profit ($/cwt)	**1.78**	**0.84**	**0.94**
SD of Total Profit	1.75	1.91	1.66
Coefficient of Variation	0.98	2.27	1.76

The gains obtained from the futures market are slightly lower $0.10 than the profit in the cash market alone. However, the coefficient of variation in the futures market is 29% higher than the cash market. When adding the gains generated by the optimal target price strategy in the futures market, the total profit increases by 89.6% compared to the cash market profit only. In addition, the variability around the mean of total profit is lower than the two markets separately.

Figure 5.9 shows total monthly profit, the cash market profit and the net gain from trade using the $0.50/cwt margin. This figure confirms an expected negative relationship between the cash market performance and short hedges in the futures markets.[52] For instance, from March 2001 until October 2001, one can observe that net gains from trade are negative while profits in the cash market are positive. On the other hand, from May 2002 until October 2002, and from January 2003 until May 2003, net gains from trade are positive while profits in the cash market are negative. The net gains from trade and the cash market profits thus tend to look like a mirror image: whenever one goes up, the other goes down, and vice versa.

[52] Recall that only one round turn is made with the target price strategy.

Figure 5.9: Cash Market Profit, Net Gains from Trade and Total Profit ($/cwt) with $0.5/cwt Margin as a Target Price Strategy. January 1999 - May 2003



5.3 Comparison between Moving Averages Strategy and Target Price Strategy

Once each strategy has been analyzed individually and the optimal parameters from each one have been obtained, it is important to compare both in order to conclude which one achieves the best results. It should be noted that both strategies share a common term when calculating total profits, namely cash market profit (or baseline). Therefore, the basic difference between the two strategies is given by the net gains (NG) in the futures market. The two strategies are compared in terms of mean, variance and coefficient of variation both for the net gains in the futures market and for the total monthly profit.

In absolute terms, table 5.8 shows that the moving averages strategy outperforms the target price strategy in the mean and the coefficient of variation for both the net gain and the total profit. For the net gain in the futures market, moving averages show a lower variance than target price, but for total profit the opposite is true, although with a smaller difference.

Table 5.8: Summary statistics of Net Gain in Futures Market and Total Profit ($/cwt). Target Price vs. Moving Averages, January 1999-May 2003

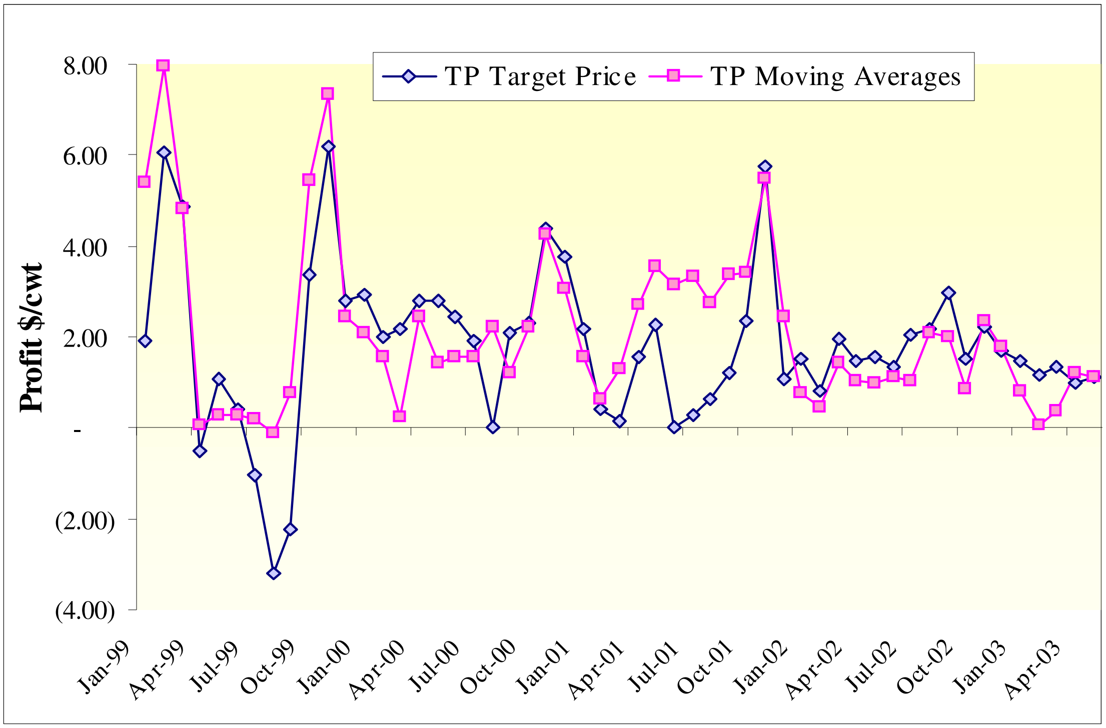
		Net Gain Futures Market			Total Profit		
	Cash Market Profit	Target Price	Moving Averages	P-values	Target Price	Moving Averages	P-values
Mean Total Profit	0.94	0.84	1.17	0.1421**	1.78	2.11	0.1764
SD Total Profit	1.66	1.91	1.10	0.0001*	1.75	1.80	0.5799
Coefficient of Variation	1.76	2.27	0.94		0.98	0.85	

* statistically significant at the 1% level
** statistically significant at the 15% level

The table also shows the p-values for both the difference in means and the difference in variances. These p-values are obtained from a one tail t-test, with unequal variances, for the means (where the null hypothesis is that moving averages produces a higher mean) and a one tail F-test for the variances (where the null hypothesis is that moving averages produces a lower variance). In statistical terms, the mean net gain generated by moving averages is higher than the mean net gain of target price, albeit only at a weak 15% significance level. In addition, the variance of the net gain generated by moving averages is significantly smaller than that of target price at a 1% significance level. Means and variances for the total profit, on the other hand, are not statistically different across the two strategies.

In absolute terms, the variation of total profit and net gain around the mean (i.e. the coefficient of variation) is lower for the moving averages than for the target price by 59% and 10%, respectively. Since no statistic is available for the coefficient of variation, these differences can not be tested statistically. Figure 5.10 displays the monthly total profits obtained from both strategies.

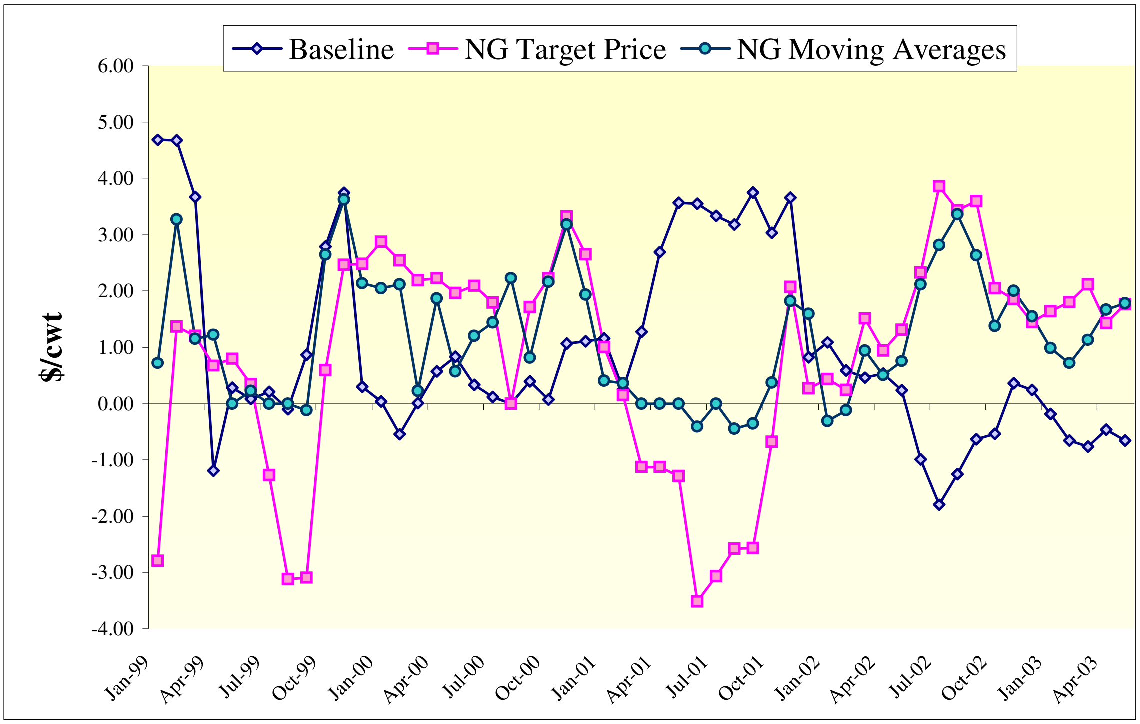
Figure 5.10: Total Profit (TP), Target Price vs. Moving Averages, January 1999 - May 2003



It is apparent that moving averages do better than target prices. The lowest total profit, a loss in this case, with moving averages is -$0.10/cwt in August 1999, while for the target price strategy, the loss is 32 times larger: -$3.99/cwt in the same month. On the other hand, the highest value of total profit registered with target price is $6.21/cwt, in November 1999, compared to $7.94/cwt of moving averages, in February 1999, 28% higher.

Hence, the moving averages strategy does not only perform better in terms of a higher mean and a lower variance, but it also achieves the highest total profit and lower losses during the period. In the period of study, coincidentally both the highest and lowest profits are registered in 1999. Figure 5.11 shows the net gains (NG) from the target price strategy, NG from the moving averages strategy and the baseline.

Figure 5.11: Cash Market Profit, Net Gains (NG) from Target Price Strategy and from Moving Averages Strategy, January 1999-May 2003



Intuitively, moving averages perform better than the target price because the farmer has more flexibility to adjust his exposure to further price increases after he has sold a contract. For example, if the future price starts a sharp increase after a contract has been sold, then moving averages will provide a signal to the farmer that the trend is going up and that he should buy back the contract before the price rises even more. Hence, moving averages give the farmer the possibility of taking advantage of the rising prices.

With a target price strategy, on the contrary, after a hedge is in place the farmer is locked in to the contract's price up to its expiration, regardless of what happens in between. If prices go up after a contract is sold, the farmer will incur margin calls, and, at the contract's expiration date, a loss in the futures market is registered when the contract is bought back.

Figures 5.12 and 5.13 show the frequency histogram and the smoothed distribution, respectively, of the cash market profit, and total profits of target price and moving averages strategies.

Figure 5.12: Frequency Histogram of Monthly Cash Market Profit, Total Profits of Target Price and Moving Averages Strategies

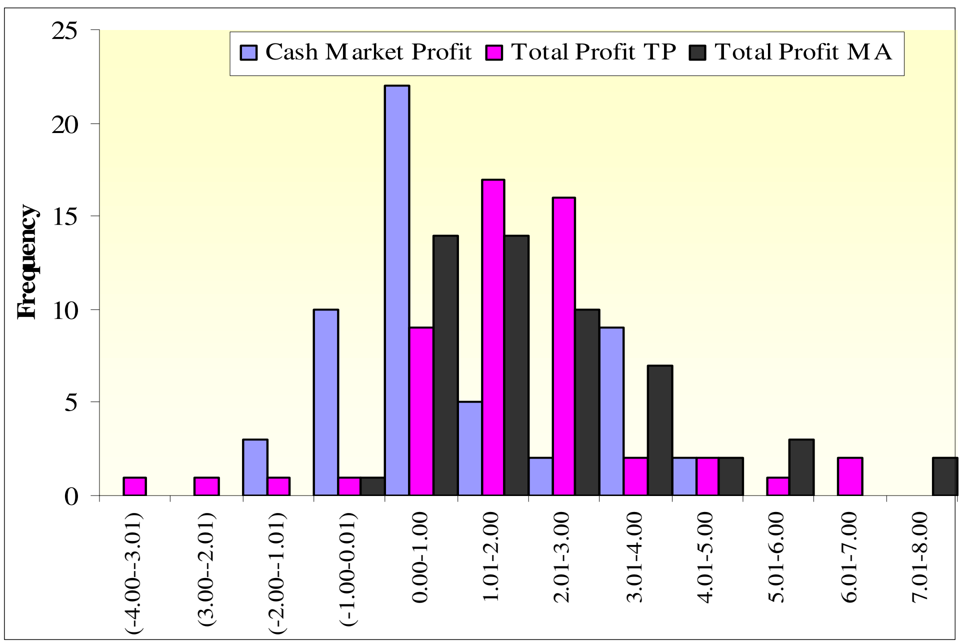
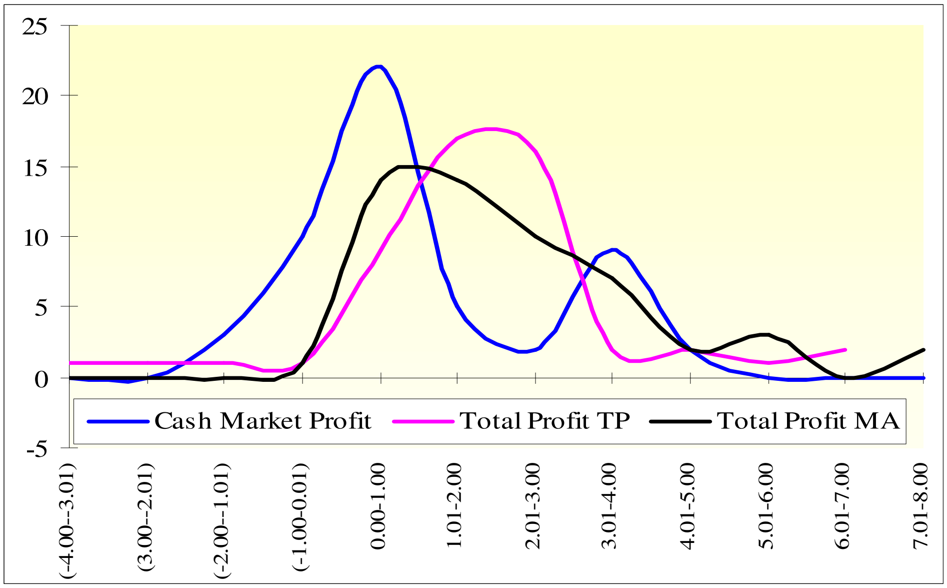


Figure 5.13: Smoothed Distribution of Monthly Cash Market Profit, Total Profits of Target Price and Moving Averages Strategies



First, the Cash Market Profit distribution is shifted to the left of both the TP and MA distributions, with a mode located at zero and another at around \$3/cwt and a significant portion of its mass below \$0/cwt. This is the reason why the monthly mean in the cash market profit is lower than that with TP and MA. The MA and TP distributions, on the other hand, have one mode at around \$0/cwt and \$2/cwt, respectively. Although the MA distribution has a lower mode, it has a greater mass on the positive tail than the TP distribution and virtually no mass to the left of -\$1/cwt. This makes the mean and variance of the MA distribution to be higher than that of the TP distribution. However, it should be noted that the increase in MA's variance is due to positive values contrary to the TP.

5.4 Out of the Sample Results

As mentioned earlier in the study, one year of data was separated from the original data received from the producers. These twelve months, from June 2003 to May 2004, are used to test the effectiveness of the best strategy derived from the historical data January 1999 to May 2003, in this case the moving averages strategy.

The optimal pairs of moving averages with their respective penetration requirements as shown in table 5.2 (section 5.1) for each month are used to provide signals for hedging decisions in the out of the sample data. As before, only short hedges are considered.

Table 5.9 shows the number of trades and round turns that took place during the out of the sample period. There are five months (August 2003, September 2003, March 2004, April 2004 and May 2004) in which no trade took place. This is explained by the fact that either penetration requirements were not met by the specified pair of moving averages or that there was a sustained upward price trend. In contrast, June 2003 and December 2003 present the highest number of trades (14 trades).

Table 5.9: Number of Trades and Round Turns using the Optimal Pairs of Moving Averages with their Respective Penetration Requirements by Month, June 2003-May 2004

Date	Trades	Round turns
Jun-03	14	7
Jul-03	10	5
Aug-03	0	0
Sep-03	0	0
Oct-03	4	2
Nov-03	4	2
Dec-03	14	7
Jan-04	8	4
Feb-04	4	2
Mar-04	0	0
Apr-04	0	0
May-04	0	0

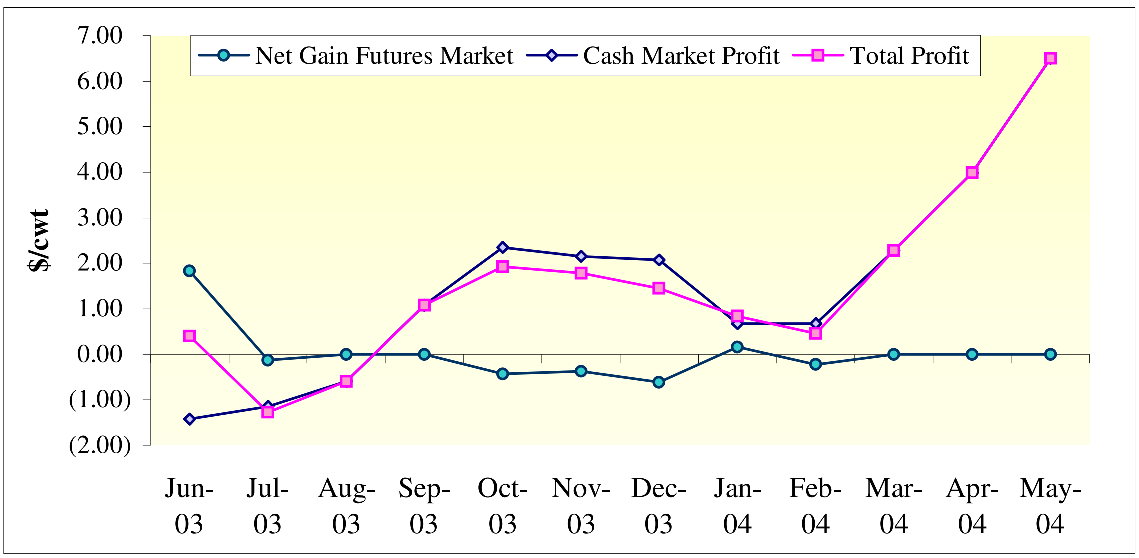
Table 5.10 exhibits the summary statistics of monthly profits using the moving averages strategy for the out of the sample period, while figure 5.14 shows the net gain from futures market, the cash market profit and the total profit by month.

Table 5.10: Summary Statistics of Monthly Total Profit ($/cwt), Net Gains in Futures Market and Profit from Cash Market. Moving Averages Strategy, June 2003- May 2004

	Total Profit	Future Market	Cash Market
Mean of Total Profit ($/cwt)	**1.57**	**0.02**	**1.55**
SD of Total Profit	2.07	0.61	2.23
Coefficient of Variation	1.32	33.47	1.44

It can be observed from figure 5.14 that the moving averages strategy generates a net gain in the futures market that is around zero during the whole period. This is confirmed by its calculated mean ($0.02/cwt). Conversely, the cash market profit starts below zero (-$1.43/cwt) but rapidly increases during the year until reaching $6.50/cwt in May 2004.

Figure 5.14: Cash Market Profit, Net Gains from Futures Market and Total Profit ($/cwt) with Moving Averages Strategy. June 2003-May 2004



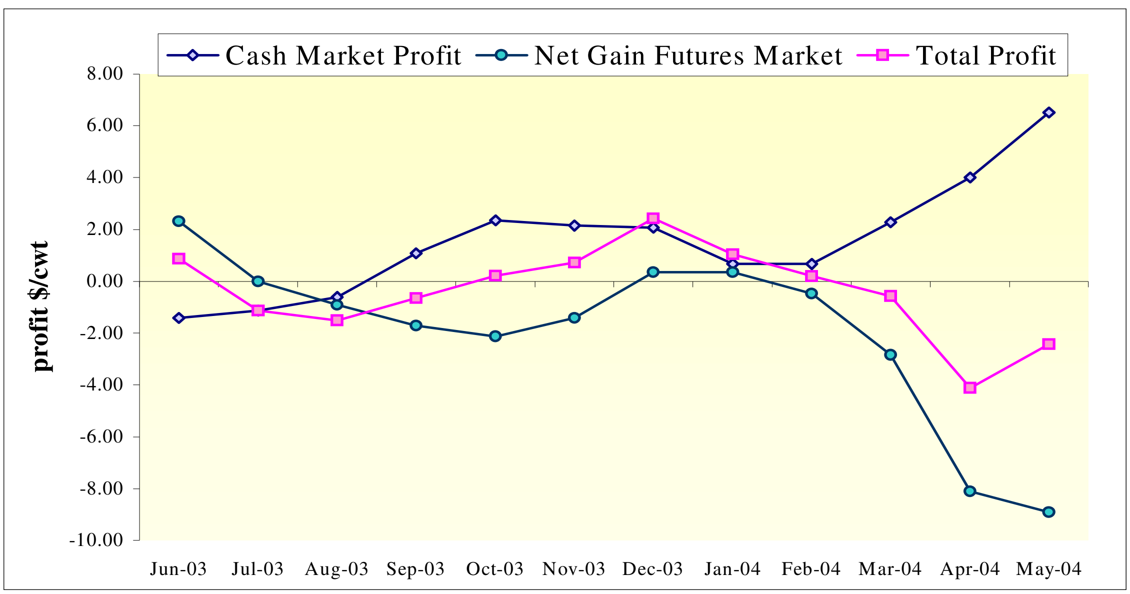
The mean of the cash market profit equals to $1.55/cwt during the whole period. Given the upward trend price in this period, the total profit is mostly reflecting the cash market profit, since the net gain from the moving averages strategy were on average close to zero. Hence, the mean of the total profit is $1.57/cwt with a variance of 2.07 and a coefficient of variation of 1.32.

Just for comparison purposes, total profits that the target price strategy would have generated are presented below. Table 5.11 shows the summary statistics of total profits, net gains from trade and cash market profits from the out of the sample period while figure 5.15 displays the monthly values.

Table 5.11: Summary Statistics of Cash Market Profit, Net Gains from Trade and Total Profit ($/cwt) with $0.5/cwt Margin as a Target Price Strategy. June 2003-May 2004

	Total Profit	Future Market	Cash Market
Mean of Total Profit ($/cwt)	**-0.41**	**-1.96**	**1.55**
SD of Total Profit	1.74	3.35	2.23
Coefficient of Variation	-4.28	-1.71	1.44

Figure 5.15: Cash Market Profit, Net Gains from Futures Market and Total Profit ($/cwt) with $0.5/cwt Margin as a Target Price Strategy, June 2003-May 2004



Observing figure 5.15, one can conclude that net gains resulting from the round turn in the futures market performs poorly in this period. This is corroborated by a mean of net gains equal to -$1.96/cwt. Indeed, for only four out of the twelve months the futures' gain are positive while for the rest losses are observed. The largest loss of \$8.92/cwt is registered in May 2004.

On the other hand, the cash market profit presents an upward trend during the period (going from -\$1.43/cwt to \$6.50/cwt), with a mean equal to \$1.55/cwt. However, the profits obtained in the cash market are more than offset by the big losses obtained in the futures market, generating a mean total loss of -\$0.41/cwt with a variation coefficient of 4.28 for the June 2003-May 2004 period. Hence, in this out of the sample test, the target price strategy actually reduces the mean of total profit and increases the variation around the mean compared to a cash market speculative position.

The moving averages strategy performs better since it allows the farmer to take advantage of the rising cash prices (i.e. there are no short hedges when prices are increasing) and at the same time covers the downside risk (low prices). Nevertheless, it should be noted that one of the characteristics of moving averages is that they perform best when sustained price trends are in place, which is in fact the case of this period.

For the out of sample period, Class III Milk prices reach one of their highest prices in history, \$20.58/cwt in May 2004. Figure 5.16 shows the May 2004 milk futures contract with a 15-day and a 27-day moving averages.

Figure 5.16 May 2004 Class III Milk Futures, 15-Day (red) and 27-Day (green) Moving Averages

From the chart a steep upward trend is observed since the beginning towards the end of the May 2004 futures contract. In addition, the 15-day and 27-day moving averages do not generate any signal; actually there is no crossover action at all during the whole life of the contract.

If out of sample data would not have had the unusual upward trend to record highs, the comparison of the performance of both strategies may have appeared similar to the results obtained with the historical data.

5.5 Results from an Alternative Overall Optimal Moving Averages

After the results were obtained using the target price and moving averages strategies as depicted in the sections above, a special curiosity of the possibility of using a second and general system of moving averages emerged. As it was mentioned in section 5.1, a separate pair of moving averages (with their respective penetration requirements) was obtained for each month of the year in order to capture the seasonalities of milk prices. It was also pointed out that aggregating the data on a yearly basis may produce less efficient results.[53]

Farmers who are new to this type of strategy can find the use of different moving averages with different penetration requirements for each month an overwhelming and very complicated task to follow.[54] An alternative to the 'complex' procedure was to compute one overall moving average, with its respective penetration requirement, that can be used for all months. In essence, the mechanics of this alternative procedure are the same as in the procedure described in section 5.1, with the difference that only one optimal combination of moving averages, fast and slow (between 2 and 70 days) that maximizes the combined profit over the 53 in-the-sample months, is searched. This is done five times, one for each of the penetration requirements. The pair of moving averages that maximizes the gains for the 53 months is a 8-day (fast) and 19-day (slow) moving averages, with a penetration requirement of $0.05/cwt. Table 5.12 shows the summary statistics of the overall optimal moving averages.

[53] The out of sample results showed great variability in the number of trades placed over months. For instance in the November contract, 4 trades were placed, while in the next month's contract (December contract), 14 trades were placed. Also, for five months trades were not placed at all as is the case of May 2004, showed in figure 5.16.

[54] The farmer may prefer to use just one spreadsheet for all months instead of using twelve spreadsheets, one for each month, with different specifications. There are software packages available in the market that can calculate moving averages and other indicators with online information about futures prices.

Table 5.12: Summary Statistics Using Overall Optimal Moving Average, 8-Day and 19- Day with penetration requirement of $0.05/cwt, January 1999-May 2003

	Total Profit	Futures Market	Cash Market
Mean of Total Profit ($/cwt)	**1.86**	**0.92**	**0.94**
SD of Total Profit	1.72	1.22	1.66
Coefficient of Variation	0.92	1.32	1.76

The table shows that average monthly gains from the futures market increase the cash market profit by $0.92/cwt giving a mean total profit of $1.86/cwt, 98% higher than the one generated without hedging strategy. Conversely, the gains from the futures market increase the variability of the cash market profit by 0.06 resulting in a variance of total profit of 1.72. However, when comparing the variance around the mean, the gains in the futures market reduce the variance around the mean of total profit by 48%.

It is also useful to compare the alternative overall optimal moving average with the one calculated for each month to see if they produce statistically different results. This comparison serves as a mean to decide if the overall moving average can be used as an alternative and less-complex moving averages procedure. Table 5.13 shows the summary statistics and the p-values of the comparisons.

Table 5.13: Summary Statistics Comparison between Overall Optimal Moving Average and the Monthly Optimal Moving Average, January 1999-May 2003

		Monthly MA	Overall MA	P-values
	Cash Market	Futures Market	Futures Market	
Mean Profit ($/cwt)	**0.94**	**1.17**	**0.92**	0.1343**
SD of Total Profit	1.66	1.10	1.22	0.2401
Coefficient of Variation	1.76	0.94	1.32	

**Statistically significant at the 15% level

The mean of net gains using the overall MA is lower than that of the Monthly MA at the 15% significance level. Conversely, the variance of the overall MA is not significantly greater than the variance of the monthly MA. Therefore, the monthly MA and the overall MA reduce profit variability in a similar way, yet the monthly MA generates higher net gains than the overall MA. This fact confirms that seasonality is an important factor in Virginia and thus using the optimal monthly moving averages can increase revenue.

Given the results obtained from Table 5.13, it is also important to compare the results of the overall MA with those of the optimal target price strategy. Table 5.14 shows this comparison.

Table 5.14: Summary Statistics and Comparison between Overall Optimal Moving Average and the Optimal Target Price, January 1999-May 2003

		Overall MA	Target Price	P-values
	Cash Market	Futures Market	Futures Market	
Mean Profit ($/cwt)	**0.94**	**0.92**	**0.84**	0.4027
SD of Total Profit	1.66	1.22	1.91	0.0007*
Coefficient of Variation	1.76	1.32	2.27	

* Statistically significant at the 1% level

In terms of mean, the optimal target price performs as good as the overall MA (p-value: 0.4027). However, using the overall MA reduces the variance when compared with the target price strategy (p-value of equality of variances: <0.01). This may be explained by the fact that the overall MA follows the market trend and avoids being with short hedges when prices are trending up. At the same time, this type of system prevents the farmer from being unprotected in severe declining prices.[55]

Lastly, the out of sample results using the optimal overall MA and its penetration requirement are presented in table 5.15.

Table 5.15: Summary Statistics Using Overall Optimal Moving Average, 8-Day and 19- Day with penetration requirement of $0.05/cwt, June 2003-May 2004

	Total Profit	Futures Market	Cash Market
Mean of Total Profit ($/cwt)	**1.40**	**-0.15**	**1.55**
SD of Total Profit	2.28	0.26	2.23
Coefficient of Variation	1.62	-1.77	1.44

[55] Also, the overall MA will have a considerable lower number of margin calls, if any, when compared with the target price.

Net gains in the futures market obtained from the overall MA reduced the cash market profit by $0.15/cwt producing a total profit of $1.40/cwt in the out of sample period, almost 10% lower than without hedging strategy. Conversely, the gains in the futures market increase variability of the cash market profit (in absolute terms and around the mean) by 0.05 and 0.18 respectively, given a total profit variance of 1.62 and a coefficient of variation of 1.62.

Recall, however, that the best performer in the out-of sample exercise was the monthly MA which only increased cash market profit by 2 cents, while the target price strategy reduced it by $1.96. It may be concluded that although the overall MA does not perform as well as the monthly MA, it tends to perform better than the target price and close to the monthly MA.

6 Conclusions

The 1996 and 2002 Farm Bill changes in milk support price legislation deregulated the market and milk prices are more volatile than ever. The use of a mechanism to reduce Virginia dairy farmers' exposure to volatile milk prices is an essential management tool for assuring the viability of their farms. The type of risk management strategy that the farmer should use depends on the farm's financial situation and size as well as on the farmer's expertise with such strategies and his attitude towards risk. Leveraged farms of small size or farms where farmers' expertise is limited should employ simpler, or more conservative, risk management strategies such as cash forward contracts with their cooperative or processor. On the other hand, farms that are large enough to meet the production requirements of the futures market and have the desire to learn or gain some expertise in the mechanics of futures contracts, should strive to use the futures market directly.

An additional alternative, proposed in this study, is that besides participating directly in the futures market, the farmer may use technical analysis in the form of moving averages to engage in 'selective' hedging. Such a hedging strategy is more sophisticated, and hence requires more advanced knowledge of how the futures market operates, and is well-suited for farmers who are less risk averse. Whether it is a simple or a more sophisticated strategy, it has been shown that these mechanisms can protect farmers from unexpected declines in prices.

This study assesses the performance of two types of hedging, or risk management, strategies as tools to reduce farmers' exposure to milk price risk. The general strategy is to search for the optimal parameters for each strategy that yield highest profits in a given period. The strategy with the highest profit between the two is chosen to be evaluated based on its performance in an out-of the sample dataset.

Strategies are based on farmer's participation in the futures market by selling futures contracts and buying them back. The first, and simpler, strategy is called a target price strategy. With this strategy, the farmer selects a target price that covers his operational costs and a margin. Once a futures price is observed that meets the target price, the farmer sells a milk futures contract. The margin added to operational costs is subject to each farmer's opinion. Thus, this study evaluates the performance of the target price strategy under different margins over operational costs and chooses the margin that performs best.

The second strategy evaluated in this study is referred as a moving average strategy. The farmer uses moving averages of closing futures market prices to generate signals when the trend of milk price changes. These signals are used to help farmers make decisions on when to sell and buy futures contracts up to their expiration date. Besides the absence of a target price, the main difference between moving averages and target price is that with moving averages several trades may be executed by the farmer before the expiration of the contract. Since different choices of moving averages give different results, a search for the moving averages yielding the highest profit is conducted and identified in this study.

Using the in-sample data, both strategies increase farmers' profitability and reduce its variance compared to what is obtained in the absence of hedging where the farmer is essentially operating as a speculator in the cash market. Comparison of the two suggests that moving averages outperform the target price strategy. Using the optimal moving averages strategy the mean monthly profit is \$2.11 per cwt with a variance of 1.80 and a coefficient of variation of 0.85, while with the target price strategy the mean monthly profit is \$1.78 per cwt with a variance of 1.75 and a coefficient of variation of 0.98. These are significant improvements when compared with the mean monthly profit without hedging (\$0.94), its variance of 1.66 and coefficient of variation 1.76. The main reason for these different results is that moving averages provide the farmer with more flexibility than the target price strategy. The moving averages allows the farmer to close out his positions and follow the raising cash market prices. The static target price strategy does not allow to exiting the futures market contract until it matures. Thus, the farmer does not have the opportunity to lift the short hedge and take advantage of the higher prices.

The moving averages strategy, with its optimal parameters, is then used to assess its performance in the out-of-sample dataset. Unlike the in-sample results, mean monthly total profit with moving averages is only two cents per cwt higher than the no hedge case (from $1.55 to $1.57), while the variance decreases from 2.23 to 2.07 and the coefficient of variation decreases from 1.44 to 1.32. The reason for the slight improvement from hedging is that the out-of-sample series have an unusually strong upward trend, recording record high milk prices. The strong upward trend produces few signals and hence few trades and the moving average strategy did not add significantly to profits. Often, in strong upward trending markets, the occasional small price dip can generate premature moving average signals of a market top and short hedges will be placed only to see the upward trend resume. Ideally, in a strong up or bull market, the moving averages will keep the producer off short hedges so they can benefit from the unexpected increases in cash prices.

This simple analysis should be seen as a beginning in development of needed knowledge about price risk management in milk production. There are limitations and needs for additional work, and some of these will be laid out in the next section. The encouraging findings from this work is that relatively simple price risk management tools can generate added revenue for farmers and at the same time, reduce the variability in the revenue flow accruing to the farm. Adding revenue of only $1.00 per cwt. can make the difference between profits and losses. On a 500 cow farm with production of 25,000 lbs of milk per cow per year, the added revenue is $250 per cow or $125,000 for the entire farm. This added revenue more than accounts for family living expenses and significantly improves cash flow and the financial performance of the entire farm.

7 Limitations and Recommendations

This study focuses on a subset of possible price risk management strategies. For example, there are more sophisticated techniques than the moving averages strategy that provide buy and sell signals using the futures market. Other price risk management strategies involve the use of put options. The main reason for choosing moving averages and target price as bases for price risk management strategies is that these are less costly both in terms of money (put options may be pricey tools) and training required (moving averages are less complex). A future extension of this study would be to assess the performance of additional mechanisms and compare them with results of this study.

Another limitation of this study is the assumption that variable costs are constant across different farm sizes and over time. This assumption may be a restrictive one but it was necessary to simplify the analysis. Hence a natural extension of this work would be to analyze the sensitivity of results to varying cost structures.

Any hedging strategy, whether it is simple or more sophisticated, requires that farmers know their 'historical' basis because this information is used to calculate the farmer's expected forward price. Therefore, farmers need to be trained in executing price risk management strategies, for example through extension programs that provide them with the knowledge on how to compute and use basis for hedging strategies.

Although moving averages are less complex than other technical hedging tools, using a moving averages strategy may be seen as a complicated task for the non-experienced farmer. As an alternative, this study also considered a simpler version of moving averages (i.e. the ‘overall moving averages’, see section 5.5). Even though this variation of moving averages is less optimal than the original one, it tends to produce higher profits than the target price strategy. Moreover, this version maintains the flexibility that characterizes moving averages, namely it allows the farmer to take advantage of higher prices. It will then be up to the farmer to decide if the trade off, between using this simpler strategy and the foregone additional profits that could be obtained from the more complicated one, is taken.

When considering using moving averages it is necessary to emphasize two key factors not discussed in the study. First, since the optimal parameters of moving averages are derived from ‘historical data’ there is no guarantee that future performance will resemble past performance. The one year out-of-the-sample exercise of this study suggests that the moving averages are effective. Another crucial factor for the success of moving averages is that farmers maintain their discipline by exactly following the signals provided by the moving averages. The reason for this is that if a farmer decides to use ‘gut feeling’, instead of the moving averages signals, to buy and sell, the consequences can be financially disastrous. Moving averages are an objective and analytical way of determining trend changes in milk prices that eliminate the need to make judgments and judgment should be exercised only when deciding whether this is the right price risk management tool for a particular operation.

A word of caution is also in place with target prices. Although an optimal margin over costs is found for the target price strategy, there is no guarantee that in the future the market will provide a price that meets the cost-based target price. It may be the case that the farmer never observes this price and hence no hedging takes place. This is especially dangerous if a steep down trend in prices starts to be observed and the farmer remains unprotected. In this regard, moving averages have the advantage of providing a safety net feature by generating a selling signal when the trend switches downward regardless of how low or high the price is.

The size of the farm is also important in deciding what strategy to use. Small farms may not be able to meet the minimum production requirement of 200,000 cwt to buy a futures contract. These farms can only rely on cash forward contracts with a cooperative or processor. For farms that can trade in the futures market, special caution needs to be taken for the percentage of production that is hedged. It may be possible that when the projected milk production is unusually high, the farmer should try to hedge only the normal monthly production that will be produced by the time of contract expiration. Hence, the farmer should avoid hedging 100% of the milk if he is expecting significant variation in production levels.

Timing of hedging is very important. This study uses the last six months of trading before expiration as a proxy of an adequate time that reflects futures prices. In any case, the farmer may want to avoid hedging one year before or too close to the expiration of the contract since prices may be either too uncertain in the first case or already near the closing maturity price in the second case.

8 References

Bailey, K. "Understanding Your Milk Check" Agricultural Research and Cooperative Extension *Manuscript*, Penn State University, 2000, 5M10/00 ps4479

Bailey, K. "How Milk is Priced in Pennsylvania under Federal Order Reform" *Staff Paper Series,* Penn State University, Number 328, February 2000

Bodie, Z., Kane, A., and Marcus, A. "Investments" Mc Graw-Hill, fifth edition, 2002, chapter 6, 153-182.

Bosch, D. and Johnson, C. "An Evaluation of Risk Management Strategies for Dairy Farms" *Southern Journal of Agricultural Economics*, v24, n2, 1992, 173-82.

Bosch, D. and Johnson, C. "Price Risk Management Strategies for a Representative Virginia Dairy Farm" *Virginia's Rural Economic Analysis Program (REAP)*, 1992, Publication 448-208

Brown, G., Crabb, P. and Haushalter, D. "Are Firms Successful at Selectively Hedging?" http://ssrn.com/abstract=385169, February 2003.

Burkhart, B., Sink, S. and Purcell, W. "How Virginia Dairymen Can Manage Price Risk" *Virginia's Rural Economic Analysis Program (REAP)*, VCE Pub. No.448-243/REAP R0045, Department of Agricultural and Applied Economics College of Agriculture and Life Science, Virginia Tech, July 1999.

Chicago Mercantile Exchange (CME) website, CME Milk Class III, http://www.cme.com/trading/prd/contract_spec_DA656.html

Frechette, D. "The Demand for Hedging and the Value of Hedging Opportunities." *American Journal of Agricultural Economics*, v82, n4, 2000, 897-907

Groover, G. "The Income Side of Seasonal vs. Year-Round Pasture-based Milk Production." *Virginia Cooperative Extension,* Virginia Tech, Dairy Science Publication 404-113, 2000.

Gulen, H. Class notes, Virginia Polytechnic Institute and State University, fall 2003

Markowitz, H. "Portfolio Selection" *The Journal of Finance*, Volume 7, Number 1, 77-91, 1952

Metastock Commodity software, Equis International, Inc., version 8.0, 2002

Purcell, W., and Koontz, S. "*Agricultural Futures and Options: Principles and Strategies"* Prentice Hall, 2nd edition, 1999.

Purcell, W. "Price Risk Management in December Corn Futures" *Virginia's Rural Economic Analysis Program (REAP)*, June 2002

Short, S. "Characteristics and Production Costs of U.S. Dairy Operations", *Economic Research Service/USDA*, Statistical Bulleting No.SB974-6), February 2004.

Tomek, W., and Hikaru, H. "Risk Management in Agricultural Markets: A Review". *The Journal of Futures Markets*, Volume 21, number 10, 2001, 953-985.

USDA. (a) Dairy Yearbook at www.ers.usda.gov/briefing/dairy

______ (b) Livestock, Dairy and Poultry Outlook at www.ers.usda.gov/publications/ldp/

______ (c) Costs and Returns at

http://www.ers.usda.gov/Data/CostsAndReturns/testpick.htm#milkproduction

9 Appendix

Appendix 9.1

Virginia, monthly dairy costs of production per cwt of milk sold, 2003

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						$/cwt						
Operating costs:												
Feed--												
Feed grains	0.99	1.00	0.99	0.96	1.00	1.04	1.01	1.05	1.02	0.99	0.96	0.99
Hay and straw	0.66	0.65	0.66	0.66	0.70	0.71	0.71	0.68	0.66	0.65	0.59	0.58
Complete feed mixes	3.75	3.75	3.48	3.36	3.42	3.69	3.85	3.86	3.84	3.77	3.83	3.80
Liquid whey and milk replacer	0.10	0.10	0.10	0.10	0.10	0.11	0.12	0.12	0.12	0.12	0.11	0.11
Silage	1.29	1.28	1.30	1.30	1.36	1.38	1.39	1.34	1.28	1.27	1.15	1.13
Grazed pasture and cropland	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.11	0.11	0.11	0.10	0.10
Other feed items 1/	1.08	1.07	1.07	1.04	1.05	1.15	1.22	1.23	1.21	1.22	1.16	1.15
Total, feed costs	**7.98**	**7.96**	**7.71**	**7.54**	**7.75**	**8.19**	**8.42**	**8.39**	**8.23**	**8.13**	**7.91**	**7.85**
Veterinary and medicine	0.81	0.81	0.81	0.79	0.81	0.87	0.92	0.94	0.91	0.88	0.84	0.81
Bedding and litter	0.15	0.15	0.15	0.15	0.15	0.16	0.17	0.17	0.17	0.17	0.16	0.15
Marketing	0.41	0.41	0.41	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.41
Custom services	1.19	1.19	1.19	1.16	1.18	1.26	1.33	1.36	1.37	1.34	1.27	1.24
Fuel, lube, and electricity	0.58	0.72	0.61	0.58	0.53	0.60	0.64	0.68	0.63	0.65	0.58	0.59
Repairs	0.80	0.80	0.80	0.79	0.80	0.86	0.91	0.93	0.90	0.89	0.84	0.82
Other operating costs 2/	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest on operating capital	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.10	0.10
Total operating costs	**12.02**	**12.14**	**11.77**	**11.51**	**11.74**	**12.47**	**12.92**	**13.00**	**12.74**	**12.58**	**12.11**	**11.98**
Allocated overhead:												
Hired labor	2.14	2.14	2.14	2.05	2.09	2.24	2.28	2.32	2.25	2.25	2.14	2.09
Opportunity cost of unpaid labor	3.63	3.63	3.63	3.47	3.53	3.78	3.85	3.93	3.80	3.81	3.62	3.53
Capital recovery of machinery and equipment	2.80	2.80	2.84	2.81	2.86	3.06	3.21	3.28	3.18	3.14	2.98	2.91
Opportunity cost of land (rental rate)	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.05	0.05	0.05
Taxes and insurance	0.23	0.23	0.23	0.23	0.23	0.25	0.26	0.27	0.26	0.25	0.24	0.23
General farm overhead	0.77	0.78	0.77	0.75	0.77	0.82	0.86	0.88	0.87	0.86	0.82	0.80
Total, allocated overhead	**9.62**	**9.64**	**9.66**	**9.36**	**9.53**	**10.20**	**10.52**	**10.74**	**10.41**	**10.38**	**9.85**	**9.61**
Total costs listed	**21.65**	**21.78**	**21.44**	**20.87**	**21.27**	**22.68**	**23.44**	**23.74**	**23.15**	**22.96**	**21.96**	**21.58**

Source: 2000 Agricultural Resource Management Survey of milk producers.
R=revised using newly available updated data.
1/ Cotton seed meal, protein supplements, protein by-products, alfalfa cubes or pellets, green chop, corn stalks, and antibiotics and other medicated additives.
2/ Manure disposal fees, permits, and licenses, and odor control costs.
12/22/2004

Appendix 9.2

Virginia, monthly dairy costs of production per cwt of milk sold, 2003 (Modified)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						$/cwt						
Operating costs:												
Feed--												
Feed grains	0.99	1.00	0.99	0.96	1.00	1.04	1.01	1.05	1.02	0.99	0.96	0.99
Hay and straw	0.66	0.65	0.66	0.66	0.70	0.71	0.71	0.68	0.66	0.65	0.59	0.58
Complete feed mixes	3.75	3.75	3.48	3.36	3.42	3.69	3.85	3.86	3.84	3.77	3.83	3.80
Liquid whey and milk replacer	0.10	0.10	0.10	0.10	0.10	0.11	0.12	0.12	0.12	0.12	0.11	0.11
Silage	1.29	1.28	1.30	1.30	1.36	1.38	1.39	1.34	1.28	1.27	1.15	1.13
Grazed pasture and cropland	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.11	0.11	0.11	0.10	0.10
Other feed items 1/	1.08	1.07	1.07	1.04	1.05	1.15	1.22	1.23	1.21	1.22	1.16	1.15
Total, feed costs	**7.98**	**7.96**	**7.71**	**7.54**	**7.75**	**8.19**	**8.42**	**8.39**	**8.23**	**8.13**	**7.91**	**7.85**
Veterinary and medicine	0.81	0.81	0.81	0.79	0.81	0.87	0.92	0.94	0.91	0.88	0.84	0.81
Bedding and litter	0.15	0.15	0.15	0.15	0.15	0.16	0.17	0.17	0.17	0.17	0.16	0.15
Marketing	0.41	0.41	0.41	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.41
Custom services	1.19	1.19	1.19	1.16	1.18	1.26	1.33	1.36	1.37	1.34	1.27	1.24
Fuel, lube, and electricity	0.58	0.72	0.61	0.58	0.53	0.60	0.64	0.68	0.63	0.65	0.58	0.59
Repairs	0.80	0.80	0.80	0.79	0.80	0.86	0.91	0.93	0.90	0.89	0.84	0.82
Other operating costs 2/	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest on operating capital	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.10	0.10
Total operating costs	**12.02**	**12.14**	**11.77**	**11.51**	**11.74**	**12.47**	**12.92**	**13.00**	**12.74**	**12.58**	**12.11**	**11.98**
Hired labor	2.14	2.14	2.14	2.05	2.09	2.24	2.28	2.32	2.25	2.25	2.14	2.09
Total operating cost plus hired labored	**14.16**	**14.28**	**13.91**	**13.56**	**13.83**	**14.71**	**15.20**	**15.32**	**14.99**	**14.83**	**14.25**	**14.07**
Allocated overhead:												
Opportunity cost of unpaid labor	3.63	3.63	3.63	3.47	3.53	3.78	3.85	3.93	3.80	3.81	3.62	3.53
Capital recovery of machinery and equipment	2.80	2.80	2.84	2.81	2.86	3.06	3.21	3.28	3.18	3.14	2.98	2.91
Opportunity cost of land (rental rate)	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.05	0.05	0.05
Taxes and insurance	0.23	0.23	0.23	0.23	0.23	0.25	0.26	0.27	0.26	0.25	0.24	0.23
General farm overhead	0.77	0.78	0.77	0.75	0.77	0.82	0.86	0.88	0.87	0.86	0.82	0.80
Total Allocated overhead - hired labored	**7.48**	**7.49**	**7.52**	**7.31**	**7.44**	**7.96**	**8.24**	**8.42**	**8.17**	**8.11**	**7.71**	**7.52**
Total costs listed	**21.65**	**21.78**	**21.44**	**20.87**	**21.27**	**22.68**	**23.44**	**23.74**	**23.15**	**22.96**	**21.96**	**21.58**
Operating cost as percentage of total costs	65%	66%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Allocated overhead as percentage of total costs	35%	34%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%

Source: 2000 Agricultural Resource Management Survey of milk producers.

R=revised using newly available updated data.

1/ Cotton seed meal, protein supplements, protein by-products, alfalfa cubes or pellets, green chop, corn stalks, and antibiotics and other medicated additives.

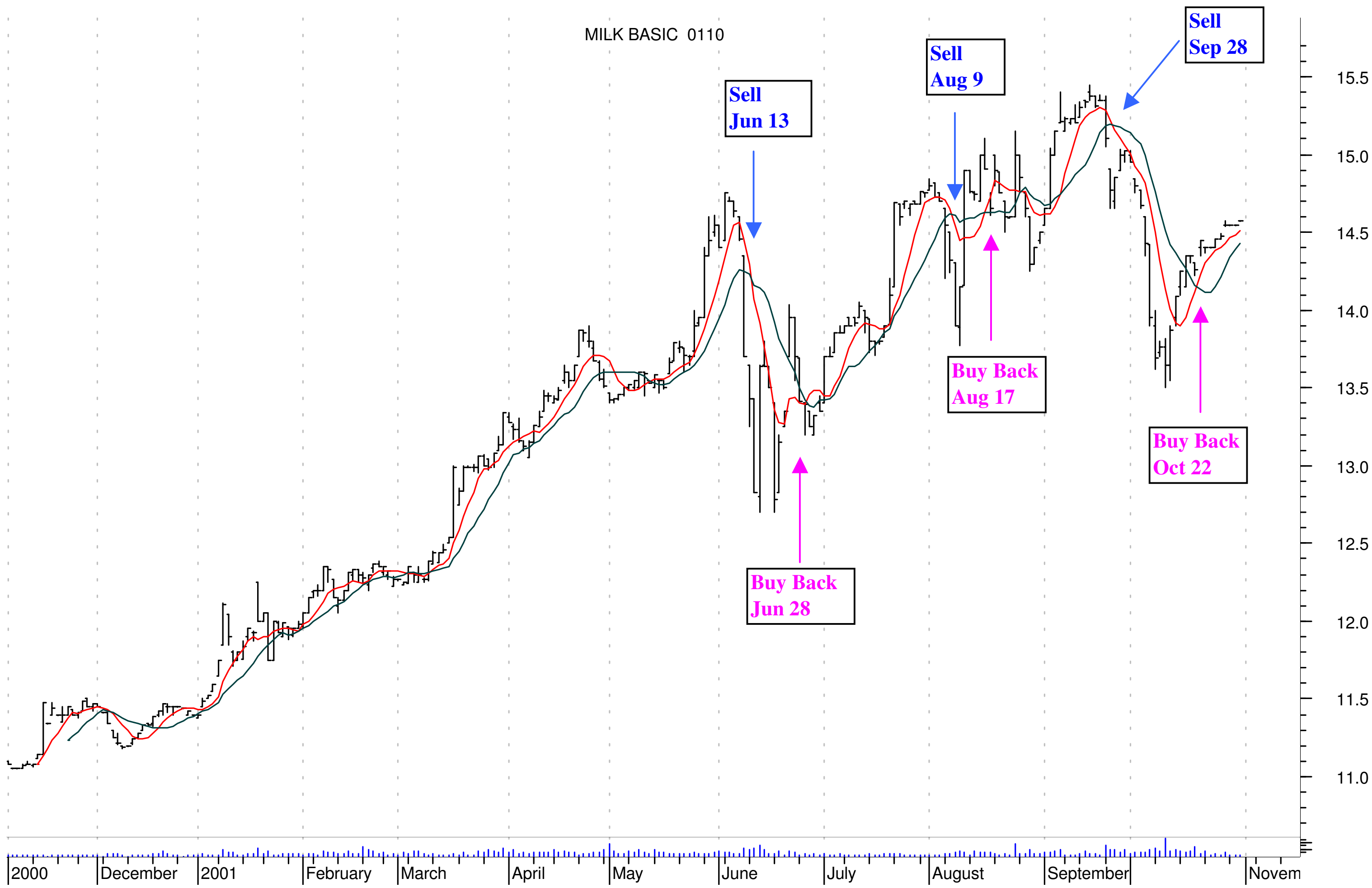
2/ Manure disposal fees, permits, and licenses, and odor control costs.

Appendix 9.3
Demonstration of how to calculate the 5-day and 12-day moving averages, using the November 1999 Milk Futures Contract

Date	Closing Price	Sum 5 last closing days	Division to 5	5-day MA	Sum 12 last closing days	Division to 12	12-day MA
14-Oct	12.1						
15-Oct	11.75						
18-Oct	11.72						
19-Oct	11.55						
20-Oct	11.48	58.6	**58.6 / 5**	11.72			
21-Oct	11.36	57.86	57.86 / 5	11.57			
22-Oct	11.35	57.46	57.46 / 5	11.49			
25-Oct	11.44	57.18	.	11.44			
26-Oct	11.44	57.07	.	11.41			
27-Oct	11.45	57.04	.	11.41			
28-Oct	11.6	57.28	.	11.46			
29-Oct	11.5	57.43	.	11.49	138.74	**138.74 / 12**	11.56
1-Nov	11	56.99	.	11.40	137.64	137.64 / 12	11.47
2-Nov	11	56.55	.	11.31	136.89	.	11.41
3-Nov	11.1	56.2	.	11.24	136.27	.	11.36
4-Nov	11.09	55.69	.	11.14	135.81	.	11.32
5-Nov	10.5	54.69	.	10.94	134.83	.	11.24
8-Nov	10.53	54.22	.	10.84	134	.	11.17
9-Nov	10.5	53.72	.	10.74	133.15	.	11.10
10-Nov	10.4	53.02	.	10.60	132.11	.	11.01
11-Nov	10.45	52.38	.	10.48	131.12	.	10.93
12-Nov	10.5	52.38	.	10.48	130.17	.	10.85
15-Nov	10.5	52.35	.	10.47	129.07	.	10.76
16-Nov	10.46	52.31	.	10.46	128.03	.	10.67
17-Nov	10.4	52.31	.	10.46	127.43	.	10.62
18-Nov	10.41	52.27	.	10.45	126.84	.	10.57
19-Nov	10.15	51.92	.	10.38	125.89	.	10.49
22-Nov	10.15	51.57	.	10.31	124.95	.	10.41
23-Nov	10.1	51.21	.	10.24	124.55	.	10.38
24-Nov	10.12	50.93	.	10.19	124.14	.	10.35
26-Nov	10.12	50.64	.	10.13	123.76	.	10.31
29-Nov	10.1	50.59	.	10.12	123.46	.	10.29
30-Nov	10.05	50.49	50.49 / 5	10.10	123.06	208.63 / 12	10.26

For a 5-day moving average, the farmer will look for the futures market prices (at the end of each trading da add the five closing prices (one for each day) and divided the value of their sum by five. For a 12-day moving average the same procedure is done, with the difference that 12 closing futures prices (12 days) are added and then their sum divided by 12.

Appendix 9.4
October 2001 Class III Milk Futures Contract
7-Day (red) and 13-Day (green) Moving Averages with a $0.10/cwt Penetration Requirement



Appendix 9.5
May 2003 Class III Milk Futures Contract
15-Day (red) and 27-Day (green) Moving Averages with a $0.025/cwt Penetration Requirement

Appendix 9.6
August 2001 Class III Milk Futures Contract
32-Day (red) and 43-Day (green) Moving Averages with a $0.00/cwt Penetration Requirement

10 Vita

Alexandra Andino was born in Ecuador. She attended The Pontifical Catholic University of Ecuador where she obtained her Bachelor of Arts degree in Economics in July 2001. She entered the Master of Science program in Agricultural and Applied Economics, Agribusiness-Finance option, at Virginia Polytechnic Institute and State University in January 2003 and will complete her degree in December 2004.

Alexandra E. Andino