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THE COST OF FORWARD CONTRACTING IN THE CIF NOLA EXPORT BID MARKET

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Abstract. The CIF NOLA "river market" represents an important but opaque forward market that serves Gulf exporters and elevators. CIF NOLA bids function similarly 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 grain sellers pay a risk premium for fall harvest delivery contracts. However, outside of fall harvest, contract liquidity, coupled with a good institutional balance of long and short market participants, mostly removes the pricing bias commonly found in farmer forward contracting in corn and soybeans.

Key words. Basis, CIF NOLA, forward contracting, risk premium, river market

JEL Classifications. D80, G13, Q13

1. Introduction

An important price discovery "paper market"[1] exists in the form of CIF NOLA (cost of insurance and freight to the Port of New Orleans) basis export bids issued by U.S. Gulf of Mexico export elevators. In spite of its importance to the U.S. grain industry, this market has received little attention from academic researchers, and the institutional details of the market are not well known outside of its industry users. CIF NOLA is a hybrid forward-futures market, where spot and forward bids for 55,000 bu. contracts of barge-delivered grain are traded. The bids are quoted in terms of basis, defined as cash less futures prices,

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1 The term "paper market" refers to the fact that the CIF NOLA river market does not necessarily require a basis seller to physically deliver grain if a subsequent offsetting bought or long position is taken. In this sense, the CIF NOLA river market is akin to a futures market.

where basis is associated with a specified futures contract month. Grain at the merchandising[2] level is typically traded in terms of basis rather than price as most merchandising firms automatically hedge their grain purchases and sales. Major exporters post bids for these spot and forward contracts to Mississippi River elevators and terminals. However, like a futures market, elevators and terminals can offset their forward contractual obligations by retrading (either selling or buying back initial positions) in a liquid over-the-counter (OTC, off-exchange) paper market. In this article, we test whether a systematic pricing bias that we define as a risk premium[3] exists in the market that creates a forward contracting cost to either party (buyers or sellers).

Prior studies, (e.g., Brorsen, Coombs, and Anderson, 1995; Elam, 1992; Mallory, Zhao, and Irwin, 2015; Miller, 1986; Taylor, Tonsor, and Dhuyvetter, 2014; Townsend and Brorsen, 2000) 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 with elevator spot cash bids, and (2) this cost is lower for shorter forward contract periods. These forward contracting costs are typically attributed to risk premiums associated with risk transference and hedging costs. In grain marketing, these hedging costs include margins, commissions, and administration incurred by elevators who take on the farmers' price risk. 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 or pay risk premiums when hedging with futures contracts. Futures markets allow both buyers and sellers to cheaply offset or retrade 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. Although the market plays the traditional forward contracting role of delivering physical cash grain, the fact that contracts can be retraded 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.

2 The term "merchandising" sector of the grain industry refers to all firms involved in the procurement, storage, and sale of grain. In the CIF NOLA river market, larger grain firms such as Cargill, ADM, Bunge, CHS, and Zennoh can be both buyers and sellers of grain destined for export from the Gulf.

3 There are many factors that influence the cost of forward contracting service, such as counterparty risk and transportation cost risk (Townsend and Brorsen, 2000). However, it is hard to measure these other factors empirically, and we use the terms *risk premium* and *pricing bias* in a general sense to capture these other factors.

In the next section, we provide a description of the institutional details of the CIF NOLA market in terms of its forward contracting and hedging functions. In the Section 3, we review the literature with respect to risk premiums in commodity forward and futures markets. In Section 4, the data and modeling approach are discussed, and in Section 5, empirical results are presented. Section 6 concludes.

2. Institutional Details of CIF NOLA Market

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 6 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 liquid market.

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 that subsequently sell the grain to Gulf exporters. The large grain merchandising firms may also be Gulf exporters and, depending on 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 bu.) to the Port of New Orleans by a specified date, and that the cost of transporting and insuring the cargo 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 bu. of grain on a barge to the Gulf, whereas, 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"[4] to the buyer. Then the seller "releases"[5] the barge to a barge line (a firm that owns

4 To "apply a barge" refers to the process by which a firm selling a barge load of grain contacts the firm buying the barge load of grain to provide it with the contractual details concerning contract number, barge number, loading port, number of bushels, grain grades, and the barge line used for transportation.

5 When a barge is "released," this means that the firm selling grain contracts with a barge line to transport the grain.

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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 prices of CIF NOLA contracts are determined through the traditional bid/ask system where sellers of grain ask for a certain basis (Gulf cash price relative to a futures price), and export elevators bid a certain basis, 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 preharvest grain for harvest delivery. As noted previously, 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 river market may also contain risk premiums. In this case, grain exporting firms that purchase grain on CIF NOLA may require a similar risk premium from firms selling grain for Gulf delivery. Specifically, if sellers pay a risk premium, forward CIF NOLA bids would be lower on average than the associated CIF NOLA spot bids for the same delivery date. Akin to the farmer-elevator case, the longer the forward delivery bid, the higher the risk premium and the lower the CIF NOLA bid.

Although Nelson (1985) stresses the importance of differentiating forward and futures contracts, the CIF NOLA forward market draws characteristics from both, given its role as a "paper hedging market" akin to an exchange traded futures market. Therefore, it is not clear that the CIF NOLA market should contain risk premiums, as hedgers are able to take both long and short positions. Importantly, because CIF brokers provide an 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. Firms may also use the CIF contract to conduct speculative basis trading.

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 bu. 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.

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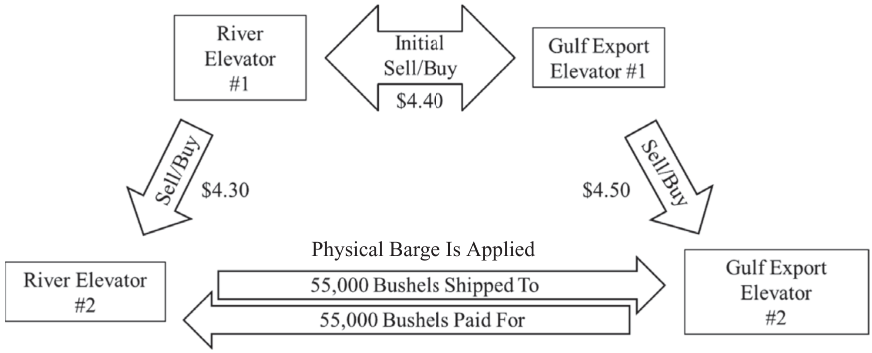

	River Elevator #1	Gulf Export Elevator #1	River Elevator #2	Gulf Export Elevator #2
Buy	+30 Dec	+40 Dec		$4.50 +50 Dec
Sell	+40 Dec	+50 Dec	$4.30 +30 Dec	
Receipts			$236,500	
(Payments)				($247,500)
Net profit (loss)	$5,500	$5,500	$236,500	($247,500)

Note that prices and basis are included in the table to determine the dollar payments and receipts associated with firms that participate in the final physical delivery process.

Figure 1. CIF NOLA (cost of insurance and freight to the Port of New Orleans) Market Example

However, similar to an exchange traded futures contract, either the initial seller or buyer can remove its 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. It is not uncommon to have a single 55,000 bu. barge contract that trades more than 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 in Figure 1, there can be many more firms or agents involved in the paper chain of a CIF NOLA transaction. The numerical

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example in Figure 1, which shows the mechanics of a specific trade, is explained in detail in the Appendix.

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. Each buyer in the chain calls its respective seller in the chain, and money is passed along the chain by wire transfer. 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 river 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 premiums. 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 a specific example. 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 the 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 on 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 the CIF NOLA market. This is referred to "FOBing" bids in the grain industry, where FOB is the 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 spot cash market and/or there are no firms willing to buy grain from the elevator at forward delivery periods. If the CIF NOLA market spikes up because of higher export demand, even if the Missouri-based elevator does not physically trade the river market, it can use the CIF NOLA market to make a "paper sale" of grain and lock in a relatively high sell basis for a forward delivery period. This lock-in sell basis is defined as

$$\begin{aligned} Lock\ in\ sell\ basis_{i,t}^{t+n} &= CIF\ basis_t^{t+n} \\ &\quad + E_t^{t+n}\left(Local\ futures\ basis_{i,\ t+n} - CIF\ basis_{t+n}\right). \end{aligned}$$

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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 NOLA basis bid posted in the current time period, t, for the future period, $t+n$, plus the expectation of what the difference between commodities futures basis for the local market, i, and the CIF NOLA basis spot bid will be at future period $t+n$. Locking in a sell basis is analogous to the process a farmer would undertake when hedging preharvest using futures contracts to lock in a sell price. For this example, however, the role of a futures contract is replaced by CIF NOLA forward basis bids. 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. From an academic perspective, 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. McKenzie (2005) found that Gulf basis bids for soybeans are positively correlated with inland soybean basis levels, specifically basis levels in Memphis and Little Rock. 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, and one would expect the CIF NOLA market to provide a useful hedging tool for inland elevators as well as Gulf exporters.

Therefore, in a similar vein to a farmer using the futures market to make a profitable sale of grain through short hedging, the Missouri-based elevator in our example can use the CIF NOLA paper market to hedge the profitable basis sale. The elevator will initially sell at a relatively high post demand shock basis level in the CIF NOLA market with no intention to physically deliver grain by barge to the Gulf. Instead, the elevator will buy the CIF NOLA basis back at a later date when it sells grain in its local market and the difference between the local basis and CIF NOLA basis has returned to a normal preshock level.

3. Risk Premiums in Commodity Forward and Futures Markets

There has been a sizable body of work investigating the costs—in the form of risk premiums—associated with using various types of futures markets and forward contracts in agriculture. The consensus result with respect to liquid commodity futures markets is that risk premiums do not exist, at least not in grain markets. For example, McKenzie and Holt (2002) analyzed the efficiency of live cattle, hog, corn, and soybean meal futures. They determined that although short-run inefficiencies and pricing biases do exist in live cattle, hogs, and corn futures contracts, in the long run grain futures contracts provide unbiased estimates of subsequent spot cash prices and contain no inherent risk premiums. In addition, 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. An exception is Kolb (1992) who found risk premiums in livestock

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markets. The recent explosion in long-only index funds is an effort to capture risk premiums, but Main et al. (2016) find that the disappointing returns of index funds is because of the lack of any substantial risk premium.

In contrast, with respect to farmer forward contracting markets, there is considerable evidence of risk premiums. 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. Townsend and Brorsen (2000) found that Oklahoma farmers forward contracting wheat 100 days preharvest using local elevator bids paid a risk premium of 6¢/bu. for the service. Brorsen, Coombs, and Anderson (1995) found that forward contracting wheat using Gulf forward basis bids 4 months out incurs an average cost of 4¢/bu. In a similar vein, Mallory, Etienne, and Irwin (2012) and Mallory, Zhao, and Irwin (2015) found significant risk premiums associated with farmer-elevator forward contracting of corn and soybeans. The general consensus of the two studies was that postharvest forward contract risk premiums of 2¢/bu. and 6¢/bu. for corn and soybeans, respectively, were documented, whereas preharvest forward contracting costs were 8¢/bu. higher than postharvest premiums.

However, little research has focused attention on forward contract markets beyond the farm level. One such article by Lewis et al. (2015) analyzed forward asks (or offers) given by soybean oil processors to end users purchasing soybean oil. In this sense, their study is closer in design to our study. However, the CIF NOLA market is inherently different as market players can be both buyers and sellers and the hybrid nature of the market allows market players to use it as a hedging vehicle as well as a grain delivery mechanism. Interestingly, Lewis et al. (2015) found that soybean oil processors do not embed a risk premium in their forward bids for soybeans.

4. Data and Modeling Approach

Following Townsend and Brorsen (2000), the costs of forward contracting in the CIF NOLA river market are estimated by a parametric model using first differences. The cost of forward contracting may be written as

$$r(t) = E_t[B(0)] - B(t), \tag{1}$$

where $E_t[B(0)]$ is the expected basis bid for delivery at time 0[6] and that is observed t days prior to delivery, and $B(t)$ is the forward basis bid t days from delivery.

Then assuming a linear functional form $r(t) \equiv a_0 - a_1 t$ for the cost of forward contracting, we estimate the forward contracting cost of using the CIF NOLA

6 It should be noted that we do not observe the terminal basis number at time period 0 in our data. The U.S. Department of Agriculture daily basis bids are only for forward delivery periods.

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market using a first differences model:

$$B(t-1) - B(t) = a_1 + E_{t-1}[B(0)] - E_t[B(0)], \quad (2)$$

where $B(t-1) - B(t)$ represents the difference between a CIF NOLA forward basis bid t – 1 days from delivery and the CIF forward basis bid from the preceding day, a_1 is a constant term representing the cost of forward contracting, and $E_{t-1}[B(0)] - E_t[B(0)]$ is the difference between the expected value of basis at the specified delivery time on day t – 1 and day t. Because the expected value of $E_{t-1}[B(0)]$ is formed using the information set available on day t, $E_{t-1}[B(0)] = E_t[B(0)]$. Therefore, $E_{t-1}[B(0)] - E_t[B(0)]$ has a zero mean and is treated as an error term in our empirical estimation. The change in a forward bid from period t to period t – 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 in the form of a risk premium. A positive value would indicate a cost to sellers, whereas a negative cost would indicate a cost to buyers. In other words, a positive risk premium indicates that sellers receive a lower forward contract price in comparison with delivery time prices. We also account for seasonality by separating our data by delivery date into three distinct seasons prior to estimating the first differences model in equation (2). To determine the statistical significance of the mean, two statistical tests are used: Student's t-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 calculate monthly average forward contracting costs over each successive month during the life of a given CIF NOLA forward contract.

The data consist of daily U.S. Department of Agriculture (USDA) Agricultural Marketing Service Gulf export basis bids for corn, soybeans, soft red winter wheat, and sorghum delivered to New Orleans. For each commodity, bids are recorded for five delivery periods: spot price or immediate delivery (0), 1 month out (1), 2 months out (2), 3 months out (3), and 4 months out (4). The publicly available USDA data set consists of 2,115 daily reports from September 28, 2007, to April 13, 2016. The quotes are for a specific quality such as U.S. No. 2 yellow corn, and thus basis variations because of quality differences such as that found by Bekkerman, Brester, and Taylor (2016) are not a concern here.

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 4 months out. These bids are basis bids, which is a price relative to a given futures contract price. The basis data only include bids. Asks or offers are not publicly available for the CIF NOLA market, and we do not have a historical record of these data. However, it would be reasonable to assume that these offers are highly correlated to bids. A recent sample of the Platts "Daily Grains" report for

Table 1. CIF NOLA (cost of insurance and freight to the Port of New Orleans) Forward Basis Bid-Ask Spreads by Commodity (corn, soybeans, and wheat [¢/bu.] and sorghum [¢/cwt.])

	Corn	Soybeans	Wheat	Sorghum
Average	3	6	12	13
Standard deviation	2	3	5	10
Maximum	10	10	20	30
Minimum	1	1	4	5

January 3, 2017, shows that the bid-ask spread ranges from 1¢/bu. to 4 ¢/bu. for different delivery periods (S&P Global Platts, 2017). We present summary statistics in Table 1 of the limited data available to us on the bid-ask spreads by commodity. Our bid-ask data are taken from 6 Scoular bid sheets dated over the last 2 years that are circulated internally on a daily basis among key employees who trade the river market. These data are proprietary, but bid-ask prices can also be observed from the Platts pricing newsletter, which is available through the Platts subscription service on its website (https://www.spglobal.com/platts/en/products-services/agriculture/daily-grains). Our Scoular data are consistent with the Platts numbers for bid-ask spreads over a similar time period. Typical corn bid-ask spreads are about 3¢/bu. (widest 10¢); soybean spreads are about 6¢/bu. (widest 10¢); wheat spreads are about 12¢/bu. (widest 20¢); and sorghum spreads, if they exist, can be very wide—up to 30¢/cwt. (average 13¢/cwt.). The relatively wider sorghum spreads are indicative of a much thinner market in comparison with corn, soybeans, and to a lesser extent wheat. These bid-ask spreads are much wider than the 0.25¢/bu. commonly seen in grain futures markets (Shah, Brorsen, and Anderson, 2012).

First, we transform the USDA data by differencing. Specifically, the high basis bid from the previous day is subtracted from the high basis bid of the current day. We elected to use the high bid because it is the price at which a market order to sell would be filled. 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. Then, we separate the data by terminal delivery date and commodity for three seasons. For corn, soybeans, and sorghum, season 1 (postharvest) comprises December, January, February, and March; season 2 includes April, May, June, and July; and season 3 (harvest time) encompasses August, September, October, and November. With respect to wheat, season 1 comprises February, March, April, and May; season 2 (harvest time) includes June, July, August, and September; and season 3 encompasses October, November, December, and January. The mean of basis difference is then found by commodity, season, and delivery period. The reports that comprise the data set used are issued daily for every weekday (5 days each week), and we assume a standard 4-week month, resulting in a 20-market-day month. In order

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to extrapolate the daily bias estimates to monthly bias estimates over the life of each contract, the daily bias estimate for each delivery period is multiplied by 20 to find the average monthly bias for each delivery period. This means that the total bias or risk premium for the life of a contract would include all of the monthly biases over the contract's life. The daily mean of basis difference is interpreted based on its magnitude and sign. A positive value indicates that the seller (taker of the bid) is paying a risk premium to forward contract. Conversely, a negative value for the mean indicates that the buyer (export elevator) is paying a risk premium.

An analysis of the first differences showed strong evidence of nonnormality. 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 5% significance level.[7] This nonnormality is a result of a large number of consecutive days having the same bid, creating a difference of zero. With respect to soybeans, wheat, and sorghum, daily changes of zero represent 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 5¢/bu. or 10¢/bu. This suggests that hypothesis testing using standard methods could result in lower power, and therefore, we also analyze the data using a nonparametric test: the Wilcoxon signed rank test.

5. Results

The main empirical results for each commodity by season and delivery period are reported in Tables 2 through 5 and include estimates of average daily bias or risk premium, the average monthly bias or risk premium over the life of the contract, and two statistical tests—one parametric and one nonparametric—for the average daily estimates: the Student's *t*-test and the Wilcoxon signed-rank test. Our bias or risk premium estimates are reported in basis units (cents per bushel for corn, soybeans, and wheat, and cents per hundredweight for sorghum).

The most notable feature of our results is evidence of a positive risk premium for all commodities during season 3. This corresponds to the fall harvest delivery period for corn, soybeans, and sorghum. This evidence is based on the Wilcoxon signed-rank tests at the 5% significance level. First, with respect to corn and soybeans, the 3- and 4-month-out forward contract estimates presented in Tables 2 and 3 show a positive monthly risk premium of 4.36¢/bu. and 6.15¢/bu., respectively. These results are consistent–at least in terms of risk premium size–with the body of work on farmer forward contracting (Mallory, Zhao and Irwin, 2015), which highlighted evidence of relatively large risk premiums with respect to preharvest corn and soybean forward contracts. Also, analogous to farmer

7 These test statistics as well as histograms of the first differences for each commodity along with quantile distributions of the data are available from the author(s) upon request.

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Table 2. Risk Premium/Bias Estimates for Corn in CIF NOLA (cost of insurance and freight to the Port of New Orleans) Forward Basis Bids (¢/bu.)

				Student's *t*-Test		Wilcoxon Signed-Rank Test	
Corn Delivery Period	Season	Average Daily Bias	Average Monthly Bias	Statistic	*P* Value	Statistic	*P* Value
0	1	0.168	0.17	− 0.86	0.39	− 653	0.75
1	1	− 0.087	− 1.74	− 1.07	0.29	− 254.5	0.90
2	1	− 0.061	− 1.22	− 0.74	0.46	− 398	0.83
3	1	− 0.119	− 2.38	− 1.47	0.14	− 1,380.5	0.30
4	1	− 0.049	− 0.98	− 0.68	0.49	− 620	0.56
0	2	− 0.139	− 0.14	− 0.27	0.79	915.5	0.62
1	2	0.008	0.16	0.07	0.94	116.5	0.53
2	2	0.048	0.96	0.45	0.66	1882	0.22
3	2	0.006	0.12	0.07	0.94	1,854.5	0.21
4	2	− 0.060	− 1.2	− 1.05	0.30	− 523.5	0.56
0	3	0.149	0.15	0.83	0.41	1,843	0.32
1	3	0.229	4.58	0.51	0.61	1,533.5	0.37
2	3	0.253	5.06	0.66	0.51	2,161	0.14
3	3	0.218	4.36*	0.46	0.65	2,681.5	0.02
4	3	− 0.049	− 0.98	− 0.14	0.89	935	0.23

Note: Asterisk (*) represents statistical significance at the 5% level.

Table 3. Risk Premium/Bias Estimates for Soybeans in CIF NOLA (cost of insurance and freight to the Port of New Orleans) Forward Basis Bids (¢/bu.)

				Student's *t*-Test		Wilcoxon Signed-Rank Test	
Soybeans Delivery Period	Season	Average Daily Bias	Average Monthly Bias	Statistic	*P* Value	Statistic	*P* Value
0	1	− 0.036	− 0.72	− 0.13	0.90	149	0.94
1	1	− 0.204	− 4.08	− 0.98	0.33	− 1,585	0.41
2	1	− 0.171	− 3.42	− 0.66	0.51	− 1,216	0.45
3	1	− 0.192	− 3.84	− 1.64	0.10	− 1,941	0.17
4	1	− 0.163	− 3.26	− 0.82	0.41	− 448	0.67
0	2	0.351	0.35	0.77	0.44	1,461	0.46
1	2	0.033	0.66	0.15	0.88	1,636	0.39
2	2	0.010	0.20	0.08	0.94	− 83	0.95
3	2	0.034	0.68	0.30	0.77	584	0.58
4	2	− 0.110	− 2.20	− 1.00	0.32	2	1.00
0	3	− 0.100	− 0.10	− 0.18	0.86	− 624	0.77
1	3	0.220	4.40	0.46	0.65	572	0.77
2	3	0.170	3.40	0.38	0.70	1,209	0.41
3	3	0.205	4.10	0.70	0.49	2,017	0.10
4	3	0.308	6.15*	1.65	0.10	2,097	0.03

Note: Asterisk (*) represents statistical significance at the 5% level.

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Table 4. Risk Premium/Bias Estimates for Wheat in CIF NOLA (cost of insurance and freight to the Port of New Orleans) Forward Basis Bids (¢/bu.)

				Student's *t*-Test		Wilcoxon Signed-Rank Test	
Wheat Delivery Period	Season	Average Daily Bias	Average Monthly Bias	Statistic	*P* Value	Statistic	*P* Value
0	1	– 0.185	– 3.70	– 1.09	0.27	– 681	0.56
1	1	– 0.089	– 1.78	– 0.51	0.61	611	0.57
2	1	– 0.234	– 4.68	– 0.98	0.33	– 124	0.90
3	1	– 0.104	– 2.08	– 0.51	0.61	729	0.35
4	1	0.046	0.92	0.35	0.73	828	0.15
0	2	0.086	0.09	0.34	0.73	1,256	0.33
1	2	– 0.109	– 2.18	– 0.43	0.66	– 17	0.99
2	2	– 0.073	– 1.46	– 0.35	0.73	906	0.46
3	2	– 0.107	– 2.14	– 0.63	0.53	722	0.51
4	2	0.020	0.40	0.13	0.90	816	0.31
0	3	0.365	0.37*	1.88	0.06	2,897	0.01
1	3	0.292	5.84*	1.42	0.16	1,445	0.02
2	3	0.314	6.28	1.44	0.15	1,559	0.10
3	3	0.138	2.76	0.87	0.39	501	0.41
4	3	0.069	1.38	0.41	0.68	327	0.58

Note: Asterisk (*) represents statistical significance at the 5% level.

forward contracting risk premiums, the positive risk premiums in our results are a cost to sellers of grain that is extracted by grain buyers. In our case, the sellers are inland grain elevators, and the buyers are Gulf exporters.

Similarly, we find a positive season 3 risk premium for wheat, although for shorter (1 month out and immediate delivery) contracts. Table 4 shows that the 1-month delivery period has a positive monthly bias of 5.84¢/bu. The estimate for immediate delivery is relatively small at 0.37¢/bu., which would be indicative of a short-term risk premium as these contracts can be delivered on immediately. Interestingly, these results show that the wheat risk premium is not related to the wheat harvest, which corresponds to June and July during season 2. In terms of magnitude, our risk premium results are consistent with the results reported by Brorsen, Coombs, and Anderson (1995), who found a 4¢/bu. cost to sellers for forward contracting wheat using Gulf elevator bids. In this sense, our wheat results are also in line with the results found by Townsend and Brorsen (2000), who found a 6¢/bu. cost to farmers for forward contracting wheat. However, the wheat risk premiums found in these earlier studies corresponded to forward contracting for harvest delivery periods. In contrast, we find no evidence of risk premiums associated with wheat harvest delivery.

Results presented in Table 5 indicate that sorghum has the largest significantly positive harvest delivery risk premium. As Table 5 shows, at the 5% confidence level the estimates for delivery periods 4 and 3 show statistically significant

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Table 5. Risk Premium/Bias Estimates for Sorghum in CIF NOLA (cost of insurance and freight to the Port of New Orleans) Forward Basis Bids (¢/cwt.)

				Student's *t*-Test		Wilcoxon Signed-Rank Test	
Sorghum Delivery Period	Season	Average Daily Bias	Average Monthly Bias	Statistic	*P* Value	Statistic	*P* Value
0	1	0.180	0.18	0.84	0.40	296	0.33
1	1	0.329	6.58	1.74	0.08	368	0.15
2	1	0.257	5.14	0.74	0.46	451	0.15
3	1	0.120	2.40	0.29	0.77	72	0.73
4	1	– 0.051	– 1.02	– 0.12	0.91	32	0.83
0	2	0.008	0.01	0.03	0.98	85	0.34
1	2	– 0.123	– 2.46	– 0.50	0.62	– 3	0.98
2	2	– 0.007	– 0.14	– 0.02	0.98	25	0.57
3	2	0.208	4.16	0.57	0.57	28	0.34
4	2	0.286	5.72	0.97	0.33	4	0.50
0	3	0.196	0.20	0.64	0.52	446	0.48
1	3	0.254	5.08	0.89	0.37	959	0.13
2	3	– 0.054	– 1.08	– 0.18	0.86	446	0.45
3	3	0.268	5.36*	1.11	0.27	834	0.02
4	3	0.453	9.06*	2.67	0.01	617	0.00

Note: Asterisk (*) represents statistical significance at the 5% level.

positive risk premiums. This represents a combined risk premium of 14.42¢/cwt. for forward contracting sorghum 3 to 4 months prior to the harvest period. This is a very large risk premium compared with the findings of prior research in other commodity forward markets. We hypothesize that this may be attributed to the relatively illiquid nature of the CIF NOLA forward market in sorghum.

In sum, our season 3 results show that the CIF NOLA market prices risk with respect to corn, soybean, wheat, and sorghum fall harvest delivery contracts. Also, with the exception of wheat, the risk premiums occur in the longer delivery periods. As discussed previously, evidence of a positive bias or risk premium suggests that grain sellers in this market (bid takers) pay a risk premium for forward contracting. This is a result of the basis bid on average decreasing over the life of a forward contract. Our results reveal that Gulf export elevators extract a risk premium from elevators delivering all four commodities to the Gulf, with the largest risk premiums associated with sorghum. Also it is particularly interesting to note that the wheat risk premium appears to be unrelated to its own harvest time (season 2) but instead is a feature of season 3 deliveries. One potential explanation for the season 3 risk premiums with respect to corn, soybeans, and sorghum is that there is a large downside basis risk prior to harvest time in anticipation of potentially large harvests. This potential risk could be priced into forward contracts by Gulf exporters in a similar vein to elevators extracting risk premiums from farmers to mitigate downside price risk

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in harvest cash bids. In addition, we argue that the season 3 risk premiums across commodities are likely driven by storage space and storage costs. At the peak of fall harvest, elevator storage space is often limited and has an implicitly high cost. In this case, there is an incentive for sellers or Mississippi River elevators to be active sellers of CIF NOLA forward contracts prior to harvest so that grain can be transported to the Gulf in a timely manner freeing up valuable storage space. Given that both grain sellers and buyers in the CIF NOLA market are likely aware of this phenomenon, it is possible that the implicit fall harvest storage space cost is priced into the forward contracts for all four commodities.

Finally, turning to results with respect to seasons 1 and 2, we find a very different risk premium picture. We find relatively small and statistically insignificant risk premiums for all four commodities. These results stand in stark contrast to the body of work on farmer forward contracting (e.g., Mallory, Zhao, and Irwin, 2015), which highlighted evidence of risk premiums with respect to both pre- and postharvest corn and soybean forward contracts. Interestingly, we do note what appears to be a consistent pattern of negative risk premiums for corn, soybeans, and wheat during season 1 across delivery periods, which would be indicative of a reversal of the harvest delivery premiums. In this instance, Gulf exporters would pay the premium. Although these negative risk premiums are not statistically significant using either the Wilcoxon signed-rank tests or *t*-tests, they are larger in absolute size than premiums observed during season 2. Also, we note that sorghum risk premiums are generally larger in absolute terms across all seasons but do not appear to have a consistent pattern with respect to sign. Therefore, we infer that although there is no evidence of a consistent risk premium or pricing bias in this market, sorghum forward contract bids provide relatively noisy forecasts of delivery time bids. This pricing behavior is indicative of a thinly traded market with low levels of liquidity.

6. Conclusions

Our study extends the literature on forward contracting costs of grain to include the CIF NOLA export bid market. Although the CIF NOLA market plays a vital role in U.S. grain export markets, its institutional details are somewhat opaque to all but a few grain firms. We explain how the market is used by industry players to physically deliver grain and hedge grain positions.

We find evidence of significantly positive risk premiums in forward contracts for all commodities for fall harvest delivery. We attribute these risk premiums to basis risk for corn, soybeans, and sorghum and to fall harvest storage costs for all four commodities. The positive risk premiums imply that Gulf exporters, the buyers in this market, extract a fall harvest risk premium from the sellers, who are typically Mississippi River elevators. The largest fall harvest risk premiums are a feature of the relatively illiquid forward bids for sorghum. In 2016, corn and soybeans accounted for 64.9 million of the 69.4 million metric tons of grain exported from the Mississippi River, whereas wheat accounted for 3.3 million metric tons, and sorghum only accounted for 261,784 metric tons (USDA, 2017). We surmise that the lack of liquidity in the sorghum CIF NOLA market may be a contributing factor as to why the fall harvest risk premiums are largest in this market. Lower liquidity leads to greater market risk and inefficiency, which in turn 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 and transporting grain over time. In sum, our results show that the important basis trading and hedging functions offered by the CIF NOLA market do come at a forward pricing cost for gain sellers using fall harvest delivery contracts.

In contrast to farmer forward contracting markets, we find no evidence of risk premiums for any of the commodities outside of fall harvest delivery. Forward contracting costs during these periods for corn, soybeans, and wheat may be limited by the hybrid forward-futures nature of the CIF NOLA market. The large number of hedgers on both sides (short and long) of the market and the ability for contracts to be traded multiple times before maturity (delivery) may create efficiency and eliminates systematic biases or risk premiums akin to liquid exchange traded commodity futures markets. However, our bid-ask spread results show that liquidity costs are still much higher than in comparative commodity futures markets. Our results with respect to delivery periods outside of fall harvest are consistent with Lewis et al. (2015) who also found no evidence of embedded risk premiums in commodity forward contracts beyond the farm level.

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Appendix

We assume that initially river elevator 1 has purchased 55,000 bu. of corn from farmers at an average cash price of $3.90/bu. and sold 55,000 bu. of December futures at $4.00/bu. to hedge the purchase, yielding an average buy basis of −10 December (or 10¢ under December futures). River elevator 1 subsequently sells one CIF NOLA contract to Gulf export elevator 1 at a +40 December basis level assuming a Gulf-delivered cash price of $4.40/bu. and a December futures price of $4.00/bu. It is common for CIF NOLA basis bids to be positive, with cash prices above futures prices reflecting higher prices for grain at the Gulf. In this case, river elevator 1 will earn a 50¢/bu. gross margin prior to accounting for storage and transaction costs on the trade and, at this point, is obligated to deliver the corn to the Gulf before the end of the December delivery period. However, prior to delivery time, river elevator 1 offsets its delivery obligation by buying an equivalent CIF NOLA contract from river elevator 2 at a +30 December basis level assuming a Gulf-delivered cash price of $4.30/bu. and again a December futures price of $4.00/bu. The physical delivery obligation now resides with elevator 2, and river elevator 1 earns an additional 10¢/bu. margin from the fall in the basis. Similarly, in our example, the obligation to accept physical delivery of corn is passed on from Gulf export elevator 1 to Gulf export elevator 2. In this case, Gulf export elevator 1 sells a CIF NOLA contract to Gulf export elevator 2 at a +50 December basis level assuming a Gulf-delivered cash price of $4.50/bu. and again a December futures price of $4.00/bu. This transaction would yield Gulf export elevator 1 a 10¢/bu. gross margin earned though a 10¢ appreciation of Gulf basis. If the chain of transactions ends here, then river elevator 2 will deliver corn to Gulf export elevator 2. Note that the payments and receipts shown in the table in Figure 1 for river elevator 2 reflect the sell price of $4.30 multiplied by the 55,000 bu. specified in a CIF NOLA contract. River elevator 2 would have purchased the 55,000 bu. 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 reflects a $4.50 buy price multiplied by 55,000 bu. 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.