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Risk Return of Farmer-Elevator Contracts for Soybeans and Corn in Arkansas

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Abstract

In Arkansas the contribution of Agriculture to the states GDP is comparatively high. To help farmer's return risk the grain industry developed several marketing tools to support farmers. Literature in this research field finds different results for different locations, commodities, marketing tools and marketing years. As Agriculture in Arkansas is important for its economy this study focuses on soybeans and corn produced in the fertile north-eastern area of Arkansas that uses Memphis Tennessee as a spot market palace. The examined marketing tools are pre-harvest futures hedges and forward contracts as well as post-harvest storage strategies and minimum price contracts. All those strategies are compared with the base strategy of harvest cash sales. Additionally, a profit margin rule with three targeted cost of production (COP) coverage levels are applied to each marketing tool resulting in 13 separate marketing strategies. The COP levels chosen are 100%, 125% and 150%. Using a simulation approach, 48000 daily price sequences are generated based upon historical price observations from 2001 to 2012 to reflect a range of potential representative market conditions. So, for each pre-harvest and post-harvest marketing year 1000 iterations of daily cash and futures price sequences are simulated for each commodity, and 312000 net returns across all strategies created. These net returns are grouped by strategy into 12 observation/year samples and 26000 sample mean net returns and sample standard deviations of net returns are measured. An ANOVA analysis is employed to provide parameter estimates for the categorical variables, commodity type and marketing strategy. The results indicate that pre-harvest marketing strategies, on average generate higher net returns than cash sales at harvest. The post-harvest strategies show a good reduction in the average standard deviation of net returns but with lower average mean net returns compared with selling the un-hedged cash crop at harvest.

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With kind regards,

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Chapter 1 Introduction

Agriculture and farming are traditionally major parts of the economy. In modern times with a more and more globalized world and economy it is getting more complicated for farmers to generate an appropriate income for their farming activities. The exposure to changes in economic conditions causes different risks for farmers. Two of the most important risks are price and return risks. The grain trading industry offers a large number of marketing contracts that may be used by farmers to increase returns and or decrease return risk. However, there is not a well developed literature that has specifically examined the relative risk return merits of elevator based marketing contracts. It is the primary goal of this thesis to address this important issue.

In the USA agriculture and related industries still contribute 4.8% to the national GDP in 2011, whereby only 0.9% comes from farmers. But the 0.9% of the GDP in 2011 represents the output of 2,635,000 people employed in farming activities. [1]

In Arkansas the contribution of agriculture to the state's GDP is much higher at 10.81%. [2] Arkansas is the biggest producer of rice in the US and was ranked second in broilers production in 2010. The 2012 production rank for Arkansas produced corn is 14th within the USA and represents 123,710 (1000 bushels).[3] For soybeans, 2012 production is ranked 9th within the USA with a production total of 135,880 (1000 bushels). Agriculture in Arkansas provides employment for 256,244 people, which represents one out of six jobs in Arkansas.

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[1] Source: Economic Research Service USDA, http://www.ers.usda.gov/faqs.aspx#howimportant, as of May 5, 2013

[2] Source: University of Arkansas Division of Agriculture Research and Extension, Economic contribution of Arkansas Agriculture 2012

[3] Source: National Agricultural Statistics Service USDA, Crop Production 2012 Summary, January 2013

Farming and agriculture are subject to risk and uncertainty, and those involved in agriculture should be aware of the risk to which they are exposed. Crop production agriculture faces two major types of risk and uncertainty. One of the two risk types is production risk. This type of risk can be addressed to varying degrees of success with crop insurance. This risk is related to weather and climatic disasters like droughts observed in the US in 2012. In general this type of risk is hard to predict and there are many factors that contribute to the risk in agricultural production process. The second type of risk that farmers, consumers and the food industry need to deal with is price risk. Prices for agricultural commodities have been very volatile in recent years. Volatile prices have also occurred in recent years in agricultural input markets. Output and input price volatility is hard to predict but have a major influence on net returns over the costs of production (COP). Prices volatility is attributed to supply and demand shifts, production shortfalls, currency exchange rate changes and many more economic reasons. Every marketing decision a farmer makes has consequences for the future. Volatile prices and recent changes in government agricultural policy in addition to risk averse behavior increases the demand of risk management and supportive marketing instruments in the agricultural sector. Risk averse behavior is different for every individual but in general individuals are willing to trade off a share of their risk for a lower return.

In the past, governments controlled supply and farm prices with their policies. Changes due to standards of the World Trade Organization pointing to unbiased trade leave more and more farmers exposed to a higher level of risk. Mostly affected from the policy changes are farmers in Europe and the US. The less governmental support puts higher pressure on the farm operator to control risk factors and secure prices and income. Over the years the grain industry has adapted to increased risk and offers various marketing contracts to control risk and uncertainty.

1.1 Thesis Statement

In the last decades many different farmer-elevator contracts have been initiated by the grain industry. Farmers make use of these marketing contracts to earn higher returns and or lower returns risk. A United States Department of Agriculture (USDA) survey conducted at the beginning of the last decade shows that the use of marketing contracts in agriculture has increased in over time. The percentage of farms that use marketing contracts increased from 6% in 1969 to 11% in 2001[4].

The increasing use of contracts in grain marketing comes with an increased need to find the most efficient way to use grain marketing contracts. This thesis compares the use of pre-harvest, harvest and post-harvest grain marketing strategies. Cash sales during harvest time will be used as benchmark to compare the risk returns of the other two post- and pre-harvest options. For the pre-harvest marketing period the thesis examines futures hedge strategies and forward contracts to log in prices prior to the harvest of the crops and their delivery. After harvest, in the post-harvest marketing period, the thesis will investigate storage strategies and minimum price contract strategies.

This thesis focuses on corn and soybeans as they are two of the most important crops grown in Arkansas and are subject to farmer-elevator marketing contracts. The thesis builds upon

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[4] MacDonald, J., Perry, J., Ahearn, M., Banker, D., Chambers, W., Dimitri, C., & Southard, L. (2004)

historic secondary data taken from the USDA Agricultural Marketing Service (AMS) homepage[5] from 2000 to 2012 and will use prices offered by average elevators surveyed in Memphis. Memphis is the reference point for spot market prices received by farmers in the corn and soybeans production areas in north-east Arkansas, which are close to the Tennessee border.

Results are based on historic and simulated price data and evaluated using a regression based Analysis of Variance approach. The outcomes could be used by Arkansas row crop farmer's to make better risk management decisions. Corn is becoming a more and more important crop for Arkansas and Arkansas is ranked 18th among corn producing states for cash receipts in 2012 by Economic Research Service (ERS) department of the USDA. The state is ranked 9th in the production of soybeans among the American States based upon ranking for cash receipts in 2012[6]. Seen from the states perspective soybeans are the 2nd most important grain and corn is ranked 5th in the dataset for Arkansas leading grains for cash receipts in 2012.[7] As agriculture is a major contributor to the economy in Arkansas this study should be helpful for many farmers in their decision-making process.

Elevators and extension service can use this thesis as a guideline for recommendations to their customers and for their decision making process in what marketing contracts and options to offer to their customers.

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[5]http://marketnews.usda.gov/portal/lg?paf_dm=full&reportConfig=true&paf_gear_id=4300017&category=
Grain

[6] Economic Research Service USDA, http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/cash-receipts-by-state.aspx#.Uii3y8ashcY, as of August 28th 2013

[7] Economic Research Service USDA, http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/value-added-years-by-state.aspx#.Uii2csashcY, as of August 28th 2013

1.2 Objectives

This section gives an overview of the general and the specific objectives elaborated in this thesis.

1.2.1 General Objective

The general objective of this thesis is to examine the effectiveness of grain marketing strategies in conjunction with different targeted COP coverage levels in increasing average net returns and reducing the average risk of net returns for corn and soybean producers in north-east Arkansas.

1.2.2 Specific Objectives

- To develop net return and risk profiles for a representative farmer producing corn and soybeans in north-east Arkansas based on simulated prices applied to alternative marketing strategies on a cents per bushel level. The alternative marketing strategies examined in this study include harvest time cash prices sales, pre-harvest futures hedges, pre-harvest forward contracts, post-harvest storage strategies and post-harvest minimum price contract strategies. All marketing strategies are implemented under a profit margin decision rule based on covering targeted cost of production COP levels of 100%, 125% and 150%.
- To rank the various outcomes after the alternative marketing various statistical tools are applied to the simulated net returns. Rankings are based on average mean net returns and average standard deviations of net returns for the various marketing strategies over simulated 12 year samples from 2001 to 2012.

1.3 Summary of Procedures

This study is based on secondary historic price data for the area in north-east Arkansas that is using Memphis as a reference market for cash sales. The thesis is built upon price simulations for cash and forward prices in Memphis, Tennessee and simulated futures prices based upon historic observations for corn and soybeans. @Risk is an Add-in for Microsoft Excel © that is used to simulate the prices. Historic prices upon which the simulations are based were collected from 2001 to 2012 from the Agricultural Marketing Service (AMS) of the United Stated Department of Agriculture (USDA) for Memphis, Tennessee[8]. Historic futures prices are taken from Chicago Board of Trade (CBOT) and were collected for soybeans and corn respectively. The CBOT data was purchased from Bridge Commodity Research Bureau.

The simulated prices are used to apply the alternative marketing strategies that are subject to the targeted COP level that the farmer wants to cover. This thesis examines 100%, 125% and 150% targeted COP levels for each strategy. The examined strategies are selling in cash market at harvest, futures hedge, forward contract, storage strategy and minimum price contracts. Net returns on cents per bushel basis are measured after subtracting the costs of production COP from the respective prices received from using the various marketing strategies. The COP data that represents the COP for each year for each commodity in Arkansas over the 2001 – 2012 period were provided by the University of Arkansas Cooperative Extension Service (CES) and are transformed from a dollar per acre measure to a cents per bushel basis for ease of comparison across the marketing strategies.

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[8] AMS USDA Homepage: http://marketnews.usda.gov/portal/lg

Chapter 2 Literature Review

Risk in agriculture appears in many ways and has an omnipresent character especially in yields, commodity prices and marketing. In the marketing of agricultural commodities research is conducted to find strategies to reduce price and return risk for farmers and increase to their net income. This chapter consists of four parts. The first part provides an explanation of the types of risk in agriculture. Following the risk explanation is the description of different methods applied in agricultural marketing to cope with its risky environment. In the third section the processes of simulation in agricultural marketing research is reviewed. The final part gives an introduction to the methods used to evaluate the results of this study.

2.1 Risk in Agriculture and Risk Management

Hardbaker et al.(2004) see risk as the unknown consequences and uncertainty as lack of perfect information. Risk is defined due to Hoag (2010) as making a decision that is putting a business in a situation that is based on an uncertain future outcome. The returns out of that business decision are supposed to outweigh the risk taking. This payoff can be captured in net returns and the probability for the payoff occurrence can be measured in the coefficient of variation and the standard deviation.

Risk that farmers are facing in agriculture can be very different. Wisner (1996) sees different types of risk that the farmer is exposed to. The first one is the production risk, which is mainly influenced by weather, natural phenomena and other factors that are relevant for the production of agricultural goods. Secondly there is the price risk the farmer needs to deal with when marketing his grain or livestock products. Price risk is simply the insecurity of how high the market price of the produced commodity will be at harvest. The most common price related risk is price-level risk and it is one of the most net return affecting ones for the farmer. Price–level risk simply expresses the risk of futures prices to change the direction of the present level. Another risk related to price is the basis risk. Basis is the difference between the local cash market and the futures market and tends to vary geographically. Basis risk is the change of the basis in an unfavorable way due to transport cost changes for instance. The risk of volatility of the market is a risk that should not be forgotten about using a minimum price contract. The last type of risk, when considering risk management via a grain marketing contract, is the counterparty risk. Under certain conditions the buyer of the produce may not be able to fulfill all the agreed contract obligations.

One reason for increased demand for risk management strategies to handle price risk is the change in policies related to agriculture all around the world, especially during the 1990s, when policy changes lead to increased volatility in agricultural markets as Tomek (2000) points out. In 1996 with the new farm bill, the US government gave up its strong role in risk management with a strict change in its farm programs. Wisner (1996) sees this especially in the US as a driver of increased risk in the marketing of grain. A big contribution to increased risk can be linked to the decrease or abolition of government supported grain storage to stabilize prices and the deficiency payments elimination of other price support systems in developed countries. Attended by new information systems, broader use, and availability, the grain industry developed different grain marketing contracts to help farmers manage their risk in grain marketing.

According to Hagedorn et al (2003) grain marketing has a challenging nature and farmers are often not very satisfied with their marketing returns. This is can explain why price risk management contracts are more and more demanded by producers. Zulaufet al. (2001) see farmers constantly on the search for risk management tools and strategies to increase returns.

2.2 Marketing Strategies in Agriculture

The reduction of the variance of the net income, the increase of net returns of farmers and also the cash flow requirements that the farmer faces in order to run his farming operation are the aims of marketing strategies in the marketing of commodities. This study does not use a whole farm approach like many previous studies have done. This is the reason why cash flow needs are neglected for his study. Various research has been conducted on marketing strategies in an agricultural context. This section will introduce the most relevant prior findings for this thesis.

Marketing in agriculture is divided in three different periods. Welch and McCorkle (2009) name them pre-harvest, harvest and post-harvest. Many different strategies for pricing grain can be considered to give the farmer the best possible outcome of his marketing activities. They recommend splitting sales to pre-harvest and post-harvest to have the best chances to reach target prices. Target prices can be derived from the cost of production (COP). The minimum goal of the famer should be to cover his COP, as we assume them profit maximizers. Welch and McCorkle (2009) list several options for post-harvest marking. Storing grain as speculative storage, replacing cash with futures, forward cash contract, storing grain and selling futures also known as a storage hedge, a forward basis contract and sell cash and buy call option.

Stone, Warner and Whitacre (2011) examined the demand for risk management tools offered by elevators. They found that country elevators try to differentiate themselves from other elevators by the variety of cash grain marketing contracts they offer to grain producers. Elevators offer contracts as simple cash grain forward contracts, minimum price contracts or even new generation grain contracts. The latter one will be not tested in this thesis. Stone, Warner and Whitacre (2011) also found that in a survey among grain elevators in Illinois in 2006 and 2011 that cash forward pricing contracts accounted for 69 % and 63 % respectively of all contracts offered as risk management tool to farmers. They also found in their survey of grain elevators that minimum price contracts are not highly demanded by farmers. Their usage comprises only 5% of overall farmers-elevator contracts.

Agricultural economists and extension personal in agriculture recommend the usage of derivate instruments in order to reduce the price risk in commodity marketing decisions. In agricultural production the decisions of what to produce and how much of it are made a long time before the prices for the commodities at harvest or time of sale are known. To cope with that risk elevators developed contracts for farmers to reduce the risk they are exposed to. Two of the longest used derivate instruments are forwards and futures contracts. Power and Turvey (2008) see an advantage in forwards for farmers as they are made tailored for the farmer. They are still under demand by farmers even if more and more complex price risk management contracts are developed. It seems that the risk of the forward contract is mainly to be carried by the farmer as the fees he has to pay for the forward contract can be higher than for a futures hedge.

Further for pre-harvest marketing Brorsen (1998) summarized the research situation with researchers seeing advantages in the utilization of risk management strategies and researchers that doubt that marketing strategies can help the farmer decrease his risk or increase his income significantly. On the side of researchers finding significant advantages of the usage of a marketing tool are Zulauf et al. (2001). They could not find any statistically significant advantage of pre-harvest marketing strategies in Ohio for corn in the period from 1986 to 1999. But they find an advantage in reducing risk, and slightly better returns, even if not significant. They conclude for farmers targeting on returns enhancement to look for alternative strategies than marketing tools to reach their target. In a later study Zulauf and Irwin (1998) explain themselves more clearly. In 1998 they examine routine and systematic marketing strategies to test marketing strategies with regard of the efficient market strategy. The study proved that the efficient market hypothesis holds and producers can usually not generate a better income over time with using the same marketing strategy. Beating the market is only possible for market participants with superior knowledge or good skills in market analysis. They conclude that the cost of production is a major factor to manage the returns for the farmer and that in the long view those farmers with the lowest production cost will be able to last longest in the market. Further they recommend using the futures market as a price source of information for the farmer to base decisions for conservative marketing strategies like storage under certain conditions.

These findings Zulauf and Irwin (1998) made are contrary to most recommendations made by extension economists and conventional wisdom and probably the hope of most producers. Research that finds statistically significant results was inter alia conducted by Wisner, Blue and Baldwin (1998), who tested the performance of pre-harvest marketing strategies, in comparison to harvest sales, for corn and soybeans in risk management. They were testing their performance in returns for model farms in Ohio and Iowa. The study assumes that prices that are fixed before the harvest period is closed are based on the cost of production and covering these costs. Alternative marketing strategies for this pre-harvest study include routine hedges and option variations for short crop years and normal crop years. This study found differences for the two locations chosen for the model farms in Iowa and Ohio. The findings for the performance of the pre-harvest marketing strategies include statistically significant differences for increased net returns compared to the base strategy for 9 out of 20 soybean strategies. All of them include options. The same observation holds for corn. Only options including pre-harvest strategies show statistical significance. This study concludes that pre-harvest marketing strategies that use options as a price floor might be a good chance for educated farmers to generate better incomes compared to harvest cash sales.

A study on storing grain post-harvest with efficient futures was conducted by Kastens and Dhuyvetter (1998) based on a 13 year historical sample in Kansas for multiple locations in Kansas and different commodities, including corn and soybeans. Based on expected profits of storage their simulation model shows a yearly increase in profits for storing of soybeans of 23.3 cents per bushel but reduced profits by 8.2 cents per bushel per year for corn.

Also Peterson and Tomek (2007) investigated the grain marketing risk management tools performance with respect of the efficient market hypothesis. General recommendations by extension economists to use risk management tools for the marketing of the main cash crops even though it is not sure that the use of the marketing strategies really can increase the mean income of the farmer or reduce the variance or the returns. In general, marketing strategies can be separated in diversification of sales or in forecast of price changes. With the use of futures, forward contracts and option markets it is possible to sell shares of the grain production already prior to harvest or extend the marketing period in contrary to a cash sale at harvest. The study uses simulated prices to compare the achieved returns of price risk management tools. 40 year samples are used to imitate the lifetime of a farmer. The marketing tools are spread into four groups. The first one is diversification of sales, the second one is hedging with futures in the pre-harvest period. Group three is focuses on post-harvest marketing sales and the last group uses speculation based on futures price forecasts. The results show that the efficient market theory applies to the simulated data, as none of them could beat the market and achieve higher net returns on a constant basis. In general many of the marketing tools were able to lower the standard deviation of returns, so reduce the risk but on the other hand they also lowered the average mean return of the farmer in comparison to selling the grain at harvest. It is still possible that single strategies in single years provide a lower standard deviation and a higher average return.

Neyhard, Tauer and Gloy (2013) assessed different price risk management strategies from a whole farm viewpoint. To evaluate the strategies, price paths computed with the simulation add-in @Risk for Excel are drawn from fitted price distributions. The study focuses on covering the costs of the business or in other words the coverage of the positive cash flow needs, what would guarantee that the business can stay in operation. The focus in this study is in dealing with the price risk for milk prices and feed prices, feed components here are corn and soybean meal. Income from milk production was set in relation to feed costs to evaluate the financial performance of the dairy farm. Price risk management tools are used when the prices generated in the simulation outnumber the margin triggers. The farmer sticks with its cash position if the simulated prices do not meet the margin requirements before the close out of the matching hedging contract. If the simulated prices provide a positive margin on any trading day the hedge is executed and held until the expiration of the nearby contract. The hedge options used in this study were a futures hedge or a European option contract. For this study hedging reduce the net income of the model farm and it also reduced the variation of the net income. As the study also considers debt status of the farm, and one observation is that as farm debt rises the use of risk management tools increases in order to protect a bigger proportion of the net farm income. The incentive for farms with higher debt might have a greater inventive to use risk management tools as the costs for those tools are relatively stable. The highest expected income could be realized with cash marketing strategies that came on the other hand with the biggest variance in net farm income. On average the highest marketing costs were observed when using futures that on the other hand provided the best reduction in income variance. The option contracts had a lower variance in the cost for the risk management than the futures but the reduction of the income variance was also not as big, but the minimum price security is given, even though with, in general, lower achieved income.

A study about the effectiveness of alternative marketing strategies in Ontario Canada by Vyn (2012) found similar results like studies conducted in the United States. The study was conducted using simulation based on historic prices observed in southwestern Ontario from 1992 to 2009. The simulation was used to compare the returns and risk for different pre-harvest marketing strategies for corn and soybeans in higher and lower price years. The tested pre-harvest marketing strategies are forward contracts, basis contracts, futures contracts and option contracts; each of them was compared to the cash sales at harvest. The study found the most statistically significant deviations from the base case returns were observed within strategies involving forward sales. Probably due to high option premiums this strategy was found to have the smallest price escalations. In general for both commodities the statistical significance is quite low for increased returns for most of the marketing strategies in most years in comparison to the base case of sales at harvest.

2.3 Simulation of Agricultural Prices

McKenzie and Kunda (2009) used a simulation to generate futures prices for a study of price risk management of the view of an elevator for time periods when prices are volatile and margin calls might become a big issue for elevators. With their simulation approach they created daily sequences of new crop December corn futures prices for hypothetical years. They start their crop year each beginning April 1st and then simulate prices until contract maturity at December 1st. Their simulation of futures prices for hypothetical crop years is derived from historical data of corn futures prices. The simulation is based upon historical observations for corn prices for two different periods. The first one 1996-2008 represents normal price volatilities over the marketing periods. The second one is 2006-2008 was picked to represent a time when price volatility was unexpectedly high. The assumptions for this simulation include log normal distribution of the daily futures price changes due to the Black-Scholes and Merton model and that the futures daily price changes follow Geometric Brownian Motion. Futures prices are also assumed to follow the efficient market hypothesis that supposes current futures prices to be the same at contract maturity. The standard deviation is derived from the expected annual volatility from the two historic data collection periods.

In the past the increase of return or the decrease of income variability were sought through the analysis of price patterns in certain time periods. In the past years the research changed to a better approach that fits better to general scenarios than price patterns that occur only under certain conditions. Neyhard, Tauer and Gloy (2013) use the financial literature log normal model. This means daily prices are computed by a data generator function. Historic price information is used to estimate the distribution of prices and volatility. The starting price is also picked randomly from the given distribution that all iterations start off with a random price following daily prices drawn from a distribution as well.

Peterson and Tomek (2007) used a model created for the US corn market by Peterson and Tomek (2005) that is based upon the rational expectation storage models for grains as created by Williams and Wright (1991). The model used is based on parameter values collected in a base period from September 1989 to August 1998. 40 years of monthly prices for cash and futures prices were simulated under the modeling assumption of market efficiency.

To evaluate hedging effectiveness McKenzie and Singh (2011) used a Monte Carlo simulation approach to generate simulated short futures hedging returns, speculative short-futures and cash returns and to evaluate if futures hedges can reduce the price risk for corn and soybeans around U.S. Department of Agriculture Crop reports. Price estimates were calculated for a 11 day period around the release dates for the Crop reports. Cash price return series and futures returns turned out as uncorrelated stochastic variables. The multivariate empirical distribution based on historical data provided 1000 iterations. For better comparison 1000 iterations of cash and futures returns were also drawn from a multivariate normal distribution where the first two moments were based on historical return data.

The simulation model used by Vyn, 2012 is slightly different from previous approaches as the prices are randomly selected from a date. The sold quantity is also not fixed to a specific date where the whole production is sold but drawn from a specified range for specified marketing periods. This range is influenced by the possible coverage of cost of production. Benchmarks for cost of production coverage and sales are 95% for a low amount sold and 105% coverage to select the simulated amount of sales from the top third. From all simulation models

1000 iteration were generated. The prices generated for the 18 years are than averaged for each of the iterations. Then for each strategy, simulation data is further used to compare returns per bushel for corn and soybeans and not like in other studies tied to a whole farm approach that also takes cash flow needs and yield risk into account. The study tested for 516 mechanical marketing strategies and one additional dynamic strategy that is based on prices at certain common marketing times in the pre-harvest marketing period.

2.4 Methods used to measure the Effectiveness of Marketing Strategies

Aiming on supporting the decision maker in his marketing decisions for the sales of his production there are a couple of methods available that help to evaluate the performance of risk management tools. The outcome of the simulation and the application of the marketing strategies need to be presented to the user to let him understand the most qualified strategy for his purpose. The optimal method to measure effectiveness of a marketing strategy presents in an easy way the highest average net return or lowest risk expressed in a low standard deviation. Richardson (2002) describes the most important strategies.

Rankings of the outputs of analyses after a simulation are a commonly used method and easy to implement. The mean only method creates a ranking by outcome of the key variable. The ranking can line up results from best to the worst. The results only respect the output variable that they are ranked after. For instance when ranking outcomes of net returns, risk is not considered.

The method of ranking can be applied the same way for the evaluation of risk, but in this case without respecting the net return results. When ranking the risk component of a study, usually the standard deviation, it is more desirable to rank the outcome parameter from low to high as a low risk level is to be preferred over high risk scenarios.

Another strategy evaluation approach that considers the relative risk and net returns is the relative risk returns associated with a specific marketing strategy, also known as the coefficient of variation (CV). This strategy is ranked like the mean only method and the standard deviation. The CV is calculated as the absolute ratio of net returns and risk ($CV = \sigma/\mu$). The output can be transformed to percentage values, and a lower value is more desirable. The CV is especially interesting informative if results in different units have to be compared. CV is used inter alia by Cox (1976) to eliminate price level effects in his study.

Chapter 3 Methodology and Data Considerations

This chapter describes the methods that are used in this thesis and is divided into five parts. The first part describes the ways that grain is usually marketed. The second part describes the price simulation procedures and the mechanics of the various marketing strategies. Part three explains how the net returns were generated. Part four describes the Analysis of Variance (ANOVA) regression approach used to model the net returns data. The last part of the chapter describes the data used in the analysis.

3.1 The Agricultural Grain Marketing Channels

The agricultural grain marketing channel describes the various stepping stones grain takes on its journey from the producer to the final consumer.

The first position in the marketing channel is occupied by the farmer. Before the growing season begins he makes decisions what to produce and in which quantities. The first step in the decision making process is influenced by the limiting factors time, money and available land for production as well as various other individual limiting factors that have to be considered by the farmer. Also farmers might have to take into account their own personal demand for food, feed or seeds that they want to cover with their own production. Right after the farmer has made his planting decision or even earlier, he has to take the next decisions in his overall business plan. Those decisions are his marketing decisions for his prospective grain production. The options farmers have are various. In general grain can be marketed pre-harvest, at harvest or post-harvest. The post-harvest option means that the farmer needs to store the grain in his own facilities or he has the option to store the grain at an elevator. Another option after harvest when the grain has already changed ownership title is the minimum price contract that allows the farmer to participate in potentially higher market prices.

3.1.1 Grain Elevators

Every agricultural product usually has several owners before it reaches its final consumer. Very important stations on this way are the agricultural elevators. These play an important role for farmers, the sellers of agricultural produce, but also for the buyers of grains who further process, use as feed, or re-sell commodities. All grains that are not used to feed livestock on the farm are sold, during harvest or after some storage time, and usually the first buyer is an elevator.

Three different types of elevators can be identified. One of the two categories is the big terminal elevators. Those usually satisfy their grain demand while buying from country elevators. Country elevators on the other hand are usually smaller and are located all over the countryside. They buy grains from farmers and supply the various types of grain users. A good transport infrastructure is a huge advantage for country elevators and they can usually be found along railway lines or waterways. Terminal elevators in contrast can be found in marketing centers like Kansas City. Cramer and Wailes (1993) define elevators as terminal elevators, when they buy more than 50% of their grain form other elevators. A sub-terminal elevator differs only in its location from terminal elevators, and typically can be found close to major urban areas and on waterways.

To classify country elevators there are different options. According to Kohls and Uhl (2002) there are three classes of elevators, the first form is the elevator that is owned and run by a single and independent owner. This form is called independent elevators. The second option is that the elevator is under control of a cooperative or farmers that are organized as a cooperative. If several elevators are operated by the same operator they are called line elevators. This is the third form of an elevator. These lines elevators can supply larger amounts of grain to buyers, which may have their own food processing or manufacturing plants. Processors or mills can own line elevators themselves for better planning and supply of their own demand.

3.1.2 Grain Storage

Many farmers store grain in a routine like manner. The main idea behind this behavior is to obtain a higher price later in the year after harvest time, which for grains like corn or soybeans usually occur each fall in the US or during spring time prior to the next harvest. This is how the producers try to capture seasonal price changes. However, the farmer should never forget that storing grain comes with a cost. Even if the farmer has on farm grain storage opportunities he still faces the issue of forgoing liquid/working capital for his business by delaying the decision to sell, and he will incur the costs associated with maintaining the stored grain such as the risk of shrinkage or quality changes. But on the other hand the farmer has the full marketing control over his produce and can sell at any time to any willing buyer – typically some form of elevator.

The second option for a farmer who is willing to store grain is to store it at a commercial storage facility, an elevator. Here he only needs to handle his grain once, when he delivers to the elevator at harvest. The storage has to be paid on a daily basis but the farmer is not responsible for shrinkage or damage risk anymore. Lorton and White (2007) give a formula how to calculate storage costs for elevator managers. The cost-of-carry can (COC) be calculated as followed:

$$COC = EOP * RIR * \frac{number\ of\ days\ of\ storage}{360}$$

Where EOP stands for estimated opportunity price (estimated cash sales price at the beginning of the storage period). RIR is the real interest rate, and is comprised of the St. Louis Federal Reserve prime interest loan rate, plus an additional 2% to cover miscellaneous costs like shrinkage and maintenance, to account for the opportunity costs of storing grain. The 360 represents the days in a bank year. In this study, the 2% additional interest expense to cover shrinkage etc. is assumed to be charged to the farmer and in reality would be charged as a storage contract fee.

3.1.3 Ends of the Marketing Channels

As grain passes further down the marketing channels it may take different routes. Grain merchants, processors, feed mills, flour mills and ethanol production companies are only a few examples of further options and final destinations for grain. Sometimes grain only has different owners on paper before really changing its physical location.

3.1.4 Farmer Elevator Contracts

With the increasing demand for risk management instruments by farmers for their agricultural products the grain industry developed several risk reducing tools that they offer to their customers. Over the years various different instruments were developed that are now sold to the farmers for a service charge. They can be used for the whole amount of the farmers harvest or only for shares of his production and several of those methods can be combined to construct a low risk marketing portfolio.

If the farmer and the elevator agree on a grain delivery contract, those contracts usually must fulfill several specifications. First of all the date and the delivery location are specified. The quantity and quality of the delivered grain are determined together with the adjustments that are made if the delivered quality is different than the stated one. Second, the price is set in the elevator contracts. Last, but very importantly, the signature of both parties and the date of signature are needed for legal issues. In addition, contracts can contain more complex details and agreements.

If a basis is mentioned in a contract that is the difference in the price between the local physical cash market location and the futures market price for the relevant commodity. Basis accounts for the local supply and demand conditions and transportation costs. In a market with high supply the basis is usually negative, that means the price paid will be below the matching futures price, whereas in a market with higher demand and tight supply the basis will be positive and the cash price would be higher than the futures price.

Several different marketing contracts and strategies are available for the farmer and the next sections give an introduction to the marketing strategies used in this study.

3.1.4.1 Sales at Harvest

The simplest form of marketing of grain is to sell the production during harvest time directly from the field, across the scales and into the elevator bins. Prices are usually a daily adjusted quote for each type of grain published in the elevators office or website. The cents per bushel net returns from selling grain in this manner are calculated as the difference between the cash sale price and the farmer’s costs of production. This thesis will use this form of selling grain as the benchmark to evaluate the efficiency of more complicated marketing opportunities.

3.1.4.2 Futures Hedge

Hedging with futures contracts is a common procedure in agricultural price risk management. Futures contracts are traded for different delivery periods throughout the year, and depending on the commodity there are different futures contracts available. In general two options of futures hedges are available. Short and long hedges are available for farmers in their price risk management procedures. If prior to harvest the farmer can cover his target returns with the current futures price and he fears a decreasing futures prices when he wants to sell his production in the cash market, he can use a short futures hedge. This means he sells futures at the current futures price and buys back futures when he sells his produce in the local market. His cents per bushel net returns consists of his net cash sales returns (cash sales price less costs of production) and the gain from selling futures at a high price and buying them back later at a lower price. Of course the futures market could also move up and the farmer could face a loss form his futures position.

3.1.4.3 Forward Cash Contract

A forward contract is set up between a farmer and an elevator. This risk management tool offers a lot of opportunities to tailor it to the needs of both parties. As no futures are actively involved contracts do not need to fulfill any standardized specifications like the futures hedge.

The contract simply guarantees a specified price for a future delivery of a commodity. Usually elevators have a daily quote they offer to their customers for forwarding grain. While setting a forward price the elevator can use the futures market as a tool to offset the inherent price risk associated with locking a fixed buying price prior to physical grain delivery. The futures contract that matches the forward contract delivery period might be use as a pricing guide by the elevator. In this case, the elevator's forward contract bid is priced off the futures contract but adjusted for expected local basis at delivery time. From the farmer's point of view his cents per bushel net returns consists of his net forward cash sales returns (forward cash sales price less costs of production).

3.1.4.4 Storage at Harvest Time

Physical delivery of grain during harvest to the elevators facilities does not necessarily lead to an immediate cash sale. The delivered grain can also go into the storage and remain in the farmer's ownership. The farmer then pays the cost-of-carry or storage to the elevator in the form of a fee for storing and maintaining his grain till he wants to sell it. The disadvantage for the farmer here is that usually the farmer is obliged to sell it to the company that stores the grain. Should a close by competitor offer a better price after harvest the farmer would have to pay a penalty fee to the company where the grain is stored at this time. That is the normal grain storing strategy that is also known as speculative storage, as the cash price in the future is unknown and it is not sure that it will offset the storage cost. So, from the farmer's point of view his cents per bushel net returns consists of his net storage cash sales returns (cash sales price at end of storage period less storage fees and costs of production).

3.1.4.5 Minimum Price Contract

A minimum price contract allows a farmer to physically deliver his grain to the elevator at harvest time but to not price it until a later date. In this sense it is similar to a storage contract. However, the terms of the minimum price contract are more complex than the terms of a storage contract. The minimum price contract limits the price risk for the producer by setting a price floor that the price cannot fall short of, while allowing the farmer to price his grain at a higher price if post-harvest grain prices rise. This price floor is the elevator's harvest cash price at time of physical grain delivery. So if prices rise after harvest the farmer can sell the grain he is storing with the elevator under the terms of the contract at a higher effective cash price. The mechanics of the contract are as follows: (1) the farmer receives the elevator's harvest cash price at physical grain delivery time, less a fee attached to the contract; (2) the contract ties the farmer's grain to a futures contract that matches his desired storage time. Any increase in this futures contract price is added to the harvest cash price originally received by the farmer. At the time the farmer chooses to price the grain, if the futures price has not increased from initial levels, the farmer simply receives the harvest cash price adjusted for the contract fee. This fee is actually the cost or price of a futures call options contract, which the elevator buys to cover his risk of having to pay the farmer a higher effective price if futures prices increase. With the long call option the elevator effectively buys futures at a low initial price and if futures prices increase his option gains cover this price increase.

3.1.5 Profit Margin Hedging

The goal of each farmer is to manage his business profitably and at a reasonable level of risk. The idea behind profit margin hedging is for farmers to base their marketing decisions on covering a specific share of their production costs and so attempt to earn a specific profit margin. In effect, this strategy entails the farmer initially calculating his cents per bushel costs of production and then selling his crop at the first opportunity – through the use of one of the aforementioned marketing strategies/tools – at cents per bushel price that covers a predetermined share or percentage of the costs of production.

This study assumes that farmers have different ideas about the outcome of market prices so this study tests profit margin strategies based on the exact coverage of the costs of production (COP), here called 100% COP, and for other coverage levels – namely higher targeted levels of 125% and 150% COP. Profit margin hedging essentially removes price speculation from the farmer's marketing decision once the initial COP level coverage is chosen.

To make the results of this study comparable across marketing strategies all outcomes are measured on a cents per bushel basis. Net returns are measured to take into account the cost of production per bushel as well as any additional storage costs per bushel and contract fees per bushel. Government support programs, revenue insurance, yield insurance, and yield risk are not considered.

3.2 Simulation Model

For the risk-return evaluation of different agricultural marketing strategies considered in this study a simulation model is used to create simulated cash and futures prices. These simulated prices are used to compare the different marketing strategies that could be used by a hypothetical/representative model farmer in Eastern Arkansas attempting to maximize his net returns and minimize his net return risk. Based on historical data this study simulates 312000 net returns. The simulation is based up on daily data observed from the years 2001 to 2012 and creates 1000 net returns iterations, per commodity, each year based upon simulated cash and futures prices for each day of the pre and post-harvest marketing periods. The simulation model is stochastic and computed with the Microsoft Excel© spreadsheet program add-in for risk analysis and simulation @Risk.

3.2.1 Deterministic and Stochastic Model Components

In general there are two components to a simulation model, a deterministic component and a stochastic component. The deterministic component captures predetermined information or known information used by the econometrician to forecast variables. The stochastic component captures all information that cannot be anticipated by the econometrician, and so accounts for the unknown risk aspect associated with underlying data generating process followed by a variable.

The simulation of cash and futures prices contains both deterministic and stochastic elements. To simulate them the variables of the model have to be split up to its deterministic parts and into its stochastic components. The uncertainty of the stochastic term has to be described by a probability distribution. To define the stochastic component of the variable more precisely it is necessary to define its range with maximum and minimum values that it could take on, as well as the probability of a value to occur in the defined range.

3.2.2 Simulation of Cash and Futures Prices

The simulation of cash and futures prices that are further used for the analysis of the net returns are generated based upon the assumptions of the Black-Scholes-Merton Model, that stock prices follow a random walk and are log normally distributed. The random walk assumption is consistent with the concept of "market efficiency", whereby financial asset prices such as commodity futures are assumed to impound all price sensitive information almost instantaneously. In this sense the current futures price is the best "guess" of the price that will prevail at contract maturity, and that daily futures returns are purely stochastic in nature. The lognormal assumption means that prices can never be negative but percentage returns to futures prices returns are normally distributed and so can be zero, negative or positive.[9]

Futures prices are simulated based on historic values from 2001 till 2012. For each year 1000 iterations of daily price sequences are simulated for corn and soybeans, cash and futures prices, over the pre-harvest and post-harvest periods.

The simulation software used in this study is the Microsoft Excel © add-in software @Risk ©. This add-in allows us to simulate stochastic variables and to set a range of uncertainty with a probability distribution function. The simulation is based upon historic cash and futures prices to measure conditional risk. The historic prices are based on the futures settlement prices of each trading day. The analysis is split up into a pre-harvest and a post-harvest period, but the results are comparable across these two periods. The harvest is assumed to occur on 1st of October. If at specific days no prices were available due to weekends or holidays, the next trading days settlement prices were used instead.

A selection of the most important simulation input values can be found in Appendix A.

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[9] Jarrow, R.A. and Chatterjea, A. (2013) p 479

3.2.2.2 Simulation of Pre-Harvest Prices

Monte Carlo simulation of the cash and futures prices for corn and soybeans was run with the Microsoft Excel® add-on for risk analysis and simulation @Risk. This simulation created 1000 price sequence iterations per marketing year for both corn and soybeans cash and futures prices, based on each one of the twelve years of available historical data. Each price sequence iteration contain daily prices for cash and futures that are later used to generate the possible net returns for the farmer with the use of the different marketing and price risk management strategies. 12000 simulated net returns per commodity (2 commodities) and per marketing strategy (13 marketing strategies) are simulated, which in total is 312000 simulated net returns. To analyze risk return differences across strategies these 312000 net returns are grouped into 26000 12 year/observation samples and 26000 mean net return and 26000 standard deviations of net return observations are modeled using ANOVA.

For the pre-harvest period 110 futures trading days are assumed, from the 1st of May of each year to the 1st of October of each year. An iterated sequence of 110 closing futures prices are simulated 1000 times for each year and for both commodities. For the pre-harvest marketing period with the assumed harvest at 1st of October the simulated futures contract for corn is the December contract. The simulated futures contract for soybeans is the November contract of the respective year.

3.2.2.2.1 Simulation of the Pre-Harvest Futures Prices

Closely following McKenzie and Kunda (2009), the simulation is based upon (1) a historically observed futures price – the predetermined or deterministic component of the simulation – and (2) a sequence of daily futures price changes which are assumed to follow Geometric Brownian Motion (consistent with a random walk) and to be log-normally distributed, as in the Black-Scholes and Merton (BSM) model – the stochastic component of the simulation. For each of the 12 years the historical December corn futures price and the November soybean futures price observed on May 1st are used as an initial starting point for each of the price sequence iterations. The following 109 futures observations in each sequence are then stochastically generated using a version of the Black-Scholes and Merton (BSM) model.

So the discrete sequence of daily futures prices can be written as:

(1) $$\ln FP_{t+\Delta t} = \ln FP_t + \left(\mu - \frac{\sigma^2}{2}\right)\Delta t + \sigma\sqrt{\Delta t}\varepsilon \ ,$$

where $\ln FP_{t+\Delta t}$ is the natural logarithm of the December (November) new crop corn (soybean) futures settlement prices observed in a sequence of daily increments (Δt), the term $\left(\mu - \frac{\sigma^2}{2}\right)\Delta t$ is the mean change in daily futures prices and the term $\sigma\sqrt{\Delta t}$ is the standard deviation of daily futures price changes, and ε is a random drawing from the standard normal distribution with a mean of zero and a standard deviation equal to one.

In this thesis it is further assumed that futures prices adhere to Efficient Markets Hypothesis (EMH). The EMH implies that current futures price FP_t will equal expected futures price at contract maturity (McKenzie and Holt, and McKenzie et al.). In this case the expected return from holding a futures contract until maturity, μ, will be zero, and equation (1) reduces to:

(2) $$\ln FP_{t+\Delta t} = \ln FP_t - \frac{\sigma^2}{2}\Delta t + \sigma\sqrt{\Delta t}\varepsilon \ .$$

To implement the simulations, σ, the expected volatility per annum, is the estimated historical implied volatility (IV) derived from the Black-Scholes and Merton (BSM) model using historical options price data for the December corn contract and November soybeans contract observed on May 1 each year (see Appendix A).

3.2.2.2.2 Simulation of the Pre-Harvest Forward Prices

Sequences of forward prices are simulated by using the simulated futures prices sequences described in section 3.2.2.2.1. Each simulated futures price iteration has an associated forward price iteration. In essence the forward iterations are the futures iterations adjusted for basis, where basis is modeled with a deterministic and a stochastic component. The deterministic component comprises an ordinary least squares (OLS) linear trend estimated from historical basis values for each of the 12 years. The stochastic component is the residual or error term from these regressions, and in the simulation is quantified as the standard deviation (SD) of the error term. The basis (forward cash price – futures price) regressions are specified as:

(3) $$fp_t - FP_t = \alpha + \beta t + e_t \ ,$$

where α is a constant term, β is the estimated parameter for the time trend term t, and e is a normally distributed error term.

So formally, forward prices are simulated using:

(4) $$fp_{t+\Delta t} = FP_{t+\Delta t} + \alpha + \beta t + \partial\sqrt{\Delta t}\nu \ ,$$

where ∂ is the SD of the error term e_t in equation (3) and ν is a random drawing from the standard normal distribution with a mean of zero and a standard deviation equal to one.

It should be noted that as harvest time approaches each year elevator forward bids and cash spot bids are equal and so forward basis and harvest cash basis converge to the same values.

3.2.2.3 Simulation of Post-Harvest Prices

The post-harvest marketing period starts the 1st of October and lasts for an assumed 146 days until the 1st of May of the following year. For the post-harvest marketing period the May corn and soybean futures contract is simulated.

3.2.2.3.1 Simulation of the Post-Harvest Futures Prices

The post-harvest price simulation procedure is similar to the pre-harvest simulations. In this case the simulation starts with the historical May futures price observed on the 1st of October each year – once again this price may be thought of as the deterministic component of the simulation. The price for the second marketing day is the first simulated price. The following 145 futures observations in each sequence are then stochastically generated using the version of the Black-Scholes and Merton (BSM) model presented in equation 2. This time,σ, the expected volatility per annum, is the estimated historical implied volatility (IV's) derived from the Black-Scholes and Merton (BSM) model using historical options price data for the May corn and soybeans contracts observed on October 1 each year (see Appendix A).

3.2.2.3.2 Simulation of the Post-Harvest Cash Prices

The post-harvest cash price simulation procedure is also similar to the pre-harvest simulations. Once again sequences of post-harvest cash prices are simulated by using the simulated futures prices sequences described in section 3.2.2.3.1., whereby each simulated futures price iteration has an associated post-harvest price iteration. These post-harvest cash price iterations are the futures iterations adjusted for the post-harvest basis, where post-harvest basis is again modeled with a deterministic and a stochastic component. The deterministic component again comprises an ordinary least squares (OLS) linear trend estimated from historical basis values for each of the 12 years. The stochastic component is again the residual or error term from these regressions and in the simulation is quantified as the standard deviation (SD) of the error term. The only difference from the pre-harvest simulation procedure is that basis is now the May basis as opposed to the December and November forward price basis.

3.2.3 Marketing Strategies Applications

The strategies each for soybeans and corn can be listed as

1.a Base strategy of cash sales at harvest

2.a Pre-harvest futures hedge with a targeted cost of production coverage of 100%

2.b Pre-harvest futures hedge with a targeted cost of production coverage of 125%

2.c Pre-harvest futures hedge with a targeted cost of production coverage of 150%

3.a Forward contract with a targeted cost of production coverage level of 100%

3.b Forward contract with a targeted cost of production coverage level of 125%

3.c Forward contract with a targeted cost of production coverage level of 150%

4.a Post-harvest storage with a targeted cost of production coverage level of 100%

4.b Post-harvest storage with a targeted cost of production coverage level of 125%

4.c Post-harvest storage with a targeted cost of production coverage level of 150%

5.a Minimum price contract with a targeted cost of production coverage level of 100%

5.b Minimum price contract with a targeted cost of production coverage level of 125%

5.c Minimum price contract with a targeted cost of production coverage level of 150%

Descriptions of the applications of strategies can be found in the following sections

3.2.3.1 Base Strategy

The base strategy in this study is the simple case of the farmer selling his harvested field crops, in this case corn and soybeans, for immediate harvest time delivery to an elevator. This means the farmer bears full price risk, and hence full net return risk. This routine strategy assumes that the representative farmer sells his production as a matter of routine on the 1st of October each year.

The cash prices that are used in this study for the 1st of October are drawn from the simulation of the forward contract prices. It is assumed that those prices are the spot market prices at harvest, which is consistent with the fact that historical forward and cash price data converge to the same value at harvest time. In order to calculate the net returns per bushel, the cost of production is subtracted from the prices on the 1st of October. It is possible for the farmer to generate negative net returns that do not cover the cost of production per bushel.

3.2.3.2 Pre-Harvest Marketing Strategies

This study focuses on two commonly used methods in the marketing of agricultural commodities before harvest. The strategies applied to the simulated pieces in this study are a forward contract and a futures hedge. The details of the use of the two strategies with target margin hedging decisions are explained in the following two sections.

3.2.3.2.1 Futures Hedge

For the futures hedge strategy the corn or soybeans futures are initially sold at some point during the pre-harvest period – to lock in prices subject to basis risk on October 1st – and are subsequently purchased to offset the position on the 1st of October each year, the time the commodity will be physically sold at harvest in the cash market. The pre-harvest marketing period is set from the 1st of May to the harvest at 1st of October. The hedged futures contracts at the Chicago Board of Trade (CBOT) are December for corn and November for soybeans. The initial futures sale day is determined by the profit margin hedging rule as the first day closing futures prices cover the targeted cost of production level at 100%, 125% or 150%. If closing futures prices never cover the targeted production cost level – it is assumed the farmer must simply sell in the cash market at harvest time. For the calculation of net returns over COP the simulated cash price is used as the harvest price that the representative farmer receives for selling his produce in the spot market. Futures gains or losses, if a futures contract was locked in, are added to the gained cash net returns.

Brokerage fees or margin calls are not considered in this study. In contrast, Neyhard, Tauer and Glory (2013) use data from the homepage of the CME Group (www.cmegroup.com) to calculate margin requirements and figured 70 Dollars as a simplified estimate for transaction costs per round turn for each futures contract.[10] A futures contract comprises 5000 bushels for corn and soybeans. Again our study only considers per bushel comparisons and assumes that the farmer trades in 5000 bushels.

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[10] Zulauf, Larson, Alexander and Irwin (2001) assume 60 Dollar per round turn of a futures contract

3.2.3.2.2 Forward Contract

Analogous to futures contract strategies the corn or soybeans forwards are initially contracted at some point during the pre-harvest period – to lock in prices – and the contracts are subsequently physically on the 1st of October each year. Again, the pre-harvest marketing period is set from the 1st of May to the harvest at 1st of October. The day the forward contract is initiated is determined as the first day forward prices cover the targeted cost of production level at 100%, 125% or 150%. If forward prices never cover the targeted production cost level – it is assumed the farmer must simply sell in the cash market at harvest time. For the calculation of net returns over COP the farmer earns the forward price.

In years that the prices do not reach levels to cover the targeted cost of production the price received to calculate net returns over COP is assumed to be the last simulated price, that is also assumed to be the cash price for harvest spot market cash sales of the commodity.

3.2.3.3 Post-Harvest Marketing Strategies

For the post-harvest marketing period this study examines two further commonly used marketing techniques, again with respect to the targeted COP level. Unhedged grain storage and a minimum price based on a European call option are the methods used here. Like in the pre-harvest marketing period the post-harvest marketing options also have three different levels to cover cost of production at 100%, 125% and 150%. The post-harvest marketing period is assumed to be 146 days long and ends at the 1st of May of the following year after harvest.

3.2.3.3.1 Storage Strategy

Storing grains causes additional costs for the producer that have to be considered when calculating net returns over production cost.

At harvest, assumed as the 1st of October, each year the farmer sells his production in the harvest time spot cash market, as long as the harvest cash price covers his targeted cost of production. The 1st of October prices are real historical observations; all subsequent prices over the following 145 post-harvest days are simulated. So if the farmer fails to sell his grain on Oct 1st he must store the grain in the hope that post-harvest prices will meet his targeted production costs. However, once storage takes place it is also necessary to consider the cost-of-carry for storing grain for the storage strategy net returns calculations, and these costs which accumulate over time are subtracted from the simulated prices. The cost-of-carry is calculated using the formula presented in section 3.2. The simulated price minus the cost-of-carry is compared to the targeted cost of production level. The first day the farmer meets his target the stored grain is assumed to be sold. This price is then used to calculate the net returns over cost of production. If the farmer never reaches his target price to cover his target cost of production the farmer's selling price is the simulated cash price observed on the 1st of May of the year following the harvest less the cost-of-carry. In this sense this storage strategy is somewhat unrealistic as it does not allow the farmer to cut short his losses in years when flat or declining post-harvest prices are unlikely to ever generate positive net returns. Of course, not accounting for early abandonment of the storage strategy will create a negative bias against this strategy in terms of performance results.

3.2.3.3.2 Minimum Price Contract

Analogous to storage contract strategies, the post-harvest marketing period analysis for minimum price contract strategies covers the period from 1st of October to May 1st of the following year. Again, it is assumed that each year the farmer sells his production in the harvest time spot cash market, as long as the harvest cash price covers his targeted cost of production. Again, the 1st of October prices are real historical observations; and again all subsequent prices over the following 145 post-harvest days are simulated. So if the farmer fails to sell his grain on Oct 1st he must store the grain now under a minimum price contract in the hope that minimum contract price comprising post-harvest futures returns added to October 1st cash prices and adjusted for the cost of the minimum price contract will meet his targeted production costs. In this case, the minimum contract is purchased at a specific cost, depending on the volatility of the commodity futures price. As in the storage strategy case, it is assumed that grain is sold at the first post-harvest minimum contract price that meets the farmer's targeted production costs. If the minimum contract prices do not reach the level to cover the targeted cost of production the farmer receives the cash price on 1st of October – the "minimum price" – less the cost for purchasing the minimum price contract. The cost or price of the minimum price contract is estimated to be the price of a May futures call option. The price of this option was calculated using the Black-Scholes-Mertons Option Pricing Model (BOPM) with historical May corn and soybean futures IV's as an input to the BOPM. The higher is the historical IV, the higher the option's price.

3.2.3.4 Cost of Production Levels

This study does not use a whole farm approach to calculate the benefits for a farmer when using a marketing strategy to increase net returns or to reduce net return risk. This study uses only price simulation analysis to measure the cents per bushel performance of marketing strategies. With this method cash flows, yield or other factors that affect the economic situation of a farmer in a whole farm approach are not considered. This price simulation analysis makes it is easier to compare marketing strategies across different commodities, which would be harder to evaluate if yield differences were also to be considered. Vyn (2012) also uses this method to find the most profitable cents per bushel strategy for various grain marketing strategies rather than use the whole farm production approach. However, this thesis extends Vyn's study in terms of the types of marketing contracts examined and by incorporating forward looking market based volatility measures (e.g. IV's) in the stochastic simulation analysis.

3.3 Generated Net Returns Output

The simulated prices: futures, forwards and cash prices applied to the various marketing strategies generate cents per bushel net returns for Memphis, TN corn and soybean markets. This market is representative of the main grain production areas of north-eastern Arkansas. To calculate the representative farmer's net returns for the various strategies associated costs of production are subtracted from respective prices received.

(5) $NR_{icm} = R_{icm} - COP_{icm}$

Where NR_{icm} Net returns per bushel per commodity per marketing strategy over cost of production per bushel

R_{ic} Return per bushel per commodity per marketing strategy

COP_{ic} Cost of production per bushel per commodity

$_i$ year

$_c$ commodity

$_m$ marketing strategy

Equation 5 contains deterministic and stochastic variables; the return per bushel is a stochastic variable, as the futures and the cash price generated in the simulation are stochastic. The Production cost per bushel in contrast is deterministic. The prices for futures and cash crops represent the market risk in the simulation and are the main source of risk in this study.

Simulated net returns for each of the various marketing strategies discussed in section 3.1 are generated from the simulated prices and actual historical production costs for each of the 12 historical years. The simulated returns for each of 5 marketing strategies are grouped in 12 observation/iteration samples based upon the historical 12 years. So for example, one sample containing the simulated net returns for the base case strategy (selling in the cash market at harvest time) will consist of a single simulated net cash harvest return value from each of the 12 historical years. This procedure results in a total of 1000 simulated 12 observation samples for each commodity and marketing strategy. The mean net return and standard deviation of net returns for each of these samples are then calculated. This yields in total 1000 mean and standard deviation observations for each commodity and marketing strategy based upon these 12 year samples. Given we analyze 2 commodities and 15 marketing strategies, this yields 30000 mean net return observations and 30000 standard deviation of net return observations. Results of the simulation model provide insights for a representative farmer as to relative risk-return profiles of the various marketing contracts. The 12-year samples are chosen to reflect a range of varied marketing characteristics in terms of price levels, price volatility and costs of production levels. By focusing on the 12-year sample mean net returns and the 12 year sample net returns standard deviations we try to quantify realistic risk-return levels that would be faced by a representative Arkansas corn and soybean famer over a relatively long marketing decision period. In other words how the various marketing strategies fair over a 12 year period should be of great concern to a representative farmer – 12 years is a large chunk of the average farmer's marketing life.

3.4 Analysis of Variance

The quantification of the relative influence of the commodity type, the marketing strategy and the target level of cost of production coverage on the 12 year sample mean net returns and 12 year sample net return standard deviations is estimated using Analysis of Variance (ANOVA). The SAS © software Syslin Procedure for Ordinary Least Squares Regression Estimation (OLS) was used to conduct the ANOVA. In this case ANOVA is equivalent to OLS regression with only dummy or interaction terms for explanatory variables. The commodity type, marketing strategy and the targeted cost of production coverage level are represented by dummy or interaction terms, which is a necessary procedure to group qualitative data. A regression of this nature yields group averages as estimates. The base case in the regression is cash sales of unhedged corn at harvest time. The base case is represented by α as the intercept of the regression. The results for the ANOVA with mean net return and standard deviation of net returns as the dependent variables can be found in the next chapter.

(5) $Var = \alpha + \sum_{i=1}^{7} \beta i D i + \beta_8 (D_1D_2) + \beta_9 (D_1D_3) + \beta_{10} (D_1D_4) \beta_{10} (D_1D_5) + \beta_{11} (D_1D_6) + \beta_{12} (D_1D_7) + \beta_{13} (D_2D_4) + \beta_{14} (D_3D_4) + \beta_{15} (D_2D_5) + \beta_{16} (D_3D_5) + \beta_{17} (D_2D_6) + \beta_{18} (D_3D_6) + \beta_{19} (D_2D_7) + \beta_{20} (D_3D_7) + \beta_{21} (D_1D_2D_4) + \beta_{22} (D_1D_2D_5) + \beta_{23} (D_1D_2D_6) + \beta_{24} (D_1D_2D_7) + \beta_{25} (D_1D_3D_4) + \beta_{26} (D_1D_3D_5) + \beta_{27} (D_1D_3D_6) + \beta_{28} (D_1D_3D_7) + \varepsilon$

Where: D_i denotes 7 dummy variables form D_1 through D_7.

The dummy variables D_1 - D_7 are indicator variables with D_1 expressing the commodity, D_2 and D_3 the target COP level. The marketing categories are represented by $D_4 – D_7$. The interaction terms are labeled from $D_1D_2 – D_1D_3D_7$.

D_1= { if commodity soybeans,
0 if corn

D_2= { 1 if targeted cost of production coverage level 125%,
otherwise 0

D_3= { 1 if targeted cost of production coverage level 150%,
otherwise 0

D_4= { pre-harvest marketing strategy futures hedge,
0 otherwise

D_5= { pre-harvest marketing strategy forward sales contract,
0 otherwise

D_6= { post-harvest marketing strategy storage,
0 otherwise

D_7= { post-harvest marketing strategy minimum price options contract,
0 otherwise

$D_1 D_2$= { soybeans cash sales with targeted cost of production coverage level 125%,
0 otherwise

D_1D_3= { soybeans cash sales with targeted cost of production coverage level 150%,
0 otherwise

D_1D_4= { soybeans pre-harvest futures hedge with a 100% of targeted coverage of cost of production, 0 otherwise

D_1D_5= { soybeans pre-harvest forward contract with a 100% of targeted coverage of cost of production, 0 otherwise

$D_1D_6=$	{	soybeans post-harvest storage with a 100% of targeted coverage of cost of production, 0 otherwise
$D_1D_7=$	{	soybeans post-harvest minimum price options contract with a 100% of targeted coverage of cost of production, 0 otherwise
$D_2D_4=$	{	corn pre-harvest futures hedge with a targeted coverage of cost of production level of 125%, 0 otherwise
$D_3D_4=$	{	corn pre-harvest futures hedge with a targeted coverage of cost of production level of 150%, 0 otherwise
$D_2D_5=$	{	corn pre-harvest forward contract with a targeted coverage of cost of production level of 125%, 0 otherwise
$D_3D_5=$	{	corn pre-harvest forward contract with a targeted coverage of cost of production level of 150%, 0 otherwise
$D_2D_6=$	{	corn post-harvest storage with a targeted coverage of cost of production level of 125%, 0 otherwise
$D_3D_6=$	{	corn post-harvest storage with a targeted coverage of cost of production level of 150%, 0 otherwise
$D_2D_7=$	{	corn post-harvest minimum price option contract with a targeted coverage of cost of production level of 125%, 0 otherwise
$D_3D_7 =$	{	corn post-harvest minimum price option contract with a targeted coverage of cost of production level of 150%, 0 otherwise
$D_1D_2D_4=$	{	soybeans pre-harvest marketing strategy futures hedge with targeted cost of production coverage level 125%, 0 otherwise
$D_1D_2D_5=$	{	soybeans pre-harvest marketing strategy forward contract with targeted cost of production coverage level 125%, 0 otherwise
$D_1D_2D_6=$	{	soybeans post -harvest marketing strategy storage with targeted cost of production coverage level 125%, 0 otherwise
$D_1D_2D_7=$	{	soybeans post -harvest marketing strategy minimum price option contract with targeted cost of production coverage level 125%, 0 otherwise
$D_1D_3D_4=$	{	soybeans pre-harvest marketing strategy futures hedge with targeted cost of production coverage level 150%, 0 otherwise
$D_1D_3D_5=$	{	soybeans pre-harvest marketing strategy forward contract with targeted cost of production coverage level 150%, 0 otherwise
$D_1D_3D_6=$	{	soybeans post -harvest marketing strategy storage with targeted cost of production coverage level 150%, 0 otherwise
$D_1D_3D_7=$	{	soybeans post -harvest marketing strategy minimum price option contract with targeted cost of production coverage level 150%,0 otherwise

3.5 Data Considerations

In this section data for cash prices, futures prices and cost of production used for this study are described. Additionally Prime Bank Loan Rates were necessary to calculate the cost of carry for the storage strategy.

3.5.1 Price Data

As Memphis, Tennessee is the market place for corn and soybeans grown in north-eastern Arkansas this thesis uses price data from the USDA AMS website[11]. Pricing point in Memphis is a Terminal elevator. A custom report to generate data is available for each year for cash and new crop. New crop is represents forward contract prices on each day. Prices were collected for each single marketing day in the years from 2001 to 2012. For the same time period futures prices of the CBOT were collected for corn and soybeans, each are contract number 2 Yellow, in cents per bushel. Futures prices and IV's were obtained from Bridge Commodity Research Bureau.

For the assessment of the pre-harvest marketing strategies no further data, except the COP and Prime Bank Loan Rates, are needed. There is additional data used for the development of net returns with the use of a storage strategy. To calculate net returns for the storage strategies the cost-of-carry for grain has to be considered. The cost-of-carry is calculated by a formula, which is further explained in 3.1.2. The calculations of cost-of-carry require a representative interest rate. In this thesis we use the Prime Bank Loan Rates. The Prime Bank Loan Rates are obtained for from the homepage of the Federal Reserve Bank of St. Louis[12] for every trading day

[11] AMS USDA Homepage: http://marketnews.usda.gov/portal/lg
[12] Federal Reserve Bank of St. Louis: http://research.stlouisfed.org/fred2/categories/117

in the relevant time period. It should be noted that other marketing costs associated with management and time devoted to decision making are not considered here – all strategies are implemented in terms of a profit margin hedging rule, which eliminates this type of marketing cost.

3.5.2 Cost of Production

To evaluate and compare the alternative marketing strategies on a per bushel basis the COP per bushel for Arkansas is needed. Dr. Flanders of the Northeast Research and Extension Center of the University of Arkansas provided the COP data generated and used by the Northeast Research and Extension Center of the University of Arkansas.

The COP respects the typical production methods (average costs across furrow, pivot and non-irrigated cropping systems) in Arkansas as well as local prices for production inputs. The COP does not include fixed costs and is based on operating costs, that per acre that are divided by the average yield observed in the matching year to calculate the COP per bushel for each commodity. Costs for land are also not icludeded in the COP estimates. The cost of production data can be found in Appendix B.

Chapter 4 Results and Discussion

This chapter describes the results generated from the simulation models for the applied marketing strategies described in the last chapter. Results are first presented in terms of simple rankings of the different marketing strategies. These ranking evaluation methods include (1) average mean returns by strategy, (2) average standard deviation (SD) of net returns by strategy, and (3) relative risk by strategy in terms of coefficient of variation (CV), by strategy. ANOVA results are also presented, which provide a more rigorous – statistical – analysis of the various marketing strategies. All results are evaluated in terms of (1) average mean net returns by marketing strategy for a representative farmer – the higher the average mean net return yielded by a strategy the better; and in terms of (2) average standard deviation of net returns (SD) by marketing strategy for a representative farmer – the lower the (SD) or risk level the better. And in terms of (3) CV – the lower the estimate the better the strategy. The ANOVA results are evaluated separately with respect to these two criteria. The optimal strategy for the representative farmer would result in increased average net returns and a decreased average net return risk compared to the base case strategy of simply selling crop at harvest time in the cash market. All results are presented and analyzed in cents per bushel and all statistical tests are conducted at a 5% level of significance.

4.1 Analysis of Average Mean Net Returns

Average mean net returns are obtained by averaging the mean returns for each of the applied risk management strategies with respect to the 1000 price iterations that were simulated across 12 year samples. In other words, first the mean return is measured for each of the 1000 – 12 observation - samples. Then the average of these 1000 means is calculated to obtain what we call the average mean net return. This procedure is performed for each of commodities (2 commodities) and marketing strategies (13 marketing strategies). These 1000 simulated 12 year samples for each commodity and marketing strategy were based on historically observed futures prices and cash price values for Memphis market between 2001 and 2012. The cost of production (COP) in cents per bushel is later subtracted from the simulated prices to calculate net returns for corn and soybeans produced in Arkansas. For the ranking the examined marketing strategies are listed by performance from highest to lowest average mean net return. Marketing strategy performance is compared with the base case strategy of selling in the cash market at harvest time.

4.1.1 Results of Ranked Average Mean Net Returns of Corn Marketing Strategies

Average Mean Net Returns of Corn Marketing Strategies		Parameter Estimate in cent/bushel [13]	Difference to Base strategy	Rank by highest Net Return
1.a	Base strategy of cash sales at harvest	45.42	0.00	5
2.a	Futures hedge with a targeted COP of 100%	53.72	8.30	1
2.b	Futures hedge with a targeted COP of 125%	53.72	8.30	1
2.c	Futures hedge with a targeted COP of 150%	50.76	5.34	3
3.a	Forward contract with a targeted COP 100%	44.55	-0.87	6
3.b	Forward contract with a targeted COP of 125%	40.61	-4.82	7
3.c	Forward contract with a targeted COP of 150%	47.88	2.45	4
4.a	Storage with a targeted COP coverage level of 100%	8.29	-37.13	10
4.b	Storage with a targeted COP coverage level of 125%	14.51	-30.91	9
4.c	Storage with a targeted COP coverage level of 150%	21.39	-24.03	8
5.a	Minimum price contract with a targeted COP of 100%	-11.75	-57.17	11
5.b	Minimum price contract with a targeted COP of 125%	-17.68	-63.11	12
5.c	Minimum price contract with a targeted COP of 150%	-23.63	-69.05	13

Table 1 Results of ranked average mean returns of corn marketing strategies

First, the average mean net returns results with respect to corn and presented in table 1 are discussed. The base strategy of cash sales of corn at harvest has an average net return parameter estimate of 45.42 cents per bushel. The highest average net return for corn was realized with the application of a pre-harvest futures hedge strategy. At all COP target coverage levels, 100%, 125% and 150%, the futures hedge strategy earns the best average net returns on a cents per bushel basis for a representative farmer. The 100% COP and the 125% COP futures hedges generate an additional 8.30 cents per bushel over and above the base strategy, and the ANOVA results presented later show this difference to be statistically significant. With average

[13] Parameter estimates calculated based on OLS Analysis and Parameter Estimates output generated by SAS statistical software, see Table 8

net returns of 47.88 cents per bushel the forward contract strategy with a targeted 150% COP level performs second best behind the futures hedges. However, the use of this price risk management tool with other targeted COP of 100% and 125%, levels actually perform worse than the base case. This may occur as although the farmer typically covers his production cost by locking in forward contracts, prices may be higher at harvest than the locked-in forwarded prices.

The pre-harvest marketing strategies perform better than the post-harvest strategies for corn. All post-harvest marketing strategies generate large average net losses in comparison to cash sales at harvest. The minimum price contract generates negative average net mean returns at all COP levels. The poor performance of the post-harvest marketing strategies storage and minimum price can be explained in terms of high average costs of storage, and in terms of high premiums for options that make minimum price contracts a costly risk management tool. It should also be emphasized again that this study does not consider brokerage fees and margin calls for the futures based strategies, thereby overstating the value of futures based strategies.

4.1.2 Results of Ranked Average Mean Net Returns of Soybean Marketing Strategies

	Average Mean Net Returns of Soybean Marketing Strategies	Parameter Estimate in cent/bushel [14]	Difference to Base strategy	Rank by highest Net Return
1.a	Base strategy of cash sales at harvest	97.23	0.00	5
2.a	Futures hedge with a targeted COP of 100%	96.39	-0.83	6
2.b	Futures hedge with a targeted COP of 125%	105.69	8.47	2
2.c	Futures hedge with a targeted COP of 150%	108.22	10.99	1
3.a	Forward contract with a targeted COP 100%	102.49	5.26	3
3.b	Forward contract with a targeted COP of 125%	98.79	1.57	4
3.c	Forward contract with a targeted COP of 150%	90.71	-6.52	7
4.a	Storage with a targeted COP coverage level of 100%	29.96	-67.27	11
4.b	Storage with a targeted COP coverage level of 125%	54.69	-42.53	8
4.c	Storage with a targeted COP coverage level of 150%	49.89	-47.33	9
5.a	Minimum price contract with a targeted COP of 100%	4.95	-92.27	13
5.b	Minimum price contract with a targeted COP of 125%	37.54	-59.68	10
5.c	Minimum price contract with a targeted COP of 150%	25.41	-71.82	12

Table 2 Results of ranked average mean returns of soybean marketing strategies

Next, the average mean net returns results with respect to soybeans, which are presented in table 2 are discussed. Soybean marketing strategies perform similarly to the comparative corn strategies. The base case of soybean cash sales at harvest generates an average net return of 97.23 cents per bushel for the representative farmer. Again, futures strategies at least at the 125% and 150% COP levels generate the highest average mean net returns. However, ANOVA results, presented later, indicate the average mean net futures returns are not statistically different from

[14] Parameter estimates calculated based on OLS Analysis and Parameter Estimates output generated by SAS statistical software, see Table 8

the base case. The highest significant average mean net return for soybeans is achieved by a forward contract with a COP target level of 100%.

Again, similar to corn, soybean post-harvest marketing period storage strategies generate lower average mean net returns for the representative farmer compared with the base case of selling cash soybeans at harvest. Also, analogous to corn, the biggest losses for soybeans can be observed when applying a minimum price contract strategy. At the 100% COP level, the high costs for purchasing a minimum price contract result in average mean net returns of only 4.95 cents per bushel, which is on average 92.27 cents per bushel less than the average mean net returns for the base strategy.

4.2 Analysis of Average Standard Deviation of Net Returns

The average SD of net returns for the various management strategies allows us to evaluate the performance of each marketing strategy in terms of return risk reduction. The lower the average SD of net return with respect to each marketing strategy, the lower the range of potential net returns associated with that strategy. A lower range of returns allows the farmer to make better forecasts in terms of expected returns that would be generated for his business, and allows better planning for the new planting season and across marketing years. The marketing strategies are ranked from best to worst with the best strategies having the lowest SD.

4.2.1 Results of Ranked Average Standard Deviations of Mean Net Returns of Corn Marketing Strategies

Table 3 presents the average standard deviations of net returns results with respect to corn strategies. Here the post-harvest marketing strategies perform better than the pre-harvest marketing strategies. The best reduction of variability of net returns, on average, is achieved with storage strategies. The 100% COP storage strategy has a significantly lower average SD of 27.66 cents per bushel compared with the base strategy. The 100% COP minimum price strategy lowers the average SD significantly as well as the 100% COP forward contract. All other pre-harvest marketing strategies increase the marketing price risk significantly compared to the base strategy.

Average Standard Deviation of Corn Marketing Strategies		Parameter Estimate in cent/bushel [15]	Difference to Base strategy	Rank by highest Net Return
1.a	Base strategy of cash sales at harvest	103.77	0.00	8
2.a	Futures hedge with a targeted COP of 100%	107.68	3.92	10
2.b	Futures hedge with a targeted COP of 125%	108.56	4.79	12
2.c	Futures hedge with a targeted COP of 150%	110.26	6.49	13
3.a	Forward contract with a targeted COP 100%	100.84	-2.93	7
3.b	Forward contract with a targeted COP of 125%	107.80	4.03	11
3.c	Forward contract with a targeted COP of 150%	106.65	2.88	9
4.a	Storage with a targeted COP coverage level of 100%	76.11	-27.66	1
4.b	Storage with a targeted COP coverage level of 125%	79.52	-24.25	2
4.c	Storage with a targeted COP coverage level of 150%	88.65	-15.12	3
5.a	Minimum price contract with a targeted COP of 100%	90.53	-13.23	4
5.b	Minimum price contract with a targeted COP of 125%	92.49	-11.28	5
5.c	Minimum price contract with a targeted COP of 150%	93.25	-10.52	6

Table 3 Average standard deviation of corn marketing strategies

4.2.2 Results of Ranked Average Standard Deviations of Net Returns of Soybean Marketing Strategies

For soybeans the results recorded in table 4 are more varied than for corn. But again the best risk reduction strategy for soybeans is generated with the use of storage at a 100% COP level. For this strategy the results show an average 123.45 cents per bushel reduction in the average standard deviation of net returns. Interestingly, in each category of strategies, the 100% COP strategies provide the greatest reduction in average standard deviations of net returns.

[15] Parameter Estimates calculated based upon OLS analysis and Parameter Estimate Output generated by SAS statistical software, see table 10.

Significantly greater average net return variation can be observed for the application of pre-harvest marketing strategies with COP target levels of 125% and 150%.

Average Standard deviation of Soybean Marketing Strategies		Parameter Estimate in cent/bushel [16]	Difference to Base strategy	Rank by highest Net Return
1.a	Base strategy of cash sales at harvest	277.65	0.00	9
2.a	Futures hedge with a targeted COP of 100%	220.42	-57.23	3
2.b	Futures hedge with a targeted COP of 125%	292.79	15.14	11
2.c	Futures hedge with a targeted COP of 150%	308.55	30.90	13
3.a	Forward contract with a targeted COP 100%	228.57	-49.08	4
3.b	Forward contract with a targeted COP of 125%	281.07	3.42	10
3.c	Forward contract with a targeted COP of 150%	301.91	24.26	12
4.a	Storage with a targeted COP coverage level of 100%	154.20	-123.45	1
4.b	Storage with a targeted COP coverage level of 125%	262.13	-15.52	6
4.c	Storage with a targeted COP coverage level of 150%	264.26	-13.39	7
5.a	Minimum price contract with a targeted COP of 100%	171.95	-105.70	2
5.b	Minimum price contract with a targeted COP of 125%	270.96	-6.69	8
5.c	Minimum price contract with a targeted COP of 150%	259.16	-18.49	5

Table 4 Average standard deviation of soybean marketing strategies

4.3 Results of Ranked Relative Risk – Coefficient of Variation

Another frequently used method to evaluate the performance of risk management strategies is the Coefficient of Variation (CV) that measures the ratio of average mean net returns to the average standard deviations of net returns (CV = σ/μ).Zulauf and Irwin (1997)[17] comment risk compensation:" a fundamental principle of modern finance is that higher risk should be

[16] Parameter Estimates calculated based upon OLS analysis and Parameter Estimate Output generated by SAS statistical software, see table 10

[17] Zulauf and Irwin, 1997: "Market Efficiency and Marketing to Enhance Income of Crop Producers" page 310

compensated with a higher return" CV analysis adheres to this by jointly considering risk and return associated with each strategy.[18]

4.3.1 Results of Ranked Relative Risk for Corn Marketing Strategies

Coefficient of Variation of Corn Marketing Strategies		Coefficient of Variation in %	Ranked by lowest CV
1.a	Base strategy of cash sales at harvest	228.45	6
2.a	Futures hedge with a targeted COP of 100%	200.46	1
2.b	Futures hedge with a targeted COP of 125%	202.06	2
2.c	Futures hedge with a targeted COP of 150%	217.21	3
3.a	Forward contract with a targeted COP 100%	226.36	5
3.b	Forward contract with a targeted COP of 125%	265.48	7
3.c	Forward contract with a targeted COP of 150%	222.77	4
4.a	Storage with a targeted COP coverage level of 100%	918.06	10
4.b	Storage with a targeted COP coverage level of 125%	547.92	9
4.c	Storage with a targeted COP coverage level of 150%	414.49	8
5.a	Minimum price contract with a targeted COP of 100%	-770.64	/
5.b	Minimum price contract with a targeted COP of 125%	-523.03	/
5.c	Minimum price contract with a targeted COP of 150%	-394.62	/

Table 5 Coefficient of variation of corn marketing strategies

In terms of absolute risk performance the corn base strategy performs moderately placing sixth in the overall marketing strategies rankings shown in table 5. The best ranked strategies using the CV criteria are the futures hedges. They cover the first three ranks with their different coverage levels. Futures hedges are followed by the 150% and 100% COP forward contracts.

[18] It should be mentioned again that in this ranking no trading costs or margin call requirements for futures hedges are included. But costs for storage and minimum price contracts are considered. This might lead to a biased output of the CV ranking in this study.

These five strategies all achieve a better marketing performance than the base strategy by CV rank. The only pre-harvest marketing strategy that is ranked worse than the base case is the 125% COP strategy. All of the COP level storage strategies and the minimum price strategies rank lower than the base case. In fact the Minimum price contracts show a negative CV and can therefore not be formally evaluated.

4.3.2 Results of Ranked Relative Risk for Soybean Marketing Strategies

Coefficient of Variation of Soybean Marketing Strategies		Coefficient of Variation in %	Ranked by lowest CV
1.a	Base strategy of cash sales at harvest	285.57	6
2.a	Futures hedge with a targeted COP of 100%	228.67	2
2.b	Futures hedge with a targeted COP of 125%	277.02	3
2.c	Futures hedge with a targeted COP of 150%	285.12	5
3.a	Forward contract with a targeted COP 100%	223.02	1
3.b	Forward contract with a targeted COP of 125%	284.50	4
3.c	Forward contract with a targeted COP of 150%	332.83	7
4.a	Storage with a targeted COP coverage level of 100%	514.74	9
4.b	Storage with a targeted COP coverage level of 125%	479.29	8
4.c	Storage with a targeted COP coverage level of 150%	529.67	10
5.a	Minimum price contract with a targeted COP of 100%	3471.09	13
5.b	Minimum price contract with a targeted COP of 125%	721.73	11
5.c	Minimum price contract with a targeted COP of 150%	1020.03	12

Table 6 Coefficient of variation of soybean marketing strategies

Turning to the soybean CV results shown in table 6 for soybeans strategies, it can be seen that analogous to corn the cash sales of soybeans at harvest strategy (the base case) ranks moderately at the sixth place. And similar to corn five out of the six pre-harvest soybean strategies rank better than the base case. For soybeans the only pre-harvest marketing strategy that is more unfavorable than the base case, by CV ranking, is the 150% COP forward contract.

According to this CV analysis the most preferred strategy would be the forward contract at a COP coverage target level of 100%.

Again analogous to corn, all post-harvest soybean strategies perform worse than the base case, and similar to corn the soybean storage contracts and the minimum price contracts rank worst. The 150% COP level minimum price contract with a 1020% CV can be considered as offering a poor risk-return performance.

4.4 Analysis of Variance Results

Empirical results with respect to the Analysis of Variance (ANOVA) model are presented in tables 7 through 10. Table 7 reports diagnostics for the average mean net returns model. The various treatment variables explain 41% of the variation in average mean net returns. Table 8 shows parameter estimates for the average mean net returns model.

Table 9 reports diagnostics for the average standard deviation of net returns model. The various treatment variables explain 83% of the variation in average standard deviation of net returns. Table 10 shows parameter estimates for the average standard deviation net returns model.

To statistically evaluate the comparative performance of the various marketing strategies for each commodity with respect to the base case and with respect to each other F-tests results are presented in tables 11 through 22.

4.4.1 Selling in Cash Market at Harvest Time

First, consider the base case results for corn and soybean markets. Intercept estimate in table 8, which captures our base case, indicates that average mean net returns for selling cash corn at harvest time are 45 cents per bushel. In contrast, selling cash soybeans at harvest time yields significantly larger average mean net returns of 97 cents per bushel (*Intercept + d1*). It should be noted that these results say nothing as to whether soybeans are on average a more profitable crop than soybeans as corn yields are much higher than soybean yields. For example Figure 3, presented in Appendix B, illustrate that average 2012 Arkansas corn yields were 178 bushels per acre compared with average 2012 Arkansas soybean yields of 43 bushels per acre.

4.4.2 Pre-Harvest Corn Futures Hedge versus selling in Cash Market at Harvest Time

Results presented in tables 8 and 11 shows that the pre-harvest corn futures hedge risk management marketing strategy would have led to increased average mean net returns for a representative farmer compared to the base case strategy. For example, the parameter estimate for futures hedging (d4) in table 8 is 8.3 cents per bushel, which is significantly different from zero, so a pre-harvest corn futures hedge implemented at 100% COP level would have yielded an 8.3 cents per bushel higher average mean net return than simply selling corn in cash market at harvest time. F-test results shown at the top of table 11 confirm this result also holds for corn futures hedges implemented at other COP levels, although at the 150% COP level average mean net returns would only have been 5 cents per bushel higher than the base case.

However, F-test results presented at the top of table 12 indicate that the pre-harvest corn futures hedges would have resulted in a higher average risk level, expressed in larger average standard deviations, compared with the base case. This is the case for all COP target levels with the 150% level strategy yielding the greatest risk – the average standard deviation of net returns is 5 cents per bushel higher than selling in the cash market at harvest time.

These observations are contrary to what Peterson and Tomek (2007) observed for futures hedges.[19] Their study found a slightly lower expected lifetime mean return for their marketing strategy but their study also could observe a decreased risk level with an expected lifetime SD of only 62% of the base case of cash sales in November. However, it should be noted that Peterson and Tomek analyze an earlier data period, when price volatility was lower, and that the Peterson and Tomek futures strategies are not conditional upon COP, but are implemented unconditionally at the same pre-harvest date for each year in their simulation.

Although Zulauf, Larson, Alexander and Irwin (2001) find a higher mean gross return and a lower standard deviation of gross returns for their pre-harvest pricing research, their results are not statistically significant. The difference in this study compared to Zulauf, Larson, Alexander and Irwin (2001) is in the whole farm approach that the latter one uses. Only 50% of the production was hedged and returns were calculated on a per acre basis.

In contrast, Vyn (2012) finds in his study statistically higher average returns for the use of some pre-harvest marketing tools than the returns from the base strategy. In particular, spring futures hedging and forward contracting for corn is found to produce statistically higher average returns than selling at harvest time However, most pre-harvest marketing strategies analyzed in Vyn's study are lacking statistical significance.

[19] Peterson and Tomek (2007) crop marketing strategy Number 2a sells the expected harvest of year t in May with usage of the Futures contract for December. But they also assume one month of automatic post-harvest storage after a harvest dated for November. So the hedge strategy is completed in December with the sales for cash corn and the matching futures contract purchase.

4.4.3 Pre-Harvest Soybean Futures Hedge versus selling in Cash Market at Harvest Time

In contrast to corn hedging, the pre-harvest soybean futures average mean net returns, irrespective of COP level, are not significantly different to average mean net returns of cash soybean harvest sales (see top of table 13). With respect to risk (table 14), average standard deviation of net returns of futures hedges differ significantly compared with average standard deviation of net returns of cash sales. However, the only futures hedge that actually results in less risk or lower SD is the 100% COP strategy. This hedge reduces the SD on average by 57.23 cents per bushel compared with the base case.

4.4.4 Pre-Harvest Corn Forward Contract

Results presented in lower half of table 11, show corn forward strategies have a very mixed performance. For corn the 100% and the 125% percent COP coverage strategies yield on average less mean net returns than the base strategy but the average lower mean net returns are not significantly different from the base case. The corn 150% COP forward strategy leads to increased average mean net returns compared with the base case, but again this is not significantly different from then base case. In table 12, an average risk reduction cannot be seen for the forward contract strategies. All the COP levels lead to an average increased risk also at significant levels. The worst performance of the three coverage levels is the 125% COP coverage level that shows increased risk with lower average mean returns in comparison to the base strategy.

4.4.5 Pre-Harvest Soybean Forward Contract

Forward contract results for soybeans, shown in the lower halves of tables 13 and 14, are as varied as the corn results. The average mean net returns compared to the base case are only significant for the 100% COP level. The 100% and the 125% COP forward strategy for soybeans lead to increased average mean net returns compared with the base case. Forward contracts with a target level of 150% COP lead to lower average mean net returns for soybean producers (table 13). The 100% COP forward strategy significantly decreases the average variability of the net returns compared to the base case by 49.08 cents per bushel (table 14). However, in contrast the 100% and 150% COP forward strategies increase the average risk level compared with the base case by 24.26 cent per bushel. So, the optimal strategy is the 100% COP forward soybean strategy that results in an increase in the average mean net returns with a decreased risk level.

4.4.6 Summary of Pre-Harvest Strategies

The f-tests among the forward contract strategies do not reveal a lot significant differences when comparing the strategies among the different COP levels and compared to cash sales of the same commodity. For corn the 125% COP strategy generates losses of average 4.82 cents per bushel when compared to cash sales and the 150% COP strategy generates a premium of 7.22 cents per bushel when comparing with the 125% COP strategy. For soybeans only the comparison of the 100% forward strategy can increase average mean net returns by 7.22 cents per bushel compared to cash sales. In means of risk reduction the F-tests show that for corn the 125% and 150% COP level strategies increase the marketing risk by 4.03 and 2.88 cents per bushel in contrast to the cash sales average standard deviation. Soybeans forward contracts with a target 100% COP coverage level can significantly reduce marketing risk by 49.08 cents per bushel compared to the base strategy. The 125% COP strategy is significantly 52.49 cents per bushel worse than the 100% COP strategy and the 150% COP is another 20.84 cents per bushel worse than the 125% COP strategy in means of standard deviations.

Like for the futures strategies the forward contracts for soybeans increase the average mean net returns at all COP levels significantly. At the 125% COP level soybeans have in average 58.19 cents per bushel higher average mean net returns than corn. When seeking for reduced risk the corn strategies show all more than one Dollar per bushel lower standard deviations. The most evident is the 150% COP SD for corn that undercuts the matching soybeans strategy by 195.26 cents per bushel.

4.4.7 Post-Harvest Corn Storage

For corn this study finds statistically significant lower average mean net returns for the post-harvest storage strategy at all three tested COP coverage levels compared to the base strategy (see top half of table 15). The average lower mean net returns for corn reach from 37.13 cents per bushel for the 100% COP strategy to average lower mean net returns of 24.03 cents per bushel for the 150% COP strategy compared to the base strategy. On the other hand the risk level, as shown in table16, was decreased by an average 24.25 cents per bushel for the 125% COP strategy compared to the base case. However, risk was only reduced by an average SD of 1.4 cents per bushel for the 100% COP strategy.

4.4.8 Post-Harvest Soybean Storage

Soybean results presented in tables 17 and 18 are similar to the corn storage results. Here, the average mean net returns for the storage strategy dropped in comparison to cash sales in October, like for corn. The reduction in average mean net returns compared to the base case range from 42.43 cents per bushel for the 125% COP strategy to 67.27 cents per bushel for the 100% COP strategy. On the other hand the average SD of net returns is reduced significantly compared with the base case for all COP coverage levels. Average reductions range from 13.39 cents per bushel for the 150% COP strategy to 123.45 cents per bushel for the 100% COP strategy.

Perterson and Tomek (2007) observed the same behavior for lifetime returns of unhedged post-harvest storage as this study observes for mean average net returns of post harvest storage.[20] Different to this study, however, they observed larger average standard deviations of net returns to storage in comparison to their base strategy of selling cash at harvest. This study finds the opposite, significantly lower average standard deviations of the average net returns for post-harvest storage strategies compared to the base case of selling cash at harvest.

4.4.9 Post-Harvest Corn Minimum Price

Results with respect to minimum price corn contracts are reported in the lower halves of tables 15 and 16. Marketing performance in terms of average mean net returns, like storage, is relatively poor. All three COP target level strategies have significant average mean net return losses and perform poorly in comparison to cash harvest sales. In fact, the corn minimum price

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[20] Peterson and Tomek (2007) Base strategy corn cash sales in Novemeber, the post-harvest ungedged strategy is number 3a with a storage from November harvest until sales in May

contracts are the only strategies that result in actual average mean net losses. The 150% COP level contract for corn has negative average mean net returns of 23.63 cents per bushel, equivalent to 69.05 cents per bushel less than the base strategy would generate. The minimum price strategies, again like storage strategies, perform better in terms of the average reduction of SD of net returns in comparison to harvest time cash sales. This is the case for all examined COP levels. For corn the greatest reduction in average SD can be observed for the 100% COP strategy that shows 13.23 cents per bushel lower average SD of net returns than the base case.

4.4.10 Post-Harvest Corn Minimum Price

Results with respect to minimum price soybean contracts are reported in the lower halves of tables 17 and 18. Marketing performance in terms of average mean net returns is again relatively poor and similar to storage and corn minimum price strategies. At the 100% COP level the soybean strategy shows 92.27 cents per bushel lower average mean net returns than cash sales of soybeans at harvest. The 125% COP strategy yields on average 32.59 cents per bushel more than the 100% COP strategy but this is still worse than the base case. Most evident are the low average mean net returns associated with the 150% COP level minimum price contract for soybeans. This particular strategy causes on average 71.82 cents per bushel lower mean net return than the soybeans harvest sale. However, the average mean net returns for all of the minimum price contract soybean strategies are still positive in contrast to the equivalent strategies applied for corn marketing. Also, again like corn, the soybean minimum price contracts seem to offer better risk reduction than simply selling at harvest. The 100% COP minimum price contract performs the best in this regard lowering the average SD of net returns in comparison to the average SD of net returns of cash sales by a statistically significant 105.07cents per bushel.

4.4.11 Pre-Harvest Corn Futures versus Forward Strategies

Comparing futures and forward pre-harvest marketing strategies for corn we find that the futures generate additional average mean net returns for the representative farmer (see top half of table 19). With a targeted 100% coverage of COP the futures hedge generates on average significant 9.17 cents per bushel more than the forward contract. On the other hand, as can be seen in table 20, the futures hedge increases the variation of net returns risk by an average 6.84 cents per bushel. The greatest significant difference can be observed at the 125% COP level where futures hedges beat forward contracts by an average 13.12 cents per bushel in terms of higher mean net returns, without increasing the SD significantly.

4.4.12 Post-Harvest Corn Storage versus Minimum Price Strategies

Results presented tables 19 and 20 indicate that storage strategies in the post-harvest marketing period show significantly higher average mean net returns compared with minimum price strategies for all examined COP levels. The greatest difference can be observed for the 150% COP target level with average 45.01 cents per bushel higher average mean net return for storage compared with the minimum price contract. In the post-harvest marketing period the storage strategies also lower the risk level significantly at all COP levels for corn. The best average reduction in net returns standard deviations can be seen for the 100% COP storage strategy which in comparison with the equivalent 100% COP minimum price strategy reduces average standard deviation by a further 14.42 cents per bushel.

4.4.13 Pre-Harvest Soybean Futures versus Forward Strategies

Results of comparative marketing performance between soybean futures and forward contract strategies are presented in tables 19 and 20. In contrast to corn, at the 100% COP level, the futures hedge on average performs significantly worse than the forward contract. The average difference is 6.10 cents per bushel higher mean net returns for the forward contract. But at this same COP level the futures hedge lowers average SD of net returns by 8.15 cents per bushel compared to the forward strategy. Interestingly, at the 150% COP level results are reversed with futures yielding significantly higher average mean net returns of 17.51 cents per bushel compared with the forward contract. However, both the 125% and 150% COP level futures hedges significantly lower average standard deviation of net returns in comparison to equivalent COP level forward contracts, at least at the 5% and 10% significance levels respectively.

4.4.14 Post-Harvest Soybeans Storage versus Minimum Price Strategies

Results of comparative marketing performance between soybean storage and minimum price contract strategies are presented in tables 19 and 20. The storage strategy shows significantly higher average mean net returns for the 100% and 125% COP levels compared to the equivalent COP level minimum price contract strategies. The differences at the 100% COP are on average 25 cents per bushel higher mean net returns than the minimum price strategy. Storing soybeans also decreases the marketing risk significantly at the 100% and 125% level compared with equivalent COP level minimum price strategies. At the 100% COP level the average SD of net returns is 17.75 cents per bushel higher when using a minimum price contract instead of the storage strategy.

Neyhard, Tauer and Gloy (2013) find futures to be most efficient in risk management of corn and soybean used as feed for milking cows compared to cash and options based strategies. They see futures more efficient in risk management for those commodities than option prices. This study also finds futures hedges to be the most efficient strategies when it comes to increased average net returns. Results presented in this thesis are consistent with Neyhard, Tauer and Glory's finding that the option based strategies usually have lower average returns than cash sales.

4.5 Conclusions

This study examined pre-harvest marketing strategies and post-harvest strategies separately for corn and soybeans. Average mean net returns are considered as well as average standard deviations of net returns to measure the risk return. A farmer should be compensated for taking on higher levels of risk.

As the farmer is a profit maximizer it is very important that the farmer can generate good mean average net returns to stay in production and keep his business generating positive returns. This study found for both commodities that pre-harvest marketing strategies perform better than post-harvest strategies in increasing mean average net returns. Four pre-harvest marketing strategies out of 6 perform better than harvest sales in increasing average mean net returns across a representative 12 years sample period. In this study the pre-harvest marketing strategies provide better return results than the post-harvest marketing strategies, even though the post-harvest marketing tools offer a better reduction in the average standard deviation of net returns. As the results are presented as an average result of the most recent 12 marketing years the farmers get a good risk return when choosing a more risky pre-harvest marketing strategy

In this study the futures hedges showed the best results for corn produced in north-east Arkansas followed by the other examined pre-harvest marketing strategy of forward contracting. At the 125% COP coverage level the difference is 13.12 cents per bushel higher average mean net returns for the futures compared with the forwards, which should be more than enough to offset the costs for hedging with futures that are not explicitly considered in this study. (E.g. commission and margin costs)

Among the forward contract strategies for corn the only strategy preferred to harvest cash sales is the 150% targeted COP coverage strategy.

Post-harvest all strategies perform worse than harvest cash sales. All three minimum price strategies generate total average mean net returns that are negative and do not cover the production cost. Storage provides the farmer with a positive average mean net return but this return is lower compared with the base case of cash sales at harvest.

When looking at the pre-harvest soybean results, the average standard deviation of net returns is greater than for corn and some strategies can lower the standard deviation by on average more than a dollar per bushel. The best risk reducing strategies are the 100% COP level for storage and minimum price contracts. On the other hand their average mean net returns do compare as well as most pre-harvest strategies.

The-pre harvest marketing strategies for soybeans show similar results to corn. Here the best strategies are the 150% and 125% Target COP level futures hedges, followed by 100% and 125% COP level forward contracts. Even though the 100% COP futures strategy and the 150% COP forward strategy show lower average mean net returns their differences are not significant at a 5% level to the soybean harvest cash sales.

All the post-harvest marketing strategies are significantly worse than soybean cash sales at harvest. Like for corn, the minimum price contracts are worse compared to storage.

So in conclusion the futures strategy performs best for corn and soybean marketing in north-east Arkansas. Forward strategies also show satisfactory average mean net returns in comparison to cash sales at harvest. Pre-harvest marketing is better than post-harvest marketing for both commodities. It has to be mentioned that the costs for storing grain and purchasing an option can be quite high. For futures this study does not consider hedging costs[21] . Margin calls are not considered and this study does not evaluate the marketing performance under a whole farm approach, so cash-flow needs are also not considered.

Neyhard, Tauer and Glory (2013) find futures to be most efficient in risk management of corn and soybean, used as feed inputs for milking cows compared to cash and options based strategies. They see futures as more efficient in risk management for those two commodities than option based strategies. This study also finds futures hedges to be the most efficient strategies when it comes to increasing average net returns. This study is also in line with Neyhard, Tauer and Glory's finding that the option based strategies usually have lower average returns than cash sales. The option based minimum price strategy performed worst of all assessed methods for this study

The poor performance of minimum price contract strategy in this study could explain the low demand for those contracts that Stone, Warner and Whitacre (2011) found compared with the demand for other marketing tools. Vyn (2012) finds high price deviations for strategies using options in Canada as well.

Forward contracts that perform fairly well are under steady demand by farmers. Power and Turvey (2008) and Stone, Warner and Whitacre (2011) both observed this demand. Their performance in increasing average mean returns justifies the demand by farmers for those contracts even if there are more and more specialized and complex marketing tools are available.

[21] Neyhard, Tauer and Glory (2013) use data from the homepage of the CME Group (www.cmegroup.com) to calculate margin requirements and figured 70 Dollars as a simplified estimate for transaction costs per round turn for each futures contract. This estimate would mean 0.014 cents per bushel transaction costs for a futures trade.

The good performance of the pre-harvest marketing strategies is not consistent with Zulauf et al (2001) and Zulauf and Irwin (2007). They found better returns, like this study, but between harvest cash sales they did not find significant differences. They also did not find any strategy that presents better results over multiple years. In this study, over a period of 12 years, for instance in this study the three futures strategies for corn have significantly higher average mean returns over a 12 years study period.

Kastens and Dhuyvetter (1998) find increased returns for storing soybeans but reduced returns for the storage of corn. In this study the storage contract performance is lowers average mean net returns for both commodities compared to harvest and pre-harvest strategies.

4.6 Significance of this Study

This thesis focuses on the examination of risk returns of existing marketing tools for corn and soybean producers in north-east Arkansas. Risk management tools offer the possibility of reducing the net return variation for the farmer and additionally increasing the mean net returns when applied over several years.

Most research of this nature has focused on mid-west agricultural production regions, not in the southern regions in the US. This study focuses on north-east Arkansas, which is located in the South of the US, and which in terms of GDP relies heavily on agriculture.

Net returns to a dynamic profit margin hedging rule applied to various marketing strategies are simulated. Most previous research is static in nature using mechanical strategies. (i.e. sell crop on the same day each year). Forward looking, market based, price risk levels are modeled using implied volatilities derived from options contracts. In addition, the simulation of net returns is based on daily simulated price sequences. This adds an additional level of realism to the model compared with previous studies that have based their analysis on monthly prices.

Finally, this study provides a more in-depth analysis of popular elevator contracts compared with previous literature, and in particular represents the first known analysis of minimum price contracts.

4.7 Limitations and Further Research

This study focuses on the comparison of agricultural marketing strategies on a per bushel basis in terms of net return enhancement and the reduction of net return risk. However, hedging costs like brokerage fees for the futures hedging strategies are not considered. Also not considered are margin calls and cash flow needs the farmer has when evaluating his performance under a whole farm approach. In addition, as the farmer depends upon achieving a good income it could be important to examine his overall economic situation when evaluating different marketing strategies. Also, this thesis assumed farmers hedge one hundred percent of their production. However, from a technical marketing standpoint it should be noted that a futures contract size is fixed at 5000 bushels but the farmer's production is usually not in exact 5000 bushels amounts and so hedging one hundred percent of production is not usually possible. Furthermore, because of yield risk many famers only hedge a specific share of their expected or actual production, and yield risk was not considered in this study.

Interesting extensions of this study might take into account other types of risk, like yield risk, and more specific types of production costs associated with different crop production practices (e.g. irrigated versus dry land systems). Such costs could be considered in a whole farm study that takes the overall net returns of all produced crops into account.

When evaluating relative risk and return of the various marketing strategies modeling approaches that incorporate expected utility maximization and risk preferences could be considered. For example the standard deviation risk of net returns could be analyzed using a lower partial moment (LPM) approach like Vyn (2012). The LPM measures the frequency of net returns falling below a set threshold, the downside risk. Financial literature uses this approach to evaluate portfolio risk.

The SYSLIN Procedure
Ordinary Least Squares Estimation

Model	Rev_Av
Dependent Variable	Rev_Av

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	29	49427658	1704402	705.7	<.0001
Error	29970	72383494	2415.2		
Corrected Total	29999	121810000.00			

Root MSE	49.1447	**R-Square**	0.40577
Dependent Mean	45.8835	**Adj R-Sq**	0.4052
Coeff Var	107.107		

Table 7 SAS output ANOVA net returns

Indicator or Interaction term	Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
	Parameter Estimates					
Corn, cash	**Intercept**	1	45.42	1.55409	29.23	<.0001
Soybeans	**d1**	1	51.80	2.19782	23.57	<.0001
125% COP level	**d2**	1	0.00	2.19782	0	1
150% COP level	**d3**	1	0.00	2.19782	0	1
Futures	**d4**	1	8.30	2.19782	3.78	0.0002
Forward	**d5**	1	-0.87	2.19782	-0.4	0.691
Storage	**d6**	1	-37.13	2.19782	-16.9	<.0001
Minimum price	**d7**	1	-57.17	2.19782	-26.01	<.0001
Soybeans, cash, 125%COP	**d1d2**	1	0.00	3.10818	0	1
Soybeans, cash, 150% COP	**d1d3**	1	0.00	3.10818	0	1
Soybeans, Futures, 100% COP	**d1d4**	1	-9.13	3.10818	-2.94	0.0033
Soybeans, Forward, 100% COP	**d1d5**	1	6.13	3.10818	1.97	0.0484
Soybeans, Storage, 100% COP	**d1d6**	1	-30.14	3.10818	-9.7	<.0001
Soybeans, Minimum price, 100% COP	**d1d7**	1	-35.10	3.10818	-11.29	<.0001
Corn, Futures, 125% COP	**d2d4**	1	0.01	3.10818	0	0.9986
Corn, Futures, 150% COP	**d3d4**	1	-2.96	3.10818	-0.95	0.3415
Corn, Forward, 125% COP	**d2d5**	1	-3.94	3.10818	-1.27	0.2047
Corn, Forward, 150% COP	**d3d5**	1	3.33	3.10818	1.07	0.2844
Corn, Storage, 125% COP	**d2d6**	1	6.22	3.10818	2	0.0453
Corn, Storage, 150% COP	**d3d6**	1	13.10	3.10818	4.21	<.0001
Corn, Minimum price, 125% COP	**d2d7**	1	-5.94	3.10818	-1.91	0.0562
Corn, Minimum price, 150% COP	**d3d7**	1	-11.88	3.10818	-3.82	0.0001
Soybeans, Futures, 125% COP	**d1d2d4**	1	0.17	4.39563	0.04	0.9689
Soybeans, Forward, 125% COP	**d1d2d5**	1	2.44	4.39563	0.56	0.5787
Soybeans, Storage, 125% COP	**d1d2d6**	1	-5.40	4.39563	-1.23	0.2191
Soybeans, Minimum price, 125% COP	**d1d2d7**	1	-2.51	4.39563	-0.57	0.5677
Soybeans, Futures, 150% COP	**d1d3d4**	1	2.69	4.39563	0.61	0.5399
Soybeans, Forward, 150% COP	**d1d3d5**	1	-5.64	4.39563	-1.28	0.1993
Soybeans, Storage, 150% COP	**d1d3d6**	1	-10.20	4.39563	-2.32	0.0203
Soybeans, Minimum price, 150% COP	**d1d3d7**	1	-14.65	4.39563	-3.33	0.0009

Table 8 ANOVA average mean net returns parameter estimates

The SYSLIN Procedure
Ordinary Least Squares Estimation

Model	Rev_Std
Dependent Variable	Rev_Std

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	29	140300000.00	4837814	4876.22	<.0001
Error	29970	29733981.00	992.125		
Corrected Total	29999	170030000.00			

Root MSE	31.498	**R-Square**	0.82513
Dependent Mean	158.943	**Adj R-Sq**	0.82496
Coeff Var	19.8172		

Table 9 SAS output ANOVA net returns SD

Indicator or Interaction term	Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
			Parameter Estimates			
Corn, cash	**Intercept**	1	103.77	0.99606	104.18	<.0001
Soybeans	**d1**	1	173.88	1.40863	123.44	<.0001
125% COP level	**d2**	1	0.00	1.40863	0	1
150% COP level	**d3**	1	0.00	1.40863	0	1
Futures	**d4**	1	3.92	1.40863	2.78	0.0054
Forward	**d5**	1	-2.93	1.40863	-2.08	0.0376
Storage	**d6**	1	-27.66	1.40863	-19.64	<.0001
Minimum price	**d7**	1	-13.23	1.40863	-9.4	<.0001
Soybeans, cash, 125%COP	**d1d2**	1	0.00	1.99211	0	1
Soybeans, cash, 150% COP	**d1d3**	1	0.00	1.99211	0	1
Soybeans, Futures, 100% COP	**d1d4**	1	-61.15	1.99211	-30.69	<.0001
Soybeans, Forward, 100% COP	**d1d5**	1	-46.15	1.99211	-23.17	<.0001
Soybeans, Storage, 100% COP	**d1d6**	1	-95.79	1.99211	-48.08	<.0001
Soybeans, Minimum price, 100% COP	**d1d7**	1	-92.47	1.99211	-46.42	<.0001
Corn, Futures, 125% COP	**d2d4**	1	0.87	1.99211	0.44	0.6612
Corn, Futures, 150% COP	**d3d4**	1	2.58	1.99211	1.29	0.1958
Corn, Forward, 125% COP	**d2d5**	1	6.96	1.99211	3.49	0.0005
Corn, Forward, 150% COP	**d3d5**	1	5.81	1.99211	2.92	0.0035
Corn, Storage, 125% COP	**d2d6**	1	3.41	1.99211	1.71	0.0868
Corn, Storage, 150% COP	**d3d6**	1	12.55	1.99211	6.3	<.0001
Corn, Minimum price, 125% COP	**d2d7**	1	1.96	1.99211	0.98	0.326
Corn, Minimum price, 150% COP	**d3d7**	1	2.71	1.99211	1.36	0.1734
Soybeans, Futures, 125% COP	**d1d2d4**	1	11.23	2.81727	3.99	<.0001
Soybeans, Forward, 125% COP	**d1d2d5**	1	6.35	2.81727	2.25	0.0243
Soybeans, Storage, 125% COP	**d1d2d6**	1	12.14	2.81727	4.31	<.0001
Soybeans, Minimum price, 125% COP	**d1d2d7**	1	6.54	2.81727	2.32	0.0202
Soybeans, Futures, 150% COP	**d1d3d4**	1	26.98	2.81727	9.58	<.0001
Soybeans, Forward, 150% COP	**d1d3d5**	1	27.19	2.81727	9.65	<.0001
Soybeans, Storage, 150% COP	**d1d3d6**	1	14.27	2.81727	5.07	<.0001
Soybeans, Minimum price, 150% COP	**d1d3d7**	1	-5.26	2.81727	-1.87	0.062

Table 10 ANOVA average standard deviation parameter estimates

F-Test results pre-harvest strategies corn average net revenue

Corn 100 futures vs. corn cash	Test Results				Parameter Estimate
H0: d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4≠0	1	29970	14.4	0.0001	8.296971

Corn 125 futures vs. cash	Test Results				Parameter Estimate
H0: d2+d4+d2d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d4+d2d4≠0	1	29970	14.41	0.0001	8.3

Corn 150 futures vs. cash	Test Results				Parameter Estimate
H0: d3+d4+d3d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d4+d3d4≠0	1	29970	5.96	0.0146	5.34

Corn 125 futures vs. corn 100 futures	Test Results				Parameter Estimate
H0: d2+d2d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d2d4≠0	1	29970	0	0.998	0.01

Corn 150 futures vs. corn 100 futures	Test Results				Parameter Estimate
H0: d3+d3d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d4≠0	1	29970	1.83	0.1764	-2.9566

Corn 150 futures vs. corn 125 futures	Test Results				Parameter Estimate
H0: d3+d3d4-d2-d2d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d4-d2-d2d4≠0	1	29970	1.83	0.1756	-2.96

Corn 100 forward vs. corn cash	Test Results				Parameter Estimate
H0: d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d5≠0	1	29970	0.16	0.6895	-0.87376

Corn 125 forward vs. cash	Test Results				Parameter Estimate
H0: d2+d5+d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d5+d2d5≠0	1	29970	4.85	0.0276	-4.82

Corn 150 forward vs. cash	Test Results				Parameter Estimate
H0: d3+d5+d3d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d5+d3d5≠0	1	29970	1.26	0.2619	2.45

Corn 125 forward vs. corn 100 forward	Test Results				Parameter Estimate
H0: d2+d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d2d5≠0	1	29970	3.25	0.0714	-3.94

Corn 150 forward vs. corn 100 forward	Test Results				Parameter Estimate
H0: d3+d3d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d5≠0	1	29970	2.31	0.1282	3.327024

Corn 150 forward vs. corn 125 forward	Test Results				Parameter Estimate
H0: d3+d3d5-d2-d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d5-d2-d2d5≠0	1	29970	11.05	0.0009	7.27

Table 11 F-test results pre-harvest strategies corn average mean net returns

F-Test results pre-harvest strategies corn average standard deviation

Corn 100 futures vs. corn cash	Test Results				Parameter Estimate
H0: d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4≠0	1	29970	7.77	0.0053	1.404911

Corn 125 futures vs. cash	Test Results				Parameter Estimate
H0: d2+d4+d2d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d4+d2d4≠0	1	29970	11.62	0.0007	4.79

Corn 150 futures vs. cash	Test Results				Parameter Estimate
H0: d3+d4+d3d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d4+d3d4≠0	1	29970	21.35	0.0001	6.49

Corn 125 futures vs. corn 100 futures	Test Results				Parameter Estimate
H0: d2+d2d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d2d4≠0	1	29970	0.39	0.5344	0.87

Corn 150 futures vs. corn 100 futures	Test Results				Parameter Estimate
H0: d3+d3d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d4≠0	1	29970	3.36	0.0666	3.391755

Corn 150 futures vs. corn 125 futures	Test Results				Parameter Estimate
H0: d3+d3d4-d2-d2d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d4-d2-d2d4≠0	1	29970	1.47	0.2252	1.7

Corn 100 forward vs. corn cash	Test Results				Parameter Estimate
H0: d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d5≠0	1	29970	4.35	0.0371	1.404911

Corn 125 forward vs. cash	Test Results				Parameter Estimate
H0: d2+d5+d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d5+d2d5≠0	1	29970	8.24	0.0041	4.03

Corn 150 forward vs. cash	Test Results				Parameter Estimate
H0: d3+d5+d3d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d5+d3d5≠0	1	29970	4.21	0.0402	2.88

Corn 125 forward vs. corn 100 forward	Test Results				Parameter Estimate
H0: d2+d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d2d5≠0	1	29970	24.55	0.0001	6.96

Corn 150 forward vs. corn 100 forward	Test Results				Parameter Estimate
H0: d3+d3d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d5≠0	1	29970	17.11	0.0001	3.391755

Corn 150 forward vs. corn 125 forward	Test Results				Parameter Estimate
H0: d3+d3d5-d2-d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d5-d2-d2d5≠0	1	29970	0.67	0.413	-1.15

Table 12 F-Test results pre-harvest strategies corn average standard deviation of net returns

F-Test results pre-harvest strategies soybeans average net revenue

Soybeans 100 futures vs. soybeans cash	Test Results				Parameter Estimate
H0: d4+d1d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d1d4≠0	1	29970	0.15	0.7027	-0.83

Soybeans 125 futures vs. soybeans cash	Test Results				Parameter Estimate
H0: d2+d4+d1d2d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d4+d1d2d4≠0	1	29970	1.36	0.243	8.47

Soybeans 150 futures vs. soybeans cash	Test Results				Parameter Estimate
H0: d3+d4+d1d3d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d4+d1d3d4≠0	1	29970	2.3	0.1297	10.99

Soybeans 125 futures vs. soybeans 100 futures	Test Results				Parameter Estimate
H0: d2+d1d2d4-d1d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d1d2d4-d1d4≠0	1	29970	1.29	0.2555	9.3

soybeans 150 futures vs. soybeans 100 futures	Test Results				Parameter Estimate
H0: d3+d1d3d4-d1d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d4-d1d4≠0	1	29970	2.09	0.1484	11.8261

Soybeans 150 futures vs. soybeans 125 futures	Test Results				Parameter Estimate
H0: d3+d1d3d4-d2-d1d2d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d4-d2-d1d2d4≠0	1	29970	0.19	0.6628	2.52

Soybeans 100 forward vs. soybeans cash	Test Results				Parameter Estimate
H0: d5+d1d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d5+d1d5≠0	1	29970	5.79	0.0162	5.26

Soybeans 125 forward vs. soybeans cash	Test Results				Parameter Estimate
H0: d2+d5+d1d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d5+d1d2d5≠0	1	29970	0.05	0.8289	6.81

Soybeans 150 forward vs. soybeans cash	Test Results				Parameter Estimate
H0: d3+d5+d1d3d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d5+d1d3d5≠0	1	29970	0.81	0.369	-6.52

soybeans 125 forward vs. soybeans 100 forward	Test Results				Parameter Estimate
H0: d2+d1d2d5-d1d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d1d2d5-d1d5≠0	1	29970	0.2	0.6517	-3.69

soybeans 150 forward vs. soybeans 100 forward	Test Results				Parameter Estimate
H0: d3+d1d3d5-d1d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d5-d1d5≠0	1	29970	2.07	0.1501	-11.77622

Soybenas 150 forward vs. soybenas 125 forward	Test Results				Parameter Estimate
H0: d3+d1d3d5-d2-d1d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d5-d2-d1d2d5≠0	1	29970	1.95	0.1624	-8.08

Table 13 F-Test results pre-harvest soybeans average standard deviations of net returns

F-Test results pre-harvest strategies soybeans average standard deviation

Soybeans 100 futures vs. soybeans cash	Test Results				Parameter Estimate
H0: d4+d1d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d1d4≠0	1	29970	1659.5	0.0001	-57.23173

Soybeans 125 futures vs. soybeans cash	Test Results				Parameter Estimate
H0: d2+d4+d1d2d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d4+d1d2d4≠0	1	29970	10.56	0.0012	15.143045

Soybeans 150 futures vs. soybeans cash	Test Results				Parameter Estimate
H0: d3+d4+d1d3d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d4+d1d3d4≠0	1	29970	43.97	0.0001	30.9

Soybeans 125 futures vs. soybeans 100 futures	Test Results				Parameter Estimate
H0: d2+d1d2d4-d1d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d1d2d4-d1d4≠0	1	29970	189.56	0.0001	72.37477

soybeans 150 futures vs. soybeans 100 futures	Test Results				Parameter Estimate
H0: d3+d1d3d4-d1d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d4-d1d4≠0	1	29970	281.08	0.0001	2.227889

Soybeans 150 futures vs. soybeans 125 futures	Test Results				Parameter Estimate
H0: d3+d1d3d4-d2-d1d2d4=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d4-d2-d1d2d4≠0	1	29970	17.97	0.0001	15.7553

Soybeans 100 forward vs. soybeans cash	Test Results				Parameter Estimate
H0: d5+d1d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d5+d1d5≠0	1	29970	1220.53	0.0001	-49.08197

Soybeans 125 forward vs. soybeans cash	Test Results				Parameter Estimate
H0: d2+d5+d1d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d5+d1d2d5≠0	1	29970	0.54	0.4635	9.155084

Soybeans 150 forward vs. soybeans cash	Test Results				Parameter Estimate
H0: d3+d5+d1d3d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d5+d1d3d5≠0	1	29970	27.1	0.0001	24.25723

soybeans 125 forward vs. soybeans 100 forward	Test Results				Parameter Estimate
H0: d2+d1d2d5-d1d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d1d2d5-d1d5≠0	1	29970	99.74	0.0001	52.498062

soybeans 150 forward vs. soybeans 100 forward	Test Results				Parameter Estimate
H0: d3+d1d3d5-d1d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d5-d1d5≠0	1	29970	194.65	0.0001	2.227889

Soybenas 150 forward vs. soybenas 125 forward	Test Results				Parameter Estimate
H0: d3+d1d3d5-d2-d1d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d5-d2-d1d2d5≠0	1	29970	31.44	0.0001	20.841138

Table 14 F-test results pre-harvest strategies soybeans average standard deviation of net returns

F-Test results post-harvest strategies corn average net revenue

Corn 100 storage vs. corn cash	Test Results				Parameter Estimate
H0: d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6≠0	1	29970	298.12	0.0001	-37.7569

Corn 125 storage vs. corn cash	Test Results				Parameter Estimate
H0: d2+d6+d2d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d6+d2d6≠0	1	29970	208.3	0.0001	-31.56

Corn 150 storage vs. corn cash	Test Results				Parameter Estimate
H0: d3+d6+d3d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d6+d3d6≠0	1	29970	122.14	0.0001	-24.17

Corn 125 storage vs. corn 100 storage	Test Results				Parameter Estimate
H0: d2+d2d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d2d6≠0	1	29970	8.03	0.0046	6.2

Corn 150 storage vs. corn 100 storage	Test Results				Parameter Estimate
H0: d3+d3d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d6≠0	1	29970	38.62	0.0001	13.5892

Corn 150 storage vs. corn 125 storage	Test Results				Parameter Estimate
H0: d3+d3d6-d2-d2d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d6-d2-d2d6≠0	1	29970	11.43	0.0007	7.39

Corn 100 min. price vs. corn cash	Test Results				Parameter Estimate
H0: d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d7≠0	1	29970	683.51	0.0001	-57.1703

Corn 125 min. price vs. corn cash	Test Results				Parameter Estimate
H0: d2+d7+d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d7+d2d7≠0	1	29970	832.81	0.0001	-63.11

Corn 150 min. price vs. corn cash	Test Results				Parameter Estimate
H0: d3+d7+d3d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d7+d3d7≠0	1	29970	997.13	0.0001	-69.05

Corn 125 min. price vs. corn 100 min. price	Test Results				Parameter Estimate
H0: d2+d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d2d7≠0	1	29970	7.37	0.0066	-5.94

Corn 150 min. price vs. corn 100 min. price	Test Results				Parameter Estimate
H0: d3+d3d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d7≠0	1	29970	29.52	0.0001	-11.8814

Corn 150 min. price vs. corn 125 min. price	Test Results				Parameter Estimate
H0: d3+d3d7-d2-d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d7-d2-d2d7≠0	1	29970	7.39	0.0066	-5.95

Table 15 F-Test results post-harvest strategies corn average mean net return

F-Test results post-harvest strategies corn average standard deviation

Corn 100 storage vs. corn cash	Test Results				Parameter Estimate
H0: d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6≠0	1	29970	373.95	0.0001	1.404911

Corn 125 storage vs. corn cash	Test Results				Parameter Estimate
H0: d2+d6+d2d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d6+d2d6≠0	1	29970	283.35	0.0001	-23.64893

Corn 150 storage vs. corn cash	Test Results				Parameter Estimate
H0: d3+d6+d3d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d6+d3d6≠0	1	29970	103.45	0.0001	-14.28945

Corn 125 storage vs. corn 100 storage	Test Results				Parameter Estimate
H0: d2+d2d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d2d6≠0	1	29970	6.27	0.0123	3.51887

Corn 150 storage vs. corn 100 storage	Test Results				Parameter Estimate
H0: d3+d3d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d6≠0	1	29970	84.03	0.0001	3.391755

Corn 150 storage vs. corn 125 storage	Test Results				Parameter Estimate
H0: d3+d3d6-d2-d2d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d6-d2-d2d6≠0	1	29970	44.38	0.0001	9.35948

Corn 100 min. price vs. corn cash	Test Results				Parameter Estimate
H0: d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d7≠0	1	29970	88.74	0.0001	1.404911

Corn 125 min. price vs. corn cash	Test Results				Parameter Estimate
H0: d2+d7+d2d7=0	Num DF	Den DF	F Value	Pr > F	

Ha: d2+d7+d2d7≠0	1	29970	64.44	0.0001	-11.27792

Corn 150 min. price vs. corn cash	Test Results				Parameter Estimate
H0: d3+d7+d3d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d7+d3d7≠0	1	29970	56.09	0.0001	-10.52225

Corn 125 min. price vs. corn 100 min. price	Test Results				Parameter Estimate
H0: d2+d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d2d7≠0	1	29970	1.94	0.1637	1.956584

Corn 150 min. price vs. corn 100 min. price	Test Results				Parameter Estimate
H0: d3+d3d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d7≠0	1	29970	3.73	0.0535	3.391755

Corn 150 min. price vs. corn 125 min. price	Test Results				Parameter Estimate
H0: d3+d3d7-d2-d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d3d7-d2-d2d7≠0	1	29970	0.29	0.5907	0.755671

Table 16 F-Test results post-harvest strategies corn average standard deviation of net returns

F-Test results post-harvest strategies soybeans average net revenue

Soybeans 100 storage vs. soybeans cash	Test Results				Parameter Estimate
H0: d6+d1d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d1d6≠0	1	29970	885.17	0.0001	-65.06

Soybeans 125 storage vs. soybeans cash	Test Results				Parameter Estimate
H0: d2+d6+d1d2d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d6+d1d2d6≠0	1	29970	29.63	0.0001	-39.48

Soybeans 150 storage vs. soybeans cash	Test Results				Parameter Estimate
H0: d3+d6+d1d3d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d6+d1d3d6≠0	1	29970	29.56	0.0001	-39.43

Soybeans 125 storage vs. soybeans 100 storage	Test Results				Parameter Estimate
H0: d2+d1d2d6-d1d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d1d2d6-d1d6≠0	1	29970	9.78	0.0018	25.58

soybeans 150 storage vs. soybeans 100 storage	Test Results				Parameter Estimate
H0: d3+d1d3d6-d1d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d6-d1d6≠0	1	29970	9.81	0.0017	25.63058

Soybeans 150 storage vs. soybeans 125 storage	Test Results				Parameter Estimate
H0: d3+d1d3d6-d2-d1d2d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d6-d2-d1d2d6≠0	1	29970	0	0.9933	0.05

Soybeans 100 min. price vs. soybeans cash	Test Results				Parameter Estimate
H0: d7+d1d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d7+d1d7≠0	1	29970	1780.49	0.0001	-92.27

Soybeans 125 min. price vs. soybeans cash	Test Results				Parameter Estimate
H0: d2+d7+d1d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d7+d1d2d7≠0	1	29970	67.72	0.0001	-59.68

Soybeans 150 min. price vs. soybeans cash	Test Results				Parameter Estimate
H0: d3+d7+d1d3d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d7+d1d3d7≠0	1	29970	98.06	0.0001	-71.82

Soybeans 125 min. price vs. soybenas 100 min. price	Test Results				Parameter Estimate
H0: d2+d1d2d7-d1d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d1d2d7-d1d7≠0	1	29970	15.86	0.0001	32.59

soybeans 150 min. price vs. soybeans 100 min. price	Test Results				Parameter Estimate
H0: d3+d1d3d7-d1d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d7-d1d7≠0	1	29970	6.25	0.0124	20.4532

Soybeans 150 min. price vs. soybeabs 125 min. price	Test Results				Parameter Estimate
H0: d3+d1d3d7-d2-d1d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d7-d2-d1d2d7≠0	1	29970	4.4	0.0359	-12.14

Table 17 F-Test results post-harvest strategies soybeans average mean net return

F-Test results post-harvest strategies soybeans average standard deviation

Soybeans 100 storage vs. soybeans cash	Test Results				Parameter Estimate
H0: d6+d1d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d1d6≠0	1	29970	7997.13	0.0001	-125.6365

Soybeans 125 storage vs. soybeans cash	Test Results				Parameter Estimate
H0: d2+d6+d1d2d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d6+d1d2d6≠0	1	29970	11.67	0.0006	-15.91862

Soybeans 150 storage vs. soybeans cash	Test Results				Parameter Estimate
H0: d3+d6+d1d3d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d6+d1d3d6≠0	1	29970	4.46	0.0347	-9.83907

Soybeans 125 storage vs. soybeans 100 storage	Test Results				Parameter Estimate
H0: d2+d1d2d6-d1d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d1d2d6-d1d6≠0	1	29970	435.64	0.0001	109.71788

soybeans 150 storage vs. soybeans 100 storage	Test Results				Parameter Estimate
H0: d3+d1d3d6-d1d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d6-d1d6≠0	1	29970	485.26	0.0001	2.227889

Soybeans 150 storage vs. soybeans 125 storage	Test Results				Parameter Estimate
H0: d3+d1d3d6-d2-d1d2d6=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d6-d2-d1d2d6≠0	1	29970	2.68	0.1019	6.07955

Soybeans 100 min. price vs. soybeans cash	Test Results				Parameter Estimate
H0: d7+d1d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d7+d1d7≠0	1	29970	5660.68	0.0001	-105.702

Soybeans 125 min. price vs. soybeans cash	Test Results				Parameter Estimate
H0: d2+d7+d1d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d7+d1d2d7≠0	1	29970	2.06	0.151	-6.69

Soybeans 150 min. price vs. soybeans cash	Test Results				Parameter Estimate
H0: d3+d7+d1d3d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d7+d1d3d7≠0	1	29970	15.75	0.0001	-18.49297

Soybeans 125 min. price vs. soybenas 100 min. price	Test Results				Parameter Estimate
H0: d2+d1d2d7-d1d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d2+d1d2d7-d1d7≠0	1	29970	354.76	0.0001	99.009908

soybeans 150 min. price vs. soybeans 100 min. price	Test Results				Parameter Estimate
H0: d3+d1d3d7-d1d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d7-d1d7≠0	1	29970	275.23	0.0001	2.227889

Soybeans 150 min. price vs. soybeabs 125 min. price	Test Results				Parameter Estimate
H0: d3+d1d3d7-d2-d1d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d3+d1d3d7-d2-d1d2d7≠0	1	29970	10.08	0.0015	-11.80088

Table 18 F-Test results post-harvest strategies soybeans average standard deviation of net returns

F-Test results pre- and post-harvest strategy comparison by commodity average net revenue

Corn futures 100 vs. corn forward 100	Test Results				Parameter Estimate
H0: d4-d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4-d5≠0	1	29970	17.59	0.0001	9.17

Corn futures 125 vs. corn forward 125	Test Results				Parameter Estimate
H0: d4+d2d4-d5-d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d2d4-d5-d2d5≠0	1	29970	35.99	0.0001	13.12

Corn futures 150 vs. corn forward 150	Test Results				Parameter Estimate
H0: d4+d3d4-d5-d3d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d3d4-d5-d3d5≠0	1	29970	1.74	0.1868	2.89

Corn 100 storage vs. corn 100 min. price	Test Results				Parameter Estimate
H0: d6-d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6-d7≠0	1	29970	78.81	0.0001	19.41

Corn 125 storage vs. corn 125 min. price	Test Results				Parameter Estimate
H0: d6+d2d6-d7-d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d2d6-d7-d2d7≠0	1	29970	208.1	0.0001	31.55

Corn 150 storage vs. corn 150 min. price	Test Results				Parameter Estimate
H0: d6+d3d6-d7-d3d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d3d6-d7-d3d7≠0	1	29970	421.3	0.0001	44.88

Soybeans 100 futures vs. soybeans 100 forward	Test Results				Parameter Estimate
H0: d4+d1d4-d5-d1d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d1d4-d5-d1d5≠0	1	29970	7.77	0.0053	-6.1

Soybenas 125 futures vs. soybeans 125 forward	Test Results				Parameter Estimate
H0: d4+d1d2d4-d5-d1d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d1d2d4-d5-d1d2d5≠0	1	29970	1.42	0.2329	6.03

Soybeans 150 futures vs. soybeans 150 forward	Test Results				Parameter Estimate
H0: d4+d1d3d4-d5-d1d3d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d1d3d4-d5-d1d3d5≠0	1	29970	9.16	0.0025	17.51

Soybeans 100 storage vs. soybeans 100 min. price	Test Results				Parameter Estimate
H0: d6+d1d6-d7-d1d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d1d6-d7-d1d7≠0	1	29970	154.86	0.0001	27.21

Soybeans 125 storage vs. soy 125 min. price	Test Results				Parameter Estimate
H0: d6+d1d2d6-d7-d1d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d1d2d6-d7-d1d2d7≠0	1	29970	12.2	0.0005	20.2

Soybeans 150 storage vs. soybeans 150 min. price	Test Results				Parameter Estimate
H0: d6+d1d3d6-d7+d1d3d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d1d3d6-d7+d1d3d7≠0	1	29970	0.15	0.6948	32.39

Table 19 F-Test results pre- and post-harvest strategy comparison by commodity average mean net returns

F-Test results pre- and post-harvest strategy comparison by commodity average standard deviation

Corn futures 100 vs. corn forward 100	Test Results				Parameter Estimate
H0: d4-d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4-d5≠0	1	29970	23.73	0.0001	6.84

Corn futures 125 vs. corn forward 125	Test Results				Parameter Estimate
H0: d4+d2d4-d5-d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d2d4-d5-d2d5≠0	1	29970	0.29	0.5906	0.75578

Corn futures 150 vs. corn forward 150	Test Results				Parameter Estimate
H0: d4+d3d4-d5-d3d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d3d4-d5-d3d5≠0	1	29970	6.6	0.0102	3.61

Corn 100 storage vs. corn 100 min. price	Test Results				Parameter Estimate
H0: d6-d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6-d7≠0	1	29970	98.36	0.0001	-13.93

Corn 125 storage vs. corn 125 min. price	Test Results				Parameter Estimate
H0: d6+d2d6-d7-d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d2d6-d7-d2d7≠0	1	29970	77.54	0.0001	-12.37101

Corn 150 storage vs. corn 150 min. price	Test Results				Parameter Estimate
H0: d6+d3d6-d7-d3d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d3d6-d7-d3d7≠0	1	29970	7.19	0.0073	-3.767205

Soybeans 100 futures vs. soybeans 100 forward	Test Results				Parameter Estimate
H0: d4+d1d4-d5-d1d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d1d4-d5-d1d5≠0	1	29970	33.65	0.0001	-8.149755

Soybenas 125 futures vs. soybeans 125 forward	Test Results				Parameter Estimate
H0: d4+d1d2d4-d5-d1d2d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d1d2d4-d5-d1d2d5≠0	1	29970	9.95	0.0016	8.797783

Soybeans 150 futures vs. soybeans 150 forward	Test Results				Parameter Estimate
H0: d4+d1d3d4-d5-d1d3d5=0	Num DF	Den DF	F Value	Pr > F	
Ha: d4+d1d3d4-d5-d1d3d5≠0	1	29970	3.19	0.074	6.641115

Soybeans 100 storage vs. soybeans 100 min. price	Test Results				Parameter Estimate
H0: d6+d1d6-d7-d1d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d1d6-d7-d1d7≠0	1	29970	201.33	0.0001	-19.9345

Soybeans 125 storage vs. soy 125 min. price	Test Results				Parameter Estimate
H0: d6+d1d2d6-d7-d1d2d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d1d2d6-d7-d1d2d7≠0	1	29970	6.16	0.0131	-9.226528

Soybeans 150 storage vs. soybeans 150 min. price	Test Results				Parameter Estimate
H0: d6+d1d3d6-d7+d1d3d7=0	Num DF	Den DF	F Value	Pr > F	
Ha: d6+d1d3d6-d7+d1d3d7≠0	1	29970	0.14	0.713	8.6539

Table 20 F-Test results pre- and post-harvest strategy comparison by commodity average standard deviation of net returns

References

Agricultural Marketing Service, U. (2013). Livestock and grain market news. Retrieved 1/25, 2013, from http://marketnews.usda.gov/portal/lg

Bridge Commodity Research Bureau. (2013). Implied volatility data and futures prices corn and soybeans. Unpublished data.

Brorsen, B. W. (1998). Can preharvest marketing strategies be used to increase income? Review of Agricultural Economics, 20(2), 286-287.

Cox, C. (1976). Futures trading and market information. Journal of Political Economy, 84(6), 1215-1237.

Cramer, G., & Wailes E. (Eds.). (1993). Grain marketing (2nd ed.). Boulder, Colorado: Westview Press, Inc.

Economic Research Service USDA. (2013). Faqs. Retrieved 5/5/, 2013, from http://www.ers.usda.gov/faqs.aspx#howimportant

Economic Research Service USDA. (2013). Farm income and wealth statistics. Retrieved 8/28, 2013, from http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/cash-receipts-by-state.aspx#.Uii3y8ashcY

Economic Research Service USDA. (2013). Farm income and wealth statistics. Retrieved 8/28, 2013, from http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/value-added-years-by-state.aspx#.Uii3cMashcY

Hagedorn, L. A., Irwin, S. H., Good, D. L., Martines-Filho, J., Sherrick, B. J. & Schnitkey, G. D. (2003). New generation grain marketing contracts. Retrieved 2/18, 2013, from http://www.farmdoc.illinois.edu/marketing/agmas/reports/2003-01/agmas_2003-01.pdf

Hardbaker, J. B., Huirne, R. B. M., Anderson, J. R., & Lien, G. (2004). Coping with risk in agriculture (First edition ed.) CABI.

Hoag, D. L. (2010). Applied risk management in agriculture. Boca Raton, Florida: CRC Press, Taylor & Francis Group.

IDRE Research Technology Group, UCLA. (2013). FAQ: What is the coefficient of variation?.Retrieved 7/2, 2013, from http://www.ats.ucla.edu/stat/mult_pkg/faq/general/coefficient_of_variation.htm

Jarrow, R. A., & Chatterjea, A. (2013). An introduction to derivative securities, financial markets, and risk management (First Edition ed.). New York, NY: W. W. Norton & Company.

Kastens, T. L., & Dhuyvetter, K. C. (1998). Post-harvest grain marketing with efficient futures. Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. , Chicago, IL.

Kohls, R. L., & Uhl, J. N. (Eds.). (2002). Marketing of agricultural products (9th ed.). Upper Saddle River, NJ: Prentice Hall.

Lorton, S., & White, D. (2006). The art of grain merchandising (Silver ed.). Campaign, IL 61820: Stripes Publishing Company.

MacDonald, J., Perry, J., Ahearn, M., Banker, D., Chambers, W., Dimitri, C., & Southard, L. (2004). Contracts, markets, and prices. (No. 837). USDA, Economic Research Service.

McKenzie, A. M., & Holt, M. T. (2002). Market efficiency in agricultural futures markets. Applied Economics, 34(12), 1519-1532.

McKenzie, A. M., Jiang, B., Djunaidi, H., Hoffman, L. A., & Wailes, E. J. (2002). Unbiasedness and market efficiency tests of the U.S. rice futures market. Review of Agricultural Economics, 24(2), 474-493.

McKenzie, A. M., & Singh, N. (2011). Hedging effectiveness around U.S. department of agriculture crop reports. Journal of Agricultural and Applied Economics, 43(1), 77-94.

McKenzie, A. M., & Kunda E.L. (2009). Managing price risk in volatile grain markets, issues and potential solutions. Journal of Agricultural and Applied Economics, 41(02), 353-362.

National Agricultural Statistics Service USDA. (2013). Crop production 2012 summary. National Agricultural Statistics Service USDA.

Neyhard, J., & Tauer, L. and Gory, B. (2013). Analysis of price risk management strategies in dairy farming using whole-farm simulations. Journal of Agricultural and Applied Economics, 45(2), 313-327.

Peterson H. H., and Tomek, W. G. (2005). How much of commodity price behaviour can a rational expectations storage model explain? Agricultural Economics, 33, 289-303.

Peterson, H. H., & Tomek, W. G. (2007). Grain marketing strategies within and across lifetimes. Journal of Agricultural and Resource Economics, 32(1), 181-200.

Power, G. J., & Turvey C. G. (2009). On the exit value of a forward contract. Journal of Futures Markets, 29(2), 179-196.

Richardson, J. W. (2002). Simulation for applied risk management: With an introduction to the software package simetar Department of Agricultural Economics Texas A&M University.

Stone, R., Warner, C. & Whitacre, R. (2011). Grain marketing tools: A survey of illinois grain elevators . Retrieved 02/18, 2013, from http://www.farmdoc.illinois.edu/nccc134/conf_2011/pdf/confp02-11.pdf

University of Arkansas Cooperative Extension Service. (2013). In M. Houpert, Dr. A McKenzie (Ed.), Cost of production for corn and soybeans in Arkansas

Tomek, W. G. (2000). Commodity prices revisited. Agricultural and Resource Economics Review, 29(2), 125-137.

University of Arkansas Division of Agriculture Research and Extension. (2013). Economic contribution of arkansas agriculture 2012. University of Arkansas Division of Agriculture Research and Extension.

Vyn, R. J. (2012). The effectiveness of alternative marketing strategies for Ontario corn and soybean producers. Canadian Journal of Agricultural Economics, 60, 427-449.

Welch, M., & McCorkle, D. (2009). Post-harvest marketing alternatives. Retrieved 2/18, 2013, from http://agecoext.tamu.edu/fileadmin/user_upload/Documents/Resources/Risk_Management/rm2-5.pdf

Williams, J. C., & Wright, B. D. (1991). Storage and commodity markets Cambridge University Press.

Wisner, R. N. (1996). Commonly used grain contracts. Retrieved 02/18, 2013, from http://www.extension.iastate.edu/Publications/PM1697A.pdf

Wisner, R. N., Blue, E. N., & Baldwin, E. D. (1998). Preharvest marketing strategies increase net returns for corn and soybean growers. Review of Agricultural Economics, 20(2), 288-307.

Zulauf, C. R., & Irwin, S. H. (1998). Market efficiency and marketing to enhance income of crop producers. Review of Agricultural Economics, 20(2), 308-331.

Zulauf, C. R., Larson, D. W., & Alexander C.K. and Irwin, S.H. (2001). Pre-harves pricing strategies in ohio corn markets: Their effect on returns and cash flow. Journal of Agricultural and Applied Economics, 33(1), 103-115.

Appendix A
Most relevant Simulation Input Data for Corn and Soybeans

Data used for simulation of corn prices

year	Forward price May 1st	Cash May 1st	Futures Dec contract May 1st	Futures Dec IV[22] May 1st	Futures May contract Oct 1st	Futures May IV[23] Oct 1st	Cash Oct 1st	Futures Dec contract Oct 1st	Interest rate Oct 1st	options price
2001	2.02	1.95	226.75	27.32	218.75	25.86	1.82	210.5	0.0600	17
2002	1.92	2.005	219.75	23.31	230.25	16.94	2.52	255.75	0.0475	12
2003	2.28	2.405	233.25	22.55	266	22.06	2.18	220.25	0.0400	17
2004	3.16	3.235	319.75	34.39	233.5	19.16	1.87	206	0.0475	13
2005	2.14	2.115	226.5	25.41	224.25	19.43	1.76	208.75	0.0675	13
2006	2.465	2.475	271.5	31.28	229	17.27	2.79	267.75	0.0825	11
2007	3.425	3.755	378.5	34.80	289	25.23	3.66	368.75	0.0775	21
2008	5.82	5.905	631.5	42.33	395	26.86	4.39	484	0.0500	31
2009	3.88	4.08	433.25	42.28	515	33.25	3.39	340.5	0.0325	51
2010	3.595	3.77	389.5	29.29	362	29.81	4.51	465.75	0.0325	32
2011	6.885	7.41	661.25	37.56	484	32.88	5.86	592.5	0.0325	47
2012	5.3	6.705	538.75	26.97	613.75	31.45	7.255	756.75	0.0325	57

Table 21 Simulation input data corn

[22] Implied volatility pre-harvest
[23] Implied volatility post-harvest

Data used for simulation of soybean prices

year	Forward price May 1st	Cash May 1st	Futures Nov contract May 1st	Futures Nov IV[24] May 1st	Futures May contract Oct 1st	Futures May IV[25] Oct 1st	Cash Oct 1st	Futures Nov contract Oct 1st	Interest rate Oct 1st	options price
2001	4.24	4.415	433.75	26.02	517.25	21.89	4.475	452	0.0600	33
2002	4.525	4.685	456	20.58	471	18.11	5.5	542	0.0475	25
2003	5.59	6.32	553	22.79	548.5	18.52	6.885	687.25	0.0400	30
2004	7.595	10.45	553	35	663.75	19.71	5.295	534.5	0.0475	39
2005	6.18	6.355	622	27.38	553.5	25.93	5.475	581	0.0675	42
2006	6.085	6.045	626	24.33	604.5	22.92	5.465	545.25	0.0825	37
2007	7.51	7.26	783.5	24.41	581	19.07	9.625	991.5	0.0775	32
2008	11.25	12.5	1193.25	43.55	1021	26.18	10.1	1053	0.0500	79
2009	9.51	11.15	971	41.29	1097	36.36	9.32	918	0.0325	119
2010	9.585	9.695	966.5	21.78	920.75	26.86	10.6	1057	0.0325	74
2011	13.6	14.1	1373.75	26.62	1078.25	23.75	11.6	1177.5	0.0325	77
2012	14.1	15.25	1392.5	22.94	1205	22.19	15.65	1560.25	0.0325	80

Table 22 simulation input data soybeans

[24] Implied volatility pre-harvest
[25] Implied volatility post-harvest

Appendix B
Cost of Production for Corn and Soybean Production in Arkansas

Cost of Production Data used for simulation of corn prices

Weighted Average Net Returns, per Acre, Arkansas Corn, 2001-2012												
Expense	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
Average Yield (bu.)	178.0	142.0	150.0	148.0	155.0	169.0	146.0	131.0	140.0	140.0	134.0	145.0
Price Received	6.95	6.27	4.55	3.79	4.42	3.80	2.73	2.15	2.39	2.37	2.43	2.02
Operating Costs	494.60	460.06	400.06	390.72	464.21	356.70	318.27	294.98	264.88	247.41	225.45	247.91
Returns to Operating Costs	742.50	430.28	282.44	170.20	220.89	285.50	80.31	-13.33	69.72	84.39	100.17	44.99
Fixed Costs	69.13	66.94	64.15	61.92	58.29	53.27	50.76	48.25	45.18	42.11	41.28	40.16
Total Costs[1]	563.73	527.00	464.20	452.64	522.50	409.97	369.03	343.23	310.07	289.52	266.73	288.07
Net Returns to Land & Management	673.37	363.34	218.30	108.28	162.60	232.23	29.55	-61.58	24.53	42.28	58.89	4.83
[1]Does not include land cost.												
operating costs per bushel	2.779	3.240	2.667	2.640	2.995	2.111	2.180	2.252	1.892	1.767	1.682	1.710
Total Costs to Land & Management per bushel	3.167	3.711	3.095	3.058	3.371	2.426	2.528	2.620	2.215	2.068	1.990	1.987
proft margin 150% of net ret to land & Mgt	4.751	5.567	4.642	4.588	5.056	3.639	3.791	3.930	3.322	3.102	2.986	2.980
proft margin 125% of net ret to land & Mgt	3.959	4.639	3.868	3.823	4.214	3.032	3.159	3.275	2.768	2.585	2.488	2.483

Table 23 Cost of Production for corn in Arkansas 2001-2012

Cost of Production Data used for simulation of soybean prices

Weighted Average Net Returns, per Acre, Arkansas Soybean, 2006-2011												
Expense	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
Average Yield (bu.)	43.0	38.5	35.0	37.5	38.0	36.0	35.0	34.0	39.0	38.5	33.5	32.0
Price Received	14.40	12.30	10.90	9.66	9.64	9.02	6.41	5.92	5.88	7.11	5.65	4.37
Operating Costs	234.03	224.20	209.52	195.59	202.87	177.48	168.08	160.16	141.78	133.63	126.07	122.88
Returns to Operating Costs	385.17	249.35	171.98	166.66	163.45	147.24	56.27	41.12	87.54	140.11	63.20	16.96
Fixed Costs	56.59	46.81	44.86	43.29	40.76	37.25	35.49	33.74	31.59	29.45	28.86	28.08
Total Costs[1]	290.62	271.01	254.37	238.88	243.62	214.73	203.57	193.90	173.38	163.08	154.94	150.96
Net Returns to Land & Management	328.58	202.54	127.13	123.37	122.70	109.99	20.78	7.38	55.94	110.66	34.34	-11.12
[1]Does not include land cost.												
operating costs per bushel	5.443	5.823	5.986	5.216	5.339	4.930	4.802	4.711	3.635	3.471	3.763	3.840
Net returns to Land & Management per bushel	6.759	7.039	7.268	6.370	6.411	5.965	5.816	5.703	4.446	4.236	4.625	4.717
proft margin 150% of net ret to land & Mgt	10.138	10.559	10.902	9.555	9.617	8.947	8.725	8.554	6.668	6.354	6.937	7.076
proft margin 125% of net ret to land & Mgt	8.448	8.799	9.085	7.963	8.014	7.456	7.271	7.129	5.557	5.295	5.781	5.897

Table 24 Cost of Production for Soybeans in Arkansas 2001-2012