MINIMUM RISK HEDGE RATIOS FOR OKLAHOMA FEEDER CATTLE

By

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MINIMUM RISK HEDGE RATIOS FOR OKLAHOMA

FEEDER CATTLE

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CHAPTER 1

INTRODUCTION

1.1 Oklahoma's Cattle Industry

The cattle industry is a major source of income for the agricultural sector of Oklahoma. In 1991 the total value of production for all agricultural products in Oklahoma was $2.9 billion with $1.5 billion coming from the production of cattle and calves (Oklahoma Agricultural Statistics 1991). This value of production was more than all other agricultural products for the state combined.

The stocker-feeder industry is a major part of the cattle industry in Oklahoma. Oklahoma has 1.15 million head of calves under 500 pounds and ranks second behind Texas (Agricultural Statistics 1992). By adding the number of steers and heifers from 500-900 pounds, Oklahoma ranks third behind Texas and Kansas. This combination of high numbers of stocker cattle and the availability of forage both in the winter and the summer makes Oklahoma an ideal state to operate stocker enterprises.

1.2 Problem Statement

The role of the stocker industry is to prepare cattle for the feedlot. The stocker industry also contributes to the long-run economic balance between the cattle, grain, and forage markets. A major problem in this industry is the amount of profit volatility faced by the producers. This profit volatility is largely caused by volatility of cash prices.

Figure 1 shows the historic monthly average price of Oklahoma 600-700 pound steers and heifers during 1989-1991. The amount of price volatility Oklahoma producers have faced has varied greatly over the last three years. In 1991 the largest month-to-month drop in the average price was $5 per hundred weight between the months of July and August. The average continued to drop until December. The total decrease in the monthly average was $10. With large fluctuations in price, producers are subject to significant price risk.

One method of managing price risk is through hedging feeder and stocker cattle with commodities futures contracts. However, once the producer decides to hedge an additional problem emerges. How many contracts should be traded to optimally reduce price risk given the type of cattle produced? There is a general lack of information on how to hedge the different weights and sex of feeder cattle using a feeder cattle contract that is specified for 50,000 lbs. of Medium Frame #1 and Medium and Large Frame #1 steers weighing 700-799 lbs, as of January 1993. Producers and economists usually assume a one-to-one relationship between feeder cattle cash and futures position (hedge ratio of 1.0) for both sexes and the different weight groups (Earnst, Kenyon, Purcell, and Bainbridge). This one-to-one relationship implies that a producer who uses futures contracts to hedge against price risk would use one pound of futures contract for one pound of physical commodity. Another assumption made by producers and economists is that the nearby feeder cattle contract must be used to hedge feeder cattle instead of using later maturing contracts or a live cattle contract.[1] As a result, a producer hedging different weights of steers and heifers using a one-to-one hedge ratio and the nearby feeder cattle futures contract may not be reducing price volatility as much as if an optimal hedge ratio that is different from 1.0 and/or a different futures contract is used. Another problem is, how will the hedge ratio vary given the type of production schedules used and the weights and sex of feeder cattle that are marketed in Oklahoma.

1.3 Production Schedules

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[1] The nearby contract is the contract that expires the closest to but not before the expected time of marketing.

Producers in Oklahoma basically use two different types of production schedules when operating a stocker program. The first type is a Summer Grass program. Stockers are placed on summer pasture, generally an improved grass pasture (Bernardo and McCollum), in the middle of April and are marketed in September. Stocker calves weighing 400-600 pounds are grazed at stocking rates of 5 acres per head, with an average gain of 225 pounds or 1.5 pounds per day. By using this type of production schedule, producers are able use land that would otherwise require a substantial amount of labor and inputs to produce a grain or hay crop.

The second type is a Winter Wheat grazing program. This program provides a rare opportunity. By using wheat pasture for growing out of stocker calves, producers are able to produce an additional product with little or no effect on wheat harvested. Stockers weighing 400-600 pounds are placed on wheat pasture around the first of November and are marketed around March (if the wheat crop is to be harvested). According to wheat pasture survey studies conducted by Walker, Bernardo, Trapp, and Rodriguez, approximately 50% of Oklahoma's wheat acreage is grazed in Winter Wheat programs. By using Oklahoma's 7.4 million acres of planted wheat (Oklahoma Agricultural Statistics 1991) at a stocking rate of 2.0 acres per head, an average gain of 2 pounds per day for 120 days, producers can generate 444 million pounds of feeder cattle gain. The value of this added weight is $339.2 million.[2] With this added value it is easy to see how important winter stocking programs can be to Oklahoma's agricultural economy.

1.4 Objectives and Hypothesis

This study has five specific objectives. The first objective is to calculate long-run and short-run minimum risk hedge ratios for a producer wanting to hedge a group of steers weighing 600-700, or 700-800 pounds or

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[2] This is calculated using the added weight and multiplying by the December 1991 average monthly price.

a group of heifers weighing 600-700 pounds at marketing. These hedge ratios will be calculated using the weekly feeder cattle cash price for the different weight groups and sexes of Oklahoma City (OKC) feeder cattle regressed on the corresponding feeder cattle futures contract offered by the Chicago Mercantile Exchange (CME).

The second objective will be to perform three different hypothesis tests. The first test will see if the hedge ratios calculated are significantly different from 1.0. This will test the hypothesis that the minimum risk hedge ratio is significantly different from the traditional hedge of 1.0. The second test will see if the hedge ratios of feeder cattle that are not the sex and weight as specified by the feeder cattle contract are significantly different from the hedge ratios for the correct sex and weight group specified by the feeder cattle contract (700-800 pound steers). The last test will examine if there is a significant difference in the calculated hedge ratios between the Summer Grass and Winter Wheat production schedules.

The third objective of this study will be to calculate long-run and short-run minimum risk hedge ratios for the various weights of steers and heifers using the live cattle contract offered by the CME. This will be done using the same cash prices as the first objective regressed on the corresponding live cattle futures quotes. The objective is to determine if a producer can effectively cross hedge feeder cattle using the live cattle contract.

The fourth objective of this study will be to measure the effect of cash settlement on hedge ratios and the difference between cash returns and futures returns. The introduction of cash settlement in the feeder cattle futures market may have had a significant effect on the relationship between cash and futures markets. This study will measure how big, in what direction, and the significance of the changes caused by cash settlement.

The fifth objective of this study will be to calculate the mean expected return and variance of returns for each weight group of steers and heifers from using different hedging strategies. This will be completed by conducting nonstochastic simulations of hedging. A simulation for all the calculated hedge ratios and two alternative marketing strategies (traditional hedge and no hedge) will be conducted using the data collected for this study. By examining the distributions of net returns for each hedging strategy the effectiveness of the minimum risk hedge ratios to stabilize returns as compared to other traditional marketing strategies can be measured.

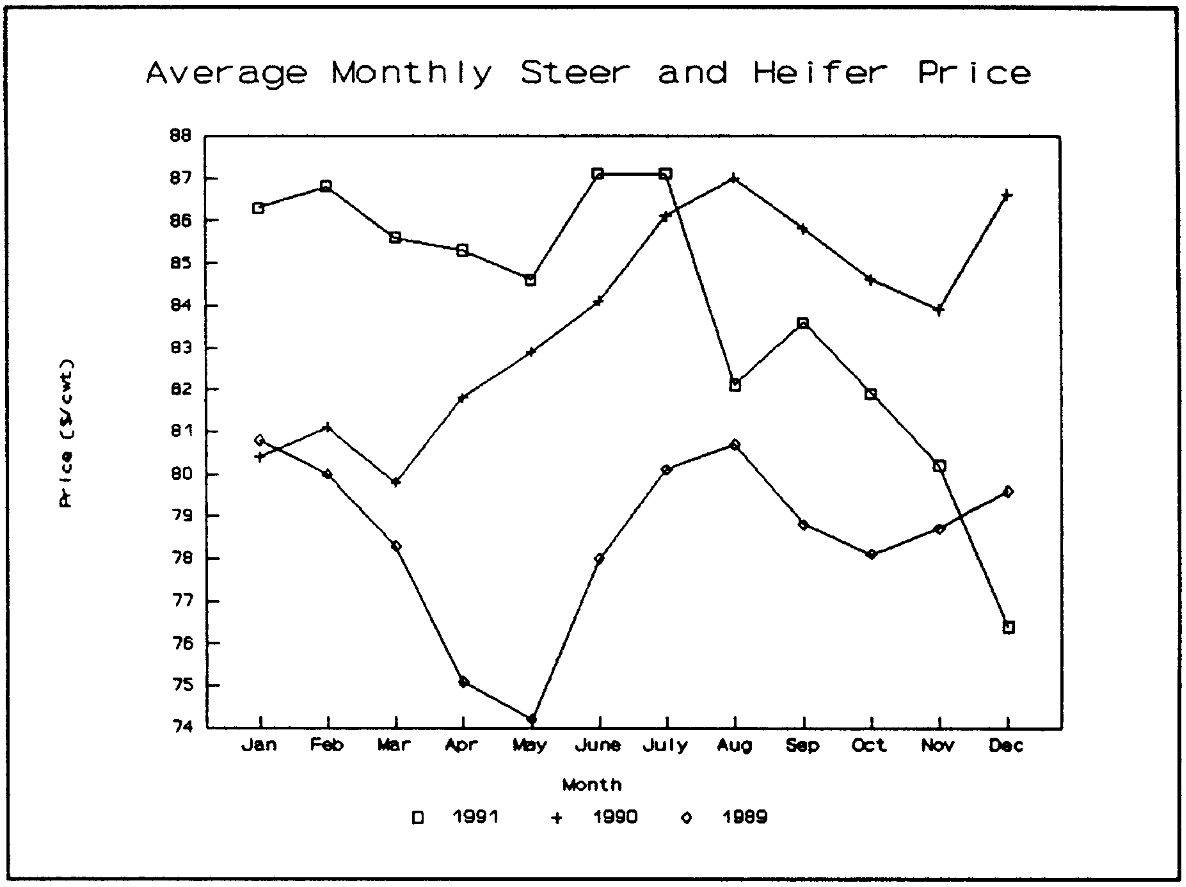
1.5 Organization of Thesis

Chapter 2 will review the literature on cross hedging and hedge ratios studies, high-lighting the differences between previous research and this study. Chapter 3 will present the theoretical and empirical models. This chapter will show the theory behind the calculation of the long-run and short-run minimum risk hedge ratios. The chapter will also show the formulas used to test the hypothesis and discuss the net return simulation model. Chapter 4 will present and discuss the calculated hedge ratios for each hedging decision, weight group, production schedule and the two different futures contracts used. The results from the three different hypothesis tests will be presented and discussed along with the results from the net return simulation. Chapter 5 will summarize the results and the implications of this study.

FIGURE 1

Oklahoma Historic Average 600-700 Pound

Steer and Heifer Price



CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides a literature review of previous hedge ratio studies using feeder cattle, and studies on cross hedging agricultural products. Section 2.2 summarizes and compares previous feeder cattle hedge ratios studies. Section 2.3 will discuss the similarities and differences between those previous studies in section 2.2 and this study. Section 2.4 will summarize and discuss previous cross-hedging studies using agricultural products.

2.2 Past Studies

Elam conducted one of the first studies comparing the differences in hedging risk between hedge ratios for the different weights and sex groups of feeder cattle before and after cash settlement. The method used to calculate these hedge ratios was a Ordinary Least Squares (OLS) regression of the Arkansas feeder cattle cash price on the nearby futures contract price at the time the hedge is to be lifted. Elam used a hedging period of three months and stated that the difference in the hedging risk for longer periods was minimal, assuming the length of hedging period was not important. Elam also believed that the Arkansas feeder cattle market would be representative of most feeder cattle markets.

Elam's results showed that for the lighter weight cattle (400-600 lbs.) the optimal hedging percentage was greater than 1.0, which means to effectively hedge the lighter weight groups a producer must over hedge. Elam also discovered that overall hedging risk was decreased after cash settlement, but Elam noted that cash settlement has caused an increase in hedging risk for cattle under 600 pounds using the March, April, and May futures contracts.

Schroeder and Mintert also conducted a study comparing the hedging risk for physical delivery and the cash settlement contracts. Schroeder and Mintert argued against Elam's statement that Arkansas would be representative of all markets. Schroeder and Mintert used four different markets (Amarillo, Kansas City, Dodge City, and Illinois) suggesting that feeder hedging risks likely differ across markets. Schroeder and Mintert believed that their markets were important markets because the first three were used in the calculations of the U.S. feeder steer price (USFSP) and the fourth, though not included in the USFSP, was a heavy volume market.

Schroeder and Mintert used the same regression and hedging risk equations as Elam.[3] Schroeder and Mintert also believed that the length of the hedging period was not important and used a three month hedging period. Schroeder and Mintert's hedge ratios for cattle not meeting the specifications of the feeder cattle contract were different from the traditional hedge of 1.0. Hedge ratios for cattle lighter than 600 pounds were greater than 1.0. Schroeder and Mintert concluded that hedging risk was generally decreased with the start of cash settlement, but disagreed with Elam's results showing that hedging risk was significantly higher for light weight steers during the Spring. Schroeder and Mintert attributed these differences to marketing locations.

A third study, by Elam and Davis, compared the hedging risk of the traditional hedge to the hedging risk of a ratio hedge using the feeder cattle price at Amarillo. Elam and Davis calculated their hedge ratios regressing the Amarillo feeder cattle cash price at the time the hedge was lifted on the futures contract price at the time the hedge was lifted. Elam and Davis stated that the exact time the hedge is placed need not be

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[3] Schroeder and Mintert observations had first order autocorrelation and were estimated using Generalized Least Square (GLS) to correct the problem.

specified because hedging risk does not depend upon the cash or futures price at the time the hedge is placed. Elam and Davis only used the March contract in calculating their hedge ratios stating that hedge ratios calculated for the March contract using Amarillo prices should hold for other months and markets.

Elam and Davis' hedge ratios are similar to the other two studies. Cattle weighing less than 600 pounds hedge ratios suggest that these animals should be over hedged. Elam and Davis concluded that using hedge ratios for hedging lighter weight cattle can significantly reduce the amount of hedging risk faced by producers.

2.3 Previous Cross-Hedging Studies

One of the objectives of this study is to calculate and evaluate long-run and short-run minimum risk hedge ratios using the live cattle contract offered by the Chicago Mercantile Exchange. By using the live cattle contract to hedge feeder cattle the producer would be by definition cross hedging. Cross hedging involves the hedging a cash position in one commodity by using the futures market for a different, but related commodity. Besides being used to hedge against price risk of a commodity for which a futures market does not exist, cross hedging can be used when the existing futures market does not provide sufficient liquidity for direct hedging. There is limited evidence regarding the effectiveness of existing agricultural commodities futures markets as a cross-hedging media (Miller 1982, Miller and Luke 1982, and Miller 1985). The aforementioned articles use the same basic formula to estimate their cross-hedging levels. This section will use the article published by Miller in 1982 to summarize previous cross-hedging results and compare the technique used to the technique in this study.

Miller published a study on forecasting feeder pig prices by cross-hedging feeder pigs using the live hog contract. Miller calculated his hedge ratios by regressing the cash price of the feeder pig at the time the hedge was placed on the futures price of the live hog contract at the same time. From this regression equation, the parameter estimate on the futures price was the hundred weight of live hog contract that would need to be sold to offset one feeder pig sold at a later time period. By using the estimated regression equation, Miller would obtain a forward price for that feeder pig to be sold at the later time period. If the regression relationship holds exactly then the forward price would be realized and would be equal to the actual price. If the relationship did not hold exactly, then the forward price would not equal the actual price. This difference in the forward and actual price, also called the forecasting error, is now the source of risk for the producer, instead of the usual price risk.

Economic theory also suggests that buyers' bids for feeder pigs were not only affected by slaughter hog prices, but also the cost of feed and that feeder pigs could be cross hedged using the live hog contract and the corn futures contract.[4] This regression equation was estimated using the same equation as before with the addition of a corn futures price independent variable.

Miller estimated regression equations using four different hedging strategies. Strategy 1 was to cross hedge using the live hog contract maturing nearest to, but not before the time the hedge was placed plus six months. This was the strategy of using the nearby contract for the end of the production period. Strategy 2 was to cross hedge using the live hog contract maturing closest to, but not before the time the hedge was placed plus ten months. This strategy was to use the contract that matured after the sow gestation period plus the market hog feeding period. Strategies 3 and 4 were the same as one and two with the addition of the corn futures contract maturing closest to, but not before the time the hedge was placed plus six months. These two strategies were to use the different hog

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[4] Miller used corn futures since corn is a major ingredient of hog finishing rations.

contracts and the nearby corn futures contract.

Miller concluded that a producer could reduce the amount of price risk by using any one of the four strategies. All four strategies produced lower variances of net price than the cash market. Strategies 2 and 4 had the lowest variance and forecasting error. All four strategies also produce lower mean net prices than the cash market. Miller suggests that cross hedging can be an effective way to stabilize revenues, but at the cost of lower net returns.

2.4 Differences Between Previous Studies and This Study

In previous studies, hedge ratios have been calculated using the price levels of different cash markets and the Chicago Mercantile Exchange (CME) futures price in a simple OLS regression. By calculating hedge ratios using the different price the levels, previous studies have calculated hedge ratios that minimize price risk. The same type of hedge ratios will be calculated in this study and referred to as a short-run hedge ratios. In addition to the short-run hedge ratios, a set of hedge ratios will be calculated using the difference between the selling and buying cash price of the various weight groups of steers and heifers regressed on the difference between the selling and buying price of the futures contract offered by the CME. By calculating hedge ratios using the returns of the final sale weight of animal, the hedge ratios calculated should minimize the return risk faced by the producer. These hedge ratios will be referred to as long-run hedge ratios.

When calculating hedge ratios, previous studies have only used the contract that matured closest to, but not before the time the animals are marketed. This is called the nearby contract. This study will calculate both the long-run and short-run hedge ratios using the nearby contract and the two contracts after the nearby. For example, if the March contract is the nearby contract, hedge ratios will be calculated using the March contract along with the April and May contracts.

In addition to the feeder cattle contracts used to calculate hedge ratios, the live cattle contract that would be used to hedge the feeder cattle through the feeding process will also be used in calculating a hedge ratio for the different weights of steers and heifers. The reasoning behind using the live cattle contract is that there have been some complaints about the ineffectiveness of the feeder cattle contract when hedging. This study will see if the live cattle contract is a more effective tool to hedge with than the feeder cattle contract. The August live cattle contract will be used for the Winter Wheat production schedule and the February live cattle contract will be used for the Summer Grass production schedule.

Previous studies have stated that the length of the hedging period is not important and have commonly use a three month hedging period. This study believes that the length of the hedging period may be important when calculating the long-run hedge ratios. Not only may the length be important, but the type of production schedule may be important as well. Therefore, this study will use two production schedules and the different weights of steers and heifers most frequently used in Oklahoma. The first production schedule will represent the Winter Wheat grazing program. A producer will place a hedge on a group of feeder animals in October, the same time the animals go to pasture and the hedge will be lifted in March when the animals come off wheat pasture. The second production schedule is representative of a Summer Grazing program. A producer will hedge a group of feeder cattle in April and remove the hedge in September when the cattle are sold. These two different production schedules should provide the producers better information on what percentage of feeder cattle should be hedged.

A major structural change has taken place in the feeder cattle futures market. This change was the implementation of cash settlement for the feeder cattle contract. Previous studies have dealt with this change by estimating two sets of hedge ratios. One set of hedge ratios was calculated using the futures price of the contracts before cash settlement and one set was calculated using the United States Feeder Steer Price (USFSP). This study will deal with the structural change by adding two explanatory variables to the regression equation. The first variable will measure the change in intercept of the regression equation caused by cash settlement. The second variable will measure the change in the hedge ratio caused by cash settlement. The significance of both explanatory variables will be tested.

This study will perform a number of specific tests after calculating both sets of hedge ratios. Each hedge ratio will be tested for any significant difference from 1.0, or the traditional hedge. None of the previous studies provide any statistical proof of a significant difference from the traditional hedge of 1.0. Also, the hedge ratios for the lighter weight of steers and all weights of heifers will be tested for any significant difference from the hedge ratios calculated for the steers weighing 700-800 pounds. This is the weight group that is specified by the feeder cattle contract offered by the CME. Another test will be performed to see if there is any difference between hedge ratios calculated for the two production schedules.

Another difference between previous studies and this study is the measurement of hedging feasibility. Previous studies have used a measurement of hedging risk to compare ratio hedges to traditional hedges. This study will use a mean return simulation to compare a ratio hedge to a traditional hedge and an nonhedged position. By calculating the mean net price and returns, this study will provide some information not provided by other studies. This information is the specific mean net price and returns and the standard deviation of price and returns for the different hedging strategies.

CHAPTER 3

THEORETICAL AND EMPIRICAL MODELS

3.1 Introduction

This chapter describes the theoretical and empirical models used to derive the minimum risk hedge ratio equations, estimate the hedge ratios, and the hypotheses tests used to examine the estimated hedge ratios. Section 3.2 considers the problems of using profit maximization for determining an optimal solution. Section 3.3 introduces the concept of an risk-return or EV Frontier and the point on the frontier that represents the minimum risk hedge ratio. Sections 3.4 and 3.5 will use the expected utility maximization problem from section 3.3 to derive long-run and short-run minimum risk hedge ratio regression equations. Section 3.6 describes the data used in the regression equation and how the variables in the regression equation are constructed from the data. Section 3.7 describes the Generalized Least Squares model used to estimate the hedge ratio equations and the hypotheses tests used in testing the minimum risk hedge ratios. Section 3.8 describes the simulations used to compare the net returns of the calculated hedge ratios to the net returns of a traditional hedge position and an nonhedged position.

3.2 Profit Maximization

When faced with the task of finding an optimal solution to a marketing problem some researchers have solved the problem by maximizing profits subject to different types of budget constraints. When solving a problem using profit maximization the researcher fails to include an important problem facing the producer. This problem is risk. In profit maximizing problems, profits are normally defined as total revenue less total costs with the selling price of the output assumed known. This is usually not the case. Producers are faced with price uncertainty.

Risk results in the variation of net returns from the different types of marketing plans available to a producer. Different levels of risk are illustrated for two different marketing plans in Figure 2. Plan A has a mean net return of $2500 while plan B has a mean net return of $3250. The area under the curves show the probability of the range of net returns from each plan. The probability of plan A yielding a negative net return is less than the probability of plan B yielding a negative net return. Although plan B has a greater possibility of having a negative net return it also has a higher probability of having a larger positive net returns. This implies that plan B has a greater amount of risk involved than plan A.

The choice of which plan to implement is not an easy one. By choosing plan B the producer has a higher probability of larger net returns than plan A, but at the same time is subject to more risk than plan A. By using profit maximization rules, which compares mean net returns, the choice would be to use plan B. However, a producer that prefers less risk and stable returns might choose plan A. The choice made depends on the preferences of a producer. This study assumes that the producer is a risk minimizer. To find the risk minimizing solution the decision framework is generalized to expected utility maximization problem.

3.3 Risk Minimization

In developing the expected utility maximization problem, the profit maximization goal is modified so that both expected returns and risk are considered. Utility is defined as a function of expected returns and risk as measured by the variability of returns. This utility function can be written as

$$U = f(E(\pi), V(\pi)), \tag{1}$$

where

U = Utility

$E(\pi)$ = Expected Profits

$V(\pi)$ = Variability of Profits.

With this utility function, the producer is assumed to prefer higher returns to lower and the producer exhibits risk aversion. This means that the producer prefers less risk to more.

The trade off between risk and expected returns for two hypothetical marketing plans are shown in Figure 3. Points M1 and M2 represent the expected returns and the risk involved with the two marketing plans. The three sets of indifference curves represent different utility functions for producers with different levels of risk preference. The vertical lines A_0, A_1, and A_2 represent the utility function of a producer that exhibits a risk minimizer preference. This producer will choose the marketing plan that has the least amount of risk involved. The set of horizontal lines B_0, B_1, and B_2 represent the utility function of a risk neutral producer. This producer will choose the profit maximizing marketing plan regardless of the risk involved. The set of indifference curves C_0, C_1, and C_2 represent the utility function for a comparatively risk-averse decision maker. This producer would be willing to trade more risk for higher returns. Each decision maker will choose the marketing plan which enables them to reach the highest possible indifference curve. Therefore, the decision maker whose risk-return utility function is represented by group C of the indifference curves would choose marketing plan 2 over 1 because marketing plan 1 has acceptable risk for the given level of returns. Similarly, the decision maker represented by Group A would choose marketing enterprise 1 over 2 because enterprise 2 has the least amount of risk.

The expected returns and risk involved for the two marketing plans in Figure 3 are now shown in Figure 4 along with a third marketing plan M3. When the producer has the choice between plans M1 or M2, he may not have to choose one or the other, but might diversify and choose a combination of the two marketing plans. The possible combinations of the two plans are shown by the line M1,M2 connecting the two points on the graph. If the producer wanted to market 50% of his output using plan 1 and 50% using plan 2 he would be at the midpoint on the line and have an expected return of ER^1 and risk of V^1.

By adding a third marketing plan M3, the producer now has the option to use all of his resources on either marketing plan 1, 2, or 3, or diversify and choose any combination of the three marketing plans. Combinations of any two marketing plans are shown by the lines connecting the two points on the graph. Combinations of all three plans are shown by the shaded area between the three points on the graph. This shaded area represents the feasible region for the three marketing plans. For any level of expected return and risk that lays outside the shaded area is infeasible using any technically possible combinations of the three marketing plans. Therefore, the producer is limited to the choices that lie within the feasible region. As more marketing plan choices are made available, the level of expected returns and risk may fall outside the shaded area. The boundary of the feasible set may become curved and eventually smooth. The North west boundary of this convex set is called the EV frontier.

An EV frontier, Figure 5, is a boundary that shows the efficient marketing plans available to the producer. An efficient marketing plan is one that for any specified level of risk the expected returns are highest, or for any given level of expected returns the amount of risk is the lowest. The area under the boundary of the EV frontier shows the opportunity set or feasible region that can result from any combination of marketing plans the producer could implement. Any outcome not on the Northwest boundary of the EV frontier is an inefficient marketing plan.

This means that for any given level of risk the expected returns are not the highest returns available. Point A and B represent two marketing plans that have the same amount of expected returns, but enterprise B has more risk involved than plan A. Therefore, the most efficient enterprise is A.

Point Z is the risk minimizing point for the feasible set. This point represents the highest expected returns for the smallest amount of risk for any combination of marketing plans. To find point Z on the EV frontier the utility function in equation 1 can be rewritten as

$$Utility = Expected\ Profits + \frac{\lambda}{2}(Variance\ of\ Profits)\,. \qquad (2)$$

This is the lagrangian equation that will be used in calculating the minimum risk hedge ratios, where lambda indicates the level of the producers degree of relative risk aversion coefficient, and $0<\lambda<\infty$. As λ approaches zero, the producer is less risk averse and the constraint for the equation becomes non-binding. Maximizing the utility function with λ equal to zero will give the profit maximizing solution. As λ approaches infinity the constraint for the utility problem becomes very binding and the risk minimizing solution is given. Every point on the EV frontier represents a different level for λ.

3.4 Minimum Risk Hedge Ratio Formula

3.4.1 Expected Returns

The minimum risk hedge ratio is obtained by maximizing the utility function of Equation (2). Profits for the minimum risk hedge ratio problem is defined as

$$\pi = CR + FR - TC \qquad (3)$$

where

CR is the returns from the feeder cattle enterprise,

FR is the returns from the futures hedge, and

TC is the other costs of the feeder cattle enterprise.

By stating profits as the cash returns plus the futures returns minus the other costs of the feeder cattle enterprise this study limits the enterprises available to only feeder cattle. Therefore, diversification is not considered as a management risk tool and limits risk management to the trading of commodity futures contracts.

Equation (3) can be written as

$$\pi = C^s_{t+j}X_s - C^b_t X_b + (F_t - F_{t+j})X_f - TC \tag{4}$$

where

C^s_{t+j} is the expected cash price at time t+j for the selling weight s (\$/cwt.),

X_s is the weight at selling time (cwt./animal),

C^b_t is the cash price at time t for the buying weight b (\$/cwt.),

X_b is the weight at buying time (cwt./animal),

F_t is the futures price at time t (\$/cwt.),

F_{t+j} is the futures price at time t+j (\$/cwt.),

X_f is the number of futures contracts (cwt.), and

TC is normal total costs.

In the profit equation, the amount of profit gained from the cash enterprise are measured by the amount of weight gained by the feeder cattle and by the price change of the feeder cattle. By dividing both sides of the equation by the selling weight (X_s) the cash returns can be expressed as dollars per animal. Equation (4) can be rewritten as

$$\frac{\pi}{X_s} = C^s_{t+j} - C^b_t \frac{X_b}{X_s} + (F_t + F_{t+j})\frac{X_f}{X_s} - \frac{TC}{X_s}. \tag{5}$$

In the original utility function, expected profits were used. For the profit equation to be used in the maximization of the utility function, the expected value of π/X_s must be taken. This study uses two standard production schedules. Each of these production schedules consistently buy and sell the same weight of cattle over time. Standard production schedules assume that the buying and selling weights of feeder cattle (X_b, X_s) are known. Also, this study focuses on the cost associated with the feeder cattle and ignores other costs of the feeder cattle enterprise. This is done because the variance of total costs are assumed minimal, also the covariance between total costs and cash and futures returns are assumed small. Through these assumptions, total costs (TC) become known. With these assumptions, the expected value of Equation (5) is

$$E(\frac{\pi}{X_s}) = E(C^s_{t+j} - C^b_t \frac{X_b}{X_s}) + E(F_t - F_{t+j}) \frac{X_f}{X_s} - \frac{TC}{X_s}. \qquad (6)$$

Also, these assumptions will effect how the variance of profits equation is determined for the utility maximizing function.

3.4.2 Long-run Hedging Decisions

Equation (6) is used as the expected profit equation for the long-run hedging decision. Using Equation (6), the variance of profit part of the utility function can be written as

$$V(\frac{\pi}{X_s}) = \sigma^2_{CR} + (\frac{X_f}{X_s})^2 \sigma^2_{FR} + 2\frac{X_f}{X_s}\sigma_{CR,FR} \qquad (7)$$

where

σ^2_{CR} is the variance of the cash returns ($C^s_{t+j} - C^b_t * X_b/X_s$),

σ^2_{FR} is the variance of the futures return ($F_t - F_{t+j}$),

$\sigma_{CR,FR}$ is the covariance of the cash returns and futures returns

X_f/X_s is the futures position as a percentage of the cash position.

Combining the long-run expected value and the variance of expected profit equation, the utility equation now can be written as

$$U = E(C^s_{t+j} - C^b_t \frac{X_b}{X_s}) + E(F_t - F_{t+j}) \frac{X_f}{X_s} - \frac{TC}{X_s} - \frac{\lambda}{2}(\sigma^2_{CR} + (\frac{X_f}{X_s})^2 \sigma^2_{FR} + \frac{X_f}{X_s}\sigma_{CR,FR}) . \quad (8)$$

Using assumed selling and buying weights of feeder cattle, the producer must determine the futures position as a percentage of the cash position, or the percentage of animals that needed to be hedged. As stated earlier, traditional literature assumes that this percentage is 100%, or a hedge of one-to-one.

By maximizing the expected utility function, the futures position as a percentage of the cash position (hedge ratio) can be determined by taking the derivative of the utility function with respect to X_f/X_s,

$$\frac{\partial U}{\partial \frac{X_f}{X_s}} = E(F_t - F_{t+j}) - \lambda \frac{X_f}{X_s}\sigma^2_{FR} - \lambda\sigma_{CR,FR} = 0 \quad (9)$$

and solving for X_f/X_s yields

$$\frac{X_f}{X_s} = \frac{E(F_t - F_{t+j})}{\lambda\sigma^2_{FR}} - \frac{\sigma_{CR,FR}}{\sigma^2_{FR}} . \quad (10)$$

The hedge ratio is the sum of two terms (Anderson and Danthine). The first term is known as the speculative component. The futures position is larger if producer's expectations of the final futures price $E(F_{t+j})$ are different from the beginning futures price F_t and is smaller depending upon λ. Each point on the EV frontier (Figure 5) would indicate a different λ. As λ approaches zero, the investor is less risk averse. This study assumes that the producers do not speculate on a change in the futures price or they are risk minimizers.

The second term is known as the hedging component. This hedging component corresponds to the long-run minimum risk hedge ratio for the producer, point Z on the EV frontier (Figure 5). The long-run minimum risk hedge ratio, expressed as a percentage of the cash position equals the covariance between the cash returns and the futures returns divided by the variance of the futures returns.

$$\frac{X_f}{X_s} = -\frac{\sigma_{CR,FR}}{\sigma^2_{FR}}. \qquad (11)$$

The minus sign in front of the expression represents the fact that the producer will take the opposite position in the futures market from the cash position.

<u>3.4.3 Short-run Hedging Decisions</u>

When looking at the short-run hedging decisions the producer is only concerned about the price of the feeder cattle and futures contract at the time of marketing. Therefore, the buying price of the cattle ($C^b{}_t$) and the selling price of the futures contract (F_t) can be assumed known. The expected return equation is now written as

$$E(\frac{\pi}{X_s}) = E(C^s_{t+j}) - C^b_t\frac{X_b}{X_s} + (F_t - E(F_{t+j}))\frac{X_f}{X_s} - \frac{TC}{X_s}. \qquad (12)$$

By using Equation (12) as the expected return for the expected utility maximization problem the variance of expected returns can be written as

$$V(\frac{\pi}{X_s}) = \sigma^2_C + (\frac{X_f}{X_s})^2\sigma^2_F + 2\frac{X_f}{X_s}\sigma_{C,F} \qquad (13)$$

where

$\sigma^2{}_C$ is the variance of the selling price of cattle ($C^s{}_{t+j}$),

$\sigma^2{}_F$ is the variance of the buying price of the futures contract (F_{t+j}),

$\sigma_{C,F}$ is the covariance between the cash selling price and the futures buying price

X_f/X_s is the futures position as a percentage of the cash position.

By combining the expected returns equations and the short-run variance of profits equation, the expected utility equation can be written as,

$$E(U) = E(C^{s}_{t+j}) - C^{b}_{t}\frac{X_b}{X_s} + (F_t - E(F_{t+j}))\frac{X_f}{X_s} - \frac{TC}{X_s} - \frac{\lambda}{2}(\sigma^2_C + (\frac{X_f}{X_s})^2\sigma^2_F + 2\frac{X_f}{X_s}\sigma_{C,F}) . \quad (14)$$

By maximizing the expected utility function, the short-run minimum risk futures position as a percentage of the cash position (hedge ratio) can be determined by taking the derivative of the utility function with respect to X_f/X_s,

$$\frac{\partial U}{\partial \frac{X_f}{X_s}} = F_t - E(F_{t+j}) - \lambda\frac{X_f}{X_s}\sigma^2_F - \lambda\sigma_{C,F} \quad (15)$$

and solving for X_f/X_s yields

$$\frac{X_f}{X_s} = \frac{F_t - E(F_{t+j})}{\lambda\sigma^2_F} - \frac{\sigma_{C,F}}{\sigma^2_F}. \quad (16)$$

Again, the hedge ratio is the sum of two components, the speculative and the hedge. Assuming a risk minimizing producer, the short-run minimum risk hedge ratio equals the covariance between the selling price of the feeder cattle and the buying price of the futures contract divided by the variance of the buying price of the futures contract

$$\frac{X_f}{X_s} = -\frac{\sigma_{C,F}}{\sigma^2_F}. \quad (17)$$

The minus sign in front of the expression shows that the hedger takes the opposite position in the futures market from the cash position.

3.4.4 Summary

This study examines two different types of risk minimization problems, long-run and short-run hedging decisions. The long-run minimum risk hedge ratios are calculated using the difference between the beginning and ending cash and futures price, or the returns from each position. By ignoring total costs returns are profit margins. The short-run minimum risk hedge ratios are calculated using the final cash and futures price levels. The two approaches differ in that the long run looks at minimizing profit margin risk while the short run looks at minimizing the price risk faced by the producer at the time of marketing.

3.5 Minimum Risk Hedge Ratios Regression

3.5.1 Long-run Hedge Ratios

The slope coefficient from regressing the cash returns on the futures returns is the equation for the hedge ratio. The slope coefficient equals $\sigma_{CR,FR}/\sigma^2_{FR}$, which is the expression for the minimum risk hedge ratio. The more highly correlated the returns from the cash and futures operation, the nearer the ratio is to 1. A one-to-one traditional hedge implies that these two returns are perfectly correlated. Typically cash and futures returns are not perfectly correlated due to basis changes resulting from location, quality, and timing differences (Leuthold, Junkus, and Coridier).

The long-run minimum risk hedge ratio regression equation is written as

$$CR = \beta_0 + \beta_1 FR + \varepsilon \qquad (18)$$

where

$CR = C^s_{t+j} - C^b_t(X_b/X_s)$,

$FR = F_t - F_{t+j}$,

ϵ is error term.

The parameter β_1 is the estimated minimum risk hedge ratio, and β_0 is the difference between cash returns and futures returns. Since β_1 does not necessarily equal 1, the risk reduction achieved from the model is not measured by comparing the variance of the change in the basis to the variance of the change in the cash price, the traditional approach. Instead, hedging effectiveness is measured by comparing the variance of return in a non-hedged position to the variance of return from a hedged position. The measure of hedging effectiveness (E) is defined as the reduction in variance as a proportion of total variance that results from maintaining a hedged position rather than a non-hedged position. The hedging effectiveness equation is written as

$$E = \frac{Var(C) - Var(H)}{Var(C)} = 1 - \frac{VAR(H)}{VAR(C)} \qquad (19)$$

where Var(H) is the variance of the minimum risk hedge and Var(C) is the variance associated with the non-hedged position (cash returns). By substituting the minimum risk hedge ratio of equation (11) into the variance of expected profits for the long run, the variance of the hedged position can be written as

$$VAR(H) = \sigma^2_{CR} - \frac{\sigma^2_{CR,FR}}{\sigma^2_{FR}}. \qquad (20)$$

Substituting equation (20) into equation (19) the measure of hedging effectiveness can be written as

$$E = \frac{\sigma^2_{CR} - (\sigma^2_{CR} - \frac{\sigma^2_{CR,FR}}{\sigma^2_{FR}})}{\sigma^2_{CR}} = \frac{\sigma^2_{CR,FR}}{\sigma^2_{CR}\sigma^2_{FR}}. \qquad (21)$$

This measure of hedging effectiveness is the same as the coefficient of determination or R^2 from the regression equation (18) if OLS is used to estimate the model.

3.5.2 Short-run Hedge Ratios

Calculating long-run and short-run minimum risk hedge ratios are similar. The formulas for both hedging decisions have the same basic form, but instead of regressing the cash returns on the futures returns, the selling price of the feeder cattle are regressed on the buying price of the futures contract. The short-run minimum risk hedge ratio regression equation is written as

$$C = \alpha_0 + \alpha_1 F + \varepsilon \tag{22}$$

where

$C = C^{s}_{t+j}$,

$F = F_{t+j}$,

ϵ is the error term.

The parameter α_1 is the minimum risk hedge ratio and α_0 is the difference between the selling price of the feeder cattle and the buying price of the futures contract, or basis.

The hedging effectiveness of the short-run minimum risk hedge ratios uses the same formula as the long-run (Equation 19). By substituting the minimum risk hedge ratio of Equation (17) into the short-run variance of returns, the variance of the hedged position can be written as

$$VAR(H) = \sigma_C^2 - \frac{\sigma_{C,F}^2}{\sigma_F^2}. \tag{23}$$

Substituting equation (23) into equation (19) the measure of hedging effectiveness can be written as

$$E = \frac{\sigma_C^2 - (\sigma_C^2 - \frac{\sigma_{C,F}^2}{\sigma_F^2})}{\sigma_C^2} = \frac{\sigma_{C,F}^2}{\sigma_C^2 \sigma_F^2}. \tag{24}$$

This measure of hedging effectiveness is the same as the coefficient of determination or R^2 from the regression equation (22) if OLS is used to estimate the model.

3.5.3 Summary

The estimated regression equations implies that the cash position and futures contract are for the same commodity with the only differences being quality, location, and timing. However, Oklahoma feeder cattle do not necessarily represent the type of cattle specified by the feeder cattle contract offered by the Chicago Mercantile Exchange. Therefore, Oklahoma feeder/stocker cattle producers take a position in a related futures contract such as the feeder cattle, or the live cattle contract. For these types of hedges to be effective, the cash and futures prices must be highly correlated.

This study differs from the traditional approaches used in previous research, by developing long-run hedge ratios using the difference between the beginning and ending cash and future prices, and short-run hedge ratios using the selling price of the feeder cattle and the buying price of the futures contract. Witt, Schroeder and Hayenga summarize these three approaches to be price level models, where the cash price of the commodity is regressed on the futures price; price change models, where the change in the cash price is regressed on the change in the futures price; percent change models, where the percent change in the cash price is regressed on the percentage change in the futures price. All three above approaches rely on the day-to-day or week-to-week price levels and price changes, depending upon the data collected, associated with the commodity and futures contract in question.

Previous studies have calculated the minimum risk hedge ratios using the day-to-day, week-to-week or month-to-month changes in the cash price of the specified weight group of cattle and the feeder cattle futures contract price using the long-run formulation for variance of profits. Why did these past studies use a short time period as day-to-day and still consider this time span to be the long run, when the actual length of the production schedule for these different types of cattle was generally assumed to be three months? This study takes the approach that the producer is not concerned about week-to-week price changes, but instead is concerned in the cash and futures price change from the time the animals are bought and the hedge implemented to the time the animals are marketed and the hedge removed, or the cash and futures price at the time of marketing.

3.6 Data Used in Calculating Minimum Risk Hedge Ratios

3.6.1 Data and Production Schedules

The data used to calculate the hedge ratios was the 1981-1991 weekly cash price of Oklahoma City feeder steers weighing 400-500, 500-600, 600-700, 700-800 pounds, and heifers weighing 400-500, 500-600 and 600-700 pounds and the corresponding futures contract price of the feeder cattle contract offered by the Chicago Mercantile Exchange. Cattle are bought early in the week and the closing futures contract price on Tuesdays was used for both types of production schedules.

The two production schedules used in calculating the minimum risk hedge ratios are a Winter Wheat and Summer Grass grazing programs. These two production schedules are the most commonly used in stocker operations in Oklahoma. Winter Wheat stockers weighing either 450 or 550 pounds are purchased during the month of October and placed on wheat pasture at a stocking rate of 2 acres/head around the first of November. These animals are grazed for 135 days with an average daily gain of 1.75 pounds/day. These animals are then marketed during March weighing 686 and 786 pounds, respectively.[5] Summer Grass stockers weighing either 450 or 550 pounds are purchased and placed on Summer Grass at a stocking rate of 5 acres/head in April. These animals are grazed for 150 days with an average daily gain of 1.5 pounds/day. These animals are then marketed during September weighing 675 and 775 pounds, respectively.

3.6.2 Long-run Minimum Risk Hedge Ratios

The long-run minimum risk hedge ratios are estimated using the

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[5] This study assumes the stockers are taken off wheat pasture so that the grain may be harvested.

observations from the first four weeks of the production schedule as the starting cash (C^b_t) and futures (F_t) positions. The observations used for the final cash (C^s_{t+j}) and futures (F_{t+j}) position will be last two weeks of the month preceding the end of the production schedule and the first two weeks of the final month of the production schedule. This is done because the cattle are assumed to be removed from pasture around the middle of the final month of production and the futures contracts are closed prior to the third Thursday of the expiration month of the contract. These observations are then put together by matching each of the first four weeks of the production schedule to each of the final weeks of the production schedule. By matching each week of the starting positions with each of the four weeks of the final positions, this study looks at several different hedging horizons and the results are not conditional on specific matches of purchase weeks against sales weeks. However, the individual observations are not independent and shall not be treated as such in modelling. This study incorporates correlations between observations for any one year.

Using Generalized Least Squares Regression the observations are used to estimate the parameters in Equation (18) with the addition of two dummy variables. The dummy variables were added to the regression equation because of the structural changes that have occurred when cash settlement was introduced for the feeder cattle contract. The new regression equation is

$$\begin{aligned}(C^s_{t+j} - C^b_t \frac{X_b}{X_s}) &= \beta_0 + \beta_1 (F_t - F_{t+j}) + \beta_2 CASHS \\ &\quad + \beta_3 ((F_t - F_{t+j})\, CASHS) + \varepsilon \end{aligned} \tag{25}$$

where CASHS is a variable that is equal to one when the futures contract is cash settled and zero otherwise.[6] The coefficient on this variable (β_2) will measure any change in the intercept caused by cash settlement.

[6] Cash settlement was started with the 1986 September contract.

caused by cash settlement. Minimum risk hedge ratios can be obtained by adding α_1 and α_3, if α_3 is significantly different from zero.

The short-run minimum risk hedge ratios using the live cattle contract will use the same observations of cash prices used before and the corresponding live cattle contract and equation (22). This equation is written as

$$C^s_{t+j} = \delta_0 + \delta_1 F_{t+j} + \varepsilon \tag{28}$$

where δ_1 is the short-run minimum risk hedge ratio and the parameter δ_0 is basis between the cash feeder price and the live cattle contract at the time of marketing.

3.7 Estimation Methods and Hypothesis Testing

As stated in section 3.6, a Generalized Least Squares (GLS) regression procedure is used to estimate the long-run and short-run hedge ratio equations. This is done because of the potential for groupwise heteroskedasticity between the different hedging horizons and cross group correlation between the hedging horizons within the same year. If the regression models were estimated using Ordinary Least Squares then the parameter estimates would be unbiased, but inefficient. By estimating the models using GLS the parameter estimates are unbiased and efficient. With the efficient parameter estimates comes better standard errors which will be used in calculating the test statistics for the three hypothesis tests.

The GLS model used to estimate the hedge ratio equations is written as,

$$y_{it} = \beta' X_{it} + \varepsilon_{it}, \; i = 1, \ldots, N \; t = 1, \ldots, T, \tag{29}$$

where i equals the different hedging horizons (weeks within the year) and t equals the different years. With the data set for each production schedule sorted by the different hedging horizons for each year the GLS allows for groupwise heteroskedasticity between the different hedging horizons i, where $E[\epsilon^2_{it}] = \sigma_{ii}$, and cross group correlation between the hedging horizons within each year t, where $Cov[\epsilon_{it}, \epsilon_{jt}] = \sigma_{ij}$. Likelihood ratio statistics are used to test the hypothesis that groupwise heteroskedasticity and cross group correlation are present in the model. These two test statistics will be reported with the results for the hedge ratio equations.

After all the hedge ratios are calculated for each type of production schedule and futures contract, a set of hypotheses are tested. The first test examines the hypothesis that the calculated hedge ratios for each weight group for the steers and heifers are significantly different from the traditional one-to-one hedge. This test will be conducted using a t-test

$$t = \frac{\beta_1 + \beta_3 - 1}{S(\beta_1 + \beta_3)} \tag{30}$$

where $S(\beta_1+\beta_3)$ is

$$S(\beta_1+\beta_3) = \sqrt{VAR(\beta_1) + VAR(\beta_3) - 2COV(\beta_1,\beta_3)}\,. \tag{31}$$

The second test examines the hypothesis that the hedge ratios for each weight group are significantly different from the 700-800 pound weight group, which is the specified weight range for the feeder cattle contract. A t-test is used to examine this hypothesis.

$$t = \frac{(\beta_1^i+\beta_3^i) - (\beta_1^j+\beta_3^j)}{\sqrt{S_p^2\left(\frac{1}{n}+\frac{1}{m}\right)}} \qquad \textit{for all } i \neq 700\text{-}800\textit{lbs}, \tag{32}$$

where $\beta^j_1 + \beta^j_3$ is the hedge ratio for 700-800 pound weight group and S_p^2 equals the pooled variance between the two sets of hedge ratios,

$$S_p^2 = \frac{(n-1)S^2(\beta_1^i+\beta_3^i) + (m-1)S^2(\beta_1^j+\beta_3^j)}{(n-1)+(m-1)} \tag{33}$$

and n and m are the degrees of freedom.

The last test examines the hypothesis that the hedge ratios for each weight group and sex of feeder cattle are significantly different for the two production schedules. This test is conducted by pooling the data used to calculate the hedge ratios for the two production schedules into one large data set. After the data has been pooled, Equation (33) will be estimated.

$$(C^{s}_{t+j} - C^{b}_{t}\frac{X_b}{X_s}) = \beta_0 + \beta_1(F_t - F_{t+j}) + \beta_2 CASHS + \beta_3((F_t - F_{t+j})CASHS) + \eta_0 SUMMER + \eta_1(SUMMER(F_t - F_{t+j})) + \eta_2(SUMMERR*CASHS) + \eta_3(SUMMER((F_t - F_{t+j})CASHS)) \tag{34}$$

Equation (33) is the same regression model used to estimate the original hedge ratios with the addition of four parameter estimates. Each new parameter estimate has the variable SUMMER used. The variable SUMMER is a dummy variable that equals 1 for the observations for the Summer Grass production schedule and 0 for the Winter Wheat production schedule. By using this dummy variable and multiplying it to the original variables, the changes in the parameter estimates caused by the Summer Grass production schedule can be measured. If the change in the hedge ratios parameter estimates are significantly different from zero, then the hedge ratios for the Summer Grass production schedule can be determined significantly different from the Winter Wheat production schedule hedge ratios.

3.8 Net Return Simulation

Minimum risk hedge ratios obtained from the models in this study give the producers hedge ratios that minimize risk, but no information is given about what level of expected returns and variance of returns the producer can expect. It is possible for a minimum risk hedge ratio to cause the producer to have a negative mean expected return. To determine the mean expected return and variance of expected returns the hedge ratio will be used to calculate net returns from the data collected for this study. By determining the mean expected returns for each of the minimum risk hedge ratios, the actual reductions in the mean cash price and returns along with the reductions in the standard deviation of price and returns of hedging can be presented to producers for them to evaluate.

Also, a hedging simulation for a traditional hedge and an nonhedged position will be conducted. Then the mean expected returns and variance of returns for each of the hedge ratios will be calculated and compared to the mean expected return and variance of return for the traditional and nonhedged position. By comparing the mean expected returns and variance of returns of the long-run and short-run minimum risk hedge ratios to a traditional hedge and nonhedged position the actual ability of the hedge ratios to stabilize profits and reduce price risk can be measured.

FIGURE 2

An Illustration of Risk

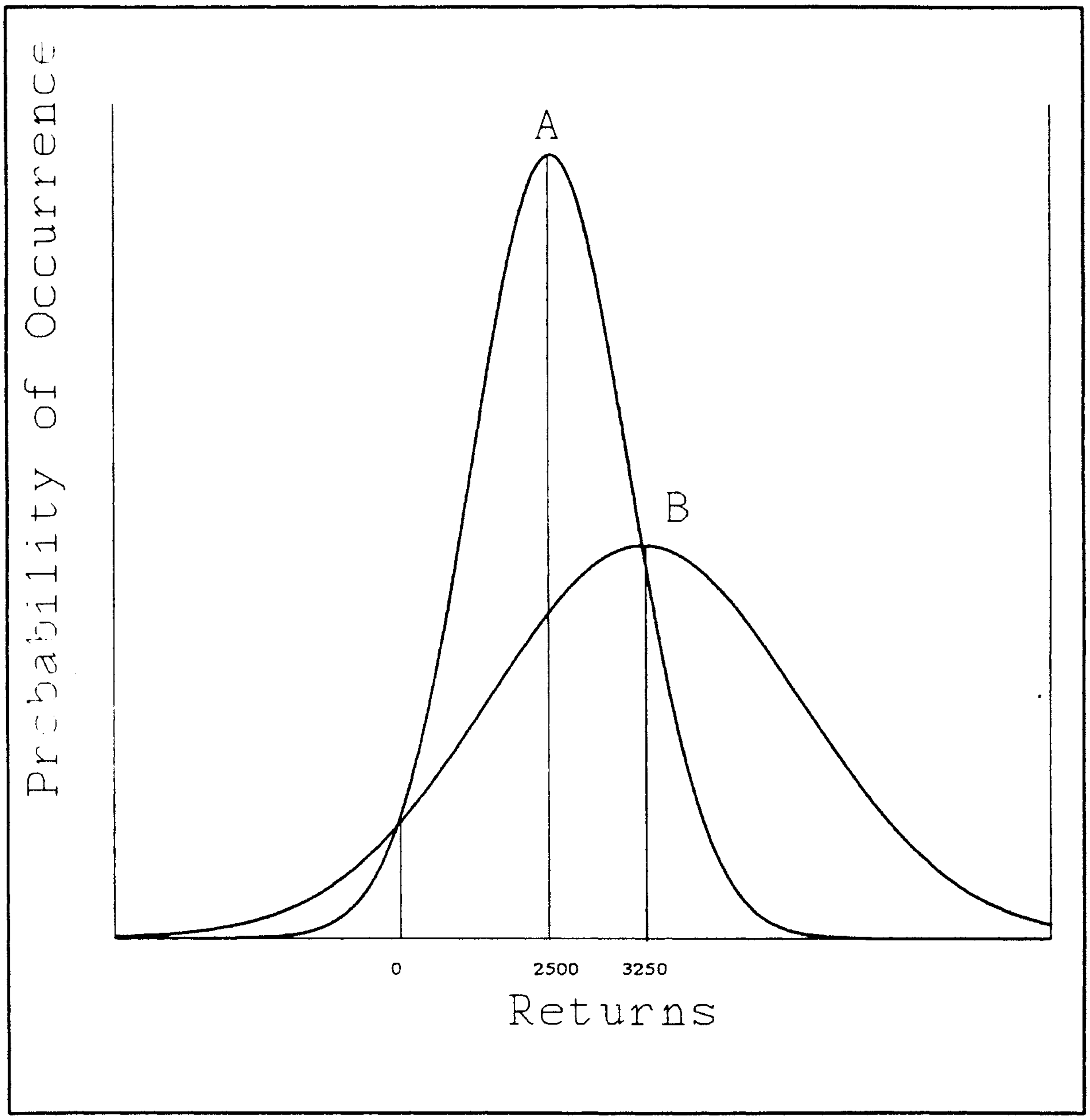


FIGURE 3

Indifference Curves

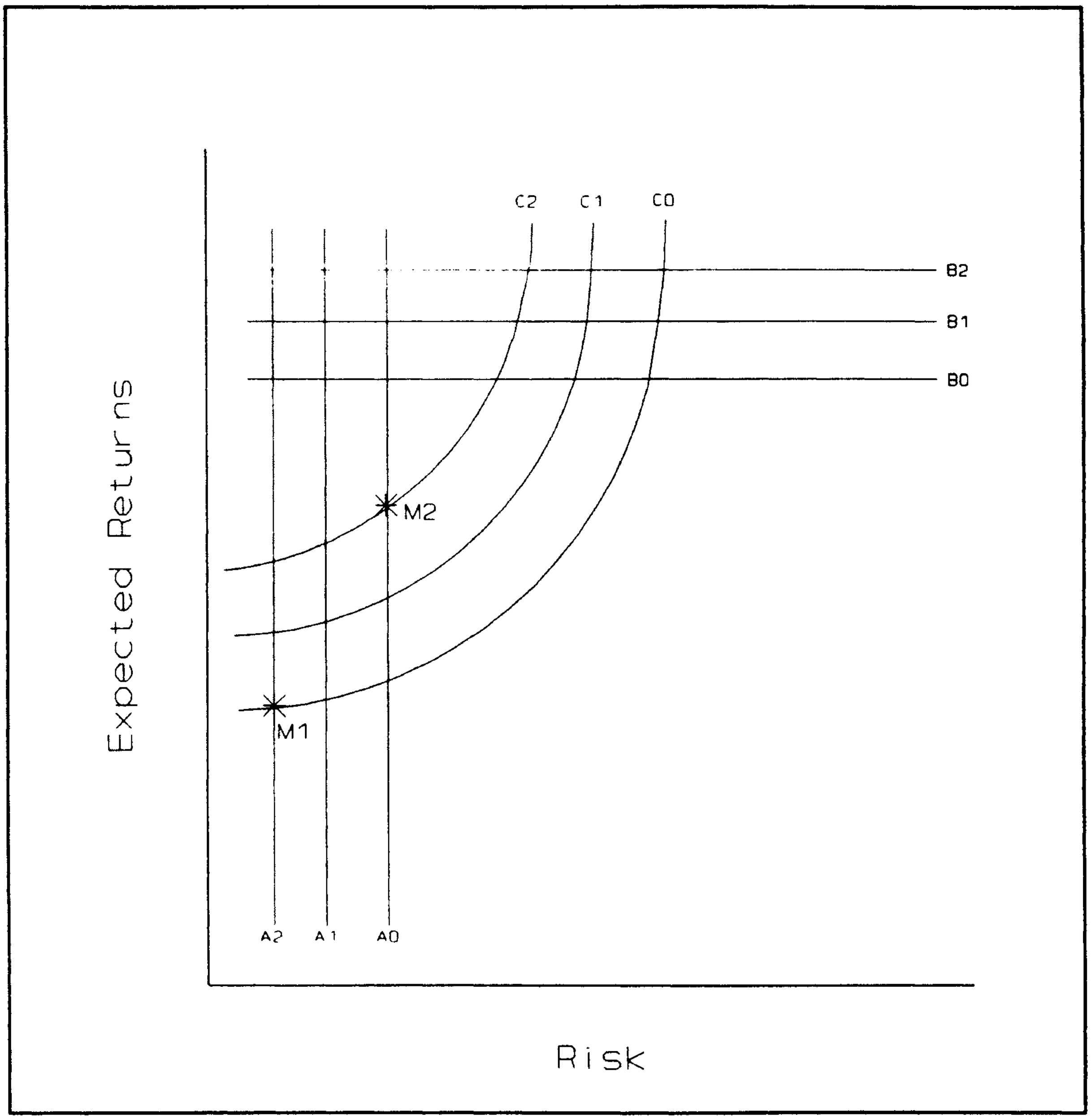


FIGURE 4

Marketing Plan Opportunity Set

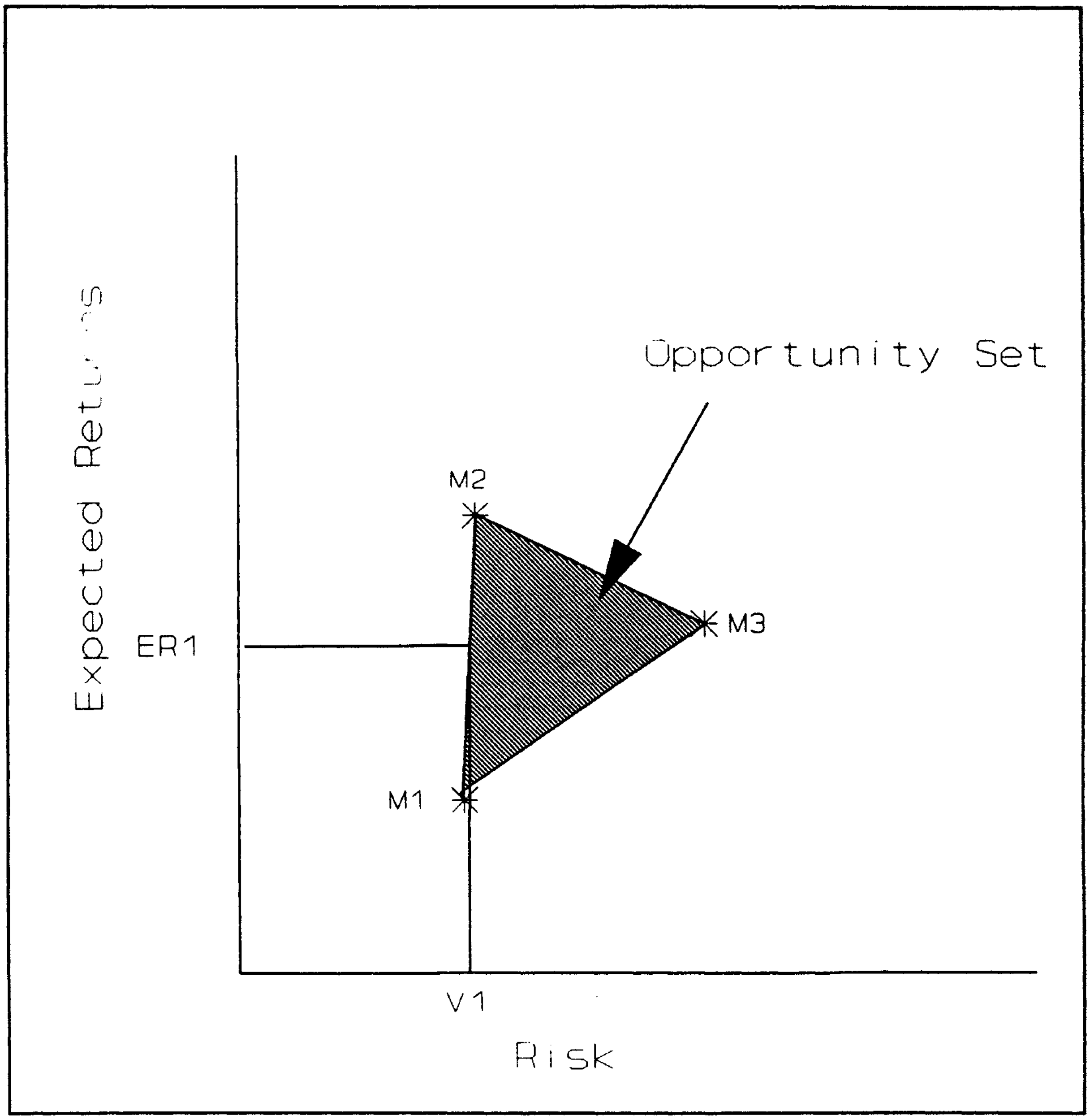
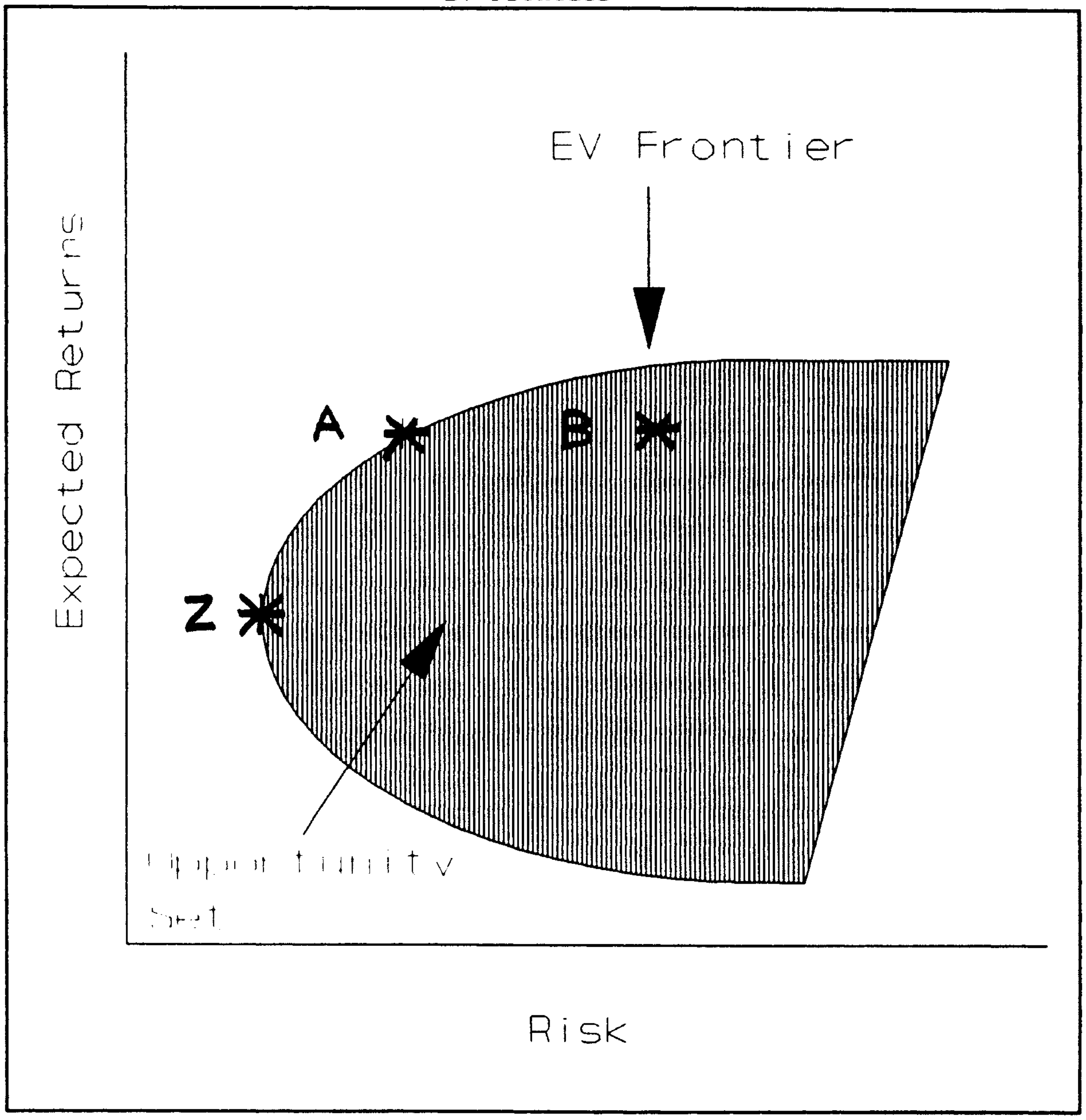


FIGURE 5

EV Frontier



CHAPTER 4

RESULTS AND IMPLICATIONS

4.1 Introduction

This chapter presents the results for all estimated hedge ratios and hypothesis tests developed in Chapter 3. Section 4.2 and 4.3 present the minimum risk hedge ratios for both production schedules. These sections will discuss both long-run and short-run results, and the differences between the results. Also, the results of the hypothesis tests examining the difference between hedge ratios and the traditional hedge, and the difference between hedge ratios for the different weight group will be shown. Section 4.4 will discuss the difference between hedge ratios for the same weight group across production schedules. Section 4.5 will show and discuss the results from the Net Return simulation.

4.2 Winter Wheat Minimum Risk Hedge Ratios

4.2.1 Long-Run Hedge Ratios

For the winter wheat production schedule, it is assumed that the producer buys 450 pound steers or heifers, or 550 pound steers in October, and sells 686 pound steers or heifers, or 786 pound steers in March. When selling in March, the producer has the ability to hedge cattle using the March, April, or May feeder cattle contract, or cross hedge using the August live cattle contract. Therefore, hedge ratios were calculated for 600-700 pound steers and heifers, and 700-800 pound steers using the March, April, and May feeder cattle contract, and the August live cattle contract.

The mean, standard deviation, maximum, and minimum of the data used to calculate the long-run winter wheat minimum risk hedge ratios are shown in Table 1. The long-run hedge ratios are calculated using the cash and futures returns. Over the time period used, the average cash return for the three weight groups ranged from $21.01/cwt. for the 700-800 pound steers to $24.56/cwt. for 600-700 pound heifers. The standard deviations ranged from $3.35/cwt. for 600-700 pound heifers to $4.01/cwt. for 600-700 pound steers. The mean return for all four futures contracts was negative over the same time period. The mean returns ranged from $-1.44/cwt. for the August live cattle contract to $-2.32/cwt. for the March feeder cattle contract. The standard deviations ranged from $2.69/cwt. for the August live cattle contract to $4.60/cwt. for the March Feeder contract.

Generalized Least Squares (GLS) was used to estimate the minimum risk hedge ratio models. The reason for using GLS, instead of OLS, was that the data used to estimate the hedge ratios possibly possesses groupwise heteroskedasticity and cross-group correlation. The results from the GLS regression estimates shows that there is no significant effect on the parameter estimates from groupwise heteroskedasticity. The test statistic used for testing the groupwise heteroskedasticity and cross-group correlation is a likelihood ratio test. These test statistics are reported with the regression equations in Tables 5-7. All of the test statistics for the long-run minimum risk hedge ratios using a winter wheat production schedule reject the hypothesis that there is no groupwise heteroskedasticity and cross-group correlation. Therefore, the GLS estimates of the hedge ratios are more efficient than OLS estimates.

The coefficients, standard errors, t-statistics, and probability that the coefficient equals zero from the regression equation for steers weighing 600-700 pounds are presented in Table 5. The hedge ratio when using the feeder cattle contract is obtained by adding the FUTDIF coefficient to the SETFUT if the SETFUT coefficient is significant.[7] The

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[7] The change in the hedge ratio caused by cash settlement was considered significant if the coefficient Setfut was significant at the 10% level.

coefficient SETFUT measures the change in the hedge ratio caused by cash settlement. Cash settlement had no significant effect on hedge ratios for 600-700 pound steers. Hedge ratios for 600-700 pound steers are 0.785, 0.909, and 1.105 for the March, April, and May feeder cattle contracts. The results for the long-run minimum risk hedge ratio for 600-700 pound steers imply that a producer that wishes to minimize return variability by hedging stocker steers using the March feeder cattle contract should hedge only 78.5% of the actual physical commodity. For example, if the producer has 100,000 pounds of feeder cattle he should hedge only 78,500 pounds to minimize return variability. These hedge ratios suggest that a producer should underhedge when using the March and April contracts and should overhedge when using the May contract. Hedging effectiveness for the estimated hedge ratios are 69.8%, 68.6%, and 66.1%, respectfully. This measure of hedging effectiveness refers to the reduction in variance as a proportion of total variance that results from maintaining a hedge position rather than an nonhedged position. By looking at the measure of hedging effectiveness, the best strategy would be to hedge 78.5% of total production of the 600-700 pound steers. The hedge ratio for a producer cross-hedging using the August live cattle contract is 1.277 with a hedging effectiveness of 69.1%. A producer that wants to minimize risk by cross hedging would hedge 127.7% of his total production of stocker steers. The hedging effectiveness measure implies that a producer would manage risk more effectively by using one of the feeder cattle contracts. All hedge ratios for the 600-700 pound steers are significantly different from 1.0 (Table 17) at the 5% level. This implies that a long-run minimum risk hedge ratios for 600-700 pound steers are different from a traditional hedge. Also, the hedge ratios using the feeder cattle contracts are significantly different from the hedge ratios calculated for 700-800 pound steers, the specified weight group for the CME feeder cattle contract at the 1% level (Table 19). This suggests that the percentage of animals a producer hedges depends upon the weight group of the animal he expects to market.

Long-run hedge ratios for 700-800 pound steers are presented in Table 6. The effect of cash settlement on the hedge ratios for 700-800 pound steers was the same as the effect of cash settlement on the hedge ratios for 600-700 pound steers. Cash settlement had no effect on any of the hedge ratios. Hedge ratios are 0.759, 0.866, and 1.028 for the March, April, and May feeder cattle contracts. The March and April contracts hedge ratios were significantly different from 1.0 (Table 7) at the 1% level. The hedging effectiveness for the three feeder cattle contracts are 80.6%, 86.6% and 83.0%. The April feeder cattle contract is the most effective. The results from the regression would indicate that a producer should hedge 86.6% of the total production of stocker steers using the April feeder cattle contract. A producer cross hedging 700-800 pound steers would hedge 108.1% of his stocker steers. The hedging effectiveness for cross hedging is 64.3%. The hedging effectiveness measurements using the August live cattle contract are lower than the hedging effectiveness using the feeder cattle contract. This implies that cross hedging steers using the August live cattle contract is not the best way to reduce risk.

Long-run minimum risk hedge ratios for 600-700 pound heifers are shown in Table 7. The effect of cash settlement on hedge ratios for 600-700 pound heifers was significant for all feeder cattle contracts. In each case, the hedging percentage was decreased after cash settlement. The hedge ratios for 600-700 pound heifers are 0.454, 0.529, and 0.648 for the March, April, and May feeder cattle contracts. All hedge ratios are significantly different from 1.0 at the 5% level (Table 17). Also, hedge ratios for 600-700 pound heifers are significantly different from the hedge ratios for 700-800 pound steers at the 1% level (Table 19). The test statistics suggest that hedge ratios for heifers are different from the traditional hedge and the hedge ratios for the specified group of cattle for the CME contract. The hedging effectiveness from the hedge ratios are 69.0%, 74.6%, and 78.3% for the March, April, and May feeder cattle contracts. By looking at the measure of hedging effectiveness, the best strategy would be to hedge 64.8% of total production of the 600-700 pound heifers using the May feeder cattle contract. A producer cross hedging 600-700 pound heifers using the August live cattle contract should use a hedge ratio of 1.108. This hedge ratio is significantly different from 1.0 (Table 17) and from the hedge ratio for the 700-800 pound hedge ratio using the August live cattle contract (Table 19) at the 5% level. The effectiveness of cross-hedging heifers using the August live cattle contract was 73.2%.

When comparing the hedge ratios for the different weights of steers and heifers, several characteristics can be seen. First, there is a distinct pattern to the hedge ratios for the different weight groups of animals. The 600-700 pound steers have larger hedge ratios than the 700-800 pound steers and the hedge ratios for the 600-700 pound heifers are smaller than the hedge ratios for the 700-800 pound steers. This implies that basis risk for the 600-700 pound heifers is greater than basis risk for the other two weight group of steers. Second, all hedge ratios using the feeder cattle contracts, except for the May contract hedge ratio for both weight groups of steers, are less than 1.0. Also, all the hedge ratios are significantly different from 1.0 at the 10% level. This implies that a producer wishing to minimize return risk when using a Winter Wheat production schedule should hedge less than 100%. These results differ from previous studies which suggested that a producer should overhedge. The third characteristic is that hedging with the feeder cattle contract is generally more effective than cross hedging using the live cattle contract for all weight groups of steer and heifers. The last characteristic is that all the hedge ratios for the lighter weight steers and heifers are significantly different from the hedge ratios for the 700-800 pound steers. This implies that determining the percentage of feeder cattle to hedge depends upon the weight and sex of the animal marketed.

4.2.2 Short-Run Minimum Risk Hedge Ratios

Short-run minimum risk hedge ratios are calculated using the selling price of cattle and buying price of the futures contract. The descriptive statistics of the price-level data used in calculating the short-run hedge ratios are shown in Table 3. The mean price levels shown in Tables 3 are the same as the mean price levels when to calculating the mean cash and futures returns for the long-run hedge ratios. The difference between the short-run and the long-run statistics are the standard deviations and number of observations. The short-run has fewer observations because of the way the data was matched for the long-run calculations. The mean cash price levels range from \$69.41/cwt. for the 600-700 pound heifers to \$75.99/cwt. for the 600-700 pound steers. The standard deviation for the cash price levels range from \$9.17/cwt. for 700-800 pound steers to \$10.63/cwt. for 600-700 pound heifers. The mean futures price levels range from \$65.87/cwt. for the August live cattle contract to \$74.41/cwt. for the March feeder cattle contract. The standard deviation of the futures price level data ranged from \$5.48/cwt. for the August live cattle contract to \$8.44/cwt. for the March feeder cattle contract.

GLS was also used to calculate short-run minimum risk hedge ratios because of groupwise heteroskedasticity and cross group correlation. Again the presence of groupwise heteroskedasticity has no significant effect. The likelihood ratio test statistics examining the effect of groupwise heteroskedasticity and cross group correlation are reported in Tables 8-10. All of the test statistics for the short-run minimum risk hedge ratios using a winter wheat production schedule reject the hypothesis that there is no groupwise heteroskedasticity and cross group correlation.

The short-run minimum risk hedge ratios for 600-700 pound steers and the related regression equation coefficients are shown in Table 8. The change in the hedge ratios caused by cash settlement were examined to determine the minimum risk hedge ratios. Unlike long-run hedge ratios, the short-run hedge ratios for 600-700 pound steers were significantly affected by cash settlement. All feeder cattle contract hedge ratios were increased by the slope coefficient SETFUT. Hedge ratios for 600-700 pound steers are 1.158, 1.226, and 1.227 for the March, April, and May feeder cattle contracts. None of the hedge ratios are significantly different from 1.0 (Table 17). These short-run hedge ratios suggest that a producer should overhedge when using feeder cattle contracts. These results are opposite of the long-run hedge ratios. Hedging effectiveness for the hedge ratios is 98.5%, 98.1%, and 98.9% The hedging effectiveness of the short-run hedge ratios is larger than those of the long-run hedge ratios. This was expected since short-run risk is less than long-run risk. By looking at the measure of hedging effectiveness, the best strategy to reduce price risk would be to hedge 122.7% of the total production of the 600-700 pound steers. The short-run hedge ratio for a producer cross-hedging using the August live cattle contract is 1.718 with a hedging effectiveness of 86.2%. This hedge ratio is significantly different from 1.0 at the 1% level (Table 17). A producer using the August live cattle contract would hedge 171.8% of his stocker steers, but the hedging effectiveness measure implies that a producer would reduce more price risk by using any of feeder cattle contracts. When comparing the hedge ratios of the 600-700 pound steers to the hedge ratios of the 700-800 pound steers, all hedge ratios are significantly different at the 1% level (Table 19). This implies that the percentage of feeders needed to be hedged depends upon the weight of the animal marketed.

Hedge ratios for 700-800 pound steers are shown in Table 9. Cash settlement had no significant effect on hedge ratios using the feeder cattle contracts. Hedge ratios are 0.884, 0.886, and 0.846 with hedging effectiveness of 97.7%, 96.7%, and 99.6% for the March, April, and May feeder cattle contracts. None of the hedge ratios were significantly different from 1.0 (Table 17). The results for this regression indicate that a producer should hedge 84.6% of his stocker steers using the May feeder cattle contract to minimize price risk most effectively. Short-run cross-hedging results for 700-800 pound steers using the August live cattle contract are also presented in Table 9. The hedge ratios for cross hedging is 1.497 with a hedging effectiveness of 83.8%. This hedge ratio is significantly different from 1.0 at the 1% level (Table 17). Again, cross hedging steers with the live cattle contract is not as effective as hedging with the feeder cattle contract.

Short-run hedge ratios for 600-700 pound heifers are presented in Table 10. No significant change in the hedge ratios was caused by cash settlement. The hedge ratios for 600-700 pound heifers are 1.019, 1.040, and 0.978 with hedging effectiveness of 97.6%, 96.4%, and 97.8% for the March, April and May feeder cattle contracts. None of the hedge ratios were significantly different from 1.0 (Table 17). The measure of hedging effectiveness implies a producer should hedge 97.8% of his stocker heifers using the May feeder cattle contract to minimize price risk. The short-run cross-hedging ratio for 600-700 pound heifers using the August Live Cattle contract is 1.695 with a hedging effectiveness of 75.9% (Table 10). This hedge ratio is significantly different from 1.0 at the 1% level. Hedging effectiveness for cross hedging with the live cattle contract is lower than the hedging effectiveness for hedging with the feeder cattle contract. This suggests cross-hedging is not the best way to minimize price risk.

The test statistics examining the difference between the hedge ratios for 700-800 pound steers and 600-700 pound heifers are shown in Table 19. All hedge ratios for the 600-700 pound heifers are significantly different at the 1% level. This suggests that there is a difference between hedge ratios for heifers and hedge ratios for the specified weight group and sex for the CME contract.

When comparing the short-run hedge ratios for the different weight groups of steers and heifers several characteristics can be noticed. First, the same pattern of larger hedge ratios for the 600-700 pound steers when compared to the hedge ratios for the 700-800 pound steer hedge ratios. The hedge ratios for 600-700 pound heifers are between the hedge ratios for the two weight groups of steers. Second, the hedge ratios for the lighter weight steers and heifers are greater than 1.0, but none of the hedge ratios are significantly different from 1.0. These results differ from the results for the long-run hedge ratios. This implies that the short-run hedge ratios are not any different from the traditional hedge of 1.0. The third characteristic is that the hedging effectiveness cross hedging is less than the hedging effectiveness for the hedging with the feeder cattle contracts. This implies that hedging may be more effective with feeder cattle contracts than live cattle contracts. Another characteristic is that all the hedge ratios for the lighter weight steers and heifers are significantly different from the 700-800 pound steers. Again, this implies that the percentage of the feeder cattle that is to be hedged to minimize risk depends upon the weight and sex of the animal intended to be marketed.

4.3 Summer Grass Minimum Risk Hedge Ratios

4.3.1 Long-Run Hedge Ratios

When using a Summer Grass production schedule it is assumed that a producer buys 450 pound steers or heifers, or 550 pound steers in April, and sells 675 pound steers or heifers, or 775 pound steers in September. By selling in September, the producer has the option of hedging his cattle using the September, October, or November feeder cattle contracts, or cross hedging using the February live cattle contract. Hedge ratios were calculated for 600-700 pound steers and heifers, and 700-800 pound steers using these contracts.

The same method used to calculate the winter wheat long-run minimum risk hedge ratios are used to estimate the summer grass long-run minimum risk hedge ratios. The descriptive statistics of the data used to calculate the cash and futures returns are shown in Tables 2. Over the time period used the mean cash returns for the three weight groups of feeder cattle ranged from $14.11/cwt. for the 700-800 pound steers to $18.03/cwt. for the 600-700 pound heifers. The standard deviation for the cash returns ranged from $5.75/cwt. for the 700-800 pound steers to $6.18/cwt. for 600-700 pound steers. The mean futures returns for the summer grass production schedule are similar to the mean futures returns for the winter wheat production schedule in that the average returns over the time period was negative except for the February live cattle contract. The mean futures returns ranged from $-1.73/cwt. for the September feeder cattle contract to $0.05/cwt. for the February live cattle contract. The standard deviation ranged from $5.99/cwt. for the November feeder cattle contract to $6.12/cwt. for the October feeder cattle contract.

The effect of groupwise heteroskedasticity on the long-run hedge ratios was not significant. The test statistics for the hypothesis that groupwise heteroskedasticity and cross-group correlation exists in the models are presented in Tables 11-13. All of the test statistics for the long-run summer grass hedge ratios reject the hypothesis that there is no heteroskedasticity and cross-group correlation. Therefore, the GLS estimates of the hedge ratios are more efficient.

The long-run hedge ratio regression equations for 600-700 pound steers are presented in Table 11. The effect of cash settlement is taken into account by adding the SETFUT coefficient to the FUTDIF coefficient if the SETFUT coefficient is significantly different from zero at the 10% level. Only the September feeder cattle contract has a significant change in the hedge ratio. Cash settlement caused the hedge ratio to increase. Hedge ratios for 600-700 pound steers are 1.232, 0.959, and 0.987 with hedging effectiveness of 88.8%, 84.8%, and 81.6% for the September, October, and November feeder cattle contract. These hedge ratios are different from the hedge ratios for the same group of cattle using a winter wheat production schedule. The results implies that a producer should hedge a bigger percentage of his stocker steers. Also, only the hedge ratio for the September feeder cattle contract is significantly different from 1.0 at the 5% level (Table 18). The September hedge ratio is the most effective and the hedge ratio results suggests that a producer should hedge 123.2% of his stocker steers using the September feeder cattle contract. A producer cross hedging 600-700 pound stocker steers using the February live cattle contract would hedge 96.2% of his stockers with a hedging effectiveness of 51.3%. This hedge ratio is not significantly different from 1.0 (Table 18). The effectiveness of the cross hedging is lower than that of the hedging with the feeder cattle contract. This implies that cross hedging the lighter weight of steers is not the best way to minimize risk.

The hedge ratios for the 600-700 pound steers are significantly different from the hedge ratios for the 700-800 pound steers at the 1% level (Table 20). This implies that the percentage of stockers steers a producer hedges depends upon the weight of the animal marketed.

Regression results for the 700-800 pound steers are shown in Table 12. Cash settlement had no effect on the hedge ratios of the 700-800 pound steers. Hedge ratios are 0.883, 0.851, 0.852 with hedging effectiveness of 83.1%, 77.7%, and 73.2% for the September, October, and November feeder cattle contract. All the hedge ratios are significantly different from 1.0 at the 5% level. The regression results indicate that a producer should hedge 88.3% of his stockers. Cross-hedging results using the February live cattle had a hedge ratio of 0.758 with a hedging effectiveness of 40.2%. This hedge ratio is significantly different from 1.0 at the 1% level (Table 18). The effectiveness of the hedge is much larger for the feeder cattle contracts than the cross hedging effectiveness. This would suggest that a producer should use the September feeder cattle contract to reduce the return risk.

Hedge ratios for 600-700 pound heifers are presented in Table 13.

Cash settlement caused the October and November contract hedge ratios to increase. Hedge ratios for 600-700 pound heifers are 0.959, 0.610, and 0.589 for the September, October, and November feeder cattle contracts. All three hedge ratios imply that a producer should underhedge to minimize risk when grazing heifers. The hedging effectiveness measures of the hedge ratios are 2.2%, 2.2%, and 1.9%. It appears that a producer will not reduce risk by hedging heifers. The hedge ratio for a producer cross-hedging 600-700 pound heifers using the February live cattle contract is 0.145 with a hedging effectiveness of 2.5%. The hedge ratios for hedging 600-700 pound heifers is not significantly different from zero. This implies that the basis risk for hedging 600-700 pound heifers using the February live cattle contract is as large as the return risk of the cash market. All of the hedge ratios calculated for the 600-700 pound heifers are significantly different from 1.0 at the 10% level (Table 18). This implies that there is a significant difference between the long-run hedge ratios for the 600-700 pound heifers and a traditional hedge of 1.0. The statistics for testing the difference between the 600-700 pound heifer hedge ratios and the 700-800 pound steer ratios are presented in Table 20. The results show that all the hedge ratios for 600-700 pound heifers are significantly different from the 700-800 pound steer hedge ratio at the 1% level.

When comparing the long-run hedge ratios for the different weights of steers and heifers several characteristics can be seen. First, the same distinctive pattern found in the long-run winter wheat production schedule hedge ratios is found in the long-run summer grass production schedule hedge ratios. The hedge ratios for the 600-700 pound steers are larger than the hedge ratios for the 700-800 pound steers and the hedge ratios for the 600-700 pound heifers are less than the hedge ratios for the 700-800 pound steers. Second, the hedge ratios are larger for the summer grass production schedule when compared to the winter wheat hedge ratios. This implies that basis risk is smaller for the summer grass production schedule. Third, most of the hedge ratios are significantly different from 1.0. This implies that long-run summer grass hedge ratios are significantly different from the traditional hedge of 1.0. The last characteristic is that all the hedge ratios for the lighter weight steers and heifers are significantly different from the hedge ratios for the 700-800 pound steers. This implies that the percentage of feeder steers and heifers that needs to be hedge to minimize risk depends upon the type of animal that will be marketed.

4.3.2 Short-Run Hedge Ratios

The descriptive statistics of the price-level data used in calculating the short-run hedge ratios are shown in Table 4. The mean price levels shown in Table 4 are the same as the mean price levels used to calculate cash and futures returns for the long-run hedge ratios. The difference between the short-run and the long-run statistics are the standard deviations and number of observations. The short-run series has fewer observations because of the way the data was matched for the long-run calculations. The mean cash price levels range from $67.43/cwt. for the 600-700 pound heifers to $74.24/cwt. for the 600-700 pound steers. The standard deviation for the cash price levels range from $11.90/cwt. for 700-800 pound steers to $12.90/cwt. for 600-700 pound steers. The mean futures price levels range from $66.09/cwt. for the February live cattle contract to $72.94/cwt. for the November feeder cattle contract. The standard deviation of the futures price level data ranged from $6.29/cwt. for the February live cattle contract to $9.77/cwt. for the March feeder cattle contract.

GLS was used to calculate summer grass short-run minimum risk hedge ratios because of the possibility of groupwise heteroskedasticity and cross-group correlation. The effect of groupwise heteroskedasticity is not significant. All of the test statistics for the short-run minimum risk hedge ratios using a summer grass production schedule reject the hypothesis that there is no groupwise heteroskedasticity and cross group correlation (Tables 14-16).

The short-run hedge ratio model regression coefficients, standard errors, t-tests, and probabilities of the coefficient equalling zero for 600-700 pound steers are shown in Table 14. The effect of cash settlement on the short-run hedge ratios for 600-700 pound steers on summer grass pasture are similar to the cash settlement affects for the short-run hedge ratios for the 600-700 pound steers hedge ratios on winter wheat pasture. Cash settlement caused the hedge ratios to increase for each feeder cattle contract hedge ratios. Short-run hedge ratios for 600-700 pound steers are 1.147, 1.248, and 1.294 with a hedging effectiveness of 99.5%, 99.2%, and 98.9% for the September, October, and November feeder cattle contracts. The short-run hedge ratios have a higher hedging effectiveness than the long-run hedge ratios. Only the hedge ratio for the September contract is not significantly different from 1.0 at the 5% level. The results suggest that 600-700 pound steers can be hedged most effectively by overhedging instead of using the traditional hedge. The most effective hedge ratio uses the September feeder cattle contract. The cross-hedge ratio for 600-700 pound steers using the February live cattle contract is 1.846 with a hedging effectiveness of 83.4%. The hedge ratio is significantly different from 1.0 at the 1% level. This is the largest hedge ratio estimated. These results suggests that a producer should cross hedge 184.6% of his stocker steers to minimize risk when cross-hedging, but the effectiveness is higher when hedging with feeder cattle contracts.

The results for testing the difference between hedge ratios for the 600-700 pound steers and the 700-800 pound steers are presented in Table 20. All hedge ratios for the 600-700 pound steers are significantly different from the weight group specified by the CME Feeder Cattle contract at the 5% level. These results would imply that there is a difference between hedge ratios for the different weight groups of cattle.

Hedge ratios for 700-800 pound stocker steers are presented in Table 15. The affect of cash settlement is significant for all hedge ratios using the feeder cattle contracts. Cash settlement caused each of the hedge ratios to increase. Hedge ratios for 700-800 pound cattle are 1.070, 1.169, and 1.203 for the September, October, and November feeder cattle contracts. The October contract hedge ratio is significantly different from 1.0 at the 10% level. The hedging effectiveness for contracts are 99.4%, 99.2% and 98.6%. The September feeder cattle contract is the most effective when hedging 107% of the total production. The hedge ratio for a producer cross-hedging 700-800 pound steers using the February live cattle contract is 1.687 with a hedging effectiveness of 85.3%. Again, the effectiveness of the cross hedge is lower than a hedge using feeder cattle contracts.

Hedge ratios for 600-700 pound heifers are presented in Table 16. Like the short-run hedge ratios for the two steer weight groups, the hedge ratios increased with the start of cash settlement. Hedge ratios for 600-700 pound heifers are 1.151, 1.250, 1.279 with a hedging effectiveness of 0.5%, 0.5%, and 0.5% for the September, October, and November feeder cattle contracts. The hedging effectiveness for summer grass heifers is almost zero for all feeder cattle contracts. This implies that hedging heifers using feeder cattle contracts will not reduce risk. A producer cross-hedging 600-700 pound heifers using the February live cattle contract would hedge 183.4% of his stocker heifers to minimize risk. The cross hedging effectiveness is similar to the feeder cattle contracts hedging effectiveness at 0.6%. The hedging effectiveness levels are considerably lower than any of the other levels in this study.

The t-statistics testing the difference between the hedge ratios and 1.0 are shown in Table 18. All the hedge ratios except the October feeder cattle contract hedge ratio are significantly different from 1.0 at the 10% level. This implies there are a significant differences from the traditional hedge. The traditional hedge will not generally minimize return or price risk. Also, the t-statistics testing the difference between the hedge ratios for the 600-700 pound heifers and the 700-800 pound steers are shown in Table 20. All of the contract hedge ratios are significantly different from the hedge ratios for the 700-800 pound steers at the 10% level.

When comparing the short-run hedge ratios for the different weight groups of steers and heifers several characteristics can be noticed. First, the same pattern for short-run hedge ratios for the winter wheat production schedule is seen as the short-run hedge ratios for the summer grass production schedule. The hedge ratios for 600-700 pound steers are larger than the hedge ratios for 700-800 pound steers. The hedge ratios for 600-700 pound heifers fall in between the hedge ratios for the two weight group of steers. Second, nine out of the twelve hedge ratios are significantly different from 1.0 at the 10% level. This implies that the short-run hedge ratios are different from the traditional hedge of 1.0. Third, the hedging effectiveness for cross hedging feeder steers and heifers is less than the hedging effectiveness when using the feeder cattle contracts. Fourth, all the hedge ratios for the lighter weight steers and heifers are significantly different from the hedge ratios for the 700-800 pound steers. This implies that the percentage of feeder cattle that needs to be hedged depends upon the weight and sex of cattle marketed.

4.4 Comparison of Production Schedule Ratios

The test statistics examining the difference between the hedge ratios for the two production schedules are shown in Table 21. The test statistics reported depend upon the effect of cash settlement on the summer grass hedge ratios. If cash settlement has no significant effect on the summer grass hedge ratios then the test statistic reported is the t-statistic examining the significance of the parameter estimate η_1 of equation (34). If the parameter estimate is significant, then the winter wheat hedge ratios are significantly different from the summer grass hedge ratios. If cash settlement had a significant effect on the summer grass hedge ratios, then the test statistic reported is the t-statistic examining if $\eta_1 + \eta_3$ of equation (34) is significantly different from zero. If the t-statistic is significant, then the winter wheat production schedule hedge ratios are significantly different from the summer grass hedge ratios.

The results from the pooled regression using the feeder cattle contract provide some interesting conclusions. All of the long-run and short-run hedge ratios for 600-700 pound steers are significantly different between the two production schedules at the 10% level. Since the hedge ratios for the 600-700 pound steers are generally larger than the other weight groups hedge ratios, this would imply that the larger the hedge ratio the more significant the difference between the two production schedules. The other weight groups hedge ratios statistics support this conclusion. Five out of the six hedge ratios for the 600-700 pound heifers are not significantly different between the two production schedules. These heifer hedge ratios were relatively small when compared to the other hedge ratios. The 700-800 pound hedge ratios which are larger than the 600-700 pound heifer hedge ratios are significantly different for two out of the six test statistics.

The results for the pooled regression using the live cattle contracts show that both the long-run and short-run hedge ratios are significantly different between the two production schedules. This backs up the previous conclusion that the larger the hedge ratio the more significant the difference between the production schedules. The hedge ratios using the live cattle contract are generally larger than the feeder cattle hedge ratios.

4.5 Net Return Simulation Results

4.5.1 Winter Wheat Production Schedule

In section 4.3 the long-run and short-run minimum risk hedge ratios regression equations were presented along with a measurement of hedging effectiveness. The measure of hedging effectiveness given was the coefficient of determination, or R^2, of the regression equation. A high R^2 does not necessarily imply that hedging should be recommended since we do not know the resulting margin levels or the extent of risk reduction. Performance of a hedge ratio can be evaluated by simulating the net price and net return means and standard deviations resulting from the hedge ratios. The results for the net price means and standard deviations for the winter wheat production schedule using the long-run, short-run, and traditional hedge ratios are shown in Table 22. The net price is the price in dollars per hundred weight of sale animal weight. This price is calculated by adding the gain or loss in the futures market to the final selling price of the animal. The gain or loss depends on the percentage of cash position hedged. Means and standard deviations are calculated for each weight group of the study. The mean net returns and standard deviation of returns for the winter wheat production schedule using the long-run, short-run, and traditional hedge ratios are shown in Table 23. The net returns is the returns in dollars per hundred weight of the sale price. Net returns are calculated by subtracting the buying price of the cattle multiplied by the ratio of the buy and sell weights from the net price results.

The mean cash price for 600-700 pound steers is $75.94/cwt. with a standard deviation of $10.63. The mean cash return for 600-700 pound steers is $22.73/cwt. with a standard deviation of $4.01. When using the long-run hedge ratios the mean net price decreases by $1.77/cwt. to $1.95/cwt. The standard deviation decreases by 8% to 12%. No clear choice can be made about which long-run hedge ratio performs best. The May contract hedge ratio decreases the standard deviation the greatest amount, 12%, but also decreases the mean net price by the greatest amount $1.95/cwt. The March contract has the smallest decrease in the mean net prices, $1.77/cwt., but also decreases the standard deviation the least, 8%. The decrease in the mean return when using long-run hedge ratios ranged from $1.82/cwt. to $1.99/cwt. with a decrease in the standard deviation of returns ranging from 35% to 44%. The April contract hedge ratio had the larger reduction in standard deviation of returns, 44%, but the March contract ratio had the higher mean return, $20.91/cwt.

The decrease in the mean net price when using a traditional hedge ranges from $1.76/cwt. to $2.09/cwt. with a standard deviation decrease ranging from 8% to 11%. The best performing contract was the May contract with a mean net price of $74.18/cwt. and a standard deviation of $9.41. By using a traditional hedge for 600-700 pound steers the mean net return decreases by a range of $1.80/cwt. to $2.32/cwt. The decrease in the standard deviation of returns ranges from 32% to 41%. The May contract hedge again has the higher mean return of $20.93/cwt., and the larger decrease in the standard deviation of returns, 41%.

By cross hedging using the long-run hedge ratios and the August live cattle contract, the mean net price was decreased by $1.80/cwt. The standard deviation of price was decreased by 10%. The mean net return decrease by $1.85/cwt., with a decrease in the standard deviation of returns of 44%.

When comparing the net price results of the three hedging strategies, long run minimum risk, traditional hedge, and long-run cross hedge, it is difficult to determine which strategy performs the best. The best long-run hedge ratio decreases the standard deviation of price more, but also has the largest decrease in the mean net price. The best traditional hedge contract month and the cross hedge both reduce the mean net price and standard deviation of net price about the same. With all three hedging strategies the reduction in the standard deviation of prices is small. By comparing the results for the net returns a clear choice can be made on which hedging strategy performs best. The cross hedge using the August live cattle contract reduces the standard deviation of returns the greatest and has the higher mean net return. In all three hedging strategies the reductions in the standard deviations of returns is much bigger than the reduction in the standard deviation of prices.

Using short-run hedge ratios for 600-700 pound steers decreases the mean net price by a range of $2.17/cwt. to $2.64/cwt. The decrease in standard deviation ranges from 11% to 13%. The May contract hedge ratio reduces the standard deviation of price the most at 13% and has the higher mean net price, $73.77/cwt. The reduction in the standard deviation of prices is larger for the short run than for the long run and traditional hedge, but the decrease in the mean net price is also larger. The decrease in the mean net return when using short-run hedge ratios ranges from $2.21/cwt. to $2.69/cwt. with a decrease in the standard deviation of returns ranging from 22% to 30%. The April contract hedge ratio reduces the standard deviation of returns the greatest at 30%, but the May contract hedge ratio has the largest mean return at $20.52/cwt. Reductions in the standard deviation of returns from the short-run hedge ratios are less than the reduction of the standard deviation of returns for long-run hedge ratios and traditional hedges. Also, reductions in the mean returns are greater for the short-run hedge ratios.

When cross hedging 600-700 pound steers using short-run hedge ratios and the August live cattle contract the mean net price decreases by $2.44/cwt. and reduces the standard deviation of prices by 11%. This reduction in the standard deviation of prices is larger for the short-run hedge ratios when compared to the long-run hedge ratio, but the decrease in the mean net price is also larger. The reduction in the mean net return when cross hedging is $2.48/cwt. with a reduction in the standard deviation of returns of 36%. This reduction in the standard deviation of returns is smaller and the decrease in the mean net return is larger for the short-run cross hedge when compared to the long-run cross hedging results. Also, the short-run cross hedge ratios performs better than the short-run hedge ratios using the feeder cattle contract. Again, the reductions in the standard deviation of prices are small when compared to the reductions in the standard deviation of returns.

The simulation results for the mean net price and returns for 700-800 pound steers are similar to the results for 600-700 pound steers. The mean cash price for 700-800 pound steers was $73.57/cwt. with a standard deviation of price of $9.18, and the mean cash return was $21.01/cwt. with a standard deviation of returns of $3.59. By using long-run hedge ratios, the mean net prices decrease from $1.67/cwt. to $1.84/cwt. The decrease in standard deviations of prices ranged from 10% to 14%. The May contract hedge ratio performs the best with a mean net price of $71.90/cwt. and a standard deviations of price at $7.90. The reduction on the mean return caused by the long-run hedge ratios ranges from $1.67/cwt. to $1.85/cwt. with decreases in the standard deviation of returns ranging from 39% to 49%. The mean returns show the March and April contracts hedge ratios reduces the variability of returns most. The March contract hedge ratio has the higher mean return at $19.25/cwt. with a standard deviation of returns of $1.98.

When using the traditional hedge with 700-800 pound steers, the mean net price decreases by a range of $1.80/cwt. to $2.31/cwt. with a reduction in the standard deviation of prices ranging from 10% to 14%. The May contract produces the highest mean net price at $71.77/cwt. and smallest standard deviation of price of $7.85. The reduction in the mean return when using the traditional hedge ranges from $1.80/cwt. to $2.32/cwt. The standard deviation of returns is decreased by a range of 31% to 44%. The April contract has the smallest standard deviation of returns at $2.02. The May contract has the highest return at $19.21/cwt. The choice of which contract to use would depend upon the risk preferences of the hedger.

When cross hedging 700-800 pound steers using a long-run hedge ratio, the mean net price decreases by $1.56/cwt. The reduction in standard deviation of price is 11%. The reduction in the mean net price is smallest when compared to hedge ratios using the feeder cattle contracts, but the reduction in standard deviation of price is also smaller than the best performing long-run feeder cattle contract hedge ratio. The reduction in the mean net return when cross hedging is $1.57/cwt. with the reduction in the standard deviation of returns of 40%. Again the reduction in the mean is smaller, along with the reduction in the standard deviation of returns.

When comparing the net price results of the three hedging strategies for the 700-800 pound steers, there is no clear best choice. Both of the best performing long-run hedge ratios and traditional hedge contract months have about the same reduction in the standard deviation of prices and mean net price. The cross-hedge ratio has the largest mean net price, but also the smallest reduction in the standard deviation of price. Again, all reduction in the standard deviation of price are less than 15%. The results for the net return provide an easier task of choosing which hedging strategy performs best. The April long-run hedge ratio reduces the standard deviation of returns the greatest amount at 49% with a mean return of $19.16/cwt. Both the May traditional hedge and the cross hedge have slightly higher mean returns but substantially lower reductions in the standard deviation of returns. As it was with the results for the 600-700 pound steers the reductions in the standard deviation of returns is much larger than the reduction in the standard deviation of price.

Short-run hedge ratios for 700-800 pound steers decrease the mean net price by a range of $1.52/cwt. to $2.05/cwt. with a decrease in the standard deviation of prices ranging from 10% to 13%. The May contract hedge ratio has the highest mean net price at $72.05/cwt. and the largest reduction in the standard deviation of prices at 13%. The short-run hedge ratios decrease standard deviations of price by about the same amount as long-run and traditional hedges. Also, reductions in mean net price are similar. The reduction in mean return caused by short-run hedge ratios is almost the same as the reduction in mean net price. The reduction in standard deviation of returns ranges from 39% to 48%. The mean return results show the April contract hedge ratio performs best. The April contract hedge ratios decrease the standard deviation of returns the most, 48%, and has mean return of $19.12/cwt., only $0.36 less than the May contract hedge ratio. The reduction in the standard deviation of returns from short-run hedge ratios is smaller than the reduction of the standard deviation of returns for the long run, but about the same as for the traditional hedge.

The reduction in the mean net price when cross hedging 700-800 pound steers using the August live cattle contract is $2.16/cwt. with a 13% reduction in the standard deviation. This reduction in the standard deviation is larger than the reduction for the standard deviation of price using the long-run hedge ratio. The reduction in mean net return when cross-hedging is the same as the reduction in mean net price. The reduction in the standard deviation of returns is 32%. The short-run cross-hedge ratio reduces the standard deviation of returns less than the short-run hedge ratios using the feeder cattle contract and has a smaller mean return. The long-run cross-hedge ratio has a bigger reduction in the standard deviation of returns and a larger mean net return.

The mean cash net price for 600-700 pound heifers was $69.41/cwt. with a standard deviation of $10.73. The mean cash return for 600-700 pound heifers was $24.56/cwt. with a standard deviation of $3.35. When using long-run hedging ratios, the mean net price decreases between $1.09/cwt. and $1.20/cwt. with a reduction in standard deviation of price ranging from 6% to 9%. This reduction in the standard deviation of price in lower than for the two weight groups of steers. This lower reduction in the standard deviation is probably caused by a large amount of basis risk faced when hedging heifers. From the net price results, it is difficult to determine which contract is the better performing contract when hedging 600-700 pound heifers. The reduction in the mean net return when using long-run hedge ratios ranges from $1.09/cwt. to $1.20/cwt. with a reduction in the standard deviation of returns ranging from 38% to 44%. The reduction on the standard deviation of returns is much larger than the reduction in the standard deviation of prices. The May contract has the largest reduction of standard deviation of returns, 44%, but also has the smallest mean return at $23.36/cwt. The March contract has the largest mean return at $23.47/cwt. with a reduction in the standard deviation of return of 38%.

Traditional hedges for 600-700 pound heifers reduce the mean net price by a range of $1.85/cwt. to $2.42/cwt. with a reduction in the standard deviation ranging from 8% to 12%. The reduction on the standard deviation of price is larger than the reduction of the standard deviation of price for the long-run hedge ratios, but reductions in the mean net price are larger. The May contract has the largest reduction in the standard deviation of price at 14% and the largest mean net price at $67.56/cwt. Traditional hedging decreased the mean return for 600-700 pound heifers by a range of $1.85/cwt. to $2.42/cwt. This reduction is equal to the reduction in the mean net price. The reduction in the standard deviation of returns ranged from 24% to 42%. This reduction in the standard deviation of returns is lower than the reduction of the standard deviation of returns for the long-run hedge ratios. Again, the May contract hedge has the highest mean return at $22.71/cwt. and the smallest standard deviation of returns at $1.93.

The reductions in the mean net price when cross hedging 600-700 pound heifers using the long-run hedge ratio is $1.60/cwt. with a reduction in the standard deviation of price of 10%. The reduction in the standard deviation of price is larger for the cross hedge than for the long-run hedge ratio using the feeder cattle contracts. Also, the mean net price reductions are larger. The reductions in the mean net return when cross hedging is the same as the reduction in the mean net price. The reduction in the standard deviation of returns is 48% The reduction in the standard deviation of returns is larger and the mean net returns smaller for the cross hedge.

When comparing the net price results for the long-run minimum risk hedge, traditional, and long-run cross hedge strategies for 600-700 pound heifers it can be determined that the reductions in the standard deviations of prices is smaller for the heifers when compared to steers. This supports the previous statement that basis risk is greater when hedging heifers than when hedging steers. Determining which hedging strategy performs best is not an easy task. The May traditional hedge reduced the standard deviation the greatest, but has the smallest mean net price. The May long-run hedge ratio has the largest mean net price, but the smallest reduction in the standard deviation of price. By looking at the mean return results, it can be determined that the May long-run hedge ratio performs best with a mean return of $22.14/cwt. and standard deviation of returns of $1.88. The reductions in the standard deviation of returns are greater than the reduction in the standard deviation of prices. Also, the reduction for the heifers standard deviation of returns is smaller than the same reduction for the two weight group of steers.

When calculating the mean net price and returns for short-run hedge ratios, the mean price was decreased between $1.81/cwt. and $2.46/cwt. The reduction in standard deviation of price ranged from 8% to 12%. The reduction in standard deviation of price is smaller for heifers than for steers. The May contract hedge ratio is the best performing hedge with a mean net price of $67.60/cwt. and a standard deviation of prices of $9.46. The reduction in standard deviation of prices is larger for the short-run hedges when compared to the long-run and traditional hedges. The reduction in mean return when using short-run hedge ratios ranged from $1.81/cwt. to $2.46/cwt. with a reduction in standard deviation of returns ranging from 32% to 43%. The reduction in standard deviation in returns is smaller for the short-run hedge ratios than for the long-run minimum risk hedges and traditional hedges. Also, the reduction in mean returns are larger. The May contract still performs best with a mean return of

$22.75/cwt. and standard deviation of returns of $1.90.

The reduction in mean net price when using the short-run cross hedge is $2.45/cwt. with a reduction in standard deviation of price of 12%. This reduction is about the same as for the best performing short-run feeder cattle hedge ratio, but the mean price is much lower. The reduction in mean net return from a cross hedge is $2.44/cwt. with a reduction of 27% in the standard deviation of returns. This reduction in standard deviation of returns and mean net return is much smaller than the reductions from short-run feeder cattle hedge ratios.

When looking at the results for the different hedging strategies and different weights of steers and heifers using a winter wheat production schedule a few conclusions can be made. First, the reduction in the standard deviation of returns was greater than the reduction in the standard deviation of prices for all hedging strategies and weight groups of animals. This implies that hedging is more effective from a long-term perspective than the short term perspective. Second, the nearby contract is not the only contract that can be used to minimize risk in a winter wheat production schedule. Several of the best performing hedges used contracts other than the nearby. Third, it is possible to effectively hedge feeder cattle using the live cattle contract. The best performing long-run strategy for 600-700 pound steers was the hedge ratio using the August live cattle contract.

4.5.2 Summer Grass Production Schedule

The same methods used to calculate the mean net price and net returns for the winter wheat production schedule are used in calculating the mean net price and return for the summer grass production schedule. The net price results are shown in Table 24 and the net returns results are shown in Table 25. The mean cash net price for 600-700 pound steers was $75.01/cwt. with a standard deviation of $12.73. The mean cash return was $15.72/cwt. with a standard deviation of $5.98. The reduction in the mean net price when using long-run hedge ratios ranges from $1.50/cwt. to $2.12/cwt. with a reduction in the standard deviation of price ranging from 12% to 16%. No result emerges is given as to which contract performs the best. The October contract hedge ratio has the largest mean net price at $73.51/cwt. with a standard deviation of price of $11.10. The September contract hedge ratio has the smallest standard deviation of price at $10.63 and mean net price of $72.89. The reduction in the mean net return from long-run hedge ratios has almost the same range as the reduction of the mean net price. However, the reductions in standard deviation of returns is not the same as the reduction in standard deviation of price. The reduction in standard deviation of returns ranges from 51% to 59%. This reduction is much larger than the reduction in standard deviation of prices. The October contract now has the higher mean return of $13.60/cwt. and the largest reduction in standard deviation of returns at 59%.

Traditional hedges on 600-700 pound steers cause the mean net price to decrease by a range of $1.56/cwt. to $1.72/cwt. with a decrease in the standard deviation of price ranging from 12% to 16%. Again there is no clear choice as to which contract performs best. The September contract has the lowest mean at $73.29/cwt. and the lowest standard deviation of price at $10.67. The October contract has the largest mean at $73.45/cwt. and a standard deviation of price of $11.10. The reduction in mean return caused by using a traditional hedge has the same range as the reduction in the mean price. The standard deviation of returns shows a reduction ranging from 55% to 61%. This reduction is much larger than the reduction in standard deviation of price. There is no clear choice as to which contract performs best. The September contract produces the lowest standard deviation of returns at $2.31 with a mean net return of $14.00/cwt. and the October contract has the largest mean at $14.16/cwt. with a standard deviation of returns of $2.52.

The results for cross hedging 600-700 pound steers using the

February live cattle contract shows that the mean net price is increased by $0.05/cwt. This increase is due to the fact that the February futures mean returns were positive over the data time period. The reduction in the standard deviation of price is 10%. This reduction is lower than reductions for long-run and traditional hedges. The mean return was also increased by $0.05/cwt. with a 30% reduction in the standard deviation of returns.

When comparing the net price results for the three hedging strategies it is difficult to determine which hedging strategy performs the best. The minimum risk and traditional hedges reduce the standard deviation of price more, but the cross hedge has the higher mean net price. Also, the reduction in the standard deviations of price are all under 16%. The net return results show that the reduction in standard deviation of returns is much larger than the reduction in standard deviation of price. The October long-run hedge ratio performs the best by reducing the standard deviation of returns by 59% with a mean return of $14.23/cwt.

Short-run hedge ratios for 600-700 pound steers decrease the mean net price between $1.95/cwt. and $2.09/cwt. with a reduction in the standard deviation of price ranging from 11% to 16%. The September contract hedge ratio has the largest reduction in standard deviation of price at 16% and a mean net price that is only $0.03/cwt lower than the largest mean net price. The reduction in standard deviation for short-run hedge ratios is about the same as the reductions in standard deviations of price for the long-run and traditional hedges, but the mean net prices are smaller in the short-run. The reduction in mean return from hedging is almost the same as the reduction in the mean net price. Also, the reduction in the standard deviation of returns is larger than the reductions in standard deviation of price. Reduction in standard deviation of returns ranged from 41% to 56%. The September contract has the lowest standard deviation of returns at $2.64 and a mean net return still only $0.03/cwt. lower than the largest mean return. Only the September hedge ratio has as large a reduction in the standard deviation of returns as the long-run and traditional hedges, but the mean return for the September hedge ratios is lower than the long-run and traditional hedge.

Like the long-run cross hedge using the February live cattle contract, the short-run cross hedge increases the mean net price by $0.09/cwt. The reduction in the standard deviation of price is 8%. This reduction in the standard deviation of price is much lower than the reduction in the standard deviation of price for the short-run feeder cattle hedge ratios. The mean net return also increases when cross hedging using the February live cattle contract. The mean return increases by $0.10/cwt. The standard deviation of return decreases by 4%. This decrease in standard deviation of returns is smaller than the decrease in standard deviation of prices. This implies that cross hedging 600-700 pound feeder steers on summer grass with the live cattle contract is not effective.

The mean cash net price for 700-800 pound steers is $72.73/cwt. with a standard deviation of $11.49. The mean cash return for 700-800 pound steers is $14.77/cwt. with a standard deviation of $5.34. The reduction in the mean net price when using long-run hedge ratios ranges from $1.33/cwt. to $1.52/cwt. with a reduction in the standard deviation of price ranging from 12% to 16%. The October contract hedge ratios has the highest mean net price, $71.40/cwt., with a standard deviation of price of $10.03. The September contract hedge ratio has a lower standard deviation of price at $9.64, but also has the lowest mean net price of $71.27/cwt. The reduction in mean return from the long-run hedge ratios has the same range as the reductions for the mean net price. The reduction in the standard deviation of returns is between 46% and 53%. The reduction in standard deviation of returns is much larger than the reduction in standard deviation of price. The September contract hedge ratio is the best performing with a mean return of $13.25/cwt. and the smallest standard deviation of returns at $2.49.

Traditional hedges on 700-800 pound steers reduce the mean cash net price between $1.56/cwt. and $1.72/cwt. with a reduction in the standard deviation of price from 11% to 16%. Reductions in the standard deviation of price are similar for the traditional hedges when compared to long-run hedge ratios results. The October contract has the largest mean net price of $71.17/cwt. with a standard deviation of price of $10.04. The September contract has the smallest standard deviation of price at $9.60 and the smallest mean net price at $71.01/cwt. The reduction in mean cash return price when using a traditional hedge has the same range as the reduction in mean net price when using a traditional hedge. The reduction in the standard deviation of returns ranges from 40% to 51%. September and October are the best performing contracts. The September contract has the smallest standard deviation of returns at $2.74 and the October contract has the largest mean net return at $13.21/cwt.

The mean net price increases by $0.04/cwt. when cross hedging 700-800 pound steers using the February live cattle contract. The standard deviation of price is reduced by 9%. The increase in mean net price is due to the positive average returns over the data period for the February live cattle contract. The mean return also increased by $0.04/cwt. when cross hedging. The reduction in the standard deviation of returns was decreased by 23%.

When comparing the long-run minimum risk, traditional, and long-run cross-hedge net price and return results for the 700-800 pound steers, it can be determined that the minimum risk hedge ratios perform best. The minimum risk hedge ratios have about the same reduction in the standard deviation of price and higher mean net prices. Also, minimum risk hedge ratios have larger reductions in the standard deviation of returns and higher mean net returns.

Reductions in the 700-800 pound mean net price when using short-run hedge ratios ranged from $1.82/cwt. to $1.95/cwt. with a reduction in the standard deviation of price ranging from 10% to 17%. The September contract hedge ratio has the highest mean net price at $70.89/cwt. and the lowest standard deviation of price at $9.59. The reductions in the standard deviation of price are about the same for the long-run, short-run, and traditional hedges, but the mean net prices are higher for the long-run and traditional hedges. Reductions in the 700-800 pound mean return when using the short-run hedge ratios ranged from $1.82/cwt. to $1.94/cwt. with a reduction in standard deviation of returns ranging from 27% to 45%. The September contract hedge ratio still out performs the other contracts with a mean return of $12.93/cwt. and a standard deviation of returns of $2.95. The short-run hedge ratios mean returns are lower than the long-run and traditional hedge results, and have higher standard deviations.

The mean net price increases by $0.08/cwt. for 700-800 pound steers are cross hedged using a short-run hedge ratio. The standard deviation of price is decreased by 7%. This reduction in standard deviation of price is smaller than the reductions in standard deviation of price for the long-run cross-hedge ratio. The mean net return also increase by $0.09/cwt. when using a short-run cross-hedge ratio. The reduction in the standard deviation of returns is 10%. This reduction in standard deviation of returns is smaller than the same reduction using the long-run hedge ratio. Also, the reductions in standard deviation of returns are larger when using the feeder cattle contract.

The mean cash net price for 600-700 pound heifers is $68.20/cwt. with a standard deviation of $12.90. The mean net cash return for 600-700 pound heifers is $17.97/cwt. with a standard deviation of $5.83. The reduction to the mean net price when using long-run hedge ratios ranges from $0.82/cwt. to $1.43/cwt. with a reduction in standard deviation of prices ranging from 10% to 16%. The choice of which contract hedge ratio performs best is not clear. The September contract hedge ratio has the largest reduction in the standard deviation of price at 16%, but the October contract has the largest mean net price at $67.38/cwt. Reduction in the mean cash return when using the long-run hedge ratio ranges from $0.73/cwt. to $1.30/cwt. with a reduction in standard deviation of returns ranging from 44% to 62%. The decision of which contract hedge ratio performs the best will have to be determined by the level of risk wanted by the producer.

Traditional hedges cause the 600-700 pound heifer mean net price to decrease by a range of $1.36/cwt. to $1.49/cwt. with a reduction in standard deviation of prices ranging from 12% to 18%. The September contract performs the best. It has the smallest standard deviation of price at $10.76 and mean net price of $66.71/cwt. The September mean net price is only $0.13/cwt. less than the highest mean price with a reduction of the standard deviation of price that is 5% more than any other reduction in standard deviation of price. Reduction in the mean return when using a traditional hedge range from $1.19/cwt. to $1.36/cwt. with a reduction in the standard deviation of returns ranging from 48% to 62%. The September contract performs best with a mean net return of $16.61/cwt. and a standard deviation of return of $2.24.

There is no change in the 600-700 pound heifer mean net price when using the February live cattle contract. The reduction in the standard deviation of price is 1%. These results imply that hedging 600-700 pound heifers on summer grass with the February live cattle contract is not effective. The change in the mean return when cross hedging is a decrease of $0.02/cwt. The standard deviation of returns is increased by 2%. These results support the previous statement that hedging 600-700 pound heifers on summer grass is ineffective.

When comparing the net price results for the long-run minimum risk, traditional, and long-run cross hedging strategies, it is difficult to determine if the long-run minimum risk or traditional hedging performs the best. Both hedging strategies have similar reductions in the standard deviation of prices and mean net prices. When the results of the net returns are considered the long-run minimum risk hedging strategy performs the best. Even though both hedging strategies have similar reductions in the standard deviation of returns the long-run minimum risk hedge ratios have the higher mean returns.

Reductions in the 600-700 pound heifers mean net price when using short-run hedge ratios ranges from $1.69 to $1.82 with reductions in the standard deviation of price ranging from 11% to 17%. The September contract hedge ratio performs best with a mean net price of $66.48/cwt. and a $10.71 standard deviation of price. The short-run hedge ratios reduce standard deviations more than long-run and traditional hedges, but the long-run and traditional hedges produce higher mean net prices. The reductions in mean returns for 600-700 pound heifers caused by short-run hedge ratios ranged from $1.49/cwt. to $1.63/cwt. with a reduction in the standard deviation of returns ranging from 34% to 55%. The September contract now has the largest mean return at $16.41/cwt. and the smallest standard deviation of returns at $2.60. The short-run hedge ratio result in higher standard deviation of returns and lower mean returns when compared to the long-run and traditional hedging results.

The short-run net price and return results for cross hedging 600-700 pound heifers are similar to the same long-run results. The reductions in the mean net price and results are very small ranging from $0.08/cwt. to $0.20/cwt., but the standard deviation of prices and returns are increased by as much as 86%. This further supports the evidence that 600-700 pound heifers on summer grass pasture can not be effectively hedged using the live cattle contract.

When looking at the results for the different hedging strategies and different weights of steers and heifers using a summer grass production schedule, three conclusions can be made. First, the reduction in the standard deviation of returns was greater than the reduction in the standard deviation of prices. This implies that hedging is more effective from a long-term perspective than the short-term perspective. Second, the nearby contract is not the only contract that can be used to minimize risk in a summer grass production schedule. Some of the best performing hedge ratios used contracts other than the nearby. Third, unlike the winter wheat production schedule, feeder steers and heifers can not be effectively hedged using the live cattle contract.

4.5.3 Summary

When comparing net price and net returns for winter wheat and summer grass production schedules, several similarities and differences can be noticed. The first similarity is the reduction in standard deviation of price versus the standard deviation of returns. In both production schedules, the reduction in standard deviation of returns was considerably larger than the reduction in standard deviation of price. This implies that hedging seems to be more effective from the long term perspective for both types of production schedules.

A second similarity between the two production schedules is the contract month that performs better for the different weight groups of feeder cattle and hedging strategies. Results for both production schedules show that the different weights of feeder cattle can be effectively hedged using contracts other than the nearby contract.

The first difference between the two production schedule is the level of reductions in the standard deviation of price and returns. In the summer grass production schedule, the reduction in the standard deviation of price and returns are larger than the same reduction for the winter wheat production schedule. This difference in the reductions of the standard deviation implies that basis risk is generally lower for producer using a summer grass production schedule.

A second difference between the two production schedules is the level of risk reduced. In the summer grass production schedule, the average reduction in the standard deviations of returns for 600-700 pound steers using a long-run hedge ratio is 55%. The same average reduction in winter wheat production schedule is 40%. The average reduction in the standard deviation of prices for 600-700 pound steers on summer grass using short-run hedge ratios is 13%. The same average reduction for the winter wheat production schedule is 9%. These results imply that more risk is reduced for the summer grass production schedule. This supports the conclusion that basis risk is smaller for the summer grass production schedule. This also contradicts the results shown in section 4.4 testing the difference between the two production schedules. Even though there is no statistical difference between the hedge ratios for the two production schedules there is a noticeable difference in the level of returns.

TABLE 1

Descriptive Price and Return Statistics for the

Long-run Winter Wheat Production Schedule.

Category	Mean Price	Standard Deviation	Minimum Price	Maximum Price	Number of Observations
Contracts					
Feeder Cattle					
Fall March	72.09	7.73	60.25	83.48	160
Spring March	74.41	8.44	60.45	90.55	160
Fall April	71.70	7.44	59.85	82.95	160
Spring April	73.83	7.93	61.48	88.60	160
Fall May	70.91	7.29	58.85	82.03	160
Spring May	72.71	8.03	61.75	87.23	160
Live Cattle					
Fall August	64.43	5.19	55.35	71.90	160
Spring August	65.87	5.48	56.88	75.35	160
Weight Groups					
Steers					
400-500	81.18	15.61	63.10	106.30	160
500-600	75.12	12.94	61.90	98.31	160
600-700	75.99	10.62	60.88	95.63	160
700-800	73.57	9.17	57.65	90.31	160
Heifers					
400-500	68.37	14.71	53.25	93.50	160
600-700	69.41	10.63	54.68	88.69	160
Returns	**Mean Returns**	**Standard Deviation**	**Minimum Returns**	**Maximum Returns**	**Number of Observations**
Cash					
Steers					
450-686	22.73	4.01	12.90	29.96	160
550-786	21.01	3.37	14.50	29.93	160
Heifers					
450-686	24.56	3.35	16.31	29.89	160
Futures Contracts					
March Feeder	-2.32	4.60	-12.98	9.35	160
April Feeder	-2.13	4.02	-11.80	7.90	160
May Feeder	-1.80	3.62	-10.90	6.45	160
August Live	-1.44	2.69	-7.87	4.90	160

TABLE 2

Descriptive Price and Return Statistics for the

Long-run Summer Grass Production Schedule

Category	Mean Price	Standard Deviation	Minimum Price	Maximum Price	Number of Observations
Contracts					
Feeder Cattle					
Spring September	71.04	8.40	54.60	87.68	176
Fall September	72.77	9.77	57.00	87.78	176
Spring October	70.74	8.41	54.80	87.48	176
Fall October	72.30	9.55	57.20	86.95	176
Spring November	71.33	8.23	55.80	87.45	176
Fall November	72.94	9.19	58.63	87.05	176
Live Cattle					
Spring February	66.14	6.10	53.80	76.40	176
Fall February	66.09	6.29	54.95	75.60	176
Weight Groups					
Steers					
400-500	88.93	16.70	71.88	122.30	176
500-600	81.67	14.42	63.16	112.40	176
600-700	74.24	12.90	57.12	94.63	176
700-800	72.07	11.90	54.60	91.31	176
Heifers					
400-500	75.89	15.49	58.25	110.60	172
600-700	67.43	12.74	51.25	88.13	172
Returns	**Mean Returns**	**Standard Deviation**	**Minimum Returns**	**Maximum Returns**	**Number of Observations**
Cash					
Steers					
450-675	14.95	6.18	3.13	28.71	176
550-775	14.11	5.75	2.12	27.65	176
Heifers					
450-675	18.03	5.98	7.10	30.04	168
Futures					
September Feeder	-1.73	6.11	-13.73	12.55	176
October Feeder	-1.56	6.12	-14.48	12.15	176
November Feeder	-1.61	5.99	-14.50	11.12	176
February Live	0.05	4.47	-9.75	10.40	176

TABLE 3

Descriptive Price Statistics for the Short-run Winter Wheat Production Schedule

Category	Mean	Standard Deviation	Minimum	Maximum	Number of Observations
Contracts					
Feeder Cattle					
March	74.41	8.44	60.45	90.55	160
April	73.83	7.93	61.48	88.60	160
May	72.71	8.03	61.75	87.23	160
Live Cattle					
August	65.87	5.48	56.88	75.35	160
Weight Groups					
Steers					
600-700	75.99	10.62	60.88	95.63	160
700-800	73.57	9.17	57.65	90.31	160
Heifers					
600-700	69.41	10.63	54.68	88.69	160

TABLE 4

Descriptive Price Statistics for the Short-run Summer Grass Production Schedule

Category	Mean	Standard Deviation	Minimum	Maximum	Number of Observations
Contracts					
Feeder Cattle					
September	72.77	9.77	57.00	87.78	176
October	72.30	9.55	57.20	86.95	176
November	72.94	9.19	58.63	87.05	176
Live Cattle					
February	66.09	6.29	54.95	75.60	176
Weight Groups					
Steers					
600-700	74.24	12.90	57.12	94.63	176
700-800	72.07	11.90	54.60	91.31	176
Heifers					
600-700	67.43	12.74	51.25	88.13	172

TABLE 5

Long-run Minimum Risk Hedge Ratios for 686 Pound Steers, Using a Winter Wheat Production Schedule

March Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	21.838	0.2349	92.988	0.0000
Futdif[b]	-0.785	0.0479	-16.360	0.0000
Cashs[c]	-1.870	0.4107	-4.555	0.0000
Setfut[d]	0.017	0.0804	0.216	0.8291

Minimum Risk Hedge Ratio	0.785
Likelihood ratio	242.743
Log-likelihood function	-311.547
Hedging Effectiveness	0.698

April Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	21.730	0.2149	101.115	0.0000
Futdif	-0.909	0.0482	-18.868	0.0000
Cashs	-2.029	0.3879	-5.232	0.0000
Setfut	-0.020	0.0875	-0.230	0.8178

Minimum Risk Hedge Ratio	0.909
Likelihood ratio	219.084
Log-likelihood function	-310.466
Hedging Effectiveness	0.729

May Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	22.371	0.1998	111.970	0.0000
Futdif	-1.106	0.0541	-20.434	0.0000
Cashs	-3.363	0.3978	-8.454	0.0000
Setfut	-0.017	0.1010	-0.165	0.8691

Minimum Risk Hedge Ratio	1.105
Likelihood ratio	210.779
Log-likelihood function	-308.718
Hedging Effectiveness	0.726

August Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	20.843	0.1884	110.650	0.0000
Futdif	-1.277	0.0638	-20.152	0.0000

Minimum Risk Hedge Ratio	1.277
Likelihood ratio	246.228
Log-likelihood function	-308.028

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference ($F_t - F_{t+j}$)
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

Table 6

Long-run Minimum Risk Hedge Ratios for 786 Pound Steers, Using the Winter Wheat Production Schedule.

March Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	20.479	0.1735	118.054	0.0000
Futdif[b]	-0.759	0.0354	-21.435	0.0000
Cashs[c]	-2.221	0.3033	-7.321	0.0000
Setfut[d]	0.058	0.0589	0.987	0.3237

Minimum Risk Hedge Ratio	0.759
Likelihood ratio	141.109
Log-likelihood function	-310.747
Hedging Effectiveness	0.806

April Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	20.684	0.1513	134.719	0.0000
Futdif	-0.866	0.0339	-25.490	0.0000
Cashs	-2.397	0.0272	-8.814	0.0000
Setfut	0.016	0.0610	0.255	0.7985

Minimum Risk Hedge Ratio	0.866
Likelihood ratio	101.298
Log-likelihood function	-309.684
Hedging Effectiveness	0.844

May Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	21.062	0.1436	146.721	0.0000
Futdif	-1.028	0.0389	-26.373	0.0000
Cashs	-3.602	0.2835	-12.704	0.0000
Setfut	0.022	0.0715	0.308	0.7578

Minimum Risk Hedge Ratio	1.028
Likelihood ratio	100.303
Log-likelihood function	-308.115
Hedging Effectiveness	0.830

August Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	19.430	0.1903	102.126	0.0000
Futdif	-1.081	0.0620	-17.209	0.0000

Minimum Risk Hedge Ratio	1.081
Likelihood ratio	241.353
Log-likelihood function	-308.351

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference ($F_t - F_{t+j}$)
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

TABLE 7

Long-run Minimum Risk Hedge Ratios for 686 Pound Heifers, Using a Winter Wheat Production Schedule

March Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	23.103	0.2025	114.087	0.0000
Futdif[b]	-0.748	0.0443	-16.909	0.0000
Cashs[c]	0.532	0.3536	1.506	0.1319
Setfut[d]	0.294	0.0690	4.264	0.0000

Minimum Risk Hedge Ratio	0.454
Likelihood ratio	191.761
Log-likelihood function	-308.146
Hedging Effectiveness	0.690

April Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	22.958	0.1814	126.550	0.0000
Futdif	-0.881	0.0438	-20.125	0.0000
Cashs	0.572	0.3247	1.763	0.0779
Setfut	0.352	0.0719	4.888	0.0000

Minimum Risk Hedge Ratio	0.529
Likelihood ratio	157.963
Log-likelihood function	-309.423
Hedging Effectiveness	0.746

May Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	23.579	0.1593	147.992	0.0000
Futdif	-1.071	0.0456	-23.468	0.0000
Cashs	-0.534	0.3141	-1.701	0.0889
Setfut	0.423	0.0777	5.435	0.0000

Minimum Risk Hedge Ratio	0.648
Likelihood ratio	126.889
Log-likelihood function	-307.880
Hedging Effectiveness	0.783

August Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	22.894	0.1436	159.423	0.0000
Futdif	-1.108	0.0478	-23.177	0.0000

Minimum Risk Hedge Ratio	1.108
Likelihood ratio	161.491
Log-likelihood function	-307.196

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference (F_t - F_{t+j})
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

Table 8

Short-run Minimum Risk Hedge Ratios for 686 Pound Steers, Using the Winter Wheat Production Schedule.

March Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	4.313	8.9490	0.482	0.6298
Futdif[b]	0.922	0.1289	7.154	0.0000
Cashs[c]	-13.286	9.2110	-1.443	0.1492
Setfut[d]	0.236	0.1319	1.792	0.0731

Minimum Risk Hedge Ratio	1.158
Likelihood ratio	21.741
Log-likelihood function	-76.632
Hedging Effectiveness	0.985

April Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	2.854	10.2500	0.279	0.7806
Futdif	0.946	0.1480	6.393	0.0000
Cashs	-16.048	10.5800	-1.516	0.1295
Setfut	0.280	0.1519	1.844	0.0652

Minimum Risk Hedge Ratio	1.226
Likelihood ratio	35.351
Log-likelihood function	-75.086
Hedging Effectiveness	0.981

May Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	7.721	12.2400	0.631	0.5282
Futdif	0.895	0.1806	4.955	0.0000
Cashs	-19.903	12.6800	-1.570	0.1165
Setfut	0.332	0.1857	1.790	0.0734

Minimum Risk Hedge Ratio	1.227
Likelihood ratio	42.505
Log-likelihood function	-79.818
Hedging Effectiveness	0.989

August Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	-32.203	9.3640	-3.973	0.0001
Futdif	1.718	0.1417	12.129	0.0000

Minimum Risk Hedge Ratio	1.718
Likelihood ratio	97.974
Log-likelihood function	-92.025

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference ($F_t - F_{t+j}$)
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

Table 9

Short-run Minimum Risk Hedge Ratios for 786 Pound Steers, Using the Winter Wheat Production Schedule.

March Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	6.232	9.4690	0.658	0.5105
Futdif[b]	0.884	0.1364	6.479	0.0000
Cashs[c]	-9.939	9.7490	-1.020	0.3079
Setfut[d]	0.161	0.1396	1.152	0.2492

Minimum Risk Hedge Ratio	0.884
Likelihood ratio	45.857
Log-likelihood function	-67.627
Hedging Effectiveness	0.977

April Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	6.225	11.0400	0.569	0.5696
Futdif	0.886	0.1594	5.560	0.0000
Cashs	-13.522	11.4300	-1.184	0.2366
Setfut	0.216	0.1639	1.139	0.1873

Minimum Risk Hedge Ratio	0.886
Likelihood ratio	53.195
Log-likelihood function	-70.328
Hedging Effectiveness	0.967

May Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	10.310	13.0500	0.790	0.4295
Futdif	0.846	0.1926	4.394	0.0001
Cashs	-16.057	13.5400	-1.186	0.2358
Setfut	0.250	0.1983	1.263	0.2067

Minimum Risk Hedge Ratio	0.846
Likelihood ratio	58.708
Log-likelihood function	-75.263
Hedging Effectiveness	0.996

August Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	-25.022	7.8630	-3.182	0.0015
Futdif	1.497	0.1190	12.581	0.0000

Minimum Risk Hedge Ratio	1.497
Likelihood ratio	87.542
Log-likelihood function	-90.101

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference (F_t - F_{t+j})
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

Table 10

Short-run Minimum Risk Hedge Ratios for 686 Pound Heifers, Using the Winter Wheat Production Schedule.

March Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	-9.400	9.6430	-0.975	0.3296
Futdif[b]	1.019	0.1388	7.342	0.0000
Cashs[c]	-2.451	9.9830	-0.245	0.8061
Setfut[d]	0.097	0.1427	0.680	0.4968

Minimum Risk Hedge Ratio	1.019
Likelihood ratio	27.026
Log-likelihood function	-82.048
Hedging Effectiveness	0.976

April Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	-10.670	11.1300	-0.959	0.3376
Futdif	1.040	0.1606	6.476	0.0000
Cashs	-5.183	11.5400	-0.449	0.6534
Setfut	0.139	0.1654	0.845	0.3982

Minimum Risk Hedge Ratio	1.040
Likelihood ratio	32.239
Log-likelihood function	-84.946
Hedging Effectiveness	0.964

May Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	-4.946	12.7600	-0.387	0.6984
Futdif	0.978	0.1883	5.196	0.0000
Cashs	-9.720	13.2500	-0.734	0.4631
Setfut	0.199	0.1939	1.030	0.3031

Minimum Risk Hedge Ratio	0.978
Likelihood ratio	38.429
Log-likelihood function	-84.946
Hedging Effectiveness	0.964

August Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	-42.188	9.7820	-4.313	0.0000
Futdif	1.695	0.1480	11.449	0.0000

Minimum Risk Hedge Ratio	1.695
Likelihood ratio	100.950
Log-likelihood function	-92.698

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference ($F_t - F_{t+j}$)
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

TABLE 11

Long-run Minimum Risk Hedge Ratios for 675 Pound Steers, Using a Summer Grass Production Schedule

September Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	15.092	0.2382	63.345	0.0000
Futdif[b]	-0.959	0.0416	-23.031	0.0000
Cashs[c]	-3.354	0.3939	-8.515	0.0000
Setfut[d]	-0.273	0.0623	-4.341	0.0000

Minimum Risk Hedge Ratio	1.232
Likelihood ratio	230.505
Log-likelihood function	-338.544
Hedging Effectiveness	0.888

October Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	15.128	0.2862	52.862	0.0000
Futdif	-0.959	0.0497	-19.320	0.0000
Cashs	-2.316	0.4448	-5.206	0.0000
Setfut	-0.102	0.0704	-1.446	0.1480

Minimum Risk Hedge Ratio	0.959
Likelihood ratio	288.340
Log-likelihood function	-338.242
Hedging Effectiveness	0.848

November Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	15.018	0.3196	46.984	0.0000
Futdif	-0.987	0.0594	-16.609	0.0000
Cashs	-1.833	0.4937	-3.713	0.0000
Setfut	-0.017	0.0808	-0.216	0.8287

Minimum Risk Hedge Ratio	0.987
Likelihood ratio	325.150
Log-likelihood function	-338.112
Hedging Effectiveness	0.816

February Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	15.805	0.3119	50.680	0.0000
Futdif	-0.962	0.0701	-13.623	0.0000

Minimum Risk Hedge Ratio	0.962
Likelihood ratio	501.652
Log-likelihood function	-338.652

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference ($F_t - F_{t+j}$)
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

Table 12

Long-run Minimum Risk Hedge Ratios for 775 Pound Steers, Using the Summer Grass Production Schedule.

September Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	14.496	0.2517	57.599	0.0000
Futdif[b]	-0.883	0.0460	-19.191	0.0000
Cashs[c]	-2.500	0.4221	-5.924	0.0000
Setfut[d]	-0.109	0.0681	-1.607	0.1079

Minimum Risk Hedge Ratio	0.883
Likelihood ratio	259.125
Log-likelihood function	-338.915
Hedging Effectiveness	0.831

October Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	14.415	0.3038	47.456	0.0000
Futdif	-0.851	0.0545	-15.600	0.0000
Cashs	-1.646	0.4798	-3.430	0.0060
Setfut	0.012	0.0768	0.152	0.8795

Minimum Risk Hedge Ratio	0.851
Likelihood ratio	315.588
Log-likelihood function	-338.697
Hedging Effectiveness	0.777

November Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	14.278	0.3338	42.771	0.0000
Futdif	-0.852	0.0637	-13.381	0.0000
Cashs	-1.217	0.5221	-2.331	0.0197
Setfut	0.038	0.0863	0.446	0.6557

Minimum Risk Hedge Ratio	0.852
Likelihood ratio	348.854
Log-likelihood function	-338.753
Hedging Effectiveness	0.732

February Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	14.937	0.3019	49.476	0.0000
Futdif	-0.758	0.0690	-10.987	0.0000

Minimum Risk Hedge Ratio	0.758
Likelihood ratio	493.512
Log-likelihood function	-338.044

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference $(F_t - F_{t+j})$
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

TABLE 13

Long-run Minimum Risk Hedge Ratios for 675 Pound Heifers, Using a Summer Grass Production Schedule

September Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	16.814	0.1453	115.692	0.0000
Futdif[b]	-0.959	0.0314	-30.519	0.0000
Cashs[c]	0.515	1.0510	0.490	0.6244
Setfut[d]	0.197	0.1851	1.064	0.2873

Minimum Risk Hedge Ratio	0.959
Likelihood ratio	787.662
Log-likelihood function	-352.662
Hedging Effectiveness	0.022

October Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	17.040	0.1681	101.348	0.0000
Futdif	-0.985	0.0339	-29.056	0.0000
Cashs	1.220	1.0260	1.189	0.2343
Setfut	0.375	0.1786	2.100	0.0357

Minimum Risk Hedge Ratio	0.610
Likelihood ratio	820.241
Log-likelihood function	-351.016
Hedging Effectiveness	0.022

November Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	16.952	0.2533	66.936	0.0000
Futdif	-0.991	0.0537	-18.456	0.0000
Cashs	1.503	1.0060	1.494	0.1351
Setfut	0.405	0.1731	2.322	0.0202

Minimum Risk Hedge Ratio	0.589
Likelihood ratio	844.563
Log-likelihood function	-352.183
Hedging Effectiveness	0.019

February Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	16.459	0.4700	35.018	0.0000
Futdif	0.145	0.1107	1.310	0.1902

Minimum Risk Hedge Ratio	0.145
Likelihood ratio	990.738
Log-likelihood function	-345.294

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference ($F_t - F_{t+j}$)
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

Table 14

Short-run Minimum Risk Hedge Ratios for 675 Pound Steers, Using the Summer Grass Production Schedule.

September Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	10.115	2.8500	3.549	0.0004
Futdif[b]	0.824	0.0439	18.778	0.0000
Cashs[c]	-16.590	3.3940	-4.888	0.0000
Setfut[d]	0.324	0.0496	6.537	0.0000

Minimum Risk Hedge Ratio	1.147
Likelihood ratio	7.884
Log-likelihood function	-75.767
Hedging Effectiveness	0.995

October Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	9.734	3.5220	2.764	0.0057
Futdif	0.836	0.0546	15.294	0.0000
Cashs	-23.704	4.2840	-5.533	0.0000
Setfut	0.412	0.0627	6.574	0.0000

Minimum Risk Hedge Ratio	1.248
Likelihood ratio	14.333
Log-likelihood function	-81.572
Hedging Effectiveness	0.992

November Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	3.972	4.9870	0.790	0.4294
Futdif	0.915	0.0763	11.988	0.0000
Cashs	-21.996	5.8600	-3.753	0.0002
Setfut	0.379	0.0855	4.431	0.0000

Minimum Risk Hedge Ratio	1.294
Likelihood ratio	21.413
Log-likelihood function	-86.222
Hedging Effectiveness	0.989

February Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	-46.972	8.2010	-5.727	0.0000
Futdif	1.846	0.1236	14.937	0.0000

Minimum Risk Hedge Ratio	1.846
Likelihood ratio	89.896
Log-likelihood function	-111.933

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference (F_t - F_{t+j})
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

Table 15

Short-run Minimum Risk Hedge Ratios for 775 Pound Steers, Using the Summer Grass Production Schedule.

September Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	7.726	2.7140	2.847	0.0044
Futdif[b]	0.847	0.0417	20.327	0.0000
Cashs[c]	-11.373	3.2050	-3.549	0.0004
Setfut[d]	0.223	0.0468	4.764	0.0000

Minimum Risk Hedge Ratio	**1.070**
Likelihood ratio	**18.099**
Log-likelihood function	**-67.745**
Hedging Effectiveness	**0.994**

October Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	6.409	3.1290	2.049	0.0405
Futdif	0.873	0.0485	17.985	0.0000
Cashs	-17.553	3.8230	-4.591	0.0000
Setfut	0.296	0.0559	5.299	0.0000

Minimum Risk Hedge Ratio	**1.169**
Likelihood ratio	**10.589**
Log-likelihood function	**-79.744**
Hedging Effectiveness	**0.992**

November Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	0.702	4.8250	0.146	0.8843
Futdif	0.949	0.0739	12.853	0.0000
Cashs	-15.097	5.7230	-2.638	0.0083
Setfut	0.254	0.0833	3.046	0.0023

Minimum Risk Hedge Ratio	**1.203**
Likelihood ratio	**18.501**
Log-likelihood function	**-87.501**
Hedging Effectiveness	**0.986**

February Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	-38.800	6.9910	-5.550	0.0000
Futdif	1.687	0.1053	16.202	0.0000

Minimum Risk Hedge Ratio	**1.687**
Likelihood ratio	**90.184**
Log-likelihood function	**-104.578**

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference (F_t - F_{t+j})
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

Table 16

Short-run Minimum Risk Hedge Ratios for 675 Pound Heifers, Using the Summer Grass Production Schedule.

September Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant[a]	8.870	3.4360	2.582	0.0098
Futdif[b]	0.742	0.0535	13.872	0.0000
Cashs[c]	-22.858	4.1370	-5.526	0.0000
Setfut[d]	0.409	0.0607	6.738	0.0000

Minimum Risk Hedge Ratio	1.151
Likelihood ratio	18.369
Log-likelihood function	-152.051
Hedging Effectiveness	0.005

October Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	7.844	5.2140	1.428	0.1534
Futdif	0.772	0.0816	9.451	0.0000
Cashs	-28.680	6.3220	-4.537	0.0000
Setfut	0.478	0.0932	5.133	0.0000

Minimum Risk Hedge Ratio	1.250
Likelihood ratio	15.759
Log-likelihood function	-154.802
Hedging Effectiveness	0.005

November Feeder Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	2.411	7.5640	0.319	0.7499
Futdif	0.839	0.1165	7.195	0.0000
Cashs	-26.249	8.9110	-2.946	0.0032
Setfut	0.440	0.1306	3.371	0.0007

Minimum Risk Hedge Ratio	1.279
Likelihood ratio	15.509
Log-likelihood function	-161.729
Hedging Effectiveness	0.005

February Live Cattle Contract

Variable	Coefficient	Standard Error	t-ratio	Probability
Constant	-52.807	9.6800	-5.455	0.0000
Futdif	1.834	0.1458	12.584	0.0000

Minimum Risk Hedge Ratio	1.834
Likelihood ratio	48.048
Log-likelihood function	-180.964

a- This is the intercept of the regression equation.
b- This is the parameter name for the Futures difference $(F_t - F_{t+j})$
c- This is the parameter name for the intercept change dummy variable.
d- This is the parameter name for the slope change dummy variable.

TABLE 17

Test Statistics for Testing Hedge Ratios
Difference From 1.0 for a Winter Wheat
Production Schedule[a]

Long Run Contract	Steers 600-700	Steers 700-800	Heifers 600-700
March	-4.4885 (0.0003)	-6.8079 (0.0001)	-5.4885 (0.0001)
April	-1.8880 (0.0304)	-3.9528 (0.0045)	-4.6392 (0.0001)
May	1.9409 (0.0270)	-0.7198 (0.2363)	-4.2696 (0.0001)
August Live	4.3417 (0.0001)	1.3065 (0.0966)	1.9390 (0.0272)
Short Run			
March	0.6092 (0.2731)	-0.8504 (0.2003)	0.1369 (0.4459)
April	0.7859 (0.2186)	-0.7152 (0.2395)	0.2491 (0.4023)
May	0.6239 (0.2683)	-0.7996 (0.2145)	-0.1168 (0.4538)
August Live	5.0670 (0.0001)	4.1765 (0.0001)	4.6959 (0.0001)

a- Probabilities for the test statistics are in parenthesis

TABLE 18

Test Statistics for Testing Hedge Ratios

Difference From 1.0 for a Summer Grass

Production Schedule[a]

Long Run Contract	Steers 600-700	Steers 700-800	Heifers 600-700
September	2.4265 (0.0081)	-2.5435 (0.0059)	-1.3057 (0.0967)
October	-0.8419 (0.2005)	-2.7339 (0.0034)	-2.0739 (0.0198)
November	-0.2189 (0.4314)	-2.3234 (0.0106)	-2.0918 (0.0189)
February Live	-0.5421 (0.2942)	3.5072 (0.0003)	-7.7236 (0.0001)
Short Run			
September	1.6205 (0.1261)	0.8139 (0.2113)	1.3639 (0.0901)
October	2.1844 (0.0174)	1.6744 (0.0567)	1.4761 (0.0738)
November	1.8678 (0.00345	1.3296 (0.0956)	1.1605 (0.1264)
February Live	6.8447 (0.0001)	6.5242 (0.0001)	5.7202 (0.0001)

a- Probabilities for the test statistics are in parenthesis

TABLE 19

Test Statistics for Testing the Difference Between Hedge Ratios for the Different Weight Groups of Animals for a Winter Wheat Production Schedule[a]

Long Run Contract	600-700 pound Steers vs 700-800 pound Steers	600-700 pound Heifers vs 700-800 pound Steers
March	6.1905 (0.0001)	-51.2973 (0.0001)
April	9.5732 (0.0001)	-52.0816 (0.0001)
May	13.8069 (0.0001)	-61.0839 (0.0001)
August Live	25.1497 (0.1557)	3.8452 (0.0002)
Short Run		
March	5.2017 (0.0001)	4.1443 (0.0001)
April	5.4707 (0.0001)	4.0428 (0.0001)
May	5.0469 (0.0001)	2.9947 (0.0024)
August Live	5.4604 (0.0001)	4.7804 (0.0001)

a- Probabilities for the test statistics are in parenthesis

TABLE 20

Test Statistics for Testing the Difference Between Hedge Ratios for the Different Weight Groups of Animals for a Summer Grass Production Schedule[a]

Long Run Contract	600-700 pound Steers vs 700-800 pound Steers	600-700 pound Heifers vs 700-800 pound Steers
September	39.7105 (0.0001)	18.6081 (0.0001)
October	20.3203 (0.0001)	-20.2412 (0.0001)
November	21.1295 (0.0001)	-21.1873 (0.0001)
February Live	31.7840 (0.0001)	-108.9080 (0.0001)
Short Run		
September	3.6034 (0.0004)	3.3647 (0.0008)
October	2.9106 (0.0029)	2.2847 (0.0138)
November	2.2881 (0.0137)	1.4672 (0.0751)
February Live	4.5255 (0.0001)	3.7726 (0.0003)

a- Probabilities for the test statistics are in parenthesis

TABLE 21

Test Statistics for Testing the Differences

Between Production Schedules[a]

	Steers 600-700	Steers 700-800	Heifers 600-700
Long Run			
March vs September			
Test Statistic	-4.184	-3.616	-1.399
	(0.001)	(0.001)	(0.081)
April vs October			
Test Statistic	-2.561	1.586	-0.786
	(0.010)	(0.113)	(0.216)
May vs November			
Test Statistic	-1.943	-0.960	-0.412
	(0.052)	(0.337)	(0.340)
August Live vs February Live			
Test Statistic	5.632	5.920	9.258
	(0.001)	(0.001)	(0.001)
Short Run			
March vs September			
Test Statistic	2.389	1.242	0.653
	(0.009)	(0.109)	(0.253)
April vs October			
Test Statistic	2.481	0.981	0.937
	(0.007)	(0.164)	(0.175)
May vs November			
Test Statistic	1.355	0.923	1.082
	(0.089)	(0.179)	(0.143)
August Live vs February Live			
Test Statistic	5.982	6.808	-1.009
	(0.001)	(0.001)	(0.312)

a- The p-values for the test statistics are presented in parenthesis.

TABLE 22

Net Price Results From Net Return Simulation

for a Winter Wheat Production Schedule

Long Run		Ratio Hedges			Traditional Hedges			Cross-Hedging Ratio
Group	Cash	March	April	May	March	April	May	August Live
Steers								
600-700	75.94	74.17	74.04	73.99	73.67	73.85	74.18	74.14
	(10.63)	(9.77)	(9.81)	(9.35)	(9.76)	(9.80)	(9.41)	(9.53)
700-800	73.57	71.81	71.73	71.90	71.26	71.44	71.77	72.01
	(9.18)	(8.20)	(8.24)	(7.90)	(8.19)	(8.22)	(7.85)	(8.11)
Heifers								
600-700	69.41	68.32	68.24	68.21	66.99	67.19	67.56	67.81
	(10.73)	(10.05)	(10.07)	(9.74)	(9.76)	(9.90)	(9.45)	(9.63)
Short Run								
Steers								
600-700	75.94	73.30	73.37	73.77	73.67	73.85	74.18	73.50
	(10.63)	(9.82)	(9.84)	(9.30)	(9.76)	(9.80)	(9.41)	(9.43)
700-800	73.57	71.52	71.68	72.05	71.26	71.44	71.77	71.41
	(9.18)	(8.17)	(8.24)	(7.97)	(8.19)	(8.22)	(7.85)	(7.95)
Heifers								
600-700	69.41	66.95	67.10	67.60	66.99	67.19	67.56	66.96
	(10.73)	(9.87)	(9.90)	(9.46)	(9.76)	(9.90)	(9.45)	(9.44)

TABLE 23

Net Return Results From Net Return Simulation

for a Winter Wheat Production Schedule

Long Run			Ratio Hedges			Traditional Hedges		Cross-Hedging Ratio
Group	Cash	March	April	May	March	April	May	August Live
Steers								
600-700	22.73	20.91	20.79	20.74	20.41	20.60	20.93	20.88
	(4.01)	(2.38)	(2.26)	(2.62)	(2.74)	(2.35)	(2.52)	(2.23)
700-800	21.01	19.25	19.16	19.34	18.69	18.87	19.21	19.44
	(3.59)	(1.98)	(1.84)	(2.20)	(2.49)	(2.02)	(2.27)	(2.14)
Heifers								
600-700	24.56	23.47	23.39	23.36	22.14	22.34	22.71	22.96
	(3.35)	(2.08)	(1.96)	(1.88)	(2.56)	(2.05)	(1.93)	(1.74)
Short Run								
Steers								
600-700	22.73	20.04	20.12	20.52	20.41	20.60	20.93	20.25
	(4.01)	(3.14)	(2.76)	(2.79)	(2.74)	(2.35)	(2.52)	(2.57)
700-800	21.01	18.96	19.12	19.48	21.10	18.87	19.21	18.85
	(3.59)	(2.19)	(1.86)	(2.15)	(2.39)	(2.02)	(2.27)	(2.43)
Heifers								
600-700	24.56	22.10	22.25	22.75	22.14	22.34	22.71	22.12
	(3.35)	(2.62)	(2.13)	(1.90)	(2.56)	(2.05)	(1.93)	(2.43)

TABLE 24

Net Price Results From Net Return Simulation

for a Summer Grass Production Schedule

Long Run		Ratio Hedges			Traditional Hedges			Cross-Hedging Ratio
Group	Cash	September	October	November	September	October	November	February Live
Steers								
600-700	75.01	72.89	73.51	73.42	73.29	73.45	73.40	75.06
	(12.73)	(10.63)	(11.10)	(11.23)	(10.67)	(11.10)	(11.22)	(11.48)
700-800	72.73	71.21	71.40	71.35	71.01	71.17	71.12	72.77
	(11.49)	(9.64)	(10.03)	(10.16)	(9.60)	(10.04)	(10.18)	(10.46)
Heifers								
600-700	68.20	66.77	67.38	67.36	66.71	66.84	66.78	68.20
	(12.90)	(10.78)	(11.47)	(11.59)	(10.76)	(11.33)	(11.33)	(12.78)
Short Run								
Steers								
600-700	75.01	73.03	73.06	72.92	73.29	73.45	73.40	75.10
	(12.73)	(10.63)	(11.18)	(11.36)	(10.67)	(11.10)	(11.22)	(11.67)
700-800	72.73	70.91	70.91	70.78	71.01	71.17	71.12	72.81
	(11.49)	(9.59)	(10.14)	(10.32)	(9.60)	(10.04)	(10.18)	(10.64)
Heifers								
600-700	68.20	66.48	66.51	66.38	66.71	66.84	66.78	68.12
	(12.90)	(10.71)	(11.29)	(11.46)	(10.76)	(10.20)	(11.33)	(14.89)

TABLE 25

Net Return Results From Net Return Simulation

for a Summer Grass Production Schedule

Long Run		Ratio Hedges			Traditional Hedges			Cross-Hedging Ratio
Group	Cash	September	October	November	September	October	November	February Live
Steers								
600-700	15.72	13.60	14.23	14.13	14.00	14.16	14.11	15.77
	(5.98)	(2.93)	(2.46)	(2.67)	(2.31)	(2.52)	(2.69)	(4.18)
700-800	14.77	13.25	13.44	13.40	13.05	13.21	13.16	14.81
	(5.34)	(2.49)	(2.68)	(2.88)	(2.74)	(3.00)	(3.18)	(4.13)
Heifers								
600-700	17.97	16.67	17.24	17.22	16.61	16.78	16.69	17.95
	(5.83)	(2.20)	(3.03)	(3.28)	(2.24)	(2.74)	(3.01)	(5.97)
Short Run								
Steers								
600-700	15.72	13.75	13.78	13.64	14.00	14.16	14.11	15.82
	(5.98)	(2.64)	(3.25)	(3.53)	(2.31)	(2.52)	(2.69)	(5.76)
700-800	14.77	12.93	12.95	12.83	13.05	13.21	13.16	14.86
	(5.34)	(2.95)	(3.62)	(3.89)	(2.74)	(3.00)	(3.18)	(5.86)
Heifers								
600-700	17.97	16.41	16.48	16.34	16.61	16.78	16.69	17.77
	(5.83)	(2.60)	(3.50)	(3.84)	(2.24)	(2.74)	(3.01)	(10.87)

CHAPTER 5

Summary and Conclusions

5.1 Summary and Conclusions of Findings

The last four chapters have discussed and described the problem of price variability that Oklahoma feeder cattle producers face, previous studies examining this problem in other markets, theory used in developing the minimum risk hedge ratios used in this study, and the study results. This chapter will summarize the results of this study and contrast the conclusions drawn from the results of other studies.

Witt, Schroeder, and Hayenga summarize that there are three different approaches for calculating hedge ratios. These approaches are price level models, price change models, and percentage change models. These three approaches allow for a great deal of interpretation as to what type of data should be used in calculating hedge ratios. These approaches also allow for different levels of hedge ratios. Previous research has only focused on price level models, short-run hedge ratios. By calculating both a price level model and a price change model using the difference in the buying and selling price of the feeder cattle and futures contracts this study is able to address the question of what type of model and data should be used.

Long-run hedge ratios are calculated using the differences in the buying and selling price of the feeder cattle and futures contracts. These differences in the buying and selling prices are the returns from the cash and futures positions. By using cash and futures returns, this study has developed a set of hedge ratios that minimize return risk. This type of hedge ratio assumes that producers are more concerned about returns from the buying and selling of feeder cattle than just the final selling price of the feeder cattle and buying price of the futures contract. Long-run hedge ratios are more intuitive than short-run hedge ratios because of this assumption. Producers are more concerned about the returns than the final prices. Also, by using cash and futures returns this study solves the problem of what type of data should be used when calculating hedge ratios.

Long-run hedge ratios for steers and heifers using a Winter Wheat production schedule range from 0.454 to 1.028 with an average hedge ratio of 0.787. This suggests that a producer should hedge on average 78.7% of total production of feeder steers and heifers to minimize return risk. The average hedging effectiveness for long-run winter wheat hedge ratios is 76.7%. Long-run summer grass hedge ratios range from 0.589 to 1.232 with an average hedge ratio of 88%. Summer Grass hedge ratios are larger than Winter Wheat hedge ratios. This implies that basis risk is greater for a Winter Wheat production schedule. The average hedging effectiveness for the Summer Grass hedge ratios is 81.5%. This implies that hedging is more effective for a Summer Grass production schedule.

There are similarities between this research and past studies examining feeder cattle hedge ratios. The first similarity is the pattern of hedge ratios for the different weight groups of steers and heifers. Both the long-run and short-run hedge ratios for the 600-700 pound steers were larger than the hedge ratios for the 700-800 pound steers. This implies that a larger percentage of the 600-700 pound steers need to be hedged to minimize risk. Also, both the long-run and short-run hedge ratios for the 600-700 pound heifers were smaller than the hedge ratios for the 600-700 pound steers. This implies that there is more basis risk for hedging heifers. The second similarity is that the percentage of animals that needed to be hedged when using the short-run hedge ratios were generally greater that 100 percent. This implies that to minimize price risk a producer should hedge more than 100 percent of the actual physical commodity.

When comparing results for the long-run and short-run hedge ratios, some interesting observations can be made. First, the long-run hedge ratios are smaller than the short-run hedge ratios. Also, the long-run hedge ratios are generally less that 1.0. This suggests that a producer should underhedge to minimize risk.

Second, hypothesis tests were used to determine if the long-run and short-run hedge ratios are significantly different from 1.0, the traditional hedge. The results from this test show that generally hedge ratios are significantly different from the traditional hedge. Short-run hedge ratio suggest hedging more than 100 percent of the cash position while long-run hedge ratios suggest hedging less than 100% of the cash position. This implies that producers will minimize risk more by using a minimum risk hedge ratio than by using a traditional hedge.

Third, another hypothesis test was used to examine the difference between the hedge ratios for the 600-700 pound steers and heifers and the hedge ratios for the 700-800 pound steers, the specified weight group for the CME feeder cattle contract. The results from this test shows that there is a significant difference between the hedge ratios for the 600-700 pound steers and heifers, and the 700-800 pound steers. This implies that the percentage of cattle needed to be hedged depends upon the weight group and sex of the cattle that are going to be marketed.

Fourth, two different production schedules were used in calculating the long-run and short-run hedge ratios. The hypothesis test used in examining the difference between the hedge ratios for the two production schedule shows that there is a significant difference in the hedge ratios for 600-700 pound steers for all contracts and a significant difference in the hedge ratios for 700-800 pound steers and 600-700 pound heifers for some of the contracts. This implies that there is a difference in the larger hedge ratios between the two production schedules.

Results from the net price and net return simulation show that when using long-run and short-run hedge ratios the mean net price and net return decrease, but the standard deviation of price and returns are decreased as well. Long-run hedge ratios decrease the mean net price by average of $1.44/cwt. with an average reduction in standard deviation of price of 11%. Short-run hedge ratios decrease the mean net price by an average of $2.01/cwt. with an average reduction in standard deviation of price of 12%. Short-run hedge ratios decrease the standard deviation of price more, but long-run hedge ratios have the larger average mean net prices. Long-run hedge ratios decrease the mean net return by an average of $1.48/cwt. with an average reduction in standard deviation of returns of 47%. Short-run hedge ratios decrease the mean return by an average of $1.99/cwt. with an average reduction in standard deviation of returns of 38%. Long-run hedge ratios decrease the standard deviation of returns the most and have the largest average mean return.

The following conclusions are drawn from results of the net price and net return simulation. First, feeder cattle can be hedged effectively using contracts other than the nearby feeder cattle contract. For example, the best performing long-run contract hedge ratio for the 700-800 pound steers on winter wheat pasture was not the March feeder cattle contract, but rather the April feeder cattle contract. Also, feeder cattle can be effectively hedged using the live cattle contract. The best performing contract for the 600-700 pound steers on a winter wheat pasture was the October live cattle contract.

Second, even though the test for examining the difference between hedge ratios for the two productions schedules showed that there was not much statistical difference between all the hedge ratios for the two production schedules, the net return simulation models show that there is a difference in the reductions of the standard deviation of prices and standard deviation of returns. The summer grass long-run hedge ratios reduced the standard deviation of returns by an average of 47 percent. The same reduction for the long-run winter wheat hedge ratios was 32 percent. That is a difference of 15 percent between the two production schedules. Also, the average reduction in the standard deviation of price for the short-run summer grass hedge ratios was 13 percent, while the same reductions for the short-run winter wheat hedge ratios was 10 percent. For both the short-run and the long-run hedging applications, the reduction in the standard deviations of price and returns were greater for the summer grass production schedule. This implies that there is a difference between hedge ratios for the two production schedules.

Third, as expected, the long-run hedge ratios reduce the standard deviation of returns more than the traditional hedge and short-run hedge ratios, and the short-run hedge ratios reduce the standard deviation of price more than the traditional hedge or long-run hedge ratios. This implies that a producer wanting to minimize return risk should use the long-run hedge ratios and a producer wanting to minimize price risk should use a short-run hedge ratio. Along these same lines, the net price and net return simulation shows the difference in reductions in standard deviation of price and standard deviation of returns. The average reduction in standard deviation of returns for both production schedules was 42 percent while the average reduction in the standard deviation of prices was 12 percent. This suggests that hedging is effective from the long-term perspective.

5.2 Weaknesses and Research Opportunities

There are a number of factors which have been ignored in order to make this issue a researchable problem. These factors are weaknesses and limit direct application of the results by Oklahoma feeder cattle producers. However, these weaknesses represent opportunities for more detailed future research.

The calculated hedge ratios represent the percentage of total production a producer should hedge in order to be at point Z on the EV frontier (Figure 5). This point represents the risk minimizing point on the EV frontier. Therefore, a producer using these hedge ratios is assumed to be a risk minimizer. This risk preference may not describe most producers. Usually producers will accept higher risk for larger returns than offered by the risk minimizing solution. Therefore, hedgers may not follow the results of this study exactly. Intuition suggest producers should hedge less than the estimated hedge ratios. However, this study provides a reference point for this decision.

Variable costs such as feed, land rent and transportation are ignored because the variance of such costs are assumed to be minimal and covariances between these costs small. This may not always be the situation. For example, bad weather may cause the producer to purchase more feed or higher fuel prices may cause the cost of transportation to increase. These occurrences cause the covariances between such cost and cash returns to increase which in turn cause the hedge ratio to decrease.

Other costs such as commission costs involved with buying and selling of futures contracts and margin money requirements are ignored. By ignoring these costs the hedging returns used are larger than normal hedging returns. If these costs were factored in the direct hedging costs would increase causing the hedge ratios to decrease.

Another weakness of this study is that it assumes that the size of the feeder cattle operation is large enough to be able to hedge using the feeder cattle contract. By assuming this the issue of the lumpiness of the CME feeder cattle contract is ignored.

The last weakness of this study is that it limits the enterprises available to only feeder cattle and risk management to the trading of commodity futures contracts. Therefore, diversification through other agricultural enterprises and other risk management tools are not considered. By developing whole farm budgets and using a quadratic program to solve for the risk minimizing solution, this weakness as well as other weaknesses involving ignored costs can be addressed. Also, by using a quadratic program solution the less risk averse preferences of the producer can be addressed.

5.3 Contributions

By calculating long-run and short-run hedge ratios this study has provided two alternative measurements of the percentage of total production a producer should hedge in order to minimize risk. The long-run hedge ratios provide information on what percentage to hedge to minimize return risk and short-run hedge ratios provide information on what percentage to hedge to minimize price risk. Previous studies have only focused on calculating short-run hedge ratios and therefore only focusing on minimizing price risk. By calculating long-run hedge ratios this study provides some new information about hedging to minimize return risk. This information may be most useful to producers. Also, this study examines hedging using contracts other than the nearby feeder cattle contract. By examining the effectiveness of using other than the nearby feeder cattle contract this study shows that feeder cattle can be effectively hedge using contracts other than the nearby feeder cattle contract. This study has also shown that feeder cattle can be effectively hedge using the live cattle contract.

By calculating the net price and net returns results, this study has provided some results on the level of net prices and net returns that can be expected from hedging in relationship to the cash net price and return. These type of results have not been presented by previous research. These results provide useful information to the producer on how effective using hedge ratios are reducing the amount of price and return variation faced by Oklahoma producers.

Overall, this study has provided some new and basic information for Oklahoma extension personnel and producers on what percentage of the total cash position stocker steers and heifers should be hedged with feeder cattle contracts in order to manage risk.

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Candidate for the Degree of

Master of Science

Thesis: MINIMUM RISK HEDGE RATIOS FOR OKLAHOMA FEEDER CATTLE

Major Field: Agricultural Economics

Biographical:

Personal Data: Born on August 27, 1969, the son of Glenn D. Stroud and V. Imogene Stroud.

Education: Graduated from Alex High School, Alex, Oklahoma, in May 1987; received Bachelor of Science Degree in Animal Science from Oklahoma State University in December, 1991; completed requirements for the Master of Science Degree at Oklahoma State University in May, 1994.

Professional Experience: Research Assistant, Department of Agricultural Economics , Oklahoma State University, January 1992 to November 1992; Graduate Assistant, Department of Agricultural Economics, Oklahoma State University, December 1992 to March 1994.