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Bradley Isbell, Andy M. McKenzie
and B. Wade Brorsen

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Bradley Isbell[1] and Andy M. McKenzie[2] and B. Wade Brorsen[3]

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(1) Graduate Research Assistant, bjisbell@uark.edu and (2) Professor in the Department of Agricultural Economics and Agricultural Business at the University of Arkansas, mckenzie@uark.edu and (3) Regents Professor and A.J. and Susan Jacques Chair in the Department of Agricultural Economics at Oklahoma State University, wade.brorsen@okstate.edu. The research was funded by the Arkansas Agricultural Experiment Station and USDA National Institute of Food and Agriculture, Hatch Project number AR02535

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Price risk management in the grain industry is typically done by hedging with forward contracts and futures contracts. An additional important price discovery and risk management "paper market" also exists in the form of CIF NOLA basis bids, traded through brokers. These bids function similar to traditional forward contracts, however, like a futures market, firms can offset their forward contractual obligations by offsetting positions in a liquid off-exchange paper market. Analysis shows that this liquidity mostly removes the pricing bias commonly found in forward contracting in corn and soybeans, although a small bias still exists in wheat and especially sorghum.

Key Words: CIF NOLA, forward contracting, risk premium, river market, basis

Introduction

Prior studies, (e.g. Miller, 1986; Elam, 1992; Brorsen, Anderson, and Coombs, 1995; Townsend and Brorsen, 2000; Shi, 2007; Taylor, Tonsor, and Dhuyvetter, 2014; Mallory, Zhao, and Irwin, 2015) have focused attention on the cost of forward contracting from the perspective of farmers. The modal conclusions from this body of research are that: (1) farmers incur a cost from forward contracting in that they receive a lower price on elevator forward bids compared to elevator spot cash bids; and (2) that this cost is lower for shorter forward contract periods. Keynes (1930) explains that these costs of forward contracting are typically attributed to the risk-management (hedging costs including margins and commissions) and administration costs incurred by elevators who take on the farmers' price risk, an occurrence he described as "backwardation". In contrast, the futures market efficiency literature concludes that in the long run, grain futures provide efficient and unbiased forecasts of subsequent spot cash prices at delivery time (e.g. McKenzie and Holt, 2002), which implicitly indicates that farmers do not consistently incur similar forward contracting costs when hedging. Similarly, Kolb and Gay (1983) found no significant bias in live cattle futures prices, indicating that live cattle futures perform well as predictors of subsequent spot prices. Futures markets allow traders to cheaply offset or re-trade contracts and this quickly eliminates pricing biases.

Given the hybrid forward-futures nature of the CIF NOLA market, which serves the "merchandising" sector of the grain industry, it is not clear as to whether forward contracting costs would be a natural feature of this market, and, if present, which party to the contract would incur the cost. While the markets play the traditional forward contracting role of delivering physical cash grain, the fact that contracts can be re-traded and that there are both long and short hedgers, might help to remove forward contracting costs akin to a traditional futures market. This is ultimately an empirical question, which we seek to answer.

Our results will provide interesting insights as to the potential existence – or absence – of forward contracting costs in a previously unexamined hybrid forward-futures market. We will be able to say who bears these potential costs, river elevators and terminals or Gulf exporters, and to what extent these potential costs differ by delivery period. For the purposes of our study, we define a bias in forward bids as a consistent difference between a forward basis bid for a given delivery period, and the subsequent spot basis level at the time of delivery. Unlike McKenzie and Holt (2002) who tested the accuracy of futures prices as forecasts for prices, we assume that any bias in CIF NOLA forward bids is not the result of inaccurate forecasts. Therefore, any bias found, which could be either positive or negative, represents what we refer to as a "risk premium" or cost of forward contracting.

Following Townsend and Brorsen (2000), the costs of forward contracting in the CIF NOLA market are estimated by a parametric model using first differences. The change in a forward bid from period *d* to period *d+1* (one period closer to contract maturity) is calculated and the mean is found to determine if a bias exists in the bids over the life of the contract which would indicate a cost to one party to use this market. A positive value would indicate a cost to buyers, while a negative cost would indicate a cost to sellers. To determine the statistical significance of the mean, three statistical tests are used: Student's T test, sign test, and Wilcoxon signed-rank test. The estimates are then extrapolated over the total time period for each delivery period. Staying consistent with the methods used in the parametric model found in Townsend and Brorsen (2000), a market day calendar (5 day week) is used to find total forward contracting costs over the life of a given CIF NOLA forward contract.

Section 2 of this study will define the characteristics of the CIF NOLA forward contract market and present background literature relevant to estimating the cost of forward contracting, the market actions that create efficiency. Section 3 will address the modeling used to calculate a potential cost of forward contracting, or bias, in the market discussed. Section 4 will present the data collected and used in this study, along with providing model estimates and an objective list of empirical results. Finally, in section 5 the results and conclusions from this study will be presented along with the study's contribution to relevant literature and impact on future research.

Institutional Details of CIF NOLA market

The CIF NOLA market is a hybrid futures/forward contract market used by elevators and exporters along the Mississippi River. The unique attributes of this market that create this hybrid environment are the dual roles it plays in the grain industry. Although, it is primarily used to trade physical cash grain for export it also serves as a liquid "paper market" to hedge the sales and purchases of large and small grain firms (e.g. elevators). For example, a number of major grain exporters ship grain from the Gulf and post daily CIF bids for spot and forward delivery periods as far as six months out. They include Cargill, ADM, Bunge, CHS and Zennoh to name a few, and this along with the fact that CIF brokers offer bids and asks for Gulf delivered grain, makes for a very liquid market. We have 2 forms of supporting evidence to back up our claim that firms make offers as well as bids. We were given access to 6 Scoular bid sheets dated over the last couple of years that are circulated internally on a daily basis among key employees who trade the River Market. Although we cannot share this data as it is proprietary, it shows that typical corn bid-ask spreads are around 3 cents/bu (widest 10), soybean spreads around 6 cents/bu (widest 10), wheat spreads around 12 cents/bu (widest 20 cents), and sorghum spreads if they exist can be very wide – up to 30 cents/bu (average 13 cents/bu). Our second piece of evidence comes from a Platt's pricing newsletter which contains similar numbers for bid-ask spreads. This newsletter is available through Platt's subscription service on their website.

First, with respect to its forward contracting role, cash grain that is originated by elevators in production regions is sold and physically delivered by barges on the Mississippi river to exporters on the Gulf coast. The country elevators either sell grain directly to Gulf exporters or sell to river terminals owned by large grain merchandising firms who subsequently sell the grain to Gulf exporters. The large grain merchandising firms may also be Gulf exporters and depending upon market circumstances can be buyers or sellers of grain destined for Gulf export. The demand for CIF NOLA grain is driven by foreign demand for U.S. grain exports. Each CIF NOLA contract stipulates the delivery of a barge load of grain (55,000 bushels) to the port of New Orleans by the specified date, and that the cost of transportation and insuring the cargo through shipment must be covered by the seller of the grain, as indicated by the term CIF (cost, insurance, freight). A firm that sells a CIF NOLA contract for a forward delivery period is committing to deliver 55,000 bushels of grain on a barge to the Gulf, while conversely the buyer of the contract must accept delivery of the barge transported grain. Firms that have sold CIF NOLA contracted grain can purchase the barge freight either directly from barge lines or through CIF freight brokers and freight can be bought in the spot market or forward contracted for a future delivery period. Thus, similar to the price risk of CIF NOLA contracted grain, the price risk of the freight can be mitigated by forward contracts. The delivery dates specified in CIF NOLA contracts are months, where delivery must occur by the end of the month specified. Specifically, the seller of a CIF NOLA contract must load a barge at a river port during the delivery period, and then once loaded the seller "applies the barge" to the buyer. Then the seller "releases" the barge to a barge line (a firm that owns barges) which transports the grain to the Gulf. When the buyer takes possession of the grain it is officially weighed by the Federal Grain Inspection Service and any weight and quality discounts are applied to the final billing invoice. All legal contractual obligations and trade rules in the CIF NOLA market are governed by the National Grain and Feed Association (NGFA) and the NGFA administers an arbitration process for contractual disputes between parties. The price of CIF NOLA contracts are determined through the traditional bid/ask system where sellers of grain ask for a certain basis (price), and export elevators bid a certain basis (price), and through the process of price discovery, the market clearing price is determined. Transactions can occur directly between firms or through a CIF broker who matches buyers and sellers in a liquid OTC market.

Traditional forward markets for grain, such as those that exist between farmers and elevators are associated with risk premiums, where it is assumed that elevators typically require a risk-premium from farmers to contract pre-harvest grain for harvest delivery. As noted earlier this risk premium manifests itself in the form of lower prices on elevator forward bids compared with elevator spot cash bids, and is larger for longer delivery periods. Therefore, a priori, one might expect, given its forward contracting role, that the CIF NOLA market may also contain risk premia. In this case grain exporting firms, who purchase grain on CIF NOLA, may require a similar risk premium from firms selling grain for Gulf delivery. Specifically, under this assumption, one would observe lower forward CIF NOLA bids compared with the associated CIF NOLA spot bids for the same delivery dates, and which would be subsequently observed at contract maturity. And, akin to the farmer-elevator case, the longer the forward delivery bid the higher the risk premium and the lower the CIF NOLA bid.

While Nelson (1985) stresses the importance of differentiating forward and futures contracts, the CIF NOLA forward market seems to draw characteristics from both, given its second important role – that of a "paper hedging market" akin to an exchange traded futures market. Therefore, it is not clear that the CIF NOLA market should contain risk premia, as hedgers are able to take both long and short positions. Importantly, because CIF brokers provide an Over-the-Counter (OTC) platform where both bids and asks (offers) are traded between merchandising firms – both exporters and elevators – hedging demand may be balanced between long and short positions. Indeed it is not uncommon for a firm to take both a long and a short offsetting basis position in a single CIF contract at different times over the contract's life. Importantly, the CIF forward market is structurally different to other agricultural forward markets where market agents are clearly separated in terms of their marketing objectives and risks. For example, in the farmer-elevator forward market; there are two distinct groups of market agents (e.g. farmers sell grain forward while elevators buy grain forward). In contrast the CIF NOLA market serves market agents – namely merchandising firms – who may be both buyers and sellers of grain. In addition, merchandising firms may use the CIF NOLA market to trade basis. As basis traders these firms seek to profit from advantageous changes in basis by buying basis at relatively low levels and selling it at relatively high levels. Firms engaged in this marketing strategy inherently take on basis risk rather than trying to minimize basis risk, and therefore risk premiums may not be a feature of the CIF NOLA market. With this in mind, it is useful to consider the mechanics of how this "paper market" works and how grain firms use it to basis trade and hedge existing or expected grain sales and purchases. Akin to trading physical barges a firm that is trading in the paper market and initially sells a CIF NOLA contract for a forward delivery period is committing to deliver 55,000 bushels of grain on a barge to the Gulf. Likewise the firm that buys the CIF NOLA contract is obligated to take delivery of the grain by unloading the barge during the delivery period. However, similar to an exchange traded futures contract either the initial seller or buyer can remove their physical cash commitments by taking offsetting positions prior to the delivery period. Each time an offsetting contract transaction takes place the obligations of the initial seller (buyer) are passed on to the other buyer (seller) in the trade. Each party to each trade is recorded by paperwork on what is referred to as a "Bill of Lading", which also includes information regarding the quantity, the type of commodity, and its final destination. In this way there can be numerous offsetting transactions with multiple sellers and buyers that form a "paper chain" for a single CIF NOLA contract. You can have a single 55,000 bushel barge contract that trades over a million bushels of paper transactions. Ultimately the final seller of the contract and the final buyer of the contract are obligated to make and take delivery of the physical barge at contract delivery. Figure 1 illustrates the contractual obligations of CIF NOLA traders and how contracts are offset in the "paper market". Note that although a four party example is illustrated, there can be many more firms or agents involved in the paper chain of a CIF NOLA transaction.

Table 1. CIF NOLA Market Example

	River Elevator #1	Gulf Export Elevator #1	River Elevator #2	Gulf Export Elevator #2
Buy	$4.30	$4.40		$4.50
Sell	$4.40	$4.50	$4.30	
Receipts	$242,000	$247,500	$236,500	
(Payments)	($236,500)	($242,000)		($247,500)
Net Profit (loss)	$5,500	$5,500	$236,500	($247,500)

Although this example uses prices for simplicity, CIF NOLA bids and offers are traded in terms of basis.

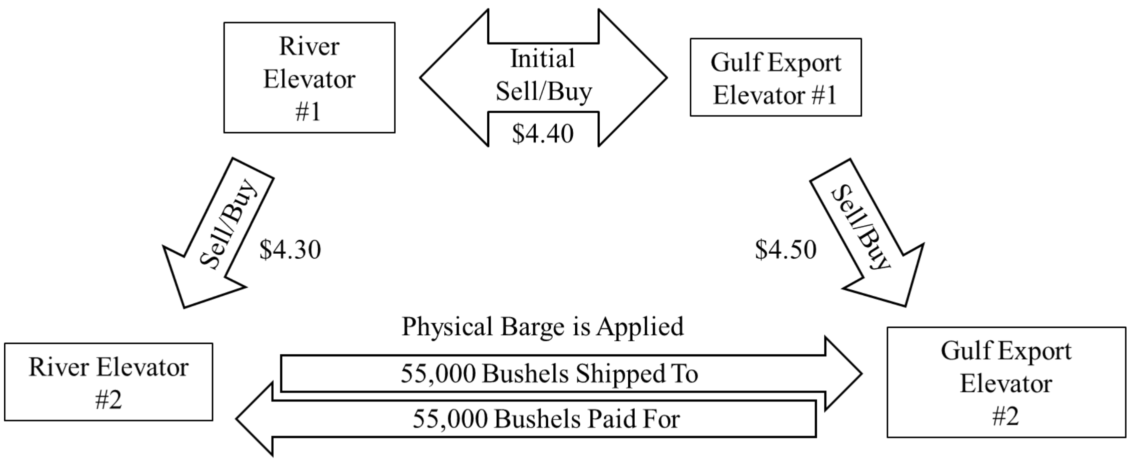

Figure 1. CIF NOLA market example

For this example, we assume that the futures contract associated with this CIF NOLA forward transaction is trading at $4.00 per bushel. It is common for CIF NOLA basis bids to be positive, creating prices above futures prices. Note that the payments and receipts shown in Table 1 for river elevator 2 is representative of the sell price of $4.30 multiplied by the 55,000 bushels specified in a CIF NOLA contract. River Elevator 2 would have purchased the 55,000 bushels of cash grain from either producers or other elevators prior to shipment, and these transactions are not shown in this illustration. Similarly, the payment of Gulf Export Elevator 2 is representative of $4.50 buy price multiplied by 55,000 bushels. It is also worth noting that river elevators and gulf export elevators have the ability to take either a short or long position, or both, in this market and often do.

When the contract enters the delivery time slot the final contract seller in the chain "applies the barge" to the final contract buyer and all financial payments and receipts are passed along to each seller and buyer in the paper chain. There are some notable differences between grain futures contracts and CIF NOLA contracts. For example, unlike futures contracts, where trades are anonymous and clearinghouses record transactions between buyers and sellers, each party is known to each other in the CIF NOLA paper market. Also, in the CIF NOLA market there is no margin accounting system to guarantee financial risks associated with contract performance.

Although there can be many offsetting trades associated with a single CIF NOLA contract, as with traditional forward markets there is counterparty risk embedded in a contract and this risk may manifest itself in the form of risk-premia. Ultimately this is an empirical question.

To better understand why merchandising firms may take both long and short CIF NOLA contract positions we turn attention to their basis trading and hedging motivations by illustrating some specific examples. Market integration ensures that the basis (difference) between the CIF NOLA basis and the basis in interior grain markets is fairly stable. In other words basis movements in CIF NOLA market are correlated with basis movements in interior grain markets. There is empirical evidence to show that basis shocks at CIF NOLA lead to basis movements in interior markets of similar magnitude and direction (e.g. McKenzie, 2005). The extent to which this form of price discovery and transmission takes place in terms of size and duration will depend upon the degree of market integration and barriers to commodity arbitrage. Anecdotally, industry conversations indicate that at least some elevators gauge the competitiveness of basis bids and offers in their local market in comparison to transportation cost adjusted bids in CIF NOLA market. This is referred to "FOBing" bids in the grain industry, where FOB is freight on board bid.

First, consider a country elevator in Missouri that wants to sell grain and make a basis sale. However, currently basis is at low and unprofitable levels in the elevator's local market spot market and/or there are no firms willing to buy grain from the elevator at forward delivery periods. If CIF NOLA market spikes up because of higher export demand, even if the Missouri based elevator doesn't physically trade the river market, it can use the CIF NOLA market to make a "paper sale" of grain and lock in relatively high sell basis for a forward delivery period using the following equation:

(1) $$Lock\ In\ Sell\ Basis_{i,t}^{t+n} = CIF\ Basis_{t}^{t+n} + E_{t}^{t+n}\,(Local\ futures\ basis_{i,t+n} - CIF\ Basis_{t+n}).$$

The lock in sell basis for an elevator's local market, *i*, locked in at the current time period, *t,* for some delivery period in the future, *t+n*, equals the CIF basis bid posted in the current time period, *t*, for the future period, *t+n,* plus the expectation operator, *E*. This expectation operator represents the expectation of what the difference between commodities futures basis for the local market, *i*, and the CIF basis spot bid will be at future period *t+n.* This equation mimics the process a farmer would undertake when hedging pre-harvest using futures contracts to lock in a sell price. For this example, however, the role of a futures contract is filled by CIF NOLA forward basis bids. So, the sell basis level that the elevator is attempting to lock in is equal to the current CIF basis bid for desired delivery period, plus the current expectation of what basis between the local market and the CIF market will be at the time of delivery. Commodity arbitrage will ensure that the CIF NOLA basis and the Missouri basis cannot diverge by an amount greater than transportation costs between the two markets for any length of time. There is a vast commodity market integration literature using cointegration analysis (e.g. Goodwin and Piggott 2001) to show that market prices are correlated through space and time. Therefore, in a similar vein to a farmer using the futures market to make a profitable sale of his grain through short-hedging, the Missouri based elevator in our example can use the CIF NOLA paper market to hedge the profitable basis sale. In this case, the elevator will buy the CIF NOLA basis back at a later date when he sells grain in his local market and the difference between his local basis and CIF NOLA basis has returned to a normal pre-shock level.

Literature Review of Risk Premiums in Commodity Forward and Futures Markets

There has been a sizeable body of work investigating the costs associated with using various types of forward contracts in agriculture. McKenzie and Holt (2002) analyzed the efficiency of live cattle, hog, corn, and soybean meal futures. They determined that while short-run inefficiencies and pricing biases do exist in live cattle, hogs, and corn futures contracts, in the long-run futures contracts do provide unbiased estimates of subsequent spot cash prices. The results for corn and soybean meal found that no risk premium is associated with their use, however, they did find evidence of time-varying risk premiums in live cattle and hog futures markets in the short-run. Kolb and Gay (1983) found no significant bias in live cattle futures prices, indicating that live cattle futures perform well as predictors of subsequent spot prices.

Brorsen, Coombs, and Anderson (1995) and Townsend and Brorsen (2000) both found an inherent cost associated with the use of forward contracts as a risk management tool for wheat producers. Using a parametric model, Townsend and Brorsen (2000) found that Oklahoma farmers forward contracting wheat 100 days pre-harvest using local elevator bids paid a risk premium of 6¢ per bushel for the service. Brorsen, Coombs, and Anderson (1995), also using a parametric model, found that forward contracting wheat using Gulf forward basis bids four months out incurs an average cost of 4¢ per bushel. In a similar vein, Mallory, Zhao, and Irwin (2015) found a risk premium associated with post-harvest forward contracting corn and soybeans of 6¢ and 2¢ per bushel, respectively, using local elevator bids from throughout Illinois. Lewis, Manfredo, and Sanders (2015), in a study that differs from most existing literature on forward contracting, found that soybean oil processors do not embed a risk premium in their forward bids for soybeans. While Brorsen, Coombs, and Anderson (1995), Townsend and Brorsen (2000), and Mallory, Zhao, and Irwin (2015) all used bids issued by elevators to suppliers of grain, Lewis, Manfredo, and Sanders (2015) analyzes forward asks (or offers) given by soybean oil processors to end-users purchasing the soybean oil. This is essentially the inverse of the traditional forward contracting market. These studies all seek to determine if a bias is present in the forward bids that creates a cost of forward contracting.

Our hypothesis that the CIF NOLA market serves a price discovery and hedging role for inland grain markets relies on the assumption that CIF NOLA basis levels are correlated with inland basis levels. Goodwin and Piggott (2001) found that even in spatially separated markets with significant transaction costs, there is still strong evidence of integration. Their analysis describes the process of market integration in the presence of unobservable transaction costs, finding that accounting for these cost through the use of thresholds results in a faster response to shocks in comparison to earlier non-threshold models. It is likely that unobservable transaction costs are a characteristic of the CIF NOLA forward market, as brokers extract fees, and there are costs associated with the loading of barges. McKenzie (2005) applies a cointegration model to the price discovery effect of both gulf soybean basis bids and barge rate levels on internal soybean basis levels. This study emphasizes the importance of analyzing commodity markets in terms of basis, given that basis is the accepted means by which grain is traded within the industry. The conclusions of the study are that gulf basis bids for soybeans are positively correlated with inland soybean basis levels, specifically basis levels in Memphis and Little Rock. Also that these inland basis levels are negatively correlated with barge rates for transportation to gulf export elevators. These market integration studies suggest that inland basis levels should not deviate from CIF NOLA basis levels beyond transportation costs (or unobservable transaction costs) in the long run.

This study seeks to extend the work of Townsend and Brorsen (2000) by extending their analysis of forward contracts to the data set created from CIF NOLA bids. We have found no known studies analyzing the efficiency of the CIF NOLA market.

Modeling and Testing for Bias

For each of the four commodities considered in this study a separate but empirically congruent model is used to determine the existence of a bias in the CIF NOLA export bids market. The model is a simple parametric approach that finds the mean of first differences of basis bids. First, the high basis bid of each day is subtracted from the high basis bid from the previous day to create the variable basis difference as defined in the equation:

(2) $$Basis\ Difference_i = Basis_i - Basis_{i-1}.$$

We elected to use the high bid in an attempt to use data as close to actual transaction prices as possible. Since data representing ask prices, which are typically higher than bid prices, in the market could not be found, the high bids for each day are thought to be the closest approximation to the actual price at which CIF NOLA forward contracts were traded at that day. The difference between the first bid of each month and the last bid of the preceding month is omitted from the data set to avoid incorporating the difference between bids in different delivery periods. The mean of Basis Difference is then found, along with descriptive statistics created by SAS proc univariate. To find the total bias for the life of a forward contract this mean, or estimate of average daily bias, the total change for the month of each delivery period is calculated, and then added to the change from the preceding delivery periods. The reports that comprise the dataset used are issued daily for every week day (5 days each week), and we assume a standard 4 week month, resulting in a 20 market day month. In order to extrapolate the daily bias estimates to estimates for the life of each contract, first the daily bias estimate for each delivery period is multiplied by 20 to find the average bias for each delivery period. Then, the average bias for a delivery period is added to the average bias for each preceding delivery period to find the average total bias for the life of forward contract. This means that the total bias for the life of a one month out delivery period contract is simply the estimate for that delivery period multiplied by 20. To find the total bias for further out delivery periods, for example, delivery period 3, the same process is performed for delivery periods 1 through 3, multiplying each estimate by 20. Then, these products are added together to find the total bias over the life of a 3 month out contract so that:

(3) $$Bias\ over\ life\ of\ contract_3 = (estimate_1 * 20) + (estimate_2 * 20) + (estimate_3 * 20).$$

Using this method, the daily estimate for the nearby delivery period, 0, is also the total bias for the life of the contract as the contract for delivery period 0 can be immediately delivered upon.

This mean will be interpreted based on its magnitude and sign. A positive value indicates that on average basis bids increased from the time the bid was initially posted to the delivery date of the contract, and therefore indicates that the seller (taker of the bid) is paying a risk premium to forward contract. This is a result of accepting a price that is on average lower than what could have been received at the time of delivery if no forward contracting would have been done. The rationale for sellers accepting this risk premium is essentially the selling of price risk to the buyer (export elevator). A negative value for the mean indicates that the buyer (export elevator) is paying a risk premium to forward contract because on average the basis bids decreased from the time the bid was initially posted to the delivery date of the contract. Likewise, this is a result of on average buying at a price higher than what could have been paid at the time of delivery. A potential rationale for this behavior would be an expectation by the export elevators that at a future point demand for exports would exceed supply of grain to New Orleans, and therefore an elevator would pay the risk premium to mitigate the risk of an export shortage.

An analysis of the first differences showed strong evidence of non-normality. The Kolmogorov-Smirnov, Cramer-von Mises, and Anderson-Darling goodness of fit tests for a normal distribution all rejected the null hypothesis of normality at the five percent confidence interval. These test statistics as well as histograms of the first differences for each commodity can be found in Appendix B, along with quantile distributions of the data. This non-normality is a result of a large number of consecutive days having the same bid, creating a difference of zero. As Appendix B shows, for soybeans, wheat, and sorghum, daily changes of zero represents approximately 75% of the observations. This number is closer to 50% for corn. Also, a common feature of the data is a round movement of the basis bid from one day to the next, often changing by five or ten cents per bushel. This suggests that hypothesis testing using standard methods could result in low power, and therefore two non-parametric tests are also used, the sign test and the Wilcoxon signed rank test. Dixon and Mood (1946) suggest using the sign test as an alternative to the t test in the presence of non-normality to determine the significance of the sign of the estimates. Following Wilcoxon (1945), the signed rank test is also provided as a more efficient alternative to the sign test based on its ability to determine significance of magnitude as well as sign.

Results and analysis

The data used for the study, and the results of the models will be discussed individually. Each of the models yielded different results. The results from each model are reported in tables 1 through 4, each reporting estimates for average daily bias, bias over the life of the contract, as well as three tests of significance for the estimates: the Student's T test, sign test, and the Wilcoxon rank sign test. The estimates for bias are reported in basis units (cents per bushel for corn, soybeans, and wheat, and cwt for sorghum).

This study was conducted with data collected from the United States Department of Agriculture (USDA) Agricultural Marketing Service (AMS). The data was extracted from archived daily grain reports, with the sample period being September 28, 2007 through April 8, 2016. Each of these daily reports includes forward bids for four different commodities: soft red winter wheat, corn, soybeans, and grain sorghum. For each commodity, bids are given for five periods beginning with the current month to four months out. These bids are given in the form of basis bids, which is a price relative to a given futures contract price. It should be emphasized the basis data only include bids. Asks or offers are not publicly available for the CIF market and we don't have an historical record of this data. However, it would be reasonable to assume that these offers are highly correlated to bids. A recent sample of Platt's "Daily Grains" report for January 3, 2017, shows that the bid ask spread ranges from 1 to 4 cents/bu for different delivery periods.

Consistent with the body of work on risk premiums involved with the forward contracting of corn (Mallory, Zhao, Irwin, 2015), the means from the model for corn in this study were small over the life of the forward contracts, as table 2 shows. The largest in magnitude, for delivery period 3, is 2.94 cents per bushel over the life of the contract (using the 20 day calendar month outlined above) and neither the sign nor the magnitude of this estimate is significant by the tests provided. The sign test finds the positive value of the estimates for delivery periods 2 and 3 (2.91 and 1.69, respectively) to be significant at the 5% confidence level. The T test and Wilcoxon signed rank test do not find the magnitude of any of the estimates to be significant, however.

The soybean model yielded even smaller estimates for bias over the life of contract in basis bids. As table 3 shows, the largest estimate was 0.61¢ per bushel over 4 months for delivery period 4. This minimal cost is consistent with risk premium estimates for forward contracting soybeans in other markets found by Mallory, Zhao, and Irwin (2015). Like with corn, the small estimates found in soybeans contributes to the lack of any statistical significance with the t test and Wilcoxon signed rank test. The positive sign for delivery period 1 is found to be significant with the sign test at the 5% confidence level, however, the significance of the magnitude of the estimate for the life of the contract (0.29¢ per bushel) cannot be determined using this test.

The model for wheat shows that a small bias does exist for 4 month out contracts (delivery period 4). Table 4 shows that the four month delivery period has a positive bias of 1.08¢ per bushel over the life of the forward contract which the Wilcoxon signed rank test shows to be significant at the 10% confidence level. This suggests that wheat sellers are paying to mitigate price risk through forward contracts with four month out delivery periods. This magnitude of this estimate is smaller than the results found by Brorsen, Coombs, and Anderson (1995), who found a 4¢ per bushel cost to sellers forward contracting wheat using gulf elevator bids. It is also smaller than the results found by Townsend and Brorsen (2000) who found a 6¢ per bushel cost to farmers for forward contracting wheat. Although the signed rank test shows the estimate for delivery period 0 to be significant at the 10% confidence level, this is irrelevant because these contracts can be delivered on immediately. The magnitude of the estimates for the other delivery periods show estimates that fall short of the significance criteria, although the one month out delivery period does show significance at the 15% confidence level using the signed rank test. The sign test indicates that the sign for all of the estimates is significant at the 5% confidence level. In Figure 4, these estimates show little in terms of a trend over time. However, when considering the two statistically significant estimates, delivery period 4 and delivery period 0, a trend does emerge showing a declining cost of forward contracting as the time to maturity decreases. This lends support to the premise that the risk premium is paid to minimize price risk over time, as the risk premium is shown decreasing as the amount of time needing risk protection decreases.

The results from the Sorghum model provides the most evidence of bias in the CIF NOLA export bid market. As Table 5 shows, at the 5% confidence level the estimates for delivery periods one, three, and four show statistically significant positive bias. As discussed previously, this positive bias suggests that sellers of sorghum in this market (bid takers) are paying a risk premium for forward contracting. This is a result of the basis bid decreasing over the life of a forward contract on average. The magnitude of the estimates is also interesting, as the model shows a 14.78¢ per bushel risk premium for forward contracting sorghum over the life of a four month contract (delivery period four, assuming a 20 market day month).

When studied visually in Figure 5, the trend originally seen in Figure 4 is even more evident. By only recognizing the estimates found to be significant by the signed rank test, a clear downward trend emerges showing that the cost of forward contracting sorghum in the CIF NOLA export market decreases as the length of the forward contract decreases. This further supports the premise that the risk premium paid is for mitigating price risk over time.

This consistency of the results of this study with the results of similar studies in different markets lends credence to the relevance of this study to literature on risk premiums associated with forward contracting. Our conclusion that the bias found in CIF NOLA forward bids for corn and soybeans are small and statistically insignificant is consistent with conclusions drawn from Mallory, Zhao, and Irwin (2015), and Lewis, Manfredo, and Sanders (2015) for forward contracting corn and soybeans using local basis bids. However, the results from wheat differ from those found by Townsend and Brorsen (2000), more closely resembling the results found by Brorsen, Anderson, and Coombs (1995) in that a small (about 2¢ per bushel) cost of forward contracting exists for further out delivery periods. Brorsen, Anderson, and Coombs (1995) also used gulf export bids in their estimation, which supports the conclusion that cost of forward contracting in the more liquid CIF NOLA export market are smaller than what is normally expected when forward contracting wheat. We believe that the costs of forward contracting are minimized (and in the case of corn and soybeans removed) by the hybrid forward-futures nature of the CIF NOLA market. The large number of hedgers found on both sides (short and long) of the market and the ability for contracts to be traded multiple times before maturity (delivery) creates efficiency (McKenzie and Holt, 2002).

The results do show large, significant biases in the forward bids for sorghum. The likely cause of the difference in the amount of bias found between the bids for corn, soybeans, and wheat and those for sorghum is the volume of contracts bought and sold of the two groups. In 2016, corn and soybeans accounted for 64.9 million of the 69.4 million metric tons of grain exported from the Mississippi River, while wheat accounted for 3.3 million metric tons and sorghum only accounted for 261,784 metric tons (USDA, 2017). What this suggests is that the market for sorghum is much less liquid than that for corn or soybeans, and to a lesser extent wheat. This lack of liquidity creates an inefficient market which allows one party, in this case the buyer or bidder, to extract a risk premium from the seller or bid taker for assuming the price risk associated with storing grain over time.

An analysis of the variance of the first differences by month reveals that seasonal volatility could be a concern for both corn and soybeans. Appendix C shows that the markets for corn and soybeans are much more volatile during the months of August and September than throughout the rest of the year. However, seasonal volatility is much less noticeable for wheat and sorghum.

Table 2. Bias estimates for Corn in CIF NOLA forward Basis Bids.

			Student's T Test		Sign Test		Wilcoxon Signed Rank Test	
Delivery Period	Average Daily Bias	Bias Over Life of Contract	Statistic	P-Value	Statistic	P-Value	Statistic	P-Value
0	-0.028	-0.03	-0.16	0.8768	32	0.0541	6877	0.4929
1	0.046	0.92	0.30	0.7627	24.5	0.1375	7709.5	0.4239
2	0.073	2.37	0.57	0.5680	38	0.0150	12025.5	0.1501
3	0.028	2.94	0.19	0.8516	42.5	0.0035	10276.5	0.1301
4	-0.053	1.88	-0.46	0.6449	10.5	0.4324	772.5	0.8686

Table 3. Bias estimates for Soybeans in CIF NOLA forward BASIS Bids

			Student's T Test		Sign Test		Wilcoxon Signed Rank Test	
Delivery Period	Average Daily Bias	Bias Over Life of Contract	Statistic	P-Value	Statistic	P-Value	Statistic	P-Value
0	0.069	0.07	0.27	0.7884	16	0.3556	3097.5	0.7761
1	0.015	0.29	0.08	0.9381	39.5	0.0165	2196.5	0.8248
2	-0.001	0.27	-0.01	0.9954	13.5	0.3853	1001.5	0.8970
3	0.012	0.51	0.11	0.9120	16	0.2694	4146	0.5146
4	0.005	0.61	0.05	0.9600	20.5	0.1112	4925.5	0.2801

Table 3. Bias estimates for Wheat in CIF NOLA forward BASIS Bids

			Student's T Test		Sign Test		Wilcoxon Signed Rank Test	
Delivery Period	Average Daily Bias	Bias Over Life of Contract	Statistic	P-Value	Statistic	P-Value	Statistic	P-Value
0	0.096	0.10	0.81	0.4202	29	0.0396	10939	0.0741
1	0.035	0.70	0.29	0.7743	39.5	0.0043	9385	0.1100
2	0.002	0.73	0.01	0.9904	29.5	0.0282	7241	0.1734
3	-0.028	0.18	-0.27	0.7895	30.5	0.0143	5725.5	0.1769
4	0.045	1.08	0.52	0.6056	30	0.0093	5949	0.0777

Table 5. Bias estimates for Sorghum in CIF NOLA forward BASIS Bids

			Student's T Test		Sign Test		Wilcoxon Signed Rank Test	
Delivery Period	Average Daily Bias	Bias Over Life of Contract	Statistic	P-Value	Statistic	P-Value	Statistic	P-Value
0	0.155	0.15	0.94	0.3467	21.5	0.0182	2241	0.1685
1	0.221	4.42	1.42	0.1569	23.5	0.0094	3124.5	0.0521
2	0.078	5.98	0.39	0.7002	18.5	0.0353	2301	0.1107
3	0.204	10.06	1.01	0.3119	19	0.0113	1967	0.0288
4	0.236	14.78	1.24	0.2162	18	0.0032	1239	0.0105

Figure 2. Average bias over life of forward contract, corn.

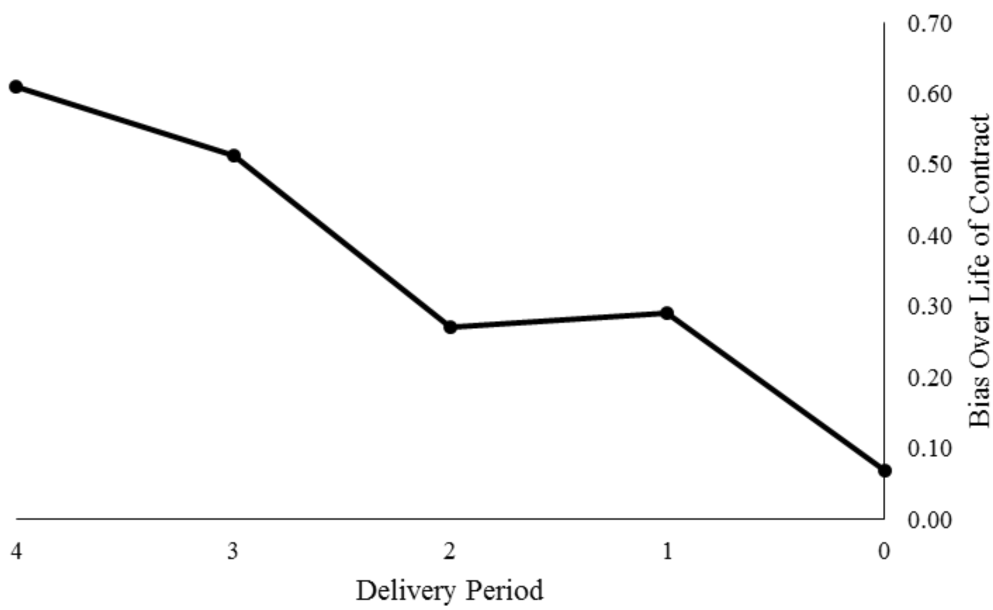

Figure 3. Average bias over life of forward contract, soybeans

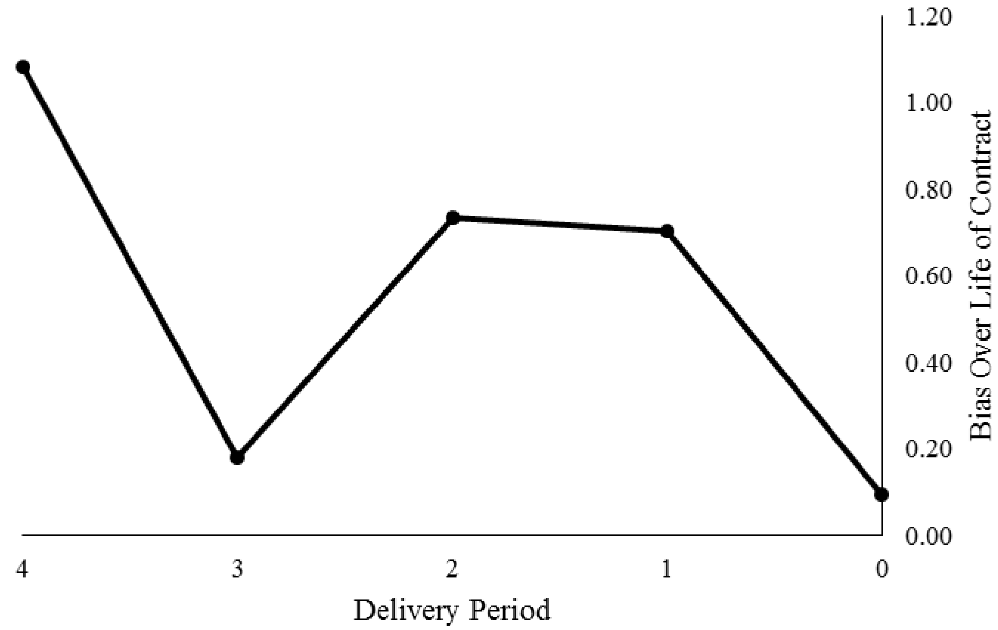

Figure 4. Average bias over life of forward contract, wheat.

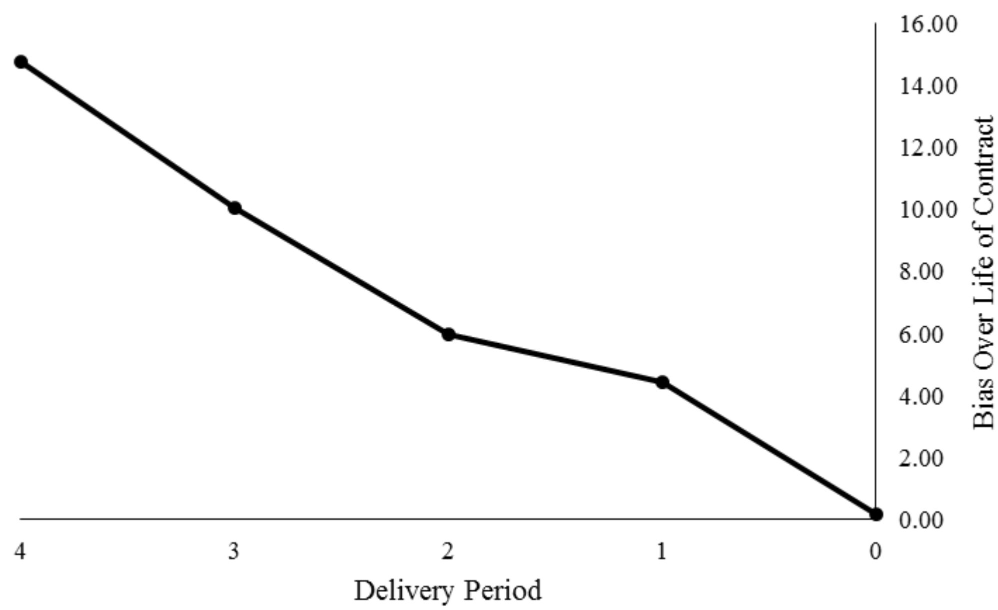

Figure 2. Average bias over life of forward contract, sorghum

Conclusions

This study expands the literature on forward contracting costs of grain to include the CIF NOLA export bid market. The CIF NOLA market, while widely used within the grain export industry, has been only minimally researched academically. Understanding the function of this market as well as determining if any bias exists in the bids posted by export firms within the market is an important first step in building a body of work on the subject, and ultimately increasing the efficiency of the market.

Although this study focuses only on the publicly available basis bids issued by grain buying export firms, another side of the market exists in the form of asking prices from grain sellers. As previously discussed, it is thought that a CIF NOLA forward contract is traded similar to typical futures contract, being bought and sold multiple times before maturity. If the ask prices could be obtained, perhaps from private firms participating in the market, then the standard bid/ask structure typically found in markets would allow a more accurate analysis of the market characteristics to be performed.

The opportunity also exists to expand upon this study by defining the relationship between basis bids given at the Gulf in New Orleans and those given at inland locations along the Mississippi River such as Memphis and Minneapolis. Finding a lagged causal relationship between Gulf bids and inland bids could help explain the behavior grain buying firms and help ensure a more efficient bid structure for buyers and sellers.

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Appendix A. CIF NOLA Daily Report Example

```
BG_GR110
Baton Rouge, LA    Wed  Feb 16, 2011    USDA- LA Dept of Ag Market News

Gulf Export bids and basis for grain delivered to gulf export elevators,
barge to Louisiana Gulf (Mississippi River), prompt or 30 day shipments,
dollar per bushel, except sorghum per cwt.
Bids as of 1:30 Central time; Subject to change.    Sent via Portland

Midday bids and basis for US 2 Soft Red Winter Wheat
Cash Bids                    Change             Basis            Change
Feb=     9.2200  - 9.3300    dn 3.25             +85 H to +96  H unch
Mar=     9.2200  - 9.3300    dn 3.25             +85 H to +96  H unch
Apr=     9.2450  - 9.3450    dn 2.75             +55 K to +65  K unch
May=     9.1950  - 9.2450    dn 2.75             +50 K to +55  K unch
Jun=     9.1875  - 9.2275    dn 2.25             +21 N to +25  N unch

_
Midday bids and basis for US 2 Corn
Cash Bids                    Change             Basis            Change
Feb=     7.4550  - 7.4650    up 2-unch           +55 H to +56  H up 2-unch
Mar=     7.4650              unch                +56 H             unch
Apr=     7.4900  - 7.5000    unch                +48 K to +49  K unch
May=     7.5300  - 7.5400    up 2-unch           +52 K to +53  K up 2-unch
Jun=     7.5850              up 1.25-up 0.25     +54 N             up 1-unch

_
Midday bids and basis for US 1 Yellow Soybeans
Cash Bids                    Change             Basis            Change
Feb=     14.3400 - 14.3600   dn 1-unch           +68 H to +70  H up 1-2
Mar=     14.3100 - 14.3400   unch                +65 H to +68  H up 2
Apr=     14.2850 - 14.3050   dn 2.75-dn 0.75     +50 K to +52  K unch-up 2
May=     14.3150 - 14.3750   dn 1.75-dn 2.75     +53 K to +59  K up 1-unch
Jun=     14.4525 - 14.4725   dn 3.25             +60 N to +62  N unch

_
Midday bids and basis for US 2 Yellow Sorghum
Cash Bids                    Change             Basis            Change
 Feb=     12.3300 - 12.6875   unch                 +0 H to +20  H unch
 Mar=     12.4200 - 12.6875   unch                 +5 H to +20  H unch
 Apr=     12.5175 - 12.8750   unch                 +0 K to +20  K unch
 May=     12.6075 - 12.9650   unch-up 9            +5 K to +25  K unch-up 5
 Jun=     NA                                       NA

 _
 Chicago Board of Trade month symbols: F January, G February, H March, J April,
 K May, M June, N July, Q August, U September, V October, X November, Z December

 Monthly Prices for:           Jan 2011

 US 2 SRW Wheat                8.7200
 US 2 Yellow Corn              6.7300
 US 1 Yellow Soybeans          14.5000
 US 2 Yellow Sorghum           11.9100

 Source:  USDA Market News Service, Portland, OR
          Niki Davila, Market Reporter, 503-326-2237
          www.ams.usda.gov/mnreports/bg_gr110.txt

 11:40    pt        nd
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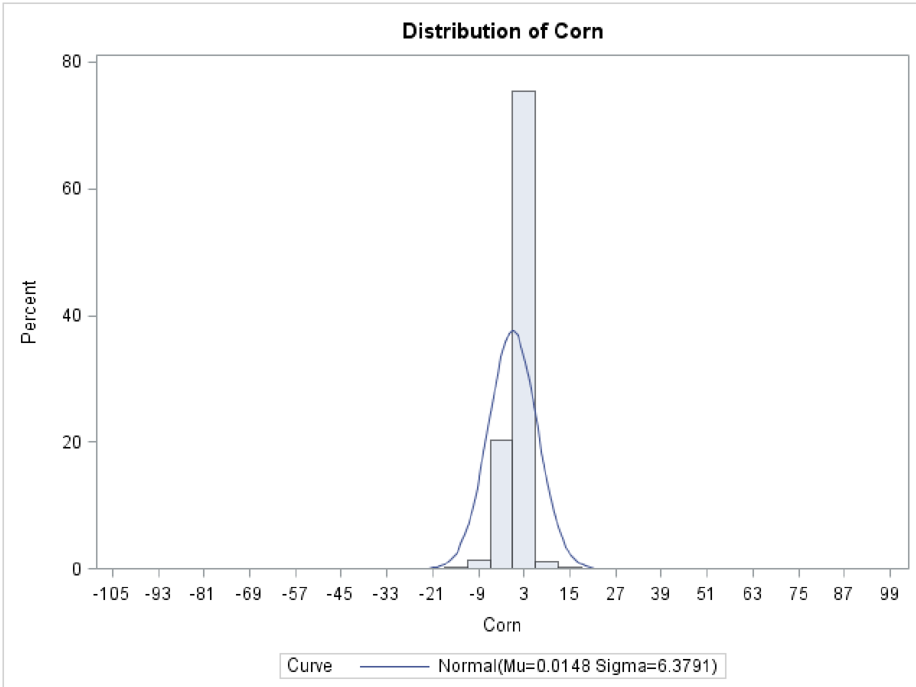
Appendix B. CIF NOLA Bid Data Distributions
Corn

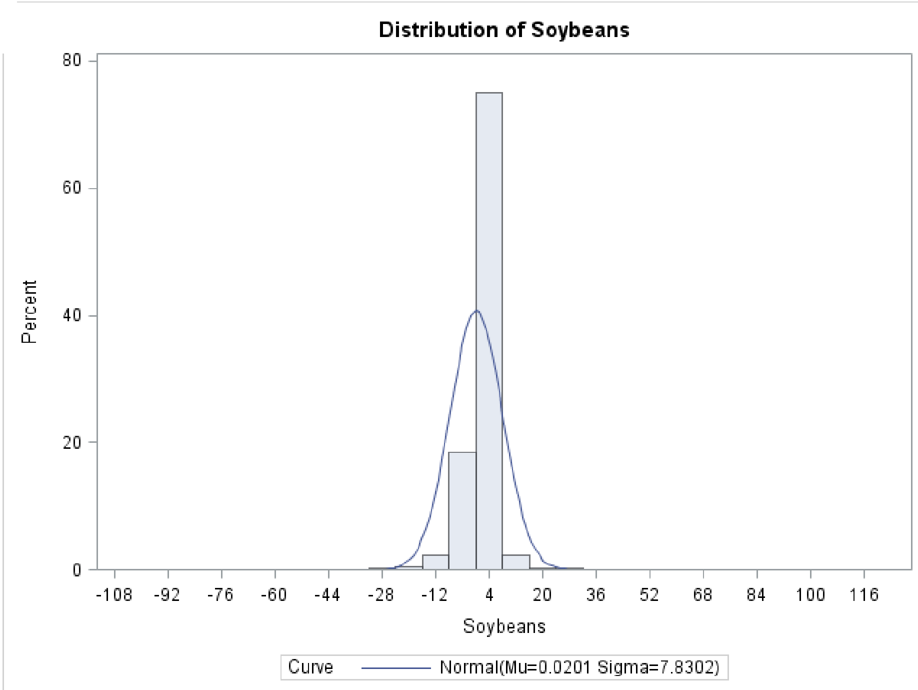


Quantiles N = 9413	
Level	Quantile
100% Max	100
99%	9
95%	3
90%	2
75% Q3	1
50% Median	0
25% Q1	0
10%	-2
5%	-4
1%	-10
0% Min	-104

Goodness-of-Fit Tests for Normal Distribution

Test	**Statistic**		**p Value**	
Kolmogorov-Smirnov	**D**	0.31251	**Pr > D**	<0.010
Cramer-von Mises	**W-Sq**	381.55106	**Pr > W-Sq**	<0.005
Anderson-Darling	**A-Sq**	1884.45602	**Pr > A-Sq**	<0.005

Soybeans

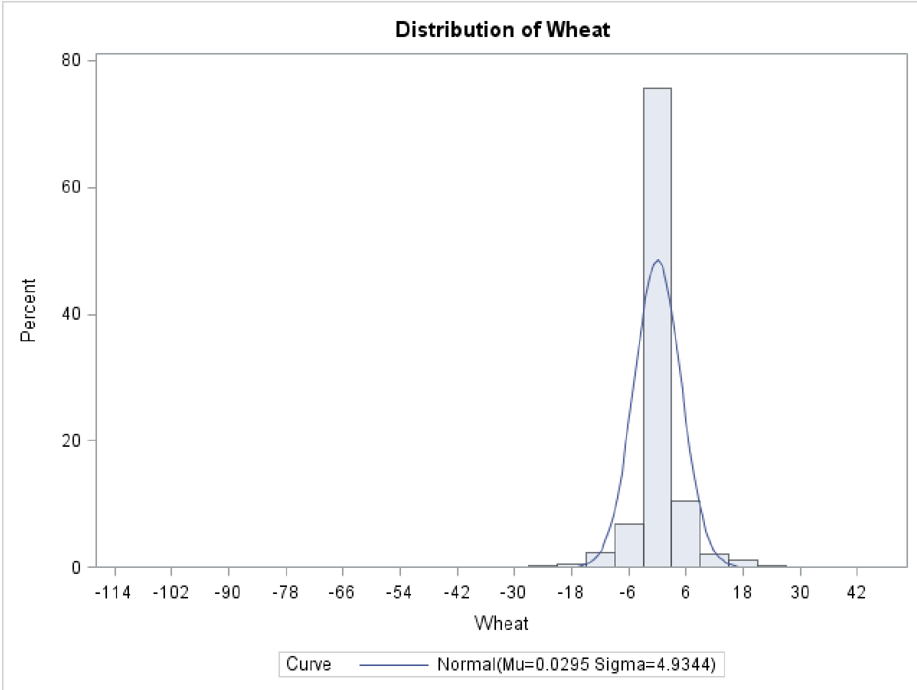


Quantiles N = 9810	
Level	Quantile
100% Max	125
99%	15
95%	5
90%	3
75% Q3	0
50% Median	0
25% Q1	0
10%	-3
5%	-6
1%	-18
0% Min	-106

Goodness-of-Fit Tests for Normal Distribution

Test	**Statistic**		**p Value**	
Kolmogorov-Smirnov	**D**	0.28416	**Pr > D**	<0.010
Cramer-von Mises	**W-Sq**	349.04698	**Pr > W-Sq**	<0.005
Anderson-Darling	**A-Sq**	1697.33712	**Pr > A-Sq**	<0.005

Wheat

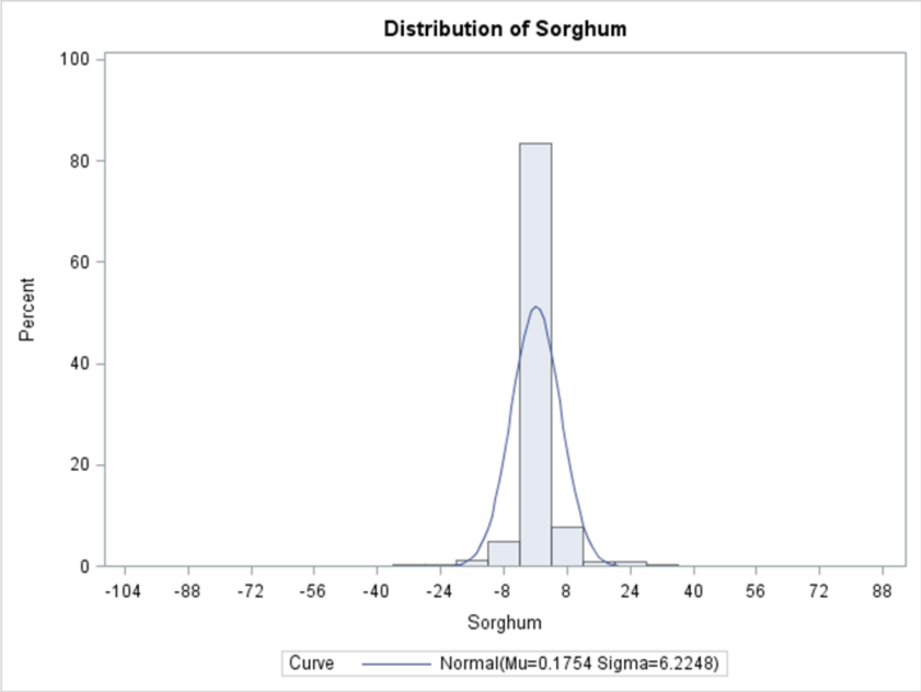


Quantiles N = 9327	
Level	Quantile
100% Max	50
99%	15
95%	5
90%	5
75% Q3	0
50% Median	0
25% Q1	0
10%	-4
5%	-5
1%	-18
0% Min	-115

Goodness-of-Fit Tests for Normal Distribution

Test	**Statistic**		**p Value**	
Kolmogorov-Smirnov	**D**	0.33604	**Pr > D**	<0.010
Cramer-von Mises	**W-Sq**	273.19986	**Pr > W-Sq**	<0.005
Anderson-Darling	**A-Sq**	1251.91926	**Pr > A-Sq**	<0.005

Sorghum



Quantiles N = 5828	
Level	Quantile
100% Max	90
99%	20
95%	5
90%	3
75% Q3	0
50% Median	0
25% Q1	0
10%	0
5%	-5
1%	-20
0% Min	-105

Goodness-of-Fit Tests for Normal Distribution

Test	**Statistic**		**p Value**	
Kolmogorov-Smirnov	**D**	0.39611	**Pr > D**	<0.010
Cramer-von Mises	**W-Sq**	264.11356	**Pr > W-Sq**	<0.005
Anderson-Darling	**A-Sq**	1207.15006	**Pr > A-Sq**	<0.005

Appendix C. Variance by month