12-2018

Risk and Return Comparisons of Pre-harvest Marketing Strategies

John Leander Turner V
University of Arkansas, Fayetteville

Risk and Return Comparisons of Pre-harvest Marketing Strategies

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Agricultural Economics

by

John Leander Turner, V
University of Arkansas
Bachelor of Science in International Business, 2016

December 2018
University of Arkansas

This thesis is approved for recommendation to the Graduate Council.

Andrew M. McKenzie, Ph.D.
Thesis Director

Jeroen Buysee, Ph.D.
Committee Member

Bruce L. Ahrendsen, Ph.D.
Committee Member

Daniel V. Rainey, Ph.D.
Committee Member

Abstract

This paper analyzes risk and returns associated with pre-harvest corn grain marketing strategies for the state of Arkansas. Farming is characterized by a volatile environment. Numerous risks are taken by producers in order to provide commodities that are bought and sold by various parties in the supply chain. Price, yield, and production costs vary daily and can have large variation between years. *Risk and Return Comparisons of Pre-harvest Marketing Strategies* examines the effectiveness of using pre-harvest marketing strategies to enhance returns and to mitigate inherent price risk in the Memphis cash corn market. Thirteen strategies are compared to the October 1 Memphis, spot price and are examined through multiple parametric and nonparametric statistical tests. To supplement the statistical findings, coefficients of variation for each strategy's annual average price received, profit per bushel, and profit per acre are compared. The nonparametric results reveal that there are significant differences in some pre-harvest marketing strategies for the state of Arkansas from marketing grain on the cash market at Memphis. The coefficient of variation comparison backs up these findings by revealing that strategies have historically had different risk and return profiles from the 2001-2017 period. World Agricultural Supply and Demand Estimate reports released by the USDA were used to forecast harvest-time Memphis cash price, and strategies based on these report-based forecasts were implemented to test if marketing after the release dates allows for returns greater than at the harvest cash price and with less variation.

Acknowledgements

The University of Arkansas has provided me with an education I could not have ever imagined. From the bottom of my heart I would like to recognize the concerted effort put forth by the staff from Dale Bumpers College of Agriculture, Agricultural Economics and Agricultural Business (AEAB). Special thanks go to my thesis advisor Andrew McKenzie, PhD., Bruce Ahrendsen, PhD., my copromotor Jeroen Buysse, PhD., and my Atlantis program advisor Daniel Rainey, PhD. Without their patience and willingness to share their wisdom and time with me, this project would have been a near impossibility. Another special thanks go to the staff of AEAB's administrative office, who have also selflessly given their assistance when need by me which was often. The international experience of the Atlantis program is something I will always remember and treasure. The memories, friends, and interactions made are priceless in my eyes. This has led me to believe that escaping comfort zones and putting yourself into unknown environments can lead to invaluable experiences. My goal for this thesis, *Risk and Return Comparisons of Preharvest Marketing Strategies,* is to add to marketing knowledge and be an aid to many agents and actors in the agricultural commodity sector as well as in other fields such as economics. Lastly, I acknowledge the unconditional love and support I have received from my family, friends, and acquaintances over the last three years.

Sincerely,

John L. Turner, V

University of Arkansas Dale Bumpers College of Agriculture and Economics and Agribusiness
Hebrews 11

Table of Contents

Chapter I Introduction………………………………………………………………………… 1

Chapter II Literature Review ……………………………………………………………… 5

Chapter III Methodology …………………………………………………………………. 12

Chapter IV Data………………………………………………………………………… 38

Chapter V Results………………………………………………………………………. 40

Chapter VI Summary and Conclusion ………………………………………………………. 54

Chapter VII Limitations and Further Research Areas……………………………………….. 56

Chapter VIII References …………………………………………………………………. 58

Chapter I Introduction

Pre-harvest marketing strategies are important for farmers who need to manage price risk and sell grain at profitable levels. Strategy performance has been the focus of much research, and various farmer pre-harvest marketing strategies have been compared with the benchmark of futures market efficiency and how it pertains to the possibility of profit realization. While simulation models of commodity prices and yields have been used for past strategy comparisons (Houpert, 2013; Rodriguez, 2003), my research takes another direction and tackles the problem of analyzing various pre-harvest marketing strategies using historically observed prices. Specifically, I analyze various pre-harvest marketing strategies for a hypothetical farmer selling corn in Memphis, Tennessee. We present and compare the historical performance of specific marketing strategies to the benchmark strategy of selling at the October cash harvest price. This research uses time series data that will give insight into average historical performance of various marketing strategies. The specifics of practically implementing each strategy will be covered in detail, along with the statistical methods used to reach conclusions about their risk-return performance. This research has important implications for Arkansas corn farmers. The effects of grain marketing are far reaching, from the producer to the broker and beyond. The livestock and meat packing industry depend on corn for grain, Tyson being a primary example. Other large industries such as distilleries and ethanol plants use corn as well and need to hedge their exposure from market fluctuations to manage risk. Producers and marketers of grain hedge against downward movement in prices, and firms that use grain as an input need to hedge against upward moving prices. This paper will focus on marketing from the perspective of the former, the farmer or merchant who needs to capture prices high enough to at least break even. Price variation is a widely studied occurrence that has significant profit consequences; thus, the effectiveness of pre-planned strategy selection for hedging against exposure is closely studied in the next chapters.

This thesis proceeds to examine revenue and profit characteristics of corn grain, comparable risk levels for each strategy, and a comparison of returns over three measurement criteria. The overarching objective in this paper is to answer the question, *do strategic marketing plans yield risk-return profiles significantly different than a simple baseline cash harvest price sale strategy?* We assume, a priori, that there is no significant difference – based on prior research and market efficiency – and test this hypothesis rigorously through multiple statistical tests. Additionally, we rank 13 individual pre-harvest marketing strategies based on average revenue in terms of price received along with profit levels, standard deviation of revenue and profit levels, and revenue and profit level coefficients of variation, allowing for a simple and straight forward, no frills apples-to-apples comparison. Our results will shed additional light on the marketing literature.

The research goals of this paper are focused on providing clear information and replicable results to marketers and commodity producers. If any of this work contributes to increased knowledge and awareness about marketing economics, it will achieve the goal in mind from the onset of research: to provide information for the grain marketing industry and contribute to academic literature that will help improve results in agricultural business strategy. We test prevailing assumptions held by different researchers that dispute effectiveness of pre-harvest hedging and marketing strategies in general. The issues addressed are conflicting to say the least, as this characteristic of the literature is apparent. Although the methods used are not a giant breakthrough in the field of mathematics, a specific effort has been made that includes models with a replicable framework. Replication will allow the ideas presented in this research to be used in other scenarios, and with other commodities. *Risk and Return Comparisons of Pre-harvest Corn Marketing Strategies* focuses on providing strategy options for a wide range of risk preferences. The following chapters include an introduction to the main and specific objectives of the research problem, a literature review for background concepts relevant to the grain market and grain market participants' behavior, research on price behavior characteristics in the market, data sources and considerations, the methodology implemented, the results of our hypotheses tests and minimum coefficients of variation framework, then finally the summary and conclusion section of the findings with implications and future research.

Overall and Specific Objectives

I. Test if it is possible to get better performance in returns using pre-harvest marketing techniques. Answer the question, *do strategic corn marketing plans yield results different than at the baseline spot market harvest price on average?*

   a. Test the null assumption of there being no statistical difference in pre-harvest strategies and harvest time sample prices using parametric and nonparametric tests. Test for statistical differences in mean strategy returns for prices received, profit per bushel, and profit per acre. Thirteen strategies tested are compared to the October 1 spot bid from Memphis including three futures strategies, three forward strategies, five variations of average price contracts, World Agriculture Supply and Demand Estimate (WASDE) Report Stocks to Use strategy, and finally WASDE Report average national price estimate strategy for pricing bushels after its May release.

II. From a risk management perspective, we rank thirteen strategies based on a minimum coefficient of variation framework that is implemented across three comparisons: prices received, profit per bushel, and profit per acre.

a. Discover if there is a significant benefit to trading after the release of May WASDE reports.
b. Discover if new generation averaging contracts perform as well as selling in the harvest-time cash market.

Chapter II Literature Review

Decisions by agents[1] in the commodity sector are dependent on information. The quality and completeness of information used is a major factor in the effectiveness of using the futures market and the determination of prices associated with market agent expectations. Results from a large body of research in this area show that United States Department of Agriculture (USDA) crop reports[2] are valuable and newsworthy. The USDA publishes reports (e.g. WASDE and crop production reports) that alter expectations, in turn creating responses in the futures market. This revelation is potentially useful to an agent trading in the futures market if they can exploit large price movements in the wake of the report release and adjust their trading, marketing, and hedging decisions accordingly. The extent to which this is possible would be contingent upon how efficiently and quickly the futures market impounds the new information contained in a report. If futures markets are efficient, then it would not be possible to systematically take advantage of price movements following report release. However, if futures market agents do not behave rationally and futures markets overreact to "bullish" report information – resulting in large price increases – then marketing strategies that incorporate such price trends could yield additional profits over and above a benchmark strategy of simply selling in the harvest-time cash market.

Pre-harvest price expectations drives the harvest-time new crop corn futures market (McKenzie, 2008), which highlights the need for complete availability and access to information for the market to remain efficient. If pre-harvest price expectations are influenced by irrational agents, then pre-harvest marketing strategies that incorporate irrational futures price movements

[1] *Agents* are all U.S. corn market participants, which include hedgers, traders, farmers, and analysts.

[2] August Crop reports by the USDA were deemed newsworthy by McKenzie's (2008) research due to futures price reactions after release dates.

could be profitable. However, McKenzie concludes that pre-harvest price expectations are generated by rational agent behavior and that a semi-strong form version of the *Efficient Market Hypothesis* holds for the corn futures market so that USDA report information is incorporated in a timely manner. Therefore, this research would infer that pre-harvest marketing strategies seeking to exploit irrationally large price increases following USDA report information would not be profitable.

In contrast, Wisner, Blue, and Baldwin (1998), and O'Brien (2000) have found that pre-harvest marketing strategies tend to lead to increases in average returns. Wisner, Blue, and Baldwin attribute this to market uncertainty during the early pre-harvest period. The uncertainty stems from potential supply and demand shocks such as drought or flood, and the overall political and economic environment which can create risk premiums in the form of abnormally high futures prices early in the year. However, Zulauf and Irwin (1998), contradict Wisner Blue and Baldwin's findings of a pre-harvest price premium and conclude that there is no significant difference in the profitability of pre-harvest strategies and a harvest time cash sale strategy.

This thesis sheds further light on the pre-harvest marketing debate by statistically testing the ability of pre-harvest strategies to increase farmers' average returns. We test the null hypothesis that there is no statistical difference in the mean returns generated by pre-harvest marketing strategies and the benchmark strategy of selling in the harvest-time cash market.

Issues with Market Agents Irrationality and Pricing Implications

Agents in the reasonably large commodity trading sector are not always rational, as shown by Richard Thaler's Nobel Prize behavioral economics research (Mental Accounting and Consumer Choice. Richard H. Thaler's Nobel Prize winning work) addresses the burgeoning issue of using the neoclassical model of rational behavior. Rational agents are characterized as those whom incorporate available information, examine costs and benefits of preferences, study event probability, and make consistent choices. In futures markets, McKenzie (2008) characterized the agents whom Thaler found that market participants do not typically behave rationally, as solution optimizers, on average and are more often subject to biases of different origins. Market participants were found to overreact to information available through news reports, media, and commodity dashboards. Proving that agents who participate in market activity, whether that is farmers or traders, exhibit significant ignorance and bias when presented with market news and information. To assume that participants are rational would be likened to assuming that the agents always incorporate all available information to come to a decision on marketing choices, which would exhibit strong form efficiency by market participants.

The status quo, which would be the neoclassical paradigm, is scrutinized in Thaler's work due to the fallacy that consumers behave in rational ways when making economic decisions. Thus, we call consumers that fall into this method of neoclassical decision making Econs[3]. Econs are predictable and facilitate model creation through assumptions of rationality and simplicity. This ignores human variability, allowing the agents in question to be standardized for comparison. Using the neoclassical paradigm model that assumes rational behavior by the actors, researchers do not have to account for irrational behavioral variables.

The Homo Economicus[4] model is considered sub-par in Thaler's research because there is the assumption of optimal solution seeking behavior on behalf of the consumer, which in turn is rarely the case. Empirical evidence shows that consumers behave highly irrationally, and this

[3] Econs is the term used by Richard Thaler to denote an agent of the neoclassical paradigm model that assumes rational behavior.
[4] Homo Economicus refers to what is otherwise termed by Thaler as Econs under rational behavior hypotheses.

fact is at odds with the neoclassical model that assumes agents behave rationally. A problem was apparent to Thaler (2016) when he "realized relying on one theory to accomplish two rather different goals, namely, to characterize optimal behavior and to predict actual behavior." We can deduct from Thaler's statement that actual and optimal behavior are far from the same. This is later studied in examples of financial markets as well as in *Bridging the Divide between Social and Behavioral Science and Policy* by Craig R. Fox and Sim B. Sitkin, 2015.

Fox and Sitkin (2015) note in their essay that humans make irrational and sub-optimal decisions quite often, which can be attributed to present bias in the mind of Homo Sapiens. Disproportionate probability weighting of outcomes, and how psychology plays a role in determining an individuals' loss aversion level, factor into predicting real human behavior. This is evident in a case study of patients choosing medical plans. On average, people selected plans that significantly fell short of optimizing their welfare. The authors say that, "Individuals have a severely limited capacity to attend to, recall, and process information, and therefore to choose optimally." Further studies show that people tend to prefer the status quo and default options if they are provided and available, when given the choice.

Another interesting finding in both Thaler's work and the essay by Fox and Sitkin examines the tendency to be myopic in decision making. Subjects will prefer gratification and fulfillment sooner rather than later, now in the present instead of in the future. Immediate consumption drives many consumers' processes.

Both papers make it clear that empirical evidence is key to the field of behavioral economics. It is noted that theory has its place, but concrete evidence is the best way to move ahead in this expanding field of study. Thaler says, "If we limit ourselves to variables that have empirical basis, all of economics will become more disciplined." Supposedly irrelevant factors to the neoclassical model of rational behavior are many times a crucial part of consumer behavior and the study thereof. It is important to constantly evolve models and develop tests to account for these factors when possible. In the context of our research question – can pre-harvest marketing strategies outperform a harvest-time cash sale benchmark strategy – if irrational agents influence pre-harvest futures prices, then pre-harvest marketing strategies that either use futures markets directly or indirectly (in the form of forward contracts) may be profitable. The potential for irrational futures behavior makes this ultimately an empirical question and one that we seek to address in this thesis.

Risk Management in Agricultural Markets

Tomek and Peterson (2001) study what academic research can and cannot contribute to producers in the form of risk management. The research covers price and revenue risk that a United States grain market participant faces, and how market information from various sources impacts his or her objectives. The authors study the current knowledge on marketing strategies implemented to price commodities along with often overlooked yield distributions, which equally play a crucial role in the outcome and livelihood of farmers.

Farmers are assumed to be profit maximizers, and depending on their degree of risk aversion, different marketing strategies are available to hedge risk and capture high enough prices to cover production costs. Tomek and Peterson conclude that farm specific total costs, yield variability, and risk for each marketing alternative should be addressed to properly study the possibilities available for constructing marketing strategies. They point out that most farmer price risk management and marketing studies fail to account for costs of production. Given this omission, they conclude that empirical results across this body of research are difficult to categorize and appraise. This thesis research attempts to address this issue by including measures of farm production costs using crop enterprise budgets. The research presented in subsequent sections incorporates total production costs to obtain cost of production coverage levels, which are used as pricing thresholds to implement pre-harvest marketing strategies. Effective prices and profits, for each strategy, on a price per bushel and a per acre basis, are then evaluated against the benchmark harvest-time cash sale strategy.

Price, Yield and Cost Risk

The management of price risk is a primary reason for analyzing returns of different hedging strategies. In this context, strategy performance is evaluated in terms of which strategy results in the lowest price risk over time. However, models that characterize risk using only price movement should also be aware that there are other crucial factors at play. Yield and cost risks can be just as detrimental to profitability and earnings and should be incorporated into models along with price. Yield varies according to soil quality, management practices, seed variety, and the planted area's climate just to name a few influences in play. Stress on crops due to weather have large influences on yields and can be the difference in making profits or losses in good and bad crop years. The interaction or correlation between marketing strategy prices and farm yields plays a crucial role in determining farmer returns and return-risk. In addition to price and yield risk farmers also face production cost risk in the form of volatile input prices. Ultimately the failure to weight yield and cost risks alongside price risk can cause producers to perform far worse than expected when marketing their crops. This thesis research explicitly accounts for price, yield and production cost risk when evaluating the return and return-risk performance of pre-harvest marketing strategies.

Can Pre-harvest Marketing Strategies be Used to Increase Income?

Extension economists rated the research issue of determining if marketing strategies can be used to increase incomes as being of prime importance (Brorsen and Anderson, 1997). Zulauf and Irwin (1998) take the position that pre-harvest marketing strategies are not able to increase farmers' income. Zulauf and Irwin's research has influenced extension economists to focus less on using futures markets to enhance profits and more on using them to manage risk by locking prices at favorable levels. However, many extension economists, together with producers, still believe that the pre-harvest period offers marketing strategy opportunities to capture higher prices than those typically available at harvest time. This line of thought is consistent with Wisner, Blue, and Baldwin (1998).

Brorsen (1998) argues that Zulauf and Irwin's findings are consistent with a form of *rational expectations theory*[5]. Brorsen, like Tomek and Peterson (2001), suggests that agents with superior analytical ability and better access to information can realize higher returns than those without. These findings explain the need for existing marketing experts and analysis among agricultural marketing consultants. Marketing advisors have a place to help producers market their crops and mitigate risk. However, Irwin et al. (2000) found that rarely can marketing advisors consistently repeat profitable marketing performance from year to year. They argue that good risk management strategies exist, but they have associated costs, and that the benefits from undertaking a specific strategy should consistently outweigh the associated costs.

[5] Rational expectations theory was proposed by John F. Muth (1961) at the University of Indiana. He ascribed economic outcomes to expectations of ebbs and flows of market performance. It is a precursor to *random walk theory* and *efficient markets hypothesis.* Rational expectations theory assumes that participants aim to maximize their utility in all situations.

Chapter III Methodology

Methodological Objectives

I. Test for increased performance in terms of higher returns using pre-harvest marketing techniques versus the harvest-time spot market. Answer the question: *Do strategic pre-harvest corn marketing plans yield results different than at the baseline spot market harvest price on average?*

   a. Test the null assumption of there being no statistical difference in pre-harvest strategies and harvest time cash prices. Test for statistical differences in mean strategy returns for prices received, profit per bushel, and profit per acre. Thirteen strategies tested are: 100%, 125%, 150% coverage of cost of production (COP) futures strategies, 100%, 125%, 150% coverage of COP, average price contract priced each Wednesday after the WASDE release until October 1, May daily average price contract, June daily average price contract, July daily average price contract, and June/July daily average price contract, WASDE Report Stocks to Use strategy, and finally WASDE Report average national price estimate strategy for pricing bushels after its May release.

II. From a risk management perspective, we rank thirteen strategies based on a minimum coefficient of variation framework that is implemented across three comparisons: prices received, profit per bushel, and profit per acre.

   a. Discover if there is a significant benefit to trading after the release of May WASDE reports.

   b. Discover if new generation averaging contracts perform as well as a benchmark harvest-time cash sale strategy

Yearly averages of prices received, profit per bushel, and profit per acre are compared for the 2001-2017 sample period. The results of all statistical tests are covered in a later results section.

In this next section all of the statistical tests used, and the hypotheses analyzed are defined:[6]

Farmer profits per bushel or per acre for any marketing strategy (pre-harvest or benchmark harvest-time cash sale) are defined as:

*Profits = price a farmer receives for his grain (P) * quantity produced (Q)- total costs (TC).*

Where Q is measured in total bushels produced or a per acre basis and is determined by average yearly Arkansas yield per acre for corn; and *TC* comprises yearly costs associated with producing an acre of corn in Arkansas (taken from crop production budgets). Arkansas average data are used for profit calculations; therefore this research does not address farm level results but may depict the Arkansas corn grain marketing environment in aggregate.

More specifically farmer returns are broken down into three categories: price received per bushel, profit per bushel, and profit per acre:

Price Received cents per bushel

$$Price_{cents/bu}$$

Profit in cents per bushel

$$(Price_{cents/bu} - Costs_{cents/bu})$$

[6] All statistical tests were run in StatTools7 software.

$ Profit per Acre

$$(Revenue_{dollars/acre} - Costs_{dollars/acre}) = ((P_{dollars/bu} * Yield_{bu/acre}) - Costs_{dollars/acre})$$

Mean differences

We found the simple mean differences in strategy average prices and profits compared to the benchmark harvest-time October 1 cash prices and profits

$$\mu_{Xi-Xs} = \left(\frac{1}{n}\sum_{i=1}^{n} Xi\right) - \left(\frac{1}{n}\sum_{i=1}^{n} Xs\right)$$

Where μ_{xi-xs} is a specific strategy *i* minus the benchmark harvest-time October 1 cash price *s*.

Xi=Strategy prices and profits selected for comparison

Xs=October 1 cash prices and profits

n= number of yearly observations, which is seventeen

Median differences

We found the median differences in strategy averages compared to the benchmark harvest-time October 1 cash price. This formula indicates the position in the set of return data, and the median becomes that value at that position in the sample.

$$M_{Mi-Ms} = \{(n+1)/2\}th_{Mi} - \{(n+1)/2\}th_{Ms}$$

Where

M_i*=median of strategy price or profit i selected for comparison*

n= the number of values in the series

th= a number corresponding to the median value after listing the values in ascending order

M_s*= the median of the October1cash prices and profits*

Parametric Tests

T-test

Two Tailed Hypothesis Test

$H_{0:}\ \mu_{Xi-Xs}=0$

$H_{A:}\ \mu_{Xi-Xs} \neq 0$

One Tailed Hypothesis test

$H_{0:}\ \mu_{Xi-Xs}=0$

$H_{A:}\ \mu_{Xi-Xs} \geq 0$

T-test

T-statistic

$$t=\frac{Xi-Xs}{\sqrt{\frac{s}{ni}^2+\frac{s}{ns}^2}}$$

t is the sample statistic

Xi=mean price/profit of selected strategy i in the comparison

Xs=mean price/profit of the harvest-time October 1 spot price

S^2*= sample variance*

Where Variance equals:

$$S^2=\frac{\sum(x-xi)^2+\sum(x-xs)^2}{ni+ns-2}$$

x=observations

Xi=mean price/profit of selected strategy i in comparison

Xs=mean price/profit of the harvest-time October 1 spot price

ni=number of observations of the selected strategy

ns=number of observations of the harvest-time October 1 spot price

Critical T

$\alpha=.10=1.697$

$\alpha=.05=2.457$

$\alpha=.01=2.75$

H_o: The null hypothesis, the mean differences between pre-harvest marketing strategy prices and profits versus benchmark harvest-time cash strategy over the 2001-2017 period is not statistically different than zero.

H_a: The alternative hypothesis, the mean differences between pre-harvest marketing strategy prices and profits versus benchmark harvest-time cash strategy over the 2001-2017 period are statistically greater than zero (one-tailed test) or statistically different from zero (two-tailed test).

Degrees of freedom

$$df=n_i+n_s-2=32$$

$n_{i=}$ *number of observations of the selected strategy 2001-2017*

$n_{s=}$*number of observations of the harvest-time October 1 spot price 2001-2017*

F-test of Equal Sample Variances

The *F*-test is used to test for equal variances in the samples.

H_0: $\sigma i^2 = \sigma s^2$

H_a: $\sigma i^2 \neq \sigma s^2$

Where

σi^2= *sample variance of the selected strategy prices and profits*

σs^2= *sample variance of the spot market prices and profits on October 1*

F Critical Value=$F_{1-\alpha/2,\, ni-1, ns-1}$

α=*significance level*

$n_{i=}$ *-1 gives degrees of freedom* df_{ni}

$n_{s=}$*number of observations for the harvest time cash price -1 for degrees of freedom* df_{ns}

α=.10=1.93992

α=.05=2.3522

α=.01=3.409

F-stat=$\frac{Si^2}{Ss^2}$

Where

Si^2=*Variance of the selected strategy prices and profits for comparison*

Ss^2=*Variance of the October 1 harvest cash prices and profits*

Nonparametric Tests

Sign test: one and two sided

The sign test looks for significant differences in the medians from 0 for selected x,y pairs, labeled M_i and M_s.

Sign test one sided

The one-sided sign test looks for medians equal or greater than 0.

$M_{Mi\ -Ms} > 0$

If not, $M_{Mi\ -Ms} = 0$

MXi=median of the selected strategy prices and profits

MXs=median of the harvest-time cash prices and profits

Sign test two sided[7]

The two-sided sign test looks for medians greater, equal to, or less than the null of 0.

MXi-MXs>0, MXi-MXs<0, MXi-MXs=0

Sign test two sided[8]

The two-sided sign test looks for medians greater, equal to, or less than the null of 0.

MXi-MXs>0, MXi-MXs<0, MXi-MXs=0

Wilcoxon Signed Rank Test Paired Sample Analysis

The Wilcoxon Signed Rank test is a test of whether means differ from the hypothesized mean of 0. It differs from the *Sign* test by measuring the magnitude of differences between the two sample means. The test assumes a symmetric but not normal distribution.

N is the sample size, which is the number of pairs. Therefore, there are a total of 2N data points. Pairs with measurement values that equals 0 are not considered.

For pairs $i=1,\ldots N$, *abs* $| X_{2,i}-X_{1,i}|$ and the sign function:

[7] Two-tailed tests intuitively have twice the p-value because the distribution includes values less than the mean of observations.

[8] Two-tailed tests intuitively have twice the p-value because the distribution includes values less than the mean of observations.

$$Sgn(x)= \{-1 \text{ if } x<0;\ 0 \text{ if } x=0;\ 1 \text{ if } x>0\}$$

The remaining pairs are ordered from the smallest absolute differences to the largest. The smallest is labeled as 1. Equivalent values are ranked according to the average of ranks spanned. Each pair receives a sign, then sum the signed ranks. The W test statistic is used to sum signed ranks as follows:

$$W=\sum_{i=1}^{Nr}\{sgn(X_{2,i}-X_{1,i})*R_i\}$$

$X_{2,i}$=difference measurement of median of the benchmark October 1 strategy prices or profits from hypothesized median of 0

$X_{1,i}$=difference measurement of the median of the selected strategy prices and profits from hypothesized median of 0

Nr=Number of pairs included in the test, where absolute values of difference measurement equal to 0 are excluded.

R_i=Rank assigned

The critical value can be found with sample size N=17 and the level of significance in a W critical value table.

For a test stat $W_{17, (.1,.05, or .01)}$, the critical values equal 41, 35, and 23 for a two tailed test respectively.

If test stat $|W| > W_{critical, Nr}$[9]; reject H_0.

The $|W|$ for each strategy is compared to the $W_{critical, Nr}$ to determine its significance. If the absolute value is greater than that of the critical value, reject the null hypothesis of no difference in the medians between strategies.

[9] The critical values for the Wilcoxon Signed Rank test will differ by Nr, i.e., the number will not of always be 17.

Chi-Squared Normality Tests

This nonparametric test reveals if the observed variable in the data for a specific variable has a normal distribution. Histograms with bins of range values are superimposed upon a normally distributed histogram to represent the distribution of values since the data is continuous.

The *chi-squared test for normality* tests for normal distribution of the data[10]. The null is that data are assumed to be normally distributed.

H_0: Data fits a normal distribution

H_a: Data is not normally distributed

Chi Squared Statistic

$$X^2=\sum\frac{(Oi-Ei)}{Ei}$$

O_i= Observed value

E_i= Expected Value

Expected Frequency

$$Ei=N(F(Y_{max})-F(Y_{min})$$

Where

Ei=Expected Frequency

N=Sample Size

F=the cumulative distribution function

i=bin class

Y_{max}=upper limit for bin i

[10] For the Chi Squared test to be relevant, the expected frequency should be at least five.

Y_{min}=lower limit for bin i

Degrees of Freedom

k=number of bins

c=number of parameters in a normal distribution +1, assuming 2 parameters.

df=k-c

df=6-3=3 degrees of freedom

Critical Region

$X^2_{1-\alpha,k-c}$

The hypothesis of a normal distribution is rejected in the event of the test stat being greater than the critical region

$X^2 > X^2_{1-\alpha, k-c}$

Critical region for the chi squared test for normal distribution at significance level α:

$X^2_{1-\alpha .1,3}$=6.251

$X^2_{1-\alpha .05,3}$=7.815

$X^2_{1-\alpha .01,3}$=11.345

The coefficient of variation is calculated as:

$$\text{Coefficient of Variation (CV\%)} = 100 * \frac{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(xi-\mu)2}}{\frac{1}{n}\sum_{i=1}^{n}Xi} = \frac{\sigma}{\mu}$$

n=number of observations

X=value of observation

i=observation

μ=*sample mean*

σ=Sample variance

Description of Various Contracts Used in the Marketing Strategies

Forward Contracts

Forward exchange contracts are used extensively for hedging risk in the form of price exposures.

Advantages:

- Locks in a negotiated price, quantity, and time frame for delivery. This allows farmers to hedge against downward movement.
- Flexibility regarding the amount to be covered. Forwards are priced in customizable bushel amounts or increments[11].
- relatively straightforward both to comprehend and to organize.

Disadvantages:

- The contractual commitment must be completed on the due date.
- No opportunity to benefit from favorable movements in exchange rates. However, pricing in increments allows for averaging of prices received.
- Risk of default and risk of over-booking projected production.

Harvest-time Cash Grain Contracts

Farmers are accustomed to marketing crops on the cash or spot market at their local grain elevator or regional grain buyer. The cash bids presented in this thesis come from the Memphis, Tennessee, daily grain spot prices. This elevator serves the Arkansas delta region as the largest buyer of grain for the area. The price is set by the elevator at a basis level +/- futures price depending on stocks and usage. Cash grain is considered the default or status quo for producers. This research finds that cash grain prices are highly variable, possessing the highest level of volatility in the test results. Elevators in different geographic locations offer cash bids at a

[11] In a discussion with multiple Mississippi River Delta farmers, it was found to be common practice to price bushel using forward contracting with a grain elevator. Bushels priced on a forward contract are dependent upon the size of an operation and are negotiable in a customizable fashion. Discussion with Will Smythe of Smythe and Sons, LLC, bushels are priced in 25,000 to 50,000 bu increments.

predetermined basis level, which equals the $\$P_{spot}$-$\$P_{futures}$. This research uses the Memphis grain elevator for the baseline or benchmark comparison against other strategies.

Futures Contracts and Futures Hedging

Futures are one way that agents participating in the grain market can smooth returns and help to hedge losses along with mitigating risk. A futures contract is a way to agree upon a price for a commodity at a specific point in time for a specific amount of the product. In the case of corn, futures contracts are traded at 1,000 and 5,000 bushels. For this research, the larger contracts of 5,000 bushels (127 metric tons) are studied. The Chicago Mercantile Exchange & Chicago Board of Trade is where futures originated in the U.S. and have existed for centuries beginning in Osaka, Japan, on the Dojima exchange to trade and hedge using rice futures (Schaede (1989).

Futures came into being so that traders and hedgers could agree upon a price into the future at a certain time for a commodity. Tomek and Peterson (2001), Carter (1999), and Fama and French (1987) define futures as:

$$F_t=E\ [F_T,\ I_t],$$

Where:

F is the price of futures, t is the current date, E is the expectation term, T as the maturity date, and I as the information set, so that the current futures price equals the expected futures price based on current knowledge of information set I. Futures contracts approaching maturity tend to converge to the cash price as uncertainty is diminished when harvest time is near. With the evolution of information sets on a day to day, and even minute by minute basis, it can be concluded that futures changes will be subject to the change in net positive and net negative news in the eyes of investors and market participants.

Basis plays a role in determining the value of a deliverable commodity and the actual price received at the elevator. The basis is equivalent to the cash spot price, *P(s)*, minus futures. A negative basis means that prices at the grain elevator are lower than the futures quote, while a positive basis indicates a spot price above the current futures contract in question. The inventory and capacity held at an elevator, along with demand, determines basis level. More favorable basis occurs when the elevator has greater need and a more negative basis occurs because inventory needs have been met which lead to a decrease in demand. The basis will differ upon location; therefore, quantifying the transport costs with the various basis bids can help producers figure out which location will be the most profitable. When a favorable basis is available, more grain arrives at that location. When the inventory becomes stocked, the basis recedes and declines because of lower demand and need for more stocks. By using this basis difference, a hedge can be implemented that allows for more desirable returns compared to accepting the cash price outright.

Benefits, Limitations, and Characteristics of Futures Contracts

1. Futures of number two corn grain have large open interest and liquidity in the market, essentially guaranteeing a buyer for every seller.
2. Standardization of contracts keeps things simple when formulating the contract and deciding how many bushels to hedge, as futures contracts for corn are either 5,000 or 1,000 bushels in size.

3. The counterparty default risk that is present in other marketing strategies is eliminated because payment is guaranteed by Chicago Board of Trade (CBOT) clearing house.

4. Basis risk remains when hedging using futures.

   a. Costs of entering into futures contracts should be accounted for. Brokerage fees and margin requirements are involved and need to be taken into consideration.

   b. Hedging is a zero-sum game; therefore, a gain in one account, cash or futures, means that a loss will occur in the other and vice versa.

Futures offer a highly used, liquid market for number two corn grain. In fact, it is one of the most popular ways to mitigate the movement in price. Two parties agree on terms and conditions for bushels priced (5,000 bushels per contract) for agreed upon price in the future, without needing to deliver the physical commodity. Next, an example of hedging using futures is given.

A producer wishes to hedge against future price movement in the cash grain market. After careful deliberation and analysis, farmer John in Helena, Arkansas, decides that the hedge will be placed in the month of May for multiple December corn contracts (symbolized on the Chicago Board of Trade (CBOT as CZ, with Z indicating maturity date). The farmer decides that the ample liquidity in the market and the right to sell at a guaranteed price without the obligation for delivery offers the best opportunity for hedging against lower harvest prices in October. Assuming that on the day of hedging, the price available on the Chicago Board of Trade is high enough to cover 100% of his operation's total costs plus profit margin. We will say that cost per bushel on his farm for the current year is $3.50, and the current futures price is $4.00. He decides to lock in this price of $4.00 per bushel with 10 futures contracts to hedge the price on 50,000 bushels of corn by selling futures. Once harvest arrives on October 1, farmer John takes his bushels to the Memphis, Tennessee, elevator that is offering a spot price of 375 cents per bushel at a basis of -5 under that day's future price of $3.80 per bushel and sells his grain to the elevator. He simultaneously buys back the 10 contracts on October 1, and the difference in the spot and futures accrues to his margin account used to buy and sell futures. This amount is the price he entered the contract at, $4.00, minus $3.80, which equals 20 cents per bushel on 50,000 bushels that accrues to farmer John's margin. In total, farmer John was able to receive .20*50,000 bushels, totaling a ten-thousand-dollar gain over what he would have received by only selling his corn on the spot market. He captures a higher price in the futures market by entering into the December corn contract in May, while covering his cost of production by 12.85%, calculated by (((375+20)-350)/350).

$$((P_S + (\Delta F_t, F_T) - C_p)/C_p$$

P_S = the Memphis spot price on October 1

$(\Delta F_t, F_T)$ = the change in futures price for new crop December corn (CZ) from the time it was entered into in May and at the price that it was bought back on October 1, for the December Corn contract F_T.

C_p = the cost of production per bushel.

Table 1- Scenarios of futures hedges that a producer could experience:

Downward Moving Market			
Date	Cash	Futures	Basis
14-May	Need 350	Sell 355	Expected=-5
1-Oct	Sell 335	Buy 345	Actual=-15
	335	20	Effective Price of 345
Grain/Loss	-15	10	-5

Upward Moving Cash and Downward Moving Futures			
Date	Cash	Futures	Basis
14-May	Need 350	Sell 400	Expected=50
1-Oct	Sell 375	Buy 380	Actual=-5
	375	20	Effective Price of 395
Grain/Loss	25	20	45

Upward Moving Market			
Date	Cash	Futures	Basis
14-May	Need 350	Sell 400	Expected=-50
1-Oct	Sell 375	Buy 418	Actual=-43
	375	-18	Effective Price of 357
Grain/Loss	25	-18	7

Worst Case Scenario: Downward Moving Cash and Upward Moving Futures			
Date	Cash	Futures	Basis
14-May	Need 350	Sell 350	Expected=0; even
1-Oct	325	Buy 354	Actual=-29
	335	20	Effective Price of 321
Grain/Loss	-15	10	-29

Implementing Strategies

The pre-harvest marketing strategies are implemented over the May 1 to October 1 marketing window. The beginning date of May 1 corresponds to a time period when farmers have made most of their initial production decisions, with planting particularly in mind.

Forward and Futures Hedging Strategies Based Upon Cost of Production Coverage Criteria

Three forward and three futures strategies use a percentage of production costs to determine when they are set. These strategies are analyzed daily using December new crop corn closing future prices and Memphis forward cash prices for new crop delivery. The first time in the marketing window when futures prices adjusted for expected harvest time basis or forward prices are greater than a designated threshold, determined by a percentage coverage of production costs (100%, 125%, and 150%), the respective futures/forward strategy is implemented. Expected harvest basis for any one crop year is estimated as a three- year moving average of previous year's harvest basis levels.

Hedge selection price equals forward/futures price acceptance where the forward contract price at the Memphis grain terminal, or futures price adjusted for harvest expected basis, is greater than the average Arkansas corn cost of production:

$$Forward\ Contract\ Level = Frw_{\$p}\ Cost\ of$$

$$Production = CoP_{100\%,125\%,150\%}$$

$$Frw_{\$p} \geq CoP_{100\%}$$

$$Frw_{\$p} \geq CoP_{125\%}$$

$$Frw_{\$p} \geq CoP_{150\%}$$

$$\textit{Futures Price Level} = F_{\$p}$$

$$\textit{Cost of Production} = CoP_{100\%,125\%,150\%}$$

$$F_{\$p} \geq CoP_{100\%}$$

$$F_{\$p \geq} CoP_{125\%}$$

$$F_{\$p \geq} CoP_{150\%}$$

If prices never reach a level over the window which allows the strategy to be implemented, it is assumed for that particular crop year that our hypothetical farmer sells his corn in the cash market on October 1. This method gives us six different futures/forward contract marketing strategies, three forward pricing contracts at the respective coverage levels and three futures at those same levels.

Average Price Contracts

Average price contracts for corn allow an agent to market grain in intervals over a negotiated amount of time. Bushels are marketed each week throughout a contracted time period, allowing marketers to smooth returns over that time. These contracts are more attractive alternatives for producers with a higher level of risk aversion. By allowing a farmer to price a specified number of bushels over time, market peaks and troughs are smoothed throughout the growing season. This allows upside potential with downside protection, while fitting a relatively risk-averse producer profile. These types of contracts have been heavily promoted by grain merchandising firms in recent years and referred to as “new generation contracts.” For illustration purposes we present a sample average price contract agreement that a grain elevator might offer a farmer:

ABC Grain
Address
City, State, Zip
Phone

Commitment Agreement

<u>Average Price Contract- CORN</u>

The average Price Contract is a cash grain contract that allows producers to price a specific amount of bushels over a specific amount of time. The bushels and the time frame are set at time of contract. Bushels on the Average Price Contract are priced over a pre-determined time frame and are priced in equal amounts on a weekly basis over the set time frame. Pricing will be done each Wednesday at the close of the CBOT market for that day. Cash contracts will use the closing cash price for the delivery period set.

We will be offering the following contract periods for Corn.

Fall 20XX Delivery Period   Pricing Period April 5, 20XX – August 16, 20XX (20 weeks)

Example: Producer contracts 5000 bushels of corn for Fall 20XX delivery to ____________________. The pricing period is April 5, 20XX – August 16, 20XX. There are 20 pricing dates (Wednesday's) during this period. 5000 bushels divided by 20 dates would price 250 bushels per Wednesday. At the end of this pricing period, the average cash price will be determined and a contract with that price will be sent to producer.

Producers will have a onetime opportunity to price out any unpriced bushels on any date during trading hours of the Chicago Board of Trade at the cash price at the time. Example: If producer is halfway through pricing period and market rallies to level where they would like to price the unpriced portion of the bushels, they can price it at current market on that date. A 2¢ early-pricing fee will be assessed on the quantity of bushels priced early. The unpriced bushels will be averaged with the bushels that have been priced to date and will then generate a contract with the average price over the pre-determined amount of bushels. These bushels will be completely priced at this time.

Cancellation of any un-priced portion of the Total Quantity committed by Seller is allowed. A 10¢ cancellation fee will be assessed on the quantity of cancelled bushels.

The sign up deadline is April 4, 20XX and there is no fee for this contract.

Pricing is set against December 20XX futures.

I, ____ agree to sell Company, City, State, Zip

_______________ bushels of _________________ for the delivery period of _________________.

________________________________   ____________________________
Signature   Date

Fig 1

Implementing Strategies

The pre-harvest marketing strategies are implemented over the May 1 to October 1 marketing window. The beginning date of May 1 corresponds to a time period when farmers have made most of their initial production decisions, with planting particularly in mind.

Forward and Futures Hedging Strategies based upon Cost of production coverage criteria

One set of strategies use a percentage of production costs to determine when they are set. These strategies are analyzed on a daily basis using December new crop corn closing future prices and Memphis forward cash prices for new crop delivery. The first time in the marketing window when futures prices adjusted for expected harvest time basis or forward prices are greater than a designated threshold, determined by a percentage coverage of production costs (100%, 125%, and 150%), the respective futures/forward strategy is implemented. Expected harvest basis for any one crop year is estimated as a 3-year moving average of previous year's harvest basis levels.

Hedge Selection Price= Forward Price Acceptance where the forward contract price at the Memphis grain terminal, or futures price adjusted for harvest expected basis, is greater than the average Arkansas corn cost of production:

$$\text{Forward Contract Level} = Frw_{\$p}$$

$$\text{Cost of Production} = CoP_{100\%,125\%,150\%}$$

$$Frw_{\$p} \geq CoP_{100\%}$$

$$Frw_{\$p} \geq CoP_{125\%}$$

$$Frw_{\$p} \geq CoP_{150\%}$$

If prices never reach a level over the window which allows the strategy to be implemented, it is assumed for that crop year that our hypothetical farmers sell their corn in the cash market on October 1. This method gives us six different futures/forward contract marketing strategies.

Average Price Contracting Strategies

May, June, July, and both June and July taken together, are average time periods considered and tested with Average price contracts in following sections. The strategy titled *Average Price Contract* is analyzed by taking the average forward cash price observed each Wednesday following the May (WASDE) release date until October 1 for each crop year over the 2001-2017 sample period. Tests are run between different average contracts based on different months through the growing season. The average contract periods for the following strategies are May, June, July, and a combination June and July average period. Average returns and profit for each period's averaging contract are compared in the results section. The results can guide producers in realizing risk and returns available in different times of the year on average.

WASDE S/U & WASDE Average Price strategies

The two WASDE based strategies use projected corn stocks to use ratios and average national cash corn price forecasts for the forthcoming crop year – taken from the May WASDE report each year of the sample period – to estimate expected harvest-time cash price in the Memphis corn market. The idea is to utilize government information released at the beginning of our pre-harvest marketing window and pertaining to current expectations about corn supply and demand. Ordinary least squares regressions are used to model the relationship between Memphis harvest-time cash prices and these WASDE information variables. The regressions are estimated for an in-sample period (1995 - 2000) and parameter estimates are used to forecast Memphis harvest-time cash prices out-of-sample, where the out-of-sample period corresponds to the sample period (2001- 2017) used to analyze all of our pre-harvest marketing strategies[12]. The WASDE marketing strategies are implemented by picking first day in each crop year marketing window that the higher of either forwards or futures prices adjusted for expected harvest basis levels are greater than the OLS Memphis harvest-time cash price forecasts.

The OLS regression methods are now discussed in more detail. The Memphis corn October 1 harvest cash bid is regressed upon the May WASDE average price for one regression, and upon the May WASDE stocks to use ratios for the other regression. The first model is regressed upon the WASDE average price estimates, while the second OLS model is using the same dependent variable regressed on WASDE projected stock to use.

WASDE S/U Price

The alpha (intercept) represents the harvest-time Memphis cash price on average for the in-sample period at a level of 429.66 cents/bu. The WASDE projected s/u coefficient has a value of -12.60 cents/bu and is significant at the 1% level. The regression fit the in-sample data well with an R-squared value of 0.93 and residual diagnostics indicated there were no autocorrelation or heteroscedasticity issues. To calculate the forecasted Memphis harvest-time cash price we added alpha to the WASDE projected s/u beta coefficient multiplied by the stocks to use ratio observed for each crop year in the out-of-sample period.

[12] The OLS regressions were also estimated for the full sample period (1995 - 2017) and the paramter estimates were found to be robust and not sensitive to sample period.

Where S/U comes from the amount of WASDE report ending stocks to total use projections.

$y=\alpha+\beta(x)$

y=harvest price

α=intercept of average Memphis spot price on October 1

β=Memphis harvest-time cents per bushel cash price reaction to a 1% increase in stocks to use.

$x=(Supply_{end\ stocks}/Demand_{total\ use})*100$

Therefore, for every 1% increase in the stock to use ratio, there is an expected change in the Memphis harvest-time cash price level of -12.60 cents.

WASDE Average Price

The alpha (intercept) of -126.31 cents per bushel represents the average difference between the harvest-time Memphis cash price relative to the WASDE national average price forecast for the in-sample period. In other words, harvest-time Memphis cash price was on average 126.31 cents per bushel below the USDA estimate in the WASDE reports. The WASDE projected average price coefficient has a value of 1.446 cents/bu and is significant at the 5% level. The regression fit the in-sample data well with an R-squared value of 0.78 and residual diagnostics indicated there were no autocorrelation or heteroscedasticity issues. The battery of residual tests includes the Ljung-Box Q Test and the Breusch-Godfrey LM tests for autocorrelation, and the Breusch-Pagan Heteroscedasticity test.

To calculate the forecasted Memphis harvest-time cash price we added alpha to the WASDE projected average price coefficient multiplied by the WASDE average price observed for each crop year in the out-of-sample period.

Where WASDE Average Price comes from the amount of WASDE report national average price projections.

$$y=\alpha+\beta(x)$$

y=harvest price

α=intercept of average Memphis spot price on October 1

β=price reaction for a 1% increase in WASDE national average price projection.

x=WASDE Average Price from (1995-2000)

Therefore, for every 1 cent per bushel increase in the WASDE average price estimation, there is a corresponding 1.45 cent/bu increase in the average Memphis harvest-time cash price on October 1.

OLS Regressions Results Table for Memphis Spot Price Regressed on WASDE S/U and WASDE Average Price.

Table 2

WASDE Stock to Use	*R^2*	0.93
	Adjusted R^2	0.91
	Constant	429.67
	Standard Error	27.72
	WASDE Stock to Use Coefficient	-12.61
	Standard Error	1.74
	p-value	0.00
WASDE Average Price	*R^2*	0.78
	Adjusted R^2	0.73
	Constant	-126.31
	Standard Error	96.49
	WASDE Price Forecast Coefficient	1.45
	Standard Error	0.38
	p-value	0.018

Table 3 **OLS Regressions Residual Tests**

WASDE Average Price

Regression Statistics	Residual Test	statistic	p-value
Autocorrelation	LBQ lag 1	0.14	0.71
Autocorrelation	LBQ lag 2	0.15	0.93
Autocorrelation	Breusch Godfrey	1.03	0.31
Heteroscedasticity	Breusch Pagan	0.07	0.79

WASDE Stock to Use

Regression Statistics	Residual Test	statistic	p-value
Autocorrelation	LBQ lag 1	2.2	0.13
Autocorrelation	LBQ lag 2	2.36	0.31
Autocorrelation	Breusch Godfrey	1.5	0.22
Heteroscedasticity	Breusch Pagan	0.071	0.79

Chapter IV Data

As already noted, WASDE stock to use ratios and national average crop year cash price projections were taken from the May WASDE reports each year (World Agricultural Supply and Demand Estimates, USDA). In addition, total specified production cost data was collected from the University of Arkansas Division of Agriculture (2018) Extension service for a typical furrow irrigated, roundup ready and bt stacked corn farm. Also, Arkansas average corn yields measured in bushels per acre were taken from USDA National Agricultural Statistics Service (USDA, AMS, 2018).

Memphis FOB[13] terminal harvest-time spot cash bids observed on October 1 each crop year and Memphis FOB new crop daily forward bids observed from May 1 through October 1 each crop year were taken from the USDA's National Agricultural Statistics Service (USDA, NASS, 2018). Daily CBOT December corn futures closing prices observed from May 1 through October 1 each crop year were also collected.

Production costs and pricing strtagies are both crucial for the success and increased profitability for a farming operation. Capturing all costs and benefits for producers has proven to be a difficult task, as each farmer has specific interests and risk preferences. This has caused complexity in research in the attempt to quantify results. Due to this complexity, statewide yields and total specified costs of production[14] for Arkansas are used instead of farm specific data in order to depict the average Arkansas farming constraints. Because of differences among individual farms, aspects of operations' objectives differ subject to their preferences which tend

[13] FOB or Free on Board is a designation for the point in which transfer of traded goods change ownership. FOB means that when a good leaves the seller's warehouse, the buyer takes full responsibility for it, incurring all delivery costs. This contrasts with Cost, Insurance, and Freight, or CIF, where the seller is responsible for transport costs until the container is loaded onto the ship and crosses its rail.

[14] Total specified costs from the University of Arkansas enterprise budgets includes the average annual Arkansas production costs per acre for stacked, roundup ready number two corn grain, which is grown in furrow irrigated, loamy soil.

to be based around input costs and expected returns, along with the acceptable level of profit margin specific to the operation. Average Arkansas production costs per acre for stacked, roundup ready, furrow irrigated, loamy soil, are divided by the yield[15] in bushels per acre to get production costs per bushel, which in turn is used to cover total specified production costs (COP) levels at breakeven (b.e.), 125% of COP, and 150% of COP. By dividing production costs in dollars per acre by bushels per acre average yield and multiply by 100, we calculate the price in cents per bushel needed to cover production expenses.

BE_{price} *=(COP/Yield) *100=cost of producing one bushel of corn in cents*

BE_{price} *=Break-even price*

COP=$/acre

Yield=bushels/acre

After the BE_{price} calculation, coverage levels are calculated by simply multiplying by 1.25, and 1.5 for 125% COP, and 150% COP respectively. Decision rules were implemented across all sample years (2001-2017) that would indicate if COP was covered with a “yes” or “no” statement in Microsoft Excel®.

[15] The yield data is an Arkansas statewide average and does not specify for stacked, roundup ready, furrow irrigated, loamy soil. Cost per bushel is likely biased in one direction or another. I would guess biased upwards. Bias may be in the other measures, e.g. risk. This should be noted as a limitation.

Chapter V Results

Comparisons of each strategy through parametric and nonparametric tests were conducted through StatTools7®, a Palisade ®add-on for Microsoft Excel®. These tests comprised parametric *t*- tests (one and two tailed), an *F*-test for equal variances; nonparametric one and two-sided sign tests, Wilcoxon signed rank tests, and chi-squared tests for normality. Results have been compiled into tables for price received, profit per bushel, and profit per acre and are presented below. Along with the significance tests, coefficients of variation are also calculated for standardized comparisons of riskiness across strategies and to rank the various strategies by both risk and return. The minimum coefficient of variation is used to choose the number one strategy with the lowest risk relative to returns. The highest coefficient of variation percentage indicates the riskiest strategy relative to returns.

First, we present results in tables 4-6 comparing each of the pre-harvest marketing strategies through Coefficient of Variation (CV%) Ranking to determine which strategies rank best and worst in terms of their relative returns and returns-risk. The best performing strategy has the lowest CV% ratio, and the worst strategy has the highest CV% ratio.

Table 4 **Price received in cents per bushel**[16]

Year	Price Received	Oct cash	WASDE S/U	WASDE Av Price	Av Price Contract	Fut 100%	Fut 125%	Fut 150%	Forward 100%	Forward 125%	Forward 150%	Av May	Av June	Av July	Av June/July
2001		182.00	188.75	188.75	200.33	182.00	182.00	182.00	182.00	182.00	182.00	192.36	187.86	207.14	197.50
2002		252.00	247.50	218.25	231.21	252.25	252.00	252.00	236.00	252.00	252.00	198.39	205.40	224.90	215.39
2003		218.00	218.00	246.25	227.79	247.25	218.00	218.00	234.00	218.00	218.00	240.12	235.95	212.95	224.19
2004		187.00	187.00	298.25	244.48	300.75	187.00	187.00	316.00	187.00	187.00	293.45	286.29	235.19	260.74
2005		176.00	189.50	189.50	220.58	176.00	176.00	176.00	176.00	176.00	176.00	216.95	229.05	234.15	231.48
2006		279.00	279.00	293.00	239.25	279.00	279.00	279.00	275.50	279.00	279.00	247.75	237.77	234.90	236.40
2007		366.00	371.75	414.75	319.82	375.75	375.75	387.75	342.50	342.50	366.00	344.55	354.90	295.55	325.23
2008		439.00	586.50	720.00	568.24	586.50	586.50	586.50	582.00	582.00	582.00	566.31	655.95	592.41	623.44
2009		339.00	446.50	339.00	349.52	431.75	339.00	339.00	388.00	388.00	339.00	397.83	396.14	318.27	357.20
2010		451.00	378.25	478.00	383.15	392.50	498.50	451.00	388.50	488.00	451.00	359.80	339.09	360.71	349.65
2011		586.00	625.00	561.00	691.43	654.75	654.75	654.75	688.50	688.50	688.50	680.55	695.73	670.43	684.15
2012		725.50	476.00	592.75	654.47	507.50	507.50	592.75	530.00	530.00	594.00	511.11	532.17	735.05	633.61
2013		417.00	517.00	626.50	513.98	526.00	526.00	417.00	553.00	553.00	553.00	552.18	569.18	511.11	538.76
2014		296.00	473.50	296.00	387.69	474.25	474.25	296.00	497.00	497.00	296.00	482.29	435.84	373.82	404.83
2015		371.50	361.25	427.75	369.24	363.00	371.50	371.45	357.50	371.45	371.45	358.68	365.30	404.00	384.65
2016		333.50	373.00	417.50	366.21	384.00	333.50	333.50	384.00	333.50	333.50	389.05	418.09	357.33	390.75
2017		301.00	336.75	301.00	355.50	344.00	301.00	301.00	376.50	301.00	301.00	370.60	373.14	368.84	371.10
Average		348	368	389	372	381	368	354	383	375	363	377	383	373	378
std dev		146	139	161	152	137	149	147	146	157	158	142	155	164	156
CV%		42.04%	37.70%	41.37%	40.96%	35.95%	40.57%	41.54%	38.19%	41.89%	43.57%	37.79%	40.30%	43.96%	41.18%
Rank		12	2	9	7	1	6	10	4	11	13	3	5	14	8
min		176.00	187.00	188.75	200.33	176.00	176.00	176.00	176.00	176.00	176.00	192.36	187.86	207.14	197.50
max		725.50	625.00	720.00	691.43	654.75	654.75	654.75	688.50	688.50	688.50	680.55	695.73	735.05	684.15
Chi Squared Stat		2.09	7.47	5.92	4.48	0.63	1.30	3.52	1.22	2.42	5.87	1.32	5.04	3.90	14.80
p-value		0.55	0.06	0.12	0.21	0.89	0.73	0.32	0.75	0.49	0.12	0.73	0.17	0.27	0.00

[16] The statistical significance key is only used for the chi squared results.

The top three strategies from *prices received* in terms of minimum CV% are

1. Futures 100% coverage of total costs of production[17]
2. WASDE Stocks to Use
3. Average May pricing contract

Clearly the Futures 100% COP strategy performs well both in terms of yielding a relatively high average price and a relatively low standard deviation of price compared with the harvest-time October cash benchmark strategy. Indeed, the harvest-time October cash benchmark strategy ranks lower than all but two of the pre-harvest marketing strategies. Also, notably, although the WASDE average price strategy performs well in terms of yielding a high average price it is riskier than most other strategies.

[17] Because futures prices are not totally predictable, the first price to meet the threshold may be equal or greater than the cost of production. The futures 100% coverage of total costs of production strategy has the main goal of covering at least the cost of production. So, because the futures price may be greater than the COP level, profit margin is possible. Anticipation of higher prices can be considered speculating if a marketer does not enter the hedge the first-time futures is equal to or greater than COP.

Table 5 **Profit in cents per bushel**

Year	Profit per bushel	production Cost $/bu	Production Cost cents/bu	Oct cash	WASDE S/U	WASDE Av Price	Av Price Contract	Fut 100%	Fut 125%	Fut 150%	Forward 100%	Forward 125%	Forward 150%	Av May	Av June	Av July	Average June/July
2001		2.20	219.87	-37.87	-31.12	-31.12	-19.54	-37.87	-37.87	-37.87	-37.87	-37.87	-37.87	-27.51	-32.01	-12.73	-22.37
2002		2.33	233.42	18.58	14.08	-15.17	-2.20	18.83	18.58	18.58	2.58	18.58	18.58	-35.03	-28.02	-8.51	-18.03
2003		2.28	228.25	-10.25	-10.25	18.00	-0.46	19.00	-10.25	-10.25	5.75	-10.25	-10.25	11.87	7.70	-15.30	-4.06
2004		2.33	233.44	-46.44	-46.44	64.81	11.03	67.31	-46.44	-46.44	82.56	-46.44	-46.44	60.01	52.84	1.75	27.30
2005		2.65	264.63	-88.63	-75.13	-75.13	-44.06	-88.63	-88.63	-88.63	-88.63	-88.63	-88.63	-47.68	-35.59	-30.48	-33.16
2006		2.86	286.29	-7.29	-7.29	6.71	-47.04	-7.29	-7.29	-7.29	-10.79	-7.29	-7.29	-38.54	-48.52	-51.39	-49.88
2007		2.53	252.52	113.48	119.23	162.23	67.30	123.23	123.23	135.23	89.98	89.98	113.48	92.02	102.38	43.03	72.71
2008		3.07	307.29	131.71	279.21	412.71	260.95	279.21	279.21	279.21	274.71	274.71	274.71	259.02	348.66	285.12	316.15
2009		3.91	391.03	-52.03	55.47	-52.03	-41.50	40.72	-52.03	-52.03	-3.03	-3.03	-52.03	6.80	5.11	-72.76	-33.82
2010		3.86	385.81	65.19	-7.56	92.19	-2.66	6.69	112.69	65.19	2.69	102.19	65.19	-26.01	-46.72	-25.10	-36.16
2011		4.27	427.27	158.73	197.73	133.73	264.16	227.48	227.48	227.48	261.23	261.23	261.23	253.28	268.46	243.16	256.88
2012		3.81	381.08	344.42	94.92	211.67	273.39	126.42	126.42	211.67	148.92	148.92	212.92	130.03	151.08	353.96	252.52
2013		3.68	367.82	49.18	149.18	258.68	146.15	158.18	158.18	49.18	185.18	185.18	185.18	184.36	201.35	143.29	170.94
2014		3.34	333.53	-37.53	139.97	-37.53	54.16	140.72	140.72	-37.53	163.47	163.47	-37.53	148.75	102.31	40.28	71.29
2015		3.54	354.29	17.21	6.96	73.46	14.95	8.71	17.21	17.16	3.21	17.16	17.16	4.38	11.00	49.71	30.35
2016		3.63	363.23	-29.73	9.77	54.27	2.98	20.77	-29.73	-29.73	20.77	-29.73	-29.73	25.82	54.86	-5.90	27.52
2017		3.39	339.18	-38.18	-2.43	-38.18	16.32	4.82	-38.18	-38.18	37.32	-38.18	-38.18	31.42	33.96	29.66	31.92
Average		3.16	316	32	52	73	56	65	53	39	67	59	47	61	68	57	62
std dev		0.65	67	107	96	130	110	97	109	110	105	112	118	101	116	124	116
CV%		20.68%	21.32%	328.96%	184.69%	178.11%	196.64%	148.65%	206.70%	284.64%	157.08%	190.64%	249.86%	165.52%	171.57%	218.68%	185.25%
Rank				14	6	5	9	1	10	13	2	8	12	3	4	11	7
min		2.20	219.87	-88.63	-75.13	-75.13	-47.04	-88.63	-88.63	-88.63	-88.63	-88.63	-88.63	-47.68	-48.52	-72.76	-49.88
max		4.27	427.27	344.42	279.21	412.71	273.39	279.21	279.21	279.21	274.71	274.71	274.71	259.02	348.66	353.96	316.15
Chi Squared Stat				8.33	7.47	3.57	15.09	2.63	7.20	10.32	4.37	5.48	13.34	6.49	7.74	18.16	14.80
p-value				0.04	0.06	0.31	0.00	0.45	0.07	0.02	0.22	0.14	0.00	0.09	0.05	0.00	0.00

The top three strategies in terms of *profit per bushel* are:

1. Futures 100% coverage of total cost of production
2. Forward 100% coverage of total cost of production
3. Average May pricing contract

The rankings in terms of profits per bushel are like those for price received per bushel, and once again the Futures 100% COP strategy performs the best of out of all of the strategies. Interestingly, in this case the harvest-time October cash benchmark strategy now ranks lower than all other strategies.

Table 6 **Dollar Profit per Acre**

Year	Profit/acre	Production Cost $/ac	Production cost cents/acre	yield/acre	Oct cash	WASDE S/U	WASDE Av Price	Av Price Contract	Fut 100%	Fut 125%	Fut 150%	Forward 100%	Forward 125%	Forward 150%	Av May	Av June	Av July
2001		$318.81	31881.00	145.00	-54.91	-45.12	-45.12	-28.33	-54.91	-54.91	-54.91	-54.91	-54.91	-54.91	-39.88	-46.42	-18.45
2002		$312.78	31278.00	134.00	24.90	18.87	-20.33	-2.95	25.24	24.90	24.90	3.46	24.90	24.90	-46.94	-37.54	-11.41
2003		$319.55	31955.00	140.00	-14.35	-14.35	25.20	-0.65	26.60	-14.35	-14.35	8.05	-14.35	-14.35	16.62	10.78	-21.41
2004		$326.82	32682.00	140.00	-65.02	-65.02	90.73	15.45	94.23	-65.02	-65.02	115.58	-65.02	-65.02	84.01	73.98	2.45
2005		$346.67	34667.00	131.00	-116.11	-98.43	-98.43	-57.72	-116.11	-116.11	-116.11	-116.11	-116.11	-116.11	-62.46	-46.62	-39.93
2006		$417.98	41798.00	146.00	-10.64	-10.64	9.80	-68.68	-10.64	-10.64	-10.64	-15.75	-10.64	-10.64	-56.27	-70.83	-75.03
2007		$426.76	42676.00	169.00	191.78	201.50	274.17	113.73	208.26	208.26	228.54	152.07	152.07	191.78	155.52	173.03	72.714
2008		$467.08	46708.00	152.00	200.20	424.40	627.32	396.64	424.40	424.40	424.40	417.56	417.56	417.56	393.71	529.97	433.38
2009		$578.72	57872.00	148.00	-77.00	82.10	-77.00	-61.42	60.27	-77.00	-77.00	-4.48	-4.48	-77.00	10.06	7.56	-107.68
2010		$578.72	57872.00	150.00	97.78	-11.35	138.28	-4.00	10.03	169.03	97.78	4.03	153.28	97.78	-39.02	-70.09	-37.65
2011		$602.45	60245.00	141.00	223.81	278.80	188.56	372.46	320.75	320.75	320.75	368.34	368.34	368.34	357.12	378.53	342.85
2012		$678.33	67833.00	178.00	613.06	168.95	376.77	486.63	225.02	225.02	376.77	265.07	265.07	378.99	231.45	268.93	630.05
2013		$684.15	68415.00	186.00	91.47	277.47	481.14	271.84	294.21	294.21	91.47	344.43	344.43	344.43	342.91	374.52	266.52
2014		$623.71	62371.00	187.00	-70.19	261.74	-70.19	101.27	263.14	263.14	-70.19	305.68	305.68	-70.19	278.17	191.31	75.33
2015		$641.27	64127.00	181.00	31.15	12.59	132.96	27.05	15.76	31.15	31.05	5.81	31.05	31.05	7.93	19.91	89.97
2016		$621.13	62113.00	171.00	-50.85	16.70	92.80	5.10	35.51	-50.85	-50.85	35.51	-50.85	-50.85	44.15	93.80	-10.09
2017		$620.70	62070.00	183.00	-69.87	-4.45	-69.87	29.86	8.82	-69.87	-69.87	68.29	-69.87	-69.87	57.50	62.15	54.28
Average		503.86	50386	158	56	88	121	94	108	88	63	112	99	78	102	113	97
std dev		141	14142	20	178	151	211	176	152	170	171	166	177	186	159	181	203
CV%		28.07%	28.07%	12.50%	320.83%	171.93%	174.25%	187.24%	140.81%	192.87%	272.89%	147.96%	179.98%	239.05%	155.62%	160.57%	209.35%
Rank					14	5	6	9	1	10	13	2	8	12	3	4	11
min		312.78	31278.00	131.00	-116.11	-98.43	-98.43	-68.68	-116.11	-116.11	-116.11	-116.11	-116.11	-116.11	-62.46	-70.83	-107.68
max		684.15	68415.00	187.00	613.06	424.40	627.32	486.63	424.40	424.40	424.40	417.56	417.56	417.56	393.71	529.97	630.05
Chi Squared Stat					7.76	10.55	5.41	14.99	2.55	6.62	8.74	6.30	5.96	11.81	11.81	11.68	15.60
p-value					0.05	0.01	0.14	0.00	0.47	0.09	0.03	0.10	0.11	0.01	0.01	0.01	0.00

Top three strategies in terms of *profit per acre are:*

1. Futures 100% coverage of total cost of production

2. Forward 100% coverage of total cost of production

3. Average May

Regarding profit per acre the rankings are identical to the profit per bushel rankings, which is not surprising as the calculation of profit per acre is almost perfectly correlated with the profit per bushel calculation. Although there is 99% correlation, there is a larger magnitude for profit per acre which is possibly due to the inclusion of yield in its calculation for dollars per acre profit. However, we believe it is informative to present the results as it is of interest to see what the profit levels are in terms of dollars per acre for each strategy. Although, our coefficient of variation (CV%) analysis provides us with straightforward way to rank the various strategies both in terms of relative returns and risk we are left asking the question as to whether average returns (price and profits) from our pre-harvest marketing strategies are significantly different from the benchmark harvest-time cash sale strategy. And from a purely risk perspective if the variance of returns (prices and profits) are significantly different from the benchmark harvest-time cash sale strategy.

With these question in mind, we turn to tables 7-9, which present results of the parametric and nonparametric tests to determine if the various pre-harvesting marketing strategies yield significantly different prices per bushel, profits per bushel and profits per acre compared with the benchmark harvest-time cash sale strategy.

Parametric Results

First, with respect to our parametric results we can see that none of the strategies yield significantly different prices or profits compared with the harvest-time cash sale strategy, irrespective of whether we use a one or two tailed *t*-test (Tables 7-9). We can conclude, that based upon our parametric results, it is not possible to generate higher prices or profits using pre-harvest marketing strategies compared with simply selling each year in the harvest-time cash market. This result is consistent with efficient markets hypothesis (EMH) and supports the conclusion reached by Zulauf and Irwin (1998) that pre-harvest marketing strategies are not able to generate higher farm incomes than simply selling in the cash market at harvest time. In addition, our *F*-tests also indicate that the variance of prices and profits for all the pre-harvest strategies are not statistically different from the benchmark harvest-time cash sale strategy. This implies that there are no advantages to using pre-harvest marketing strategies to reduce harvest-time price risk, at least not with respect to a year to year comparison.

Chi-Squared Tests for normality

However, further testing for non-normality reveals that the profit per bushel and the profit per acre distributions associated with most of the strategies are not normal. The relevant chi-squared test results with respect to non-normality are presented at the foot of tables 4, 5 and 6. This is less true with respect to the price per bushel received distributions, with our tests showing only two strategies (WASDE stocks to use, and average price during June and July) are not normally distributed.

Given the prevalence of non-normality we proceed to analyze the question of whether returns (price and profits) generated by pre-harvest marketing strategies are greater than benchmark harvest-time cash returns using two well-known nonparametric tests – the Sign test and Wilcoxon Signed Rank test.

Nonparametric Results

The Sign test uses a hypothesized median difference between the returns of each pre-harvest strategy and the benchmark harvest-time cash sale strategy of 0 then assigns values that are greater than this for the one-sided test, and values less than or greater than 0 for two-sided testing. The Wilcoxon Signed Rank test ranks samples and gives them a sign and rank to test if median differences in he returns of each pre-harvest strategy and the benchmark harvest-time cash sale strategy differ from 0 as shown by positive and negative summed ranks. Results and p-values are presented for each respective measure: price received, profit per bushel, and profit per acre (Tables 7-9).

Table 7 **Strategy Statistical Tests for Prices Received 2001-2017**

<u>**Strategies for Prices Received 2001-20017**</u>	***WASDE S/U***	***WASDE AvPrice***	***Av Price Contract***	***Fut 100%***	***Fut 125%***	***Fut 150%***	***Forward 100%***	***Forward 125%***	***Forward 150%***	***Av May***	***Av June***	***Av July***	***Av June/July***
median differences	6.75	14.00	18.33	29.25	0.00	0.00	16.00	0.00	0.00	40.95	53.05	25.14	18.20
Mean Differences	19.57	40.51	23.73	32.81	20.16	6.19	34.56	26.44	14.70	28.38	35.20	24.54	29.97
<u>**Tests**</u>													
T-test	0.56	1.00	0.64	0.94	0.55	0.17	0.96	0.71	0.38	0.80	0.93	0.62	0.79
2-sided p value	0.58	0.32	0.53	0.35	0.59	0.87	0.34	0.49	0.70	0.43	0.36	0.54	0.43
1-sided p value	0.29	0.16	0.26	0.18	0.29	0.43	0.17	0.2428	0.3519	0.2139	0.1804	0.2691	0.22
F test of equal sample variances	0.84	1.45	1.05	0.82	1.03	1.05	0.95	1.11	1.21	0.88	1.17	1.34	1.15
p value	0.73	0.47	0.92	0.70	0.95	0.92	0.93	0.83	0.71	0.80	0.76	0.57	0.78
Sign Test 2-sided >, < HM 0	11,4	12,3	11,6	11,3	9,1	6,2	9,6	6,3	3,2	11,6	11,6	11,6	12,5
p value	0.12	0.04	0.33	0.06	0.02	0.29	0.61	0.51	1.00	0.33	0.33	0.33	0.14
Sign Test 1-sided >HM 0	11	12	11	11	9	6	9	6	3	11	11	11	12
p value	0.06	0.02	0.17	0.03	0.01	0.14	0.30	0.25	0.5	0.17	0.17	0.17	0.07
Wilcoxon Signed Rank Test stat	88	94	106	82	45	25	87	34	11	108	108	108	109.00
p value 2 sided	0.12	0.06	0.17	0.07	0.08	0.38	0.14	0.20	0.44	0.14	0.14	0.14	0.13
p value 1 sided	0.06	0.03	0.08	0.03	0.04	0.19	0.07	0.10	0.22	0.07	0.07	0.07	0.06
Chi-Square Normality Test	7.47	5.92	4.48	0.63	1.30	3.52	1.22	2.42	5.87	1.32	5.04	3.90	14.80
p-value	0.06	0.12	0.21	0.89	0.73	0.32	0.75	0.49	0.12	0.73	0.17	0.27	0.00

Price received per bushel (see Table 7)

First, with respect to our price received per bushel results, we focus attention on the two cases of non-normality, relating to the WASDE stocks to use, and average price during June and July strategies. The one tailed Sign and Rank tests both indicate that the two strategies prices are on average higher than the harvest-time cash sale benchmark at the 10% level (Table 7). No statistical difference between the two strategies and the benchmark is found using two tailed tests. Thus, there is some weak evidence that the WASDE stocks to use, and average price during June and July strategies may yield significantly higher prices than those obtainable at harvest time. Regarding the average price strategy during June and July this would be consistent with the notion that a Wisner type risk-premium may be embedded in prices during this period when yields are less certain. However, this strategy is subject to much risk as highlighted by the large estimates of price volatility (standard deviation) associated with it and presented in table 1.

Profit per bushel and Profit per acre (see Table 8 &9)

Again, focusing on strategies where we found evidence of non-normality, both one and two tailed Sign and Rank tests indicate that several pre-harvest strategies (WASDE average price, futures hedge with 100% COP, and futures hedge at 125% COP) generate profits that are significantly different and larger than the harvest-time cash sale benchmark strategy at the 5% level (Tables 8 and 9). In addition, one tailed Sign and Rank tests show that WASDE stocks to use and average price during June and July strategies are significantly larger than the harvest-time cash sale benchmark strategy at the 10% level. Finally, based on the one tailed Rank test alone, several of the average price strategies (average price contract, and average prices during

May, June, and July) are all statistically larger than the harvest-time cash sale benchmark strategy at the 10% level.

Therefore, in summary, taking the profit results overall, there is substantial nonparametric evidence to indicate that a wide range of pre-harvest marketing strategies yield significantly larger profits than the harvest-time cash sale benchmark strategy. Thus, in a nonparametric/non-normal world our results provide supporting evidence to Wisner, Blue, and Baldwin (1998) results. One important caveat to note is that our nonparametric tests do not allow us to determine if the pre-harvest marketing strategies are significantly less risky than the harvest-time cash sale benchmark strategy.

Table 8 **Strategy Statistical Tests for Profit per bushel 2001-2017**

Strategies for Prices Received 2001-20017	***WASDE S/U***	***WASDE AvPrice***	***Av Price Contract***	***Fut 100%***	***Fut 125%***	***Fut 150%***	***Forward 100%***	***Forward 125%***	***Forward 150%***	***Av May***	***Av June***	***Av July***	***Av June/July***
median differences	6.75	14	18.33	29.25	0.00	0	16	0	0	40.95	53.05	18.20	18.20
mean differences	19.57	40.51	23.73	32.81	20.16	6.19	34.56	26.44	14.7	28.38	35.2	24.54	29.97
Tests													
T-stat	0.56	1.00	0.64	0.94	0.55	0.17	0.96	0.71	0.38	0.80	0.93	0.62	0.79
2-sided p value	0.58	0.32	0.53	0.35	0.59	0.87	0.34	0.49	0.70	0.43	0.36	0.54	0.43
1-sided p value	0.29	0.16	0.26	0.18	0.29	0.43	0.17	0.24	0.35	0.21	0.18	0.27	0.22
F test of equal sample variances	0.84	1.45	1.05	0.82	1.03	1.05	0.95	1.11	1.21	0.88	1.17	1.34	1.15
p value	0.73	0.47	0.92	0.70	0.95	0.92	0.93	0.83	0.71	0.80	0.76	0.57	0.78
Sign Test 2-sided >, < HM 0	11,4	12,3	11,6	11,3	9,1	6,2	9,6	6,3	3,2	11,6	11,6	11,6	12,5
p value	0.12	0.04	0.33	0.06	0.02	0.29	0.61	0.51	1.00	0.33	0.33	0.33	0.14
Sign Test 1-sided >HM 0	11	12	11	11	9	6	9	6	3	11	11	11	12
p -value	0.06	0.02	0.17	0.03	0.01	0.14	0.30	0.25	0.50	0.17	0.17	0.17	0.07
Wilcoxon Signed Rank Test Stat	88	94	106	82	45	25	87	34	11	108	108	108	109
p value 2 sided	0.12	0.06	0.17	0.07	0.08	0.38	0.14	0.20	0.44	0.14	0.14	0.14	0.13
p value 1 sided	0.06	0.03	0.08	0.03	0.04	0.19	0.07	0.10	0.22	0.07	0.07	0.07	0.06
Chi-Square Normality Test	7.47	3.57	15.09	2.63	7.20	10.32	4.37	5.48	13.34	6.49	7.74	18.16	14.80
p value	0.06	0.31	0.00	0.45	0.07	0.02	0.22	0.14	0.00	0.09	0.05	0.00	0.00

Table 9 **Strategy Statistical Tests for Profit per acre 2001-2017**

Strategies for Prices Received 2001-20017	***WASDE S/U***	***WASDE AvPrice***	***Av Price Contract***	***Fut 100%***	***Fut 125%***	***Fut 150%***	***Forward 100%***	***Forward 125%***	***Forward 150%***	***Av May***	***Av June***	***Av July***	***Av June/July***
median differences	9.7875	20.44	26.58	40.95	0.00	0.00	22.40	0.00	0.00	53.65	69.49	40.75	26.94
mean differences	19.57	40.51	23.73	32.81	20.16	6.19	34.56	26.44	14.7	28.38	35.2	24.54	29.97
Tests													
T-test	0.56	1.00	0.64	0.94	0.55	0.17	0.96	0.71	0.38	0.80	0.93	0.62	0.79
2-sided p value	0.58	0.32	0.53	0.35	0.59	0.87	0.34	0.49	0.70	0.43	0.36	0.54	0.43
1-sided p value	0.29	0.16	0.26	0.18	0.29	0.43	0.17	0.24	0.35	0.21	0.18	0.27	0.22
F test of equal sample variances	0.84	1.45	1.05	0.82	1.03	1.05	0.95	1.11	1.21	0.88	1.17	1.34	1.15
p value	0.73	0.47	0.92	0.70	0.95	0.92	0.93	0.83	0.71	0.80	0.76	0.57	0.78
Sign Test 2-sided >,< HM 0	11,4	12,3	11,6	11,3	9,1	6,2	9,6	6,3	3,2	11,6	11,6	11,6	12,5
p value	0.12	0.04	0.33	0.06	0.02	0.29	0.61	0.51	1.00	0.33	0.33	0.33	0.14
Sign Test 1-sided >HM 0	11.00	12.00	11.00	11.00	9.00	6.00	9.00	6.00	3.00	11.00	11.00	11.00	12.00
p value	0.06	0.02	0.17	0.03	0.01	0.14	0.30	0.25	0.50	0.17	0.17	0.17	0.07
Wilcoxon Signed Rank Test stat	87.00	94.00	106.00	82.00	45.00	10.00	86.00	34.00	10.00	106.00	107.00	111.00	108.00
p value 2 sided	0.14	0.06	0.17	0.07	0.08	0.63	0.15	0.20	0.63	0.17	0.16	0.11	0.14
p value 1 sided	0.07	0.03	0.08	0.03	0.04	0.23	0.08	0.10	0.31	0.08	0.08	0.05	0.07
Chi-Square Normality Test	10.55	5.41	14.99	2.55	6.62	8.74	6.30	5.96	11.81	11.81	11.68	15.60	14.06
p value	0.01	0.14	0.00	0.47	0.09	0.03	0.10	0.11	0.01	0.01	0.01	0.00	0.00

Chapter VI: Summary and Conclusion

Review of the Research Objectives

Thus, although at first blush our coefficient of variation results would suggest that most pre-harvest marketing strategies outperform the harvest-time cash sale benchmark, our parametric tests show that there is no statistical difference between pre-harvest and harvest-time strategies either in terms of returns or risk levels. With regard to pre-harvest strategies not enhancing returns above harvest returns, this result provides strong supporting evidence that futures markets and related forward markets are efficient at pricing corn and that no economic advantage is gained from contracting in the pre-harvest window. This result would put us firmly in the Zulauf and Irwin (1998) camp rather than the Wisner Blue and Baldwin (1998) camp. The finding that pre-harvest strategies fail reduce risk in comparison to selling at harvest, on a year to year basis, is not that surprising (McKenzie, 2012). Although, it is important to note that this result says nothing about the risk management benefits of futures hedging or forward contracting intra crop year price risk.

However, if we consider non-normality of price and profit distributions, and place greater credence on our nonparametric results, a different picture emerges. Our non-parametric tests and strategy comparisons across multiple facets and methods have yielded results that conclude that using pre-harvest contracts indeed give significantly different returns than by using the benchmark harvest-time October cash market. We found significant violations of the normality assumption with respect to profit distributions associated with our pre-harvest marketing strategies, and nonparametric tests – unlike parametric t-and F-tests – do not assume a normal distribution.

If we take our nonparametric results coupled with our coefficient of variation comparison results there appears to be some support for several of the pre-harvest strategies. Setting a futures hedge that covers 100% of cost of production at the first opportunity in the pre-harvest marketing window seems to have some merit over and above simply selling in the harvest-time cash market.

However, we acknowledge that overall our results are providing somewhat mixed conclusions and the question of whether it is possible to enhance farm returns by marketing the pre-harvest window over simply selling in the harvest-time cash market is still an unresolved open question. To provide any definitive conclusions on the issue would require further research that replicates our modeling framework with larger data sets. More states and additional commodities could be analyzed over a longer sample time period. Also, perhaps international comparisons of returns can be attempted as well.

Chapter VII: Research Implications, Limitations and Further Studies

In conclusion, this paper presents research that addresses an important topic in economic research (Blue, Wisner, Baldwin, 2004; Kenyon, 1997). In anticipation, we hope that a wide range of market participants and researchers can utilize our findings for their own benefit and the contribution towards improved future research. Additionally, incorporating the findings into business practices, for producers and other marketers, should lend a hand in guiding them to a more informed decision.

Perhaps further studies along the lines of Richard Thaler's behavioral research can help shed further light on the rationality of market agents participating in commodity futures markets and the implications for market efficiency. In addition, further research that can test whether futures markets do a good job of accounting for seasonality in cash prices might lead to more robust results. Also, given current grain firm preferences for promoting average pricing contracts, more research that investigates these contracts risk-return profiles would be beneficial. Moreover, the incorporation of multiperiod contracts over two or more months should be considered. Under this research area, testing for higher returns during a specified time period can help determine how long an averaging contract should be undertaken.

Some limitations of this thesis include ignoring transaction costs such as brokerage fees. Future research that incorporates this information might give a more realistic analysis of price and profit comparison across marketing strategies. For example, futures-based strategies contain brokerage fee costs such that the profit results presented here are biased upwards for futures strategies. While forward contract-based strategies do not. However, forward contracts prices may themselves contain embedded transaction costs in the form of risk-premiums implicitly charged by grain firms to farmers. Also, our research does not fully consider how yield risk might impact marketing strategies. For example, in years when there is a crop-shortfall, farmers may not produce enough crop to deliver on forward contracts, and in such cases would face a non-deliver fee imposed by grain firms. We also do not account for government risk management support programs and policies that provide price and income support such as Price Loss Coverage (PLC), Agricultural Risk Coverage (ARC), crop yield insurance or crop revenue insurance. Research is necessary to investigate how these government programs complement or substitute market-based risk management tools. From the point of view of farmers, a natural question to ask is: “how does participation in these various programs impact returns generated from marketing strategies such as hedging with futures and options and forward contracting with elevators?” The optimal and most appropriate portfolio of market based, and government supported risk management tools is likely dependent upon commodity, current market environment, and regional location, and is a potentially fruitful and practically useful area of research.

Chapter VIII: References

Brorsen, B.W., and Anderson, Kim. 1997. "Research Topics Suggested by Extension Marketing Economists." *NCR-134 Conference: Applied Commodity Price Analysis and Market Risk Management*. B.W. Brorsen, ed., p. 173-80. Stillwater: Oklahoma State University.

Carter, Colin A. 1999. "Commodity Futures Markets:" A Survey. *The Australian Journal of Agricultural and Resource Economics*, vol 43, issue 2, p.209-247.

D Kahneman, JL Knetsch, RH Thaler. 1995. "Myopic Loss Aversion and the Equity Premium Puzzle. *Journal of Economic Perspectives* 5 (1), 193-206.

De Bondt, R Thaler. 1991 "Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias." *The Journal of Finance,* 40 (3), 793-805.

Engineering Statistics Handbook. Accessed November 25, 2018. https://www.itl.nist.gov/div898/handbook/pmc/section4/pmc4481.htm.

Fama, Eugene F., French, Kenneth. 1987. "Commodity Futures Prices: Some Evidence on Forecast Power, Premiums, and the Theory of Storage." *Journal of Business*, vol. 60, issue 1, p.55-73.

Fox, C. R., & Sitkin, S. B. 2015. "Bridging the Divide between Behavioral Science & Policy." *Behavioral Science & Policy*, 1(1), pp.1–12.

Houpert, Marei U. 2013. Risk Return of Farmer Elevator Contracts for Soybeans and Corn in Arkansas. *Department of Agricultural Economics. The University of Arkansas*.

Irwin, Scott H. Good, Darrel L. and Martines-Filho, João. 1999. "Pricing Performance of Market Advisory Services for Corn and Soybeans." *AgMas Report* No. 2000-04.

Kenyon, D. 1997. "Producer Ability to Forecast Harvest Corn and Soybean Prices." *NCR-134 Conference: Applied Commodity Price Analysis and Market Risk Management*. B.W. Brorsen, ed., pp. 285-95. Stillwater: Oklahoma State University, 1.

Mckenzie, A.M. 2012. "Prefeasibility Study of an ASEAN Rice Futures Market." *Asian Development Bank Sustainable Development Working Paper Series*, No. 19. http://www.iadb.org/intal/intalcdi/PE/2012/12045.pdf

McKenzie, Andrew. "Pre-Harvest Price Expectations for Corn: The Information Content of USDA Reports and New Crop Futures." *Amer. J. Agr. Econ,* 90(2) (May 2008):351-366.

Muth, John F. 1961. "Rational Expectations and the Theory of Price Movements." *Econometrica,* vol. 29, no. 3, pp. 315–335.

O'Brien, Daniel, N. Wisner, Robert. 1997. "Development of Alternative Wheat and Corn Price Forecasting Models." *Iowa State University, Department of Economics, Staff General Research Papers.*

Rodriguez Diaz, Hector G. 2003. "Risk-Returns of Cotton and Soybean Enterprises for Mississippi County, Arkansas: A Comparison of Alternative Marketing Strategies Within a Whole Farm Framework." *Department of Agricultural Economics. The University of Arkansas*.

Schaede, Ulrike. 1989. "Forwards and Futures in Tokugawa-period Japan: A New Perspective on the Dojima Rice Market." *Journal of Banking and Finance*, 13, pp. 487–513.

Thaler, Richard. 1984. "Does the Stock Market Overreact?" *Journal of Marketing Science,* vol. 4, 199-214.

Thaler, Richard H. 2016. "Behavioral Economics: Past, Present, and Future." *American Economic Review*. vol 106, issue 7, pages 1577-1600.

Tomek, William G. 1997. "Commodity Futures Prices as Forecasts." *Applied Economic Perspectives and Policy,* Volume 19, Issue 1, 23–44.

Tomek, William G., Peterson, Hikaru Hanawa. 2001. "Risk Management in Agricultural Markets. A Review." *The Journal of Futures Markets*, Vol. 21. No. 10, pp. 953-985.

Total Specified Production Costs. Accessed May 15, 2018. *Arkansas Field Crop Enterprise Budgets*. University of Arkansas Division of Research and Extension. https://www.uaex.edu/farm-ranch/economics-marketing/farm-planning/budgets/crop-budgets.aspx.

USDA National Agriculture Statistical Service. *Arkansas Corn Yield*. Accessed May 15, 2018. https://www.nass.usda.gov/Statistics_by_Subject/result.php?90C69DEC-38D6-31B4-9953-4C6EB5E82D79&sector=CROPS&group=FIELD%20CROPS&comm=CORN.

USDA. World Agricultural Supply and Demand Estimates. Accessed May 15. 2018. https://www.usda.gov/oce/commodity/wasde/.

Wisner, Robert N., Blue, Neal, Baldwin, Dean. 1998. "Pre-harvest Marketing Strategies Increase Net Returns for Corn and Soybean Growers. *Applied Economic Perspectives and Policy*, vol. 20, Issue 2, 288–307.

WFM De Bondt, RH Thaler. Anomalies: The endowment effect, loss aversion, and status quo bias. *The Journal of Finance* 42 (3), 557-581.

USDA World Agricultural Supply and Demand Estimates. Accessed May 15. 2018. https://www.usda.gov/oce/commodity/wasde/.

Zulaf, Carl R., Irwin, Scott H. 1998. Market Efficiency and Marketing to Enhance Income of Crop Producers. *Review of Agricultural Economics*, vol. 20, No. 2, pp. 308-331.