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The Cost of Forward Contracting in Mississippi River Barge Freight and CIF NOLA Markets

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The Cost of Forward Contracting in Mississippi River Barge Freight and CIF NOLA Markets

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Abstract

Grain elevators often use paper markets to mitigate the risk of (or hedge) their cash grain positions, as well as establish a profit margin through basis trading. Typically, merchandisers use futures or forward contracts to perform these transactions. However, in order to liquidate a cash grain position, grain transportation must be arranged in order to deliver the grain to the buyer. For elevators located along the Mississippi River system selling to Gulf export elevators in New Orleans, that mode of grain transportation is most likely river barge. Contracts for barges are bought and sold by grain merchants either directly with barge lines or through private brokers, and barge contract freight rates fluctuate daily based on supply and demand. Many elevators attempt to mitigate barge freight price risk by forward contracting barges. Unlike typical forward contracts, however, these barge contracts are for the purchase of a service, grain transportation, rather than a commodity such as the grain itself. The question that this study seeks to answer is whether a systematic pricing bias exists in this market that creates a forward contracting cost to either party (buyers or sellers). Results show that a cost of forward contracting barge freight exists at three months out, but the magnitude and the party incurring the cost varies by season.

An additional important price discovery and risk management "paper market" also exists in the form of CIF NOLA (cost of insurance and freight, to port of New Orleans) 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, coupled with a good institutional balance of long and short market participants mostly removes the pricing bias commonly found in forward contracting in corn and soybeans, although a small risk premium still exists in wheat and especially sorghum.

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I. Introduction

Grain firms located on or near the Mississippi River or its navigable tributaries often use the demand for grain exports from the port of New Orleans as a buyer for their grain, and use the river system as a means of transportation for that grain to the port. Grain export firms typically buy grain by the barge load, and likewise, river transportation is based on barge loads of grain. The typical river barge holds approximately 55,000 bushels of grain, which is a relatively large amount compared to other forms of grain transportation. Because of the large scale of sales and freight contracts in this river market, the number of firms involved is significantly smaller than the number of firms that compete in other forward grain markets, such as commodity futures markets. Likewise, the number of individuals with first-knowledge and experience in using this market is also small. This dynamic has resulted in an opaque market place upon which this study seeks to shed light.

The CIF NOLA (cost of insurance and freight to New Orleans, Louisiana) export market and the Mississippi barge freight market are two pieces of the same puzzle for the movement of grain from its origin in the Midwestern United States to export markets around the world. In the CIF NOLA market, grain export firms make forward bids for the purchase of barge loads of grain to be delivered to them at the port of New Orleans. Correspondingly, barge freight lines or barge freight brokers make forward offers for their service of grain transportation via barge so that merchandising firms selling grain to export firms can deliver on their contracts. Though these two markets serve the same industry, they operate independently of each other, and both markets have developed unique characteristics that warrant individual analysis.

The CIF NOLA forward market operates in a manner seemingly similar to a standard forward contract that a farmer might enter into with a local elevator for the sale of grain. However, what makes this market unique is the ability of participating firms to offset their position (short or long) by either buying or selling back the CIF NOLA contract before the delivery period. This allows firms to use these contracts as a means of price risk management for cash grain even if the firm never intends to deliver on the contract, much like a futures contract. Because of this hybrid futures-forward nature of CIF NOLA contracts, it is not clear if its characteristics match that of a futures or a forward contract with regards to the existence of a cost of forward contracting, or risk premium. To answer this question, we apply a first differences model to determine the existence of a consistent bias in forward bids, which, if present, would represent a cost of forward contracting. The institutional details of this market are explored through the use of USDA fact sheets, first-hand accounts from market participants, relevant literature, and personal knowledge gained through research and experience. The potential existence of a cost of forward contract is examined through the use of a simple mean of first differences model. The results are then explained and conclusions drawn based on empirical results and institutional details.

The Mississippi River barge freight market too plays a forward contracting role similar to a traditional farmer-elevator forward contract, but also has characteristics that make it unique. Rather than contracting the sale or purchase of an asset like a traditional forward contract would do with agricultural commodities, barge freight forward contracts specify the purchase or sale of a service. Also, rather than being arranged directly between the buyer and seller, most barge freight contracts are brokered by intermediaries. Given these idiosyncrasies, this market too warrants individual analysis to highlight institutional details and determine the existence of a cost of forward contracting. The institutional details are garnered from USDA fact sheets, anecdotal accounts from industry experts, and first-hand experience by a contributing author. The potential existence of a cost of forward contracting is analyzed by a logarithmic first differences model. Then, the specifics of this market are used to help explain the empirical results.

The geographic congruence of these two markets clearly provides prudence to the grouping of the two studies into one thesis. Grain firms along the Mississippi River system must participate in both the CIF NOLA market as well as the barge freight market in order to successfully deliver grain to the port of New Orleans for export. Not only are the two markets used in the same region by the same industry, they are typically used simultaneously to mitigate price risk for both the sale of cash grain as well as transportation costs. Therefore, an analysis of one market should logically be accompanied by an analysis of the other in order to provide a complete picture of functionality.

II. The Cost of Forward Contracting in Mississippi River Barge Freight Market

Introduction

The Mississippi River system has been a heavily used route to transport agricultural commodities in North America since the colonization of what is now the Central and Midwestern regions of the United States. This expansive river system which includes the Mississippi, Missouri, Illinois, Ohio, Arkansas, and numerous other smaller rivers provides cost effective transport of large or bulky goods. The natural southward flow of water towards the Gulf of Mexico allowed efficient transportation even before the advent of motorized river vessels. Because of this readily available transport system, New Orleans, situated near the Mississippi River estuary, quickly developed into an epicenter of trade after its founding in 1718. Despite much change in the agriculture and transportation industries in the past three centuries, the Mississippi River System and the port of New Orleans still maintain their vital roles in moving U.S. crops from the field to markets around the world.

Despite the importance of this system, relatively little work has been done investigating the use of barge freight forward contracts by grain elevators as a means of input price risk management. This study seeks to expand the literature on forward contracts in agriculture to include forward contracts issued by barge freight lines and barge freight brokers. These contracts allow a river elevator to lock in a freight price up to three months ahead of a shipping date by accepting posted offers. Unlike a traditional forward contract used by a farmer to lock in a sell price for an output, these barge freight forward contracts are essentially offers made by the seller of an input (transportation) which are accepted by the buyer (river elevator). Although the level of price risk associated with grain transportation is not as large as the price risk associated with owning cash grain, the costs of transportation are still significant enough to affect a firm's bottom line. Furthermore, there is strong evidence that the price of barge freight on the Mississippi River System impacts local cash grain prices in markets reliant on the river system as an outlet for grain (McKenzie, 2005; Haigh and Bessler, 2004; Yu, Bessler, and Fuller, 2007). Knowing this, it is only logical to study the pricing patterns and characteristics of forward contracts for barge freight on the Mississippi River System.

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". The markets which are the focus of these studies derive their value from physical assets, agricultural commodities. The barge freight market, which is the focus of this study, is based on the service of grain transportation rather than on an asset. Barge contracts reduce risk for the barge operator as well as the elevator so theory suggests that either party could end up paying a risk premium.

There is also a body of work examining the characteristics of the now inactive BIFFEX (Baltic International Freight Futures Exchange) freight futures market. These studies range from unbiasedness tests to optimal hedge ratios and liquidity risk analysis. Kavussanos and Nomikos (1999) found that while one and two month out futures contracts did provide unbiased estimates of subsequent ocean freight spot prices, three month out contracts had a significant bias resulting in a cost of forward contracting to the purchaser of the ocean freight. They do find, however, that even these biased three month out futures prices provided more accurate forecasts of subsequent spot prices than could be created using conventional econometric forecasting methods. Though this exchange was similar to the Mississippi River barge freight forward market in that they both provide price risk management tools for freight, there are distinct differences between the two. As the name suggests, the BIFFEX functioned as a futures market which allowed for the liquid trade and offsetting of contracts before maturity. While there is evidence that some Mississippi River barge freight forward contracts are offset before maturity[1], there is no further evidence to believe that the Mississippi River barge freight market behaves as a futures market.

We seek to determine whether or not there exists a cost of forward contracting within the Mississippi River System barge freight market. Furthermore, if a bias, or cost, is found to exist, we will specify its magnitude and which party (river elevators or barge freight lines) is responsible for this cost. This previously unexplored market offers a chance to employ techniques used in the past to analyze other markets to determine if a bias exists or if the market operates efficiently. We will explore the seasonality of forward contracting costs in this market and posit possible explanations for any seasonality that may exist.

Following Townsend and Brorsen (2000), the costs of forward contracting in the Mississippi River System barge freight market is estimated using first differences. The change in a forward bid from period d to period $d+1$ (one period closer to contract maturity) is

[1] Anecdotal accounts from Scoular employees actively trading in the Mississippi River market suggest that in some cases forward freight contracts can be exchanged for contracts with sooner delivery periods (with adjusted prices) and that some contracts may be cancelled before delivery without incurring the full cost specified by the contract.

calculated and the mean is found to determine whether a significant consistent bias exists in the bids over the life of the contract, which would indicate a cost to one party to use this market. To determine the statistical significance of the mean, two statistical tests are used: Student's t test and the Wilcoxon signed-rank test. This proposed approach is repeated for each of the eight locations within the Mississippi River System for which barge rates are reported in our dataset.

Following empirical analysis to estimate the cost of forward contracting in this market, volume data are analyzed to draw conclusions on causality. Data displaying the number of up bound empty barges by month as well as barges unloaded in the port of New Orleans by month is graphically displayed to provide evidence of changing market conditions causing variation of forward contracting costs by season.

Barge Freight Information

For the purposes of this study, the vessel specified by the term "barge" is a covered, non-self-propelled vessel used to transport grain along the Mississippi River System. When in transit, multiple barges are often lashed together into groups called a tow so that one tow boat (the self-propelled vessel that pushes the barges) can move numerous barges at once. Depending on river conditions and direction of travel, as many as 40 barges can be moved by a single tow boat in this fashion. These vessels are typically 35 feet wide by 195 or 200 feet long, depending on whether it is a box or a rake barge. A rake barge, 195 feet long, has a sloped bow like a traditional boat which makes it more hydrodynamic during transit. Because of this, rake barges are placed at the front of a tow, and sometimes backwards at the rear of a tow, to make the tow easier to push through the water. A box barge, 200 feet long, is shaped like a rectangular prism. The box barge has a higher volume than a rake barge, but its flat front makes it suited only for interior positions of a tow.

The barge hull height is typically 13 or 14 feet, with the interior container walls extending an additional 4 feet above the top of the hull. The amount of grain on a barge is determined by the draft depth of the barge. This refers to the distance between the surface of the water and the bottom of the hull, measured by subtracting the distance from the surface of the water to the top of the hull from the total height of the barge hull. Depending on river conditions, barges can be filled to different draft depths. For example, if the river is lower than normal, a barge may be required to have a draft depth of no more than 10 feet. This would be accomplished by putting less grain into the barge. When full, a barge can hold about 1,500 tons of grain, which is roughly 59,000 bushels of corn, and sits at a draft depth of 11 or 12 feet for 13 or 14 foot tall barges, respectively.

Barge freight rate quotes are issued in the form of percent of tariff. This is in reference to the original southbound rates, or tariffs, set in 1976 by the then Interstate Commerce Commission, which has since become a division within the United States Department of Transportation. These tariffs were set as a standard rate (dollars per ton) for transportation from a specified origin location to the New Orleans Gulf port. The tariffs for the most northern (farthest upstream) locations are highest, and the tariffs decrease as the location's distance from New Orleans decreases. Today these tariffs are simply a benchmark for barge freight rate quotes which are reported as percent of tariff. For example, if the rate for barge transportation from Minneapolis is quoted as 200 (percent of tariff), given that the original tariff for Minneapolis is $6.19 per ton, then the barge rate in dollars per ton would be $12.38 per ton. The dataset used for this study lists weekly percent of tariff quotes for three delivery periods for each of eight locations along the Mississippi River System.

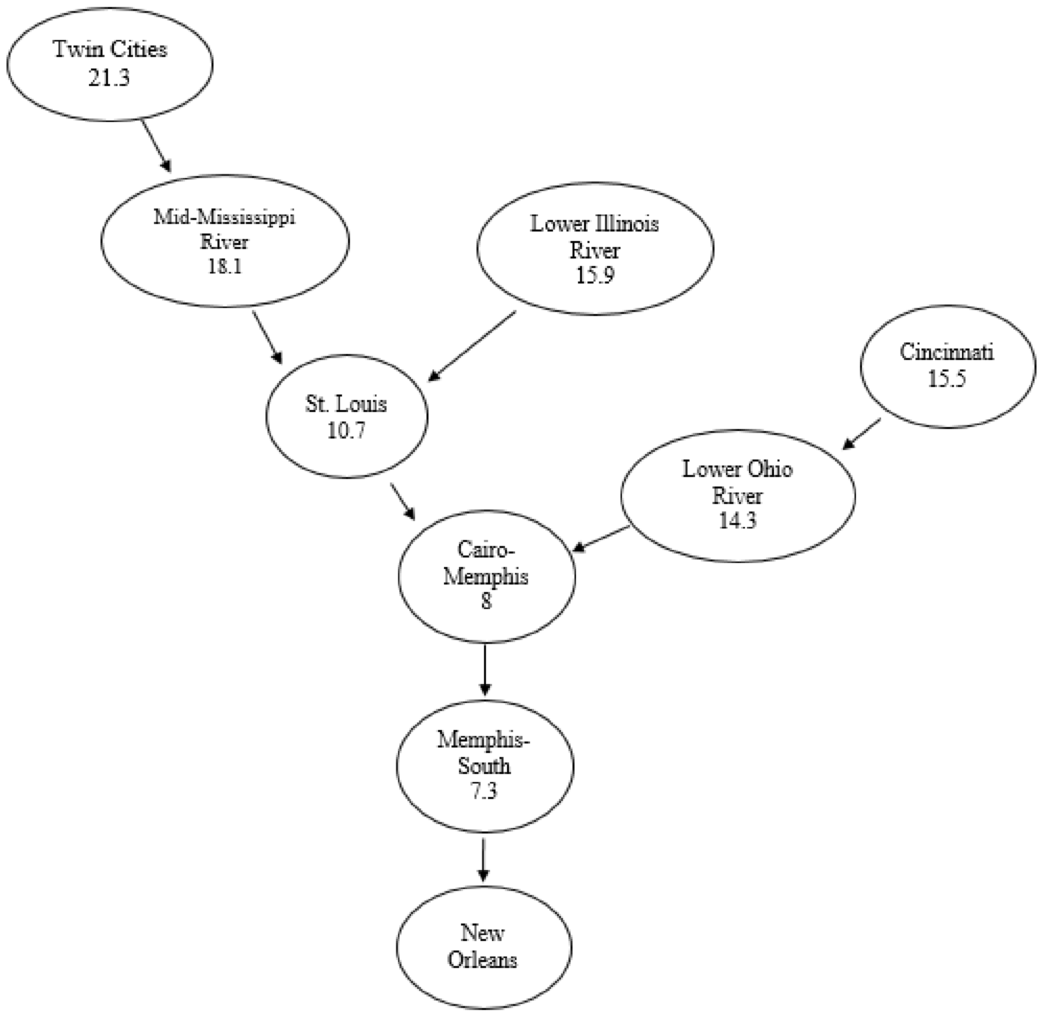

Figure 1. Barge travel time to port of New Orleans from river locations in days.

Unlike other forms of grain transportation such as truck or rail, barge freight moves remarkably slow. A southbound loaded barge only moves at an average of 6 miles per hour, and with the vast expanse of area served by the Mississippi River system, moving grain in this manner can take as much as 21 days. Figure 1 shows the river locations included in this study along with the average travel time to the port of New Orleans (in days) for a grain barge. These travel times are estimates taken from American Commercial Barge Line's customer web page

(ACBL, 2010). Clearly, the duration of a shipment indicates that the firm providing the freight would benefit from having advanced notice of demand for their service. Particularly, for the farthest out locations such as Twin Cities, barge lines would need ample time to move empty barges and tow boats to the location to be loaded, and then will see those vessels engaged in that contract for nearly a month before they are available again. Accordingly, it follows that barge lines would want to incentivize forward contracting by their customers in order to better prepare for orders.

The trading of barge freight is most commonly facilitated by a barge freight broker. Barge freight brokers on the Mississippi River System include McDonald Pelz, Ceres, and the Marine Freight Exchange, although others are active in the market. The actual barges are owned by barge lines who also work with these barge freight brokers in order to find buyers for their freight services. These barge freight line companies include Bunge, Cargill, Ingram Barge Company, American River Transportation Company (ARTCO), SEACOR, and Terral, among others.

Literature Review of Barge Freight and Risk Premiums in Commodity Forward Markets

Although research into the implied costs of forward contracting barge freight on the Mississippi River System is limited, there is a significant body of work that has investigated the costs of forward contracting commodities in other markets. Brorsen, Coombs, and Anderson (1993) and Townsend and Brorsen (2000) used empirical methods to estimate the risk premium involved with forward contracting wheat in Oklahoma. Both of these studies found a significant cost to farmers when using forward contracts to manage price risk instead of hedging using commodity futures contracts. Using the parametric model described above, Townsend and Brorsen (2000) found a 6.00¢ per bushel cost to Oklahoma farmers for forward contracting wheat 100 days prior to delivery with local elevators. Brorsen, Coombs, and Anderson (1993) used a non-parametric model to find an average forward contracting cost for Oklahoma farmers of 7.00¢ per bushel. Both studies found that the cost of forward contracting increased as the length of the forward contract increased. In contrast to these results, Mallory, Zhao and Irwin (2015) found much smaller costs of post-harvest forward contracting for corn and soybeans although the pattern of increasing costs for increasing length of contract still held. 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 (e.g. farmers), Lewis, Manfredo, and Sanders (2015) analyzed 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, however, this market structure more accurately matches the market structure of the Mississippi River barge freight forward market. These studies all seek to determine if a bias is present in the forward bids that creates a cost of forward contracting.

McKenzie (2005) used an autoregressive model to determine the effect of barge rate shocks on internal basis levels in Arkansas's delta region. The study showed that internal basis levels responded negatively to an increase in the barge rate. This suggests that at least some of the costs resulting from higher barge rates are passed to the farm level. As a result, if forward contracting costs are found and attributed to river elevators, this is only a preliminary assessment as the true cost may be passed on to the producer. McKenzie (2005) also seeks to explain the cause of shocks in barge rates. The model used shows that both soybean crush margin and financial costs of storage play a role in the movement of barge rates.

Yu, Bessler, and Fuller (2007) also sought to determine the role of transportation in determining inland cash corn prices. They found that the gulf export market accounts for 26-42% of variation in inland corn prices, while grain transportation costs account for as much as 42-64% of variation in inland grain prices. The biggest contributing factor to the variation caused by transportation costs was variance in ocean vessel rates. Barge rates and rail rates were next, with the variation in barge rates explaining 10-13% of variation of inland corn cash prices in the long run.

Haigh and Bessler (2004), in a similar vein to McKenzie (2005) and Yu, Bessler, and Fuller (2007), used a cointegration model along with directed acyclic graphs to determine the causal path of information among the gulf export market, Illinois inland grain markets, and volatile barge freight markets. The study found that the gulf market does have a significant effect on Illinois grain markets. However, contrary to similar studies, they found that in the long run it is inland grain prices that influence barge rates, as opposed to barge rates influencing inland grain prices. They conclude that both inland grain prices as well as the gulf export market influence barge rates in the long run.

This literature on barge market impacts on grain markets (Haigh and Bessler, 2004; McKenzie, 2005; Yu, Bessler, and Fuller, 2007) all emphasize the important role of the barge market in the U.S. grain industry. These studies show that barge rates are large enough to influence storage decisions as well as decisions on which market a firm will sell in (local or gulf). Given this important role, further research into forward pricing of barge rates on the Mississippi River System is justified.

Modeling and Testing for Bias

The data used for this study are from United States Department of Agriculture Agricultural Marketing Service grain transportation report datasets available publicly online (USDA, 2017). The dataset contains weekly offers for barge freight to the port of New Orleans from eight locations on the Mississippi River system: Twin Cities, Mid-Mississippi, Lower Illinois River, St. Louis, Cincinnati, Lower Ohio River, Cairo-Memphis, and Memphis-South. These offers are for this week (spot price), 1-month out, and 3-month out forward delivery periods. The sample period is from January 1, 2004 to October 28, 2015. However, for the Twin Cities location, no 3-month out bids were recorded for September, October, November, and December. This is likely due to freezing conditions closing the river to barge navigation. Also retrieved from the USDA AMS website is the number of barges unloaded at the port of New Orleans by month, as well as the number of up bound empty grain barges by month. These data are for the same time period as the barge rate data and are used as evidence to justify explanations of patterns found in the initial results.

This study will approach the empirical analysis of barge freight rates with a logarithmic first differences model. This begins by taking the natural log of each observed barge rate quote:

$$Log\ Rate_t^{l,d} = \ln(Barge\ Rate\ Quote_t^{l,d}).$$

Where the natural log of a barge rate quote for delivery period *d* at location *l* reported on day *t* creates the variable *Log Rate.* Then, first differences are taken by subtracting $Log\ Rate_{t-1}$ from $Log\ Rate_t$:

$$Log\ First\ Differences = Log\ Rate_t^{l,d} - Log\ Rate_{t-1}^{l,d}.$$

This difference represents the daily percent change in barge rate quotes. To account for rollover between months of delivery periods, a rollover variable is also created from the log rates. This is done by subtracting the first day of the 3 month out delivery period from the last day of the 1 month out delivery period:

$$Rollover^{l,3,1} = Barge\ Rate\ Quote_{t}^{l,1} - Barge\ Rate\ Quote_{t-4}^{l,3}.$$

This same process is repeated to find the rollover between the one month out delivery and the spot price. To find the average cost of forward contracting for a given delivery period, the mean of the first differences for a given location and delivery period is found, representing the average weekly percent change in barge rate bids. Because the natural log of levels rather than the levels themselves are used in the first differences model, the results can be interpreted as the weekly percent change in barge rates. To interpret results in terms of the original units of the data (percent of tariff) an exponential transformation is performed for each location and delivery period:

$$Average\ Change\ in\ Percent\ of\ Tariff^{l,d} = e^{Mean\ Log\ First\ Differences^{l,d}}.$$

Because the sign of the mean log first differences is critical to interpreting which party to the transaction incurs a potential cost of forward contracting, the sign from the mean log first differences model is attributed to the resulting average change in percent of tariff. For instance, if the average change in percent of tariff is negative, this implies a cost to the buyer of the barge freight because they accepted a forward price for an input that was higher than what the subsequent spot price ended up being at the time of deliver. Conversely, a positive sign represents the freight price increasing from the time a forward offer is made to the time of delivery, and therefore the cost of forward contracting is placed upon the seller of the barge freight. This same average process and attribution of sign is repeated for the two rollover variables. From here, the average change in percent of tariff is used to calculate the total cost of forward contracting for the life of a forward barge freight contract. This is accomplished by multiplying the average change in percent of tariff for a given delivery period by a standard four weeks which occur within that given delivery period (a delivery period being a standard calendar month) and then adding this result to any subsequent delivery period results and rollovers. Following this method, the total cost of forward contracting for a given location, l, for a delivery period three months in the future can be calculated as:

$$Total\ Cost\ of\ Forward\ Contracting^{l,3}$$
$$= (Average\ Change\ in\ Percent\ of\ Tariff^{l,3} * 4) + Rollover^{l,3,1}$$
$$+ (Average\ Change\ in\ Percent\ of\ Tariff^{l,1} * 4) + Rollover^{l,1,0}.$$

This cost of forward contracting, in units of percent of tariff, can then be multiplied by the 1976 benchmark tariff for the specified river location to transform it into dollars per ton. Ultimately, the cost in cents per bushel can be found by dividing this dollars per ton figure by 2000 and then multiplying by the number of pounds per bushel[2]. For our study, this cost per bushel is often very small (around one cent per bushel), however, when transformed into dollars per barge[3] the cost appears much more substantial.

In order to study the effects of seasonality on the potential costs of forward contracting, the data is segregated into seasons based on the month of the delivery period. The seasons used for this study are the three basic seasons of the grain production cycle. Season 1 (January through April) represents the storage season, season 2 (May through August) represents the growing season, and season 3 (September through December) represents the harvest season. These seasons were selected in an attempt to segregate the data based on differing demand for barge freight.

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[2] A standard U.S. bushel of corn weighs 56 pounds, while a bushel of soybeans or wheat weighs 60 pounds.
[3] The standard covered barge capacity on the Mississippi River system is 55,000 bushels.

Results and Analysis

For the purpose of conciseness, we will discuss the results as costs in terms of dollars per barge based on a corn barge (56 pounds per bushel). It is also important to remember that a negative number represents a cost to the river elevator (buyer), while a positive cost represents a cost to the barge line (seller). Perhaps the most interesting result from our model is the variation of forward contracting costs based on the season of delivery. As seen in table 1, the Twin Cities location shows positive costs for all three seasons, with costs of $9.22, $979.86, and $390.50 for seasons 1, 2, and 3, respectively. For this far north location on the Mississippi River, the offers seem to incentivize forward contracting over purchasing freight in the spot market from the perspective of freight buyers during all seasons of the year. With exception of the Twin Cities location, the results all follow the pattern of having a cost to the barge line for forward contracting during the summer season (season 2) and a cost of forward contracting to the river elevators during the harvest and winter season (seasons 1 and 3). Beginning with the Mid-Mississippi River location, table 1 shows costs of -$485.34, $679.28, and -$475.12 for seasons 1, 2, and 3, respectively. The lower Illinois River location shows costs of forward contracting of -$484.04, $511.22, and -$353.45 for seasons 1, 2, and 3. The St. Louis location shows costs of forward contracting of -$697.39, $460.34, and -$404.74 for seasons 1, 2, and 3. The Cincinnati location on the Ohio River has costs of forward contracting of -$705.75, $466.89, and -$412.56 for seasons 1, 2, and 3. The lower Ohio River location has costs of forward contracting of -$670.72, $443.82, and $392.38 for seasons 1, 2, and 3. The Cairo-Memphis section of the Mississippi River has costs of forward contracting of -$87.10, $313.96, and -$273.79 for seasons 1, 2, and 3. The final location, Memphis-South has costs of forward contracting of -$87.06, $409.02, and -$273.39 for seasons 1, 2, and 3. With the exception of the Twin Cities location, there does not appear to be a systematic pattern in forward contracting costs based on geographical location. However, a seasonal pattern does present itself in the form of negative costs of forward contracting (costs to buyers of freight) during seasons 1 and 3 and a positive cost of forward contracting (cost to the seller of freight) for season 2. This pattern lends support to our selection of seasonal periods and also to the examination of seasonal effects.

One logical explanation for the contrasting results coming from the Twin Cities location is the geographic characteristics of that location. Being the location furthest from the port of New Orleans, it makes sense that a barge line would want forward notice of the demand for barges at this location, as there is no instance in which barges would happen to be passing through this location on their way to other locations. If enough forewarning is given for the need of barges at this location, the barge line could consolidate barges into one large tow and make fewer trips to this far north location rather than make many trips with fewer barges in each tow. Barge lines making forward offers may provide consistently lower forward bids than spot bids in an effort to incentivize forward contracting so that they can capitalize on this opportunity to reduce their own operating costs.

One potential explanation for seasonal patterns observed at other locations is a combination of seasonal volume and the logistical characteristics of the barge freight market. Conversations with operations managers working for The Scoular Company at a barge loading facility revealed that it is common practice for barge lines to move large tows of barges upstream at the beginning of the harvest season in expectation of increased demand for barge freight in the spot market. This suggests that during times of peak volume, barge lines are already minimizing operating costs by moving the maximum number of barges at a time upstream in each tow. Therefore, there is no reason for the barge line to incentivize forward contracting through offering lower forward prices in relation to subsequent spot prices. Moreover, because these forward contracts serve a price risk transference role, the barge lines can extract a risk premium from the market, in the form of higher forward prices in relation to the subsequent spot prices, as compensation for their acceptance of the river elevators' risk. However, during lower volume periods, such as season 2, the barge lines do not take these proactive steps to accumulate barges upstream for anticipated use in the spot market. Therefore, it again follows that they should incentivize the forward contracting of barge freight by river elevators through lower forward prices, as is seen in all seasons of the Twin Cities location.

Barge movement data also retrieved from the USDA AMS (USDA, 2017) website supports the theory that seasonal volume contributes to the pattern of changing forward contracting costs in the barge freight forward market. Monthly averages for the time period matching the barge freight rate data reveals that more grain barges are unloaded at the port of New Orleans during seasons 1 and 3 than in season 2 (Figure 2). It follows that barge freight lines and barge freight brokers extract a risk premium during times of high demand through offering forward prices consistently higher than the subsequent spot prices for barge freight. Likewise, during times of low demand, this cost of forward contracting is not only reduced, but reverses to become a cost to the seller of the barge freight.

Data retrieved from the same source (USDA, 2017) showing the volume of northbound empty barges, displayed in figure 3, also lends support to our theory of varying costs of forward contracting being due to seasonal barge movement patterns. The data shows that the number of northbound empty barges is highest during the summer months (March through July) with an average of 582 barges moved north per month, then sharply decreases as harvest begins (August, September, and October) with an average of 408 barges moved north per month. The number of barges jumps back up during November and December (583 barges per month), then falls again for January and February (479 barges per month). This pattern resembles an inverse of the monthly average data for barges unloaded at the port of New Orleans. The logical conclusion from this relationship is that barge freight lines do accumulate empty barges upstream in preparation for high demand periods, and that during these high demand periods, fewer empty barges are moved upstream, likely due to a majority of tugs being used to move barges southbound.

As figure 4 shows, the cost of forward contracting in the Mississippi River barge freight market is highly seasonal. Graphically analyzing the average total cost by month across all eight locations shows that the seasonal breaks used in the analysis generally hold. This is expected based on the seasonal nature of the agricultural commodities being shipped inside the barges. Figure 5 further supports the seasonal breaks used in this analysis, as season 3 is distinctly shown to be the period of highest barge rate bids.

Table 1. Barge freight cost of forward contracting results

	Season	Spot Price	1 Month Rollover	1 Month Out	3-1 Month Rollover	3 Months Out
Twin Cities	1	-0.0125**	-0.0253	-0.0133^^***	0.0119	0.0017
	2	0.0160^^*	0.0134	0.0296^^^***	0.0341^**	0.0273^^^***
	3	0.0039	-0.0208	0.0014	0.0679^^**	N/A[†]
Mid-Mississippi River	1	-0.0317^^^***	0.0013	-0.0141^^**	0.0027	-0.0041*
	2	0.0268^^^***	-0.0026	0.0394^^^***	0.0102	0.0289^^^***
	3	-0.0009	0.0253	-0.0099	0.0825^**	-0.0126*
Lower Illinois River	1	-0.0221^^***	0.0015	-0.0188^^^***	-0.0287	-0.0045
	2	0.0315^^^***	-0.0101	0.0439^^^***	0.0140	0.0286^^^***
	3	-0.0061	0.0408	-0.0200^^**	0.0469^	-0.0199^^^***
St. Louis	1	-0.0250^^**	-0.0092	-0.0203^^***	-0.0702^^**	-0.0210
	2	0.0514^^^***	-0.0481^^**	0.0633^^^***	-0.0016	0.0325^^^***
	3	-0.0237	0.0463	-0.0398^^^***	0.0249	-0.0271^^^***
Cincinnati	1	-0.0264^^^***	-0.0208	-0.0233^^^***	-0.0898^^***	-0.0075**
	2	0.0490^^^***	-0.0589^^***	0.0597^^^***	-0.0147	0.0359^^^***
	3	-0.0184	0.0277	-0.0331^^^***	0.0322	-0.0245^^^***
Lower Ohio River	1	-0.0262^^^***	-0.0172	-0.0235***	-0.0988^^^***	-0.0077**
	2	0.0489^^^***	-0.0650^^***	0.0598^^^***	-0.0060	0.0359^^^***
	3	-0.0185	0.0272	-0.0330^^^***	0.0330	-0.0243^^^***
Cairo-Memphis	1	-0.0204^^***	-0.0374	-0.0167^^**	-0.0899^^^***	0.0025
	2	0.0583^^^***	-0.0782^^^***	0.0684^^^***	-0.0079	0.0311^^***
	3	-0.0364^^**	0.0129	-0.0472^^^***	0.0135	-0.0323^^^***
Memphis-South	1	-0.0193**	-0.0366	-0.0165^**	-0.0906^^^***	0.0029
	2	0.0560^^^***	-0.0590^^**	0.0670^^^***	0.0026	0.0299^^***
	3	0.0337^**	0.0170	-0.0476^^^***	0.0221	-0.0307^^^***

^, ^^, and ^^^ denote statistical significance at the 90%, 95%, and 99% confidence level, respectively, by student's t test.

***, **, and *** denote statistical significance at the 90%, 95%, and 99% confidence level, respectively, by Wilcoxon signed rank test.**

†No data was available for three month out bids at the Twin Cities location for season three, likely due to frozen river conditions

Estimates in terms of percent of tariff unless otherwise noted

Table 1. Barge freight cost of forward contracting results (Cont.)

	Season	Benchmark Tariff ($/ton)	Average Cost of Forward Contracting ($/ton)	$/barge corn
Twin Cities	1	$ 6.19	$ 0.01	$ 9.22
	2	$ 6.19	$ 0.64	$ 979.86
	3	$ 6.19	$ 0.25	$ 390.50
Mid-Mississippi River	1	$ 5.32	$ (0.32)	$ (485.34)
	2	$ 5.32	$ 0.44	$ 679.28
	3	$ 5.32	$ (0.31)	$ (475.12)
Lower Illinois River	1	$ 3.99	$ (0.31)	$ (484.04)
	2	$ 3.99	$ 0.33	$ 511.22
	3	$ 3.99	$ (0.23)	$ (353.45)
St. Louis	1	$ 4.64	$ (0.45)	$ (697.39)
	2	$ 4.64	$ 0.30	$ 460.34
	3	$ 4.64	$ (0.26)	$ (404.74)
Cincinnati	1	$ 4.69	$ (0.46)	$ (705.75)
	2	$ 4.69	$ 0.30	$ 466.89
	3	$ 4.69	$ (0.27)	$ (412.56)
Lower Ohio River	1	$ 4.46	$ (0.44)	$ (670.72)
	2	$ 4.46	$ 0.29	$ 443.82
	3	$ 4.46	$ (0.25)	$ (392.38)
Cairo-Memphis	1	$ 3.14	$ (0.06)	$ (87.10)
	2	$ 3.14	$ 0.20	$ 313.96
	3	$ 3.14	$ (0.18)	$ (273.79)
Memphis-South	1	$ 3.14	$ (0.06)	$ (87.06)
	2	$ 3.14	$ 0.27	$ 409.02
	3	$ 3.14	$ (0.18)	$ (273.39)

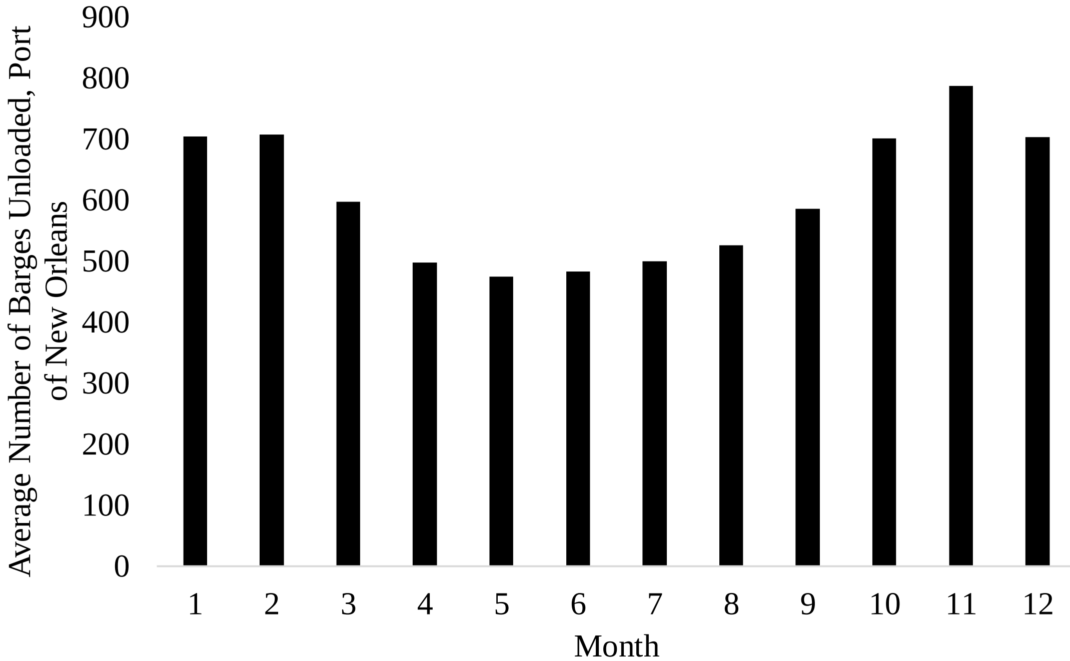

Figure 2. Average number of grain barges unloaded at the port of New Orleans by month.

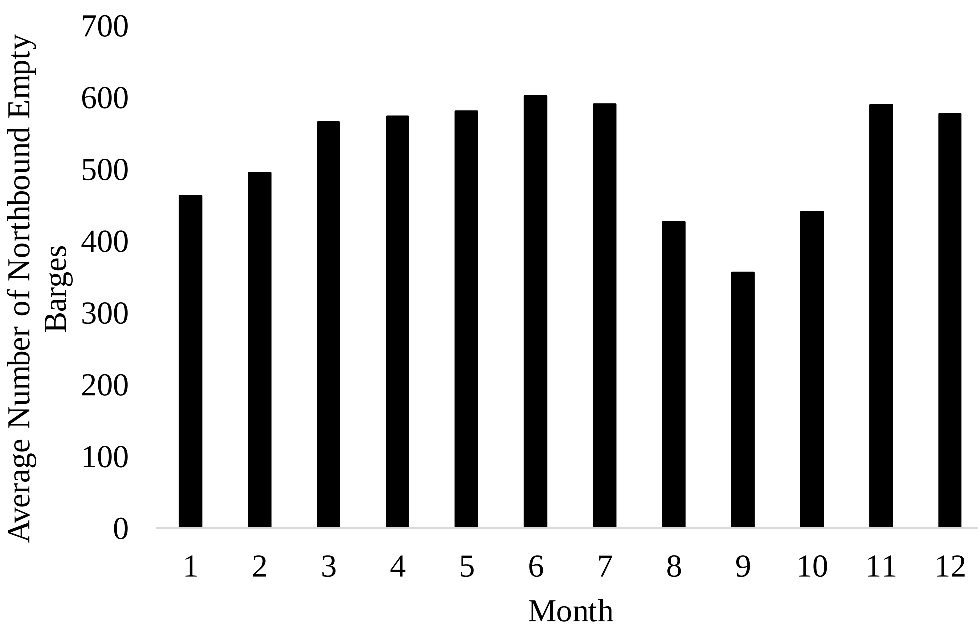

Figure 3. Average number of northbound empty barges by month.

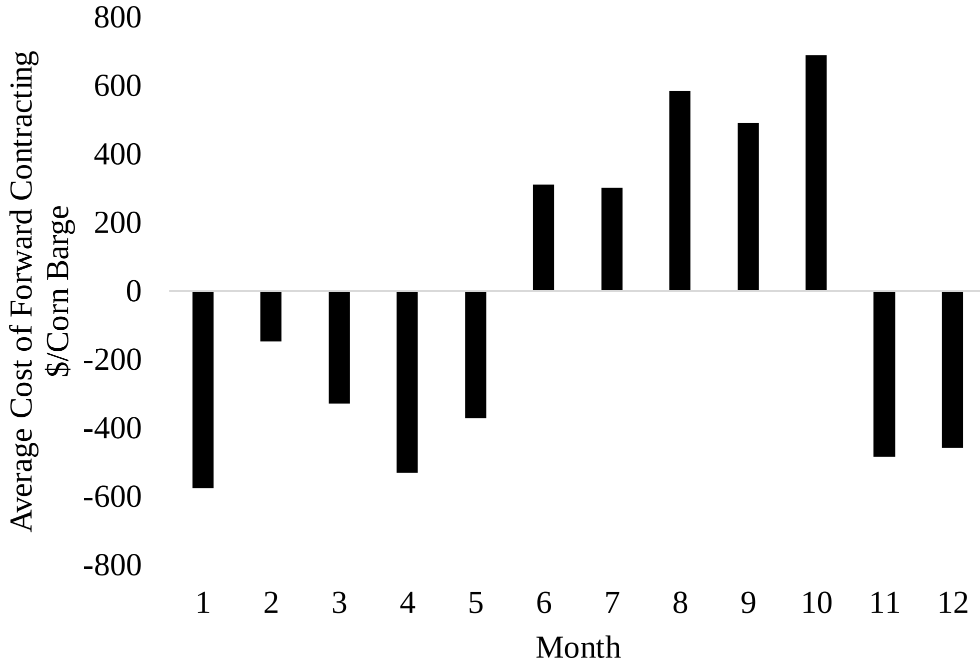

Figure 4. Average cost of forward contracting barge freight by month, all locations.

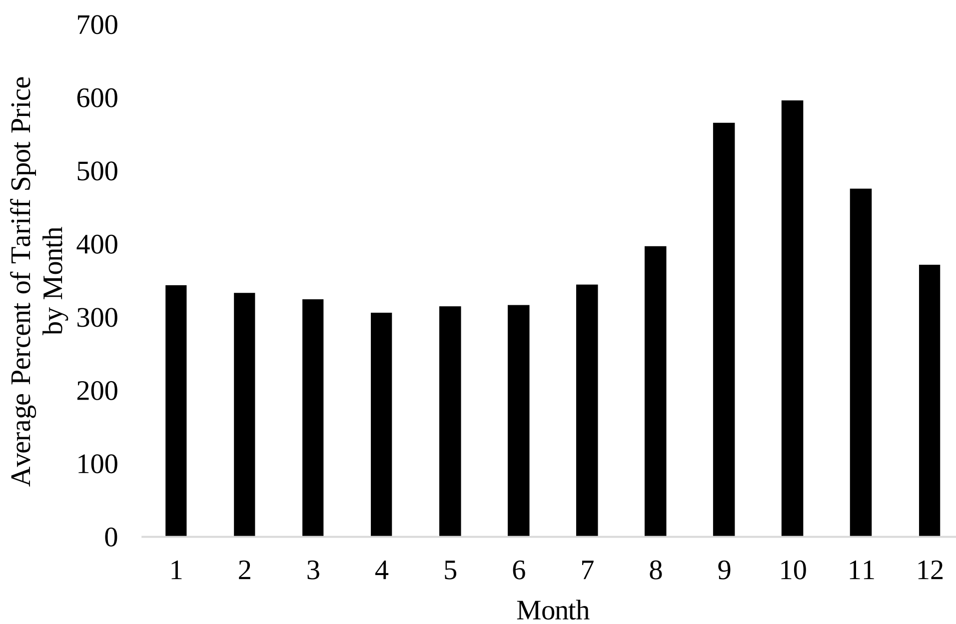

Figure 5. Average percent of tariff spot price by month.

Conclusions

This study adds to the existing literature on forward contracting costs by expanding the subject to include the forward contracting of a service, barge freight. Most forward contracts in agriculture deal with the sale/purchase of commodities, which are assets. The literature on forward contracting agricultural commodities mostly shows a significant cost of forward contracting for longer periods of time, with the seller incurring the cost. As the results of our study show, there are also significant costs of forward contracting in the barge freight forward market. However, we discovered that the party incurring these costs in the barge freight forward market varies depending on the season. The reason for this drastic swing in forward contracting costs based on season is likely due to the market's dependence on agricultural growing seasons for demand, as well as supply restrictions based on seasonal weather patterns.

What these results mean for participants in this market is that strictly in terms of minimizing average costs, forward contracting barge freight during low demand periods (season 2) can result in transportation prices lower than what they would have been had freight been purchased in the spot market as needed. Conversely, during periods of high demand (seasons 1 and 3) forward contracting barge freight will result in freight prices higher than what could have been purchased in the spot market at the time of shipment. Knowing this, on average a grain firm using barge freight to transport grain should forward contract freight for shipments made during season 3, but purchase freight in the spot market as needed for seasons 1 and 3 to minimize their transportation costs. However, it is important to consider the price risk management function that this market serves. For instance, although in the long run this outlined strategy should minimize transportation costs, not forward contracting barge freight leaves firms exposed to barge freight price risk. If a firm were to purchase freight strictly in the spot market, they might incur lower transportation costs some years, but higher transportation costs during other years could cause cash flow or liquidity problems. Given this, if the cost of forward contracting is reasonably small, barge freight purchasers might still elect to forward contract, knowingly paying the cost for the mitigation of price risk.

References

American Commercial Barge Line, ACBL. Transit times. 2010. Available from http://www.bargeacbl.com/site/ship-with-acbl/transit-times.html.

Brorsen, B. W., J. Coombs, and K. Anderson. 1995. “The Cost of Forward Contracting Wheat.” *Agribusiness* 11.4: 349-354.

Haigh, Michael S., and David A. Bessler. 2004. "Causality and Price Discovery: An Application of Directed Acyclic Graphs." Journal of Business 77, no. 4: 1099-1121.

Kaldor, Nicholas. 1939 "Speculation and Economic Stability." *The Review of Economic Studies* 7.1 : 1-27.

Kavussanos M.G., and Nomikos, N., 1999.The Forward Pricing Function of the Shipping Freight Futures Market. *Journal of Futures Markets* 19, 3, 353-376.

Lewis, K. E., M. R. Manfredo, I. Altman, and D. R. Sanders. 2013. “Risk Premiums and Forward Basis: Evidence from the Soybean Oil Market.” Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO.

Mallory, Mindy L., Winjiao Zhao, and Scott H. Irwin. 2015. "The Cost of Post-Harvest Forward Contracting in Corn and Soybeans." *Agribusiness* 31.1: 47-62.

McKenzie, A.M. and M.T. Holt. 2002. “Market Efficiency in Agricultural Futures Markets.” *Applied Economics* 34(12): 1519-1532.

Tilley, D.S., and S.K. Campbell. 1988. “Performance of the Weekly Gulf-Kansas City Hard Red Winter Wheat Basis.” *American Journal of Agricultural Economics* 70, 929–935.

Townsend, J.P., and B. W. Brorsen. 2000. “Cost of Forward Contracting Hard Red Winter Wheat." *Journal of Agricultural and Applied Economics* 32:89-94.

USDA. 2017. *Grain barges unloaded in the New Orleans port region.* Market News Service, GTR 12.

USDA. 2017. *Up bound empty barges.* Market News Service, GTR 11.

USDA. 2017. Weekly barge freight rates for southbound only shipments. Agricultural Marketing Service, GTR 9.

Yu, T.-H., Bessler, D. A. and Fuller, S. W. (2007), Price Dynamics in U.S. Grain and Freight Markets. Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 55: 381–397.

III. The Cost of Forward Contracting in CIF NOLA Export Bid Market

Introduction

The CIF NOLA (cost of insurance and freight to the port of New Orleans) export bid market functions in manner unique among other agricultural forward markets. 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 further 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 a liquid market. We have two forms of supporting evidence to back up our claim that firms make offers as well as bids. We were given access to six 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 of insurance and 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. 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 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, which would be subsequently observed at contract maturity. 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 than 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)

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

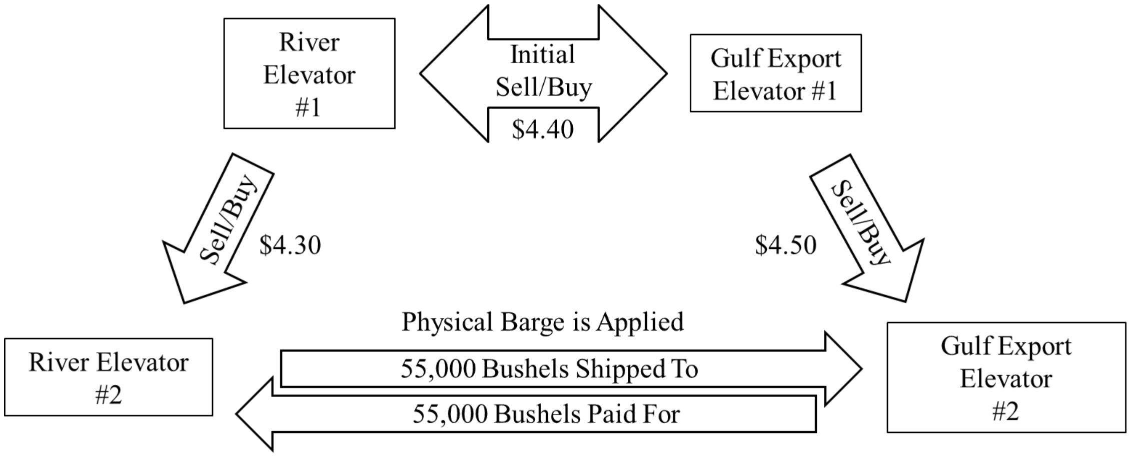

Figure 1. CIF NOLA market example

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 spot 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 using the following equation:

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

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 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 it sells grain in his local market and the difference between its 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 is 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 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 found 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) analyzed 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

The data used for this study were collected from USDA AMS daily gulf export bid reports (Davila, 2016). The data consists of daily basis bids for corn, soybeans, soft red winter wheat, and sorghum delivered to New Orleans. Bids are recorded for five delivery periods: spot price, or immediate delivery, one month out, two months out, three months out, and four months out. The dataset compiled consists of 2,115 daily reports from September 28, 2007, to April 13, 2016.

For each of the four commodities considered in this study a separate but empirically congruent model is used to determine the bias in the CIF NOLA export bids. 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:

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

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 should 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 the basis difference is then found, along with descriptive statistics created by SAS univariate procedure. 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 over 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 one through three, multiplying each estimate by twenty. Then, these products are added together to find the total bias over the life of a three-month-out contract so that:

$$\textit{Bias over life of contract}_3 = (\textit{estimate}_1 * 20) + (\textit{estimate}_2 * 20) + (\textit{estimate}_3 * 20).$$

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 buying on average 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 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 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 were 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 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 four-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. The magnitude of this estimate is smaller than that found by Brorsen, Coombs, and Anderson (1995), who found a 4¢ per bushel cost to sellers for 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 reduced (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 resultss 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. Figures 6, 7, 8, and 9 display the average daily change in CIF NOLA basis bids for corn, soybeans, wheat, and sorghum, respectively. The conclusion being that although the variance of the levels of CIF NOLA bids follows a strong seasonal pattern, the pattern of the first differences of the data is much weaker and more sporadic. Moreover, the results vary greatly by commodity, meaning that any attempt to correct for potential seasonality would need to be performed individually for each commodity.

Table 2. Bias estimates for Corn in CIF NOLA Forward Basis Bids (¢/bu).

			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 (¢/bu).

			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 2. Bias estimates for Wheat in CIF NOLA forward BASIS Bids (¢/bu).

			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 (¢/cwt).

			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.

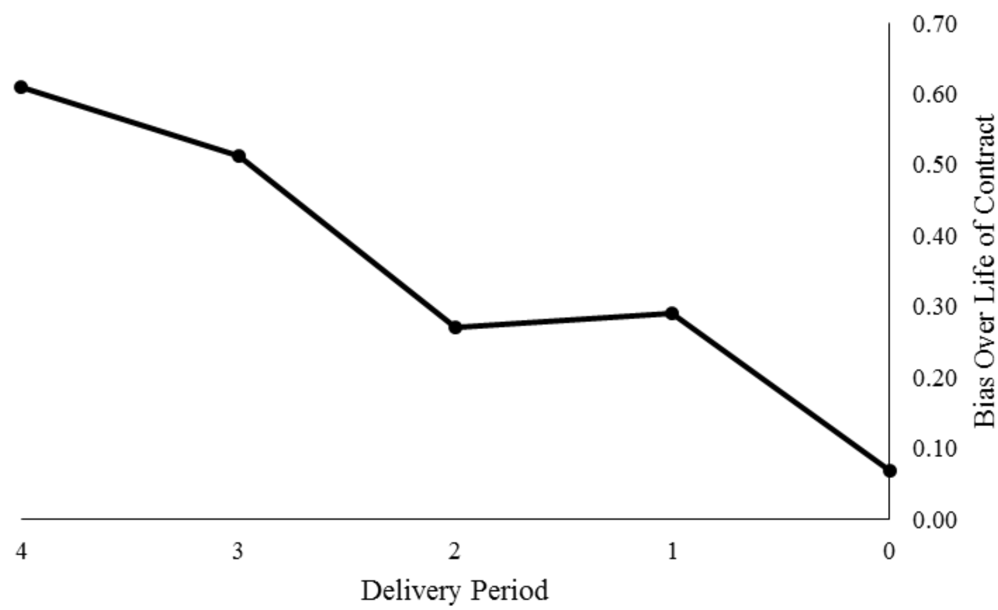

Figure 3. Average bias over life of forward contract, soybeans

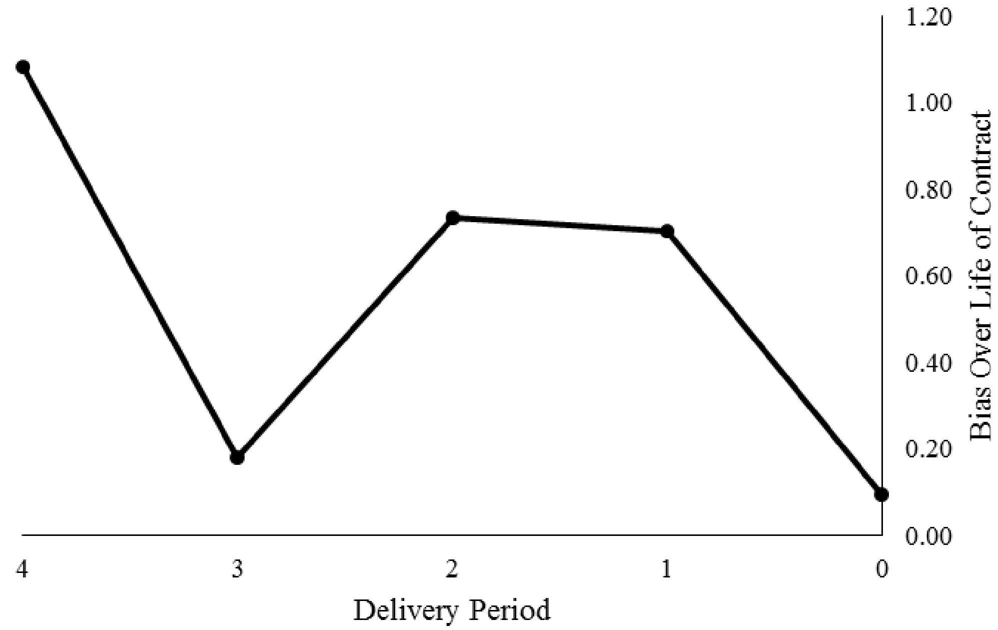

Figure 4. Average bias over life of forward contract, wheat.

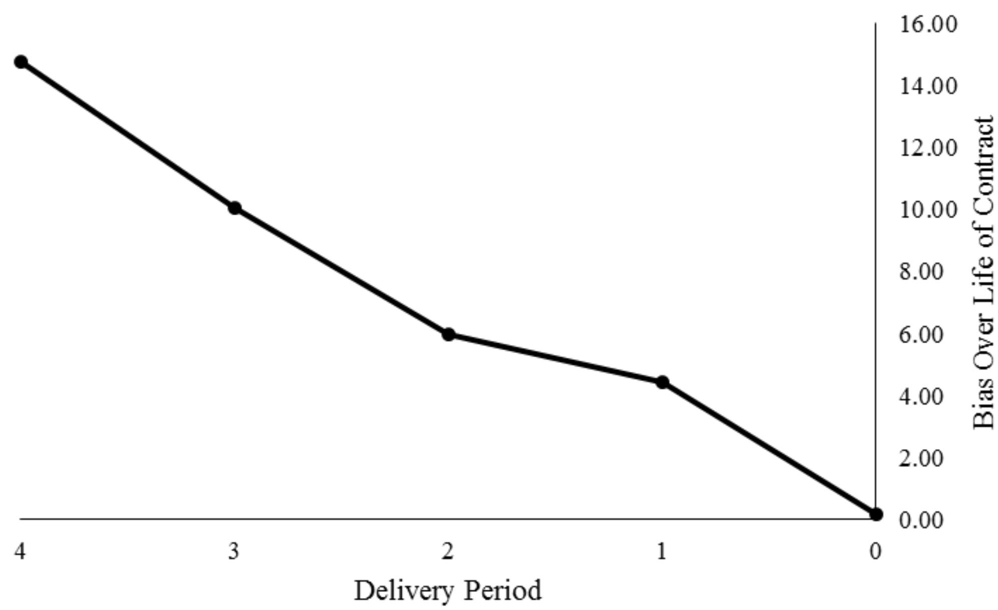

Figure 5. Average bias over life of forward contract, sorghum

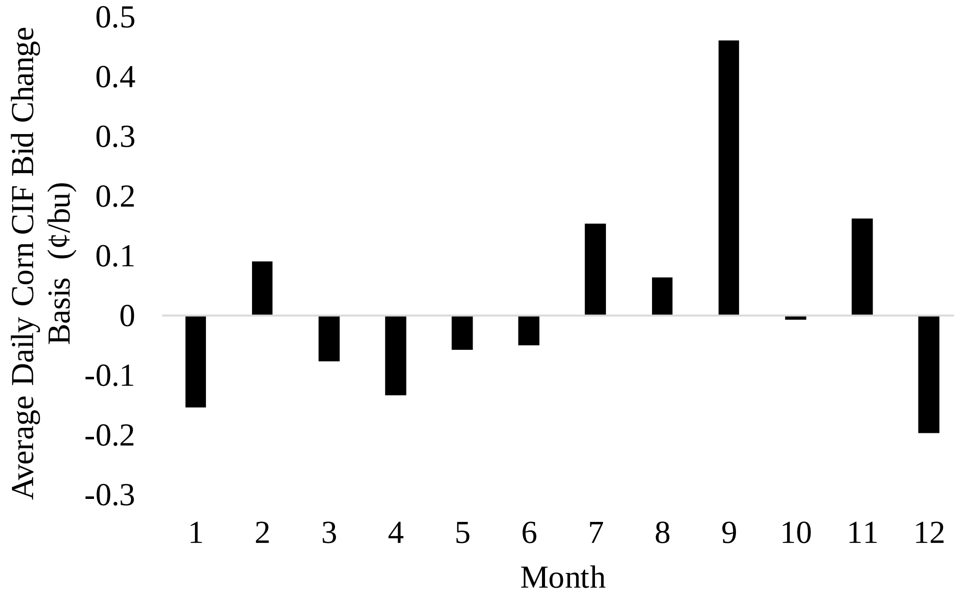

Figure 6. Average daily change in corn CIF NOLA bids by month.

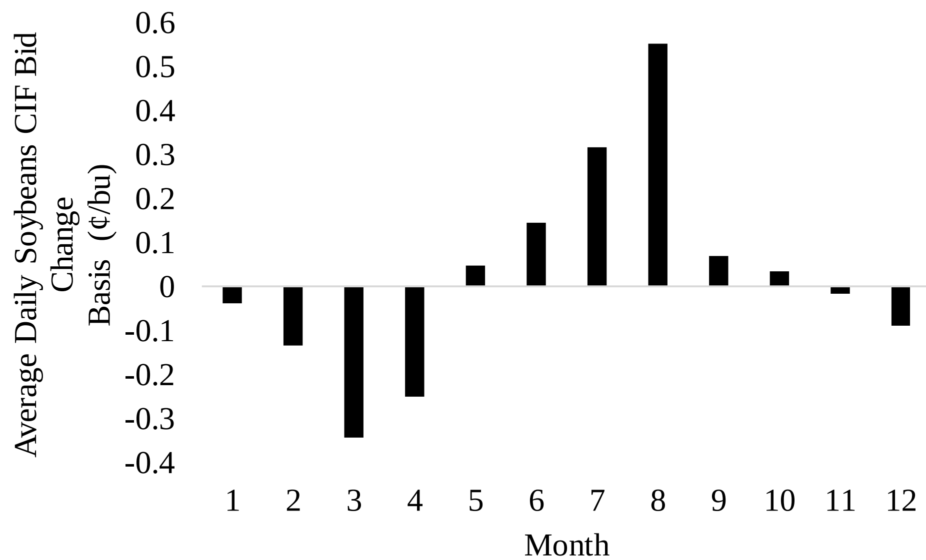

Figure 7. Average daily change in soybean CIF NOLA bids by month.

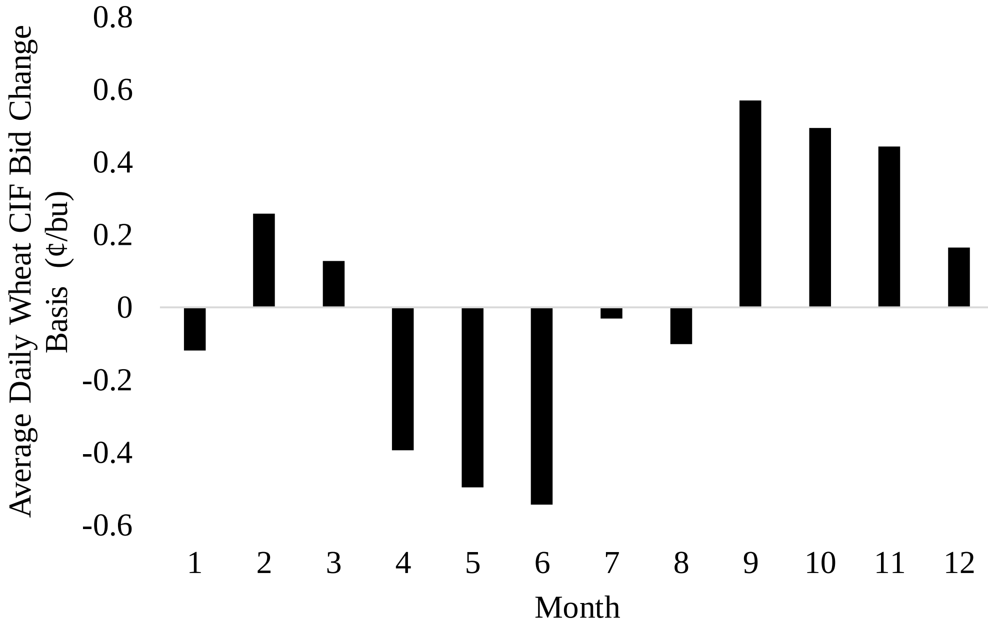

Figure 8. Average daily change in wheat CIF NOLA bids by month.

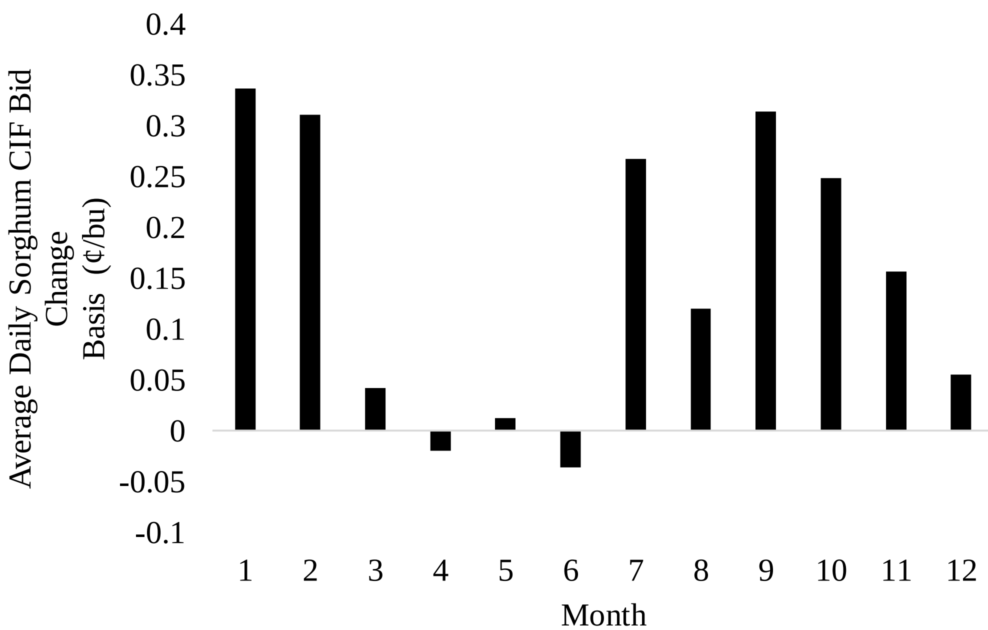

Figure 9. Average daily change in sorghum CIF NOLA bids by month.

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, CIF NOLA forward contracts are 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 complete 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.

References

Brorsen, B.W., K. Anderson, and J. Coombs. 1995. "The Cost of Forward Contracting Wheat." *Agribusiness: An International Journal* 11, no. 4: 349-354.

Davila, Niki. 2016. *Gulf export bids and basis for grain delivered to gulf export elevators.* United States Department of Agriculture, Agricultural Marketing Service: USDA Market News Service, BG_GR110.

Dixon, W. J., and A. M. Mood. "The Statistical Sign Test." *Journal of the American Statistical Association* 41, no. 236 (1946): 557-66.

Elam, Emmett. "Cash Forward Contracting versus Hedging of Fed Cattle, and the Impact of Cash Contracting on Cash Prices." *Journal of Agricultural and Resource Economics* 17, no. 1 (1992): 205-17.

Goodwin, B.K., and N.E. Piggott. 2001. "Spatial market integration in the presence of threshold effects." *American Journal of Agricultural Economics* 83, no. 2: 302-317.

Kaldor, Nicholas. "Speculation and Economic Stability." *The Review of Economic Studies* 7, no. 1 (1939): 1-27.

Keynes, John Maynard. 1930. "A Treatise on Money: Vol II, The Applied Theory of Money." n.p.: New York: Harcourt, Brace and Co., [1930], 1930.

Kolb, R.W., and G.D. Gay. 1983. "The Performance of Live Cattle Futures as Predictors of Subsequent Spot Prices." *Journal of Futures Markets* 3, no. 1: 55-63.

Lewis, K. E., Altman, I. J., Manfredo, M. R. and Sanders, D. R. 2015. Risk Premiums and Forward Basis: Evidence from the Soybean Oil Market. *Agribusiness*, 31: 388–398.

Mallory, M. L., Zhao, W. and Irwin, S. H. 2015. The Cost of Post-Harvest Forward Contracting in Corn and Soybeans. *Agribusiness*, 31: 47–62.

McKenzie, Andrew M. 2005. "The Effects of Barge Shocks on Soybean Basis Levels in Arkansas: A Study of Market Integration." *Agribusiness* 21, no. 1: 37-52.

McKenzie, A.M. and M.T. Holt. 2002. “Market Efficiency in Agricultural Futures Markets.” *Applied Economics* 34(12): 1519-1532.

Miller, Stephen E. 1986. Forward contracting versus hedging under price and yield uncertainty. *Southern Journal of Agricultural Economics* 18 (2): 139.

Nelson, Ray D. 1985. "Forward and Futures Contracts as Preharvest Commodity Marketing Instruments." *American Journal of Agricultural Economics* 67, no. 1: 15-23.

Taylor, Mykel R., Glynn T. Tonsor, and Kevin Dhuyvetter. 2014. “Structural Change in Forward Contracting Costs for Kansas Wheat.” *Journal of Agricultural and Resource Economics* 39 (2): 229.

Townsend, J. P., and B. W. Brorsen. 2000. “Cost of Forward Contracting Hard Red Winter Wheat.” *Journal of Agricultural and Applied Economics* 32, no. 1: 89–94.

USDA. 2017. Grains inspected and/or weighed for export by region and port area, 2016. Market News Service, WA_GR152.

Wilcoxon, F. "Individual Comparisons by Ranking Methods." *Biometrics Bulletin* 1, no. 6 (1945): 80-83.

Appendix A. CIF NOLA Daily Report Example

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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
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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
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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

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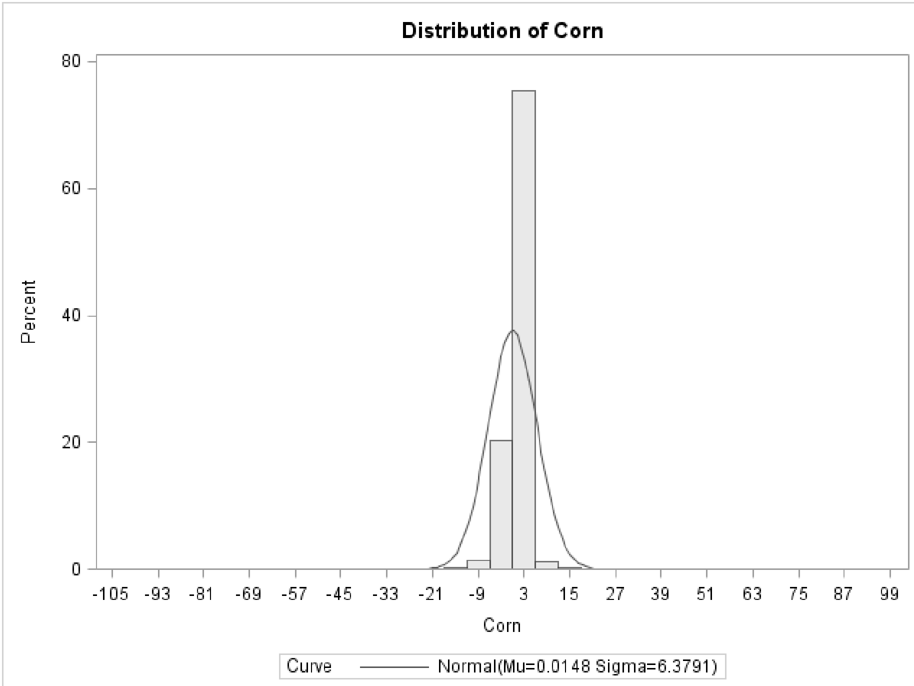
Appendix B. CIF NOLA Bid Data Distributions

Corn

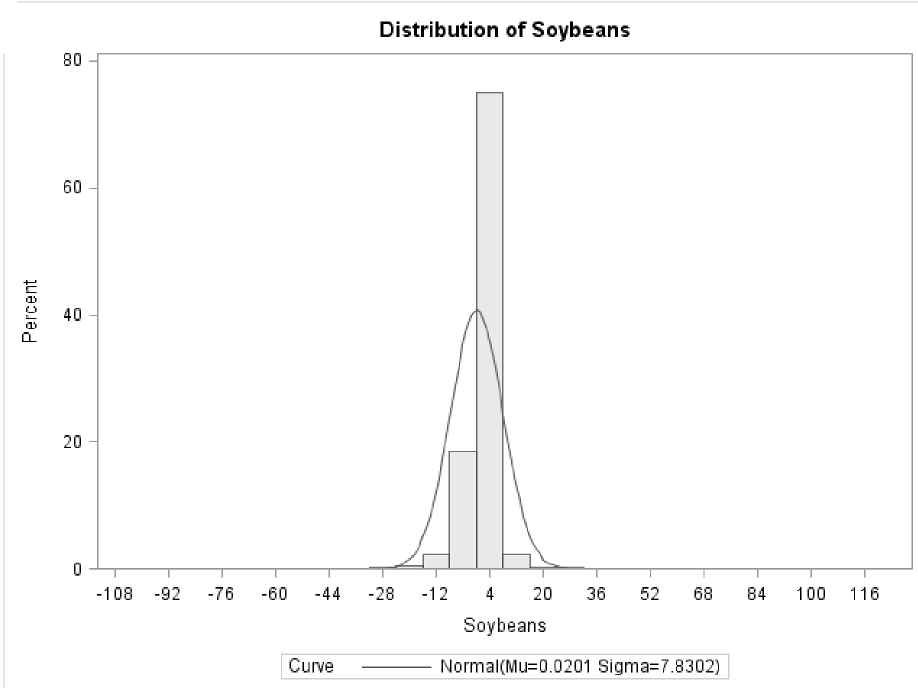


Quantiles N = 9413	
Level	Quantile
100% Max	100
99%	9
95%	3
90%	2
75% Q3	1
50% Median	0
25% Q1	0
10%	-2
5%	-4
1%	-10
0% Min	-104

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

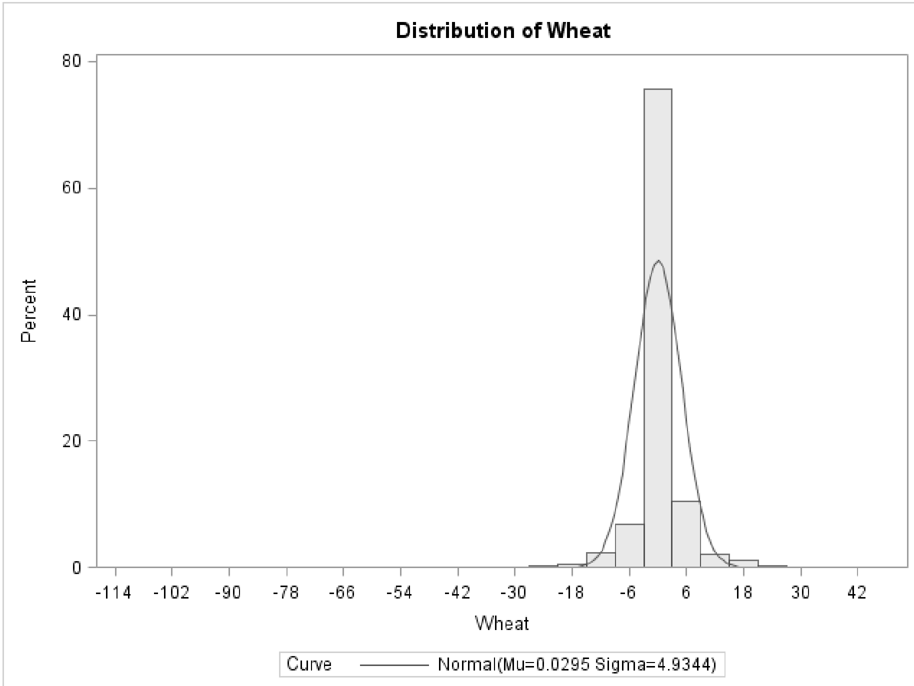


Quantiles N = 9810	
Level	Quantile
100% Max	125
99%	15
95%	5
90%	3
75% Q3	0
50% Median	0
25% Q1	0
10%	-3
5%	-6
1%	-18
0% Min	-106

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

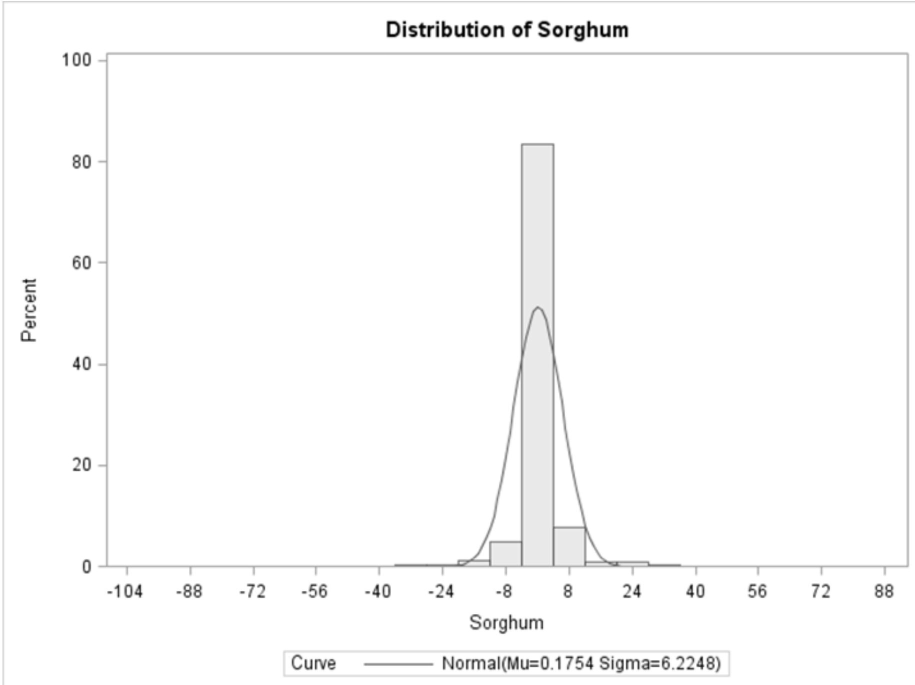


Quantiles N = 9327	
Level	Quantile
100% Max	50
99%	15
95%	5
90%	5
75% Q3	0
50% Median	0
25% Q1	0
10%	-4
5%	-5
1%	-18
0% Min	-115

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

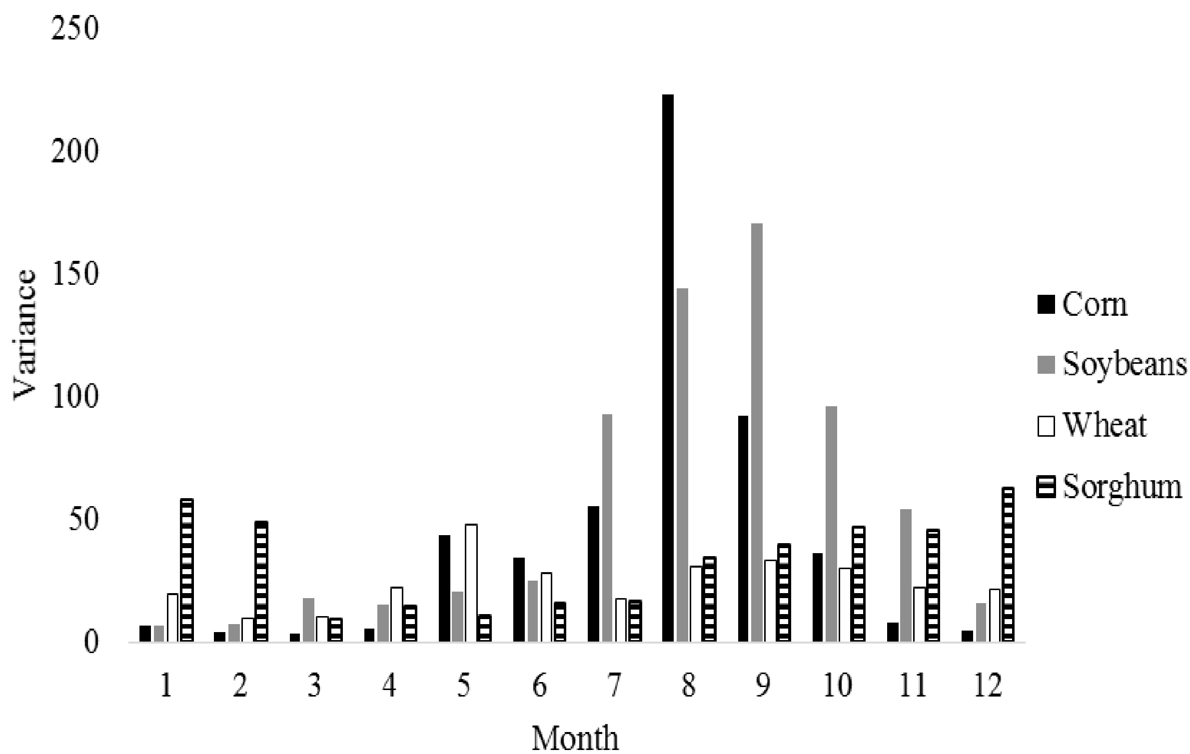


Quantiles N = 5828	
Level	Quantile
100% Max	90
99%	20
95%	5
90%	3
75% Q3	0
50% Median	0
25% Q1	0
10%	0
5%	-5
1%	-20
0% Min	-105

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 of CIF NOLA export bids by month



IV. Conclusions

With analyses of both the Mississippi River barge freight market and the CIF NOLA forward market complete, a more accurate picture of the workings of this system is available. The interdependence of the two markets has been illustrated as well as the unique characteristics that define each market.

The Mississippi River barge freight market is described in detail, outlining the specifics of barge transportation including contract terms, vessels dimensions, and travel times. Then, an empirical analysis is performed, determining that significant costs of forward contracting exist, and that depending on the season in which the transportation is needed, the party paying the cost varies. For the Twin Cities location, the cost of forward contracting is paid by the seller of the barge freight in every season. However, for every other location, the seller of the barge freight only pays this cost during the summer season, season 2, while the buyer of the barge freight pays a cost of forward contracting during seasons 1 and 3. This means that elevators purchasing barge freight can receive freight costs in this forward market that are lower than the subsequent spot price for barge freight at the time of delivery, on average, during seasons 1 and 3. But, during season 2 this is reversed, meaning forward prices are higher on average than subsequent spot prices. This suggests that firms should purchase freight in the spot market during seasons 1 and 3 and in the forward market during season 2 to minimize transportation costs, on average. Data detailing the volume of barges unloaded at the port of New Orleans by month, as well as the number of up-bound empty barges by month is then provided as evidence to explain this pattern of varying costs of forward contracting. The conclusion being that costs are paid by the seller during periods of low volume, while costs are paid by the buyer during periods of high volume.

The CIF NOLA market is explained and evidence is provided to support the claim that the forward market functions in a manner similar to a futures market. Positions can be offset before delivery so that contracts can be used simply as a means of risk management without physical delivery. Furthermore, the settlement process is described as distinct from either traditional forward or futures contracts. Empirically, we find that significant costs of forward contracting exist in the sorghum market, however, contracts for corn, soybeans, and wheat have little or no cost of forward contracting associated with their use. A possible explanation for this pattern is provided through data on the volume of each commodity exported from the port of New Orleans annually. The volume of corn, soybean and wheat exports each vastly outnumber the volume of sorghum exports. This volume in corn, soybean, and wheat contracts likely provides efficiency to this liquidly traded forward market, removing any costs of forward contracting potentially associated with their use. This implies that for these three commodities the CIF NOLA forward market can be used as a means of price risk management without paying embedded costs of forward contracting which are typical of typical farmer-elevator forward contracts.

Together, these two studies provide a detailed description and analysis of the existing system of moving grain down the Mississippi River system to the port of New Orleans for export. The institutional details of the markets are described and empirical analyses are performed to show how these markets perform their functions and provide potential strategies for their use.