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Corn Futures Deliveries: *Why? When? So What?*

Vitor M.O. **Fernandes**, University of Illinois at Urbana-Champaign, vitorm2@illinois.edu
Eugene L. **Kunda**, U.S. Commodity Futures Trading Commission, elkunda@cftc.gov
Michel A. **Robe**, University of Illinois at Urbana-Champaign, mrobe@illinois.edu

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Vitor M.O. Fernandes, Eugene L. Kunda, Michel A. Robe*

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ABSTRACT

Grain and oilseed futures deliveries facilitate convergence by allowing for arbitrage between the physical and paper markets. We investigate theoretically and empirically what drives deliveries and their timing, and the possible feedback on futures prices when deliveries happen.

We first explain the delivery process in detail, including the key role of Shipping Certificates. We then introduce the concept of Delivery Value Equivalent (DVE) as a framework for the decision-making process of whether a trader should "go for delivery." Utilizing CBOT #2Yellow Corn futures prices, NOLA CIF basis quotes, and Delivery Zone3 barge rates for all 576 delivery days from January 2011 to April 2021, we use the DVE framework to elucidate why and when corn futures deliveries take place and their magnitudes, and to ask if the publication of information regarding intentions to deliver affects calendar spread prices.

We show that the difference between the NOLA basis and the DVE is significant in explaining the occurrence and the number of deliveries. Physical market conditions and inventory levels (proxied by the market carry at the start of the delivery period) are essential to explaining whether deliveries (and thus convergence) begin early or late in the delivery period. Finally, we do not find evidence that the release of information regarding new Shipping Certificates impacts calendar-spread returns.

Keywords: Commodity futures, Deliveries, DVE, Certificate, Registration, DCUR, Price impact

JEL Codes: Q02, G13, Q13, G14, Q17

I. Introduction

As noted by Hieronymus (1977), futures contracts are generally entered into for reasons other than origination of the underlying commodity. Hieronymus refers to the futures market's purpose as a tool for hedging and for price discovery. However, for participants to transfer risk between each other through futures trading, and for futures to transmit price signals efficiently, a functional price relationship must exist between the futures and the cash commodity markets. Such is the role of convergence.

For corn futures, convergence is ensured by the fact that a player who stays in the market will eventually be able to exchange his long position for the actual cash grain—or something close to it—and *vice versa* for the short. On the one hand, the specific obligations of the parties to this transaction need to be made clear—both to preserve the above functional relationship and to improve liquidity. On the other hand, if the specifications regarding what exactly fulfills expectations are too restrictive (with respect to commodity grade, delivery location, etc.), then the contract might end up not embracing as broad a range of participants as it should and, as a result, it might fail (Pirrong, Haddock and Kormendi, 2012). Accordingly, the rules for exchanging between the financial instrument and the physical commodity are designed to be flexible enough to allow for different delivery locations, grades, and days (and define the compensation for such variations). To this exchange is given the name of "delivery."

The extant literature analyzes the delivery system for futures markets mostly (i) through the light of various options embedded in the contract specifications or (ii) in the context of understanding periods of non-convergence between futures and cash prices. The first strand of research relates to the fact that a seller (or "short futures position holder") has a number of advantages in comparison to the buyer ("long") when it comes to using the agricultural futures market as a merchandising tool. Peck and Williams (1992) and Hranaiova, Jarrow, and Tomek (2005) are contributors to this part of the literature. The second issue (convergence) became a hot policy and research topic a dozen or so years ago, after the futures and cash prices had failed to meet in numerous instances in the soybeans (CBOT) and wheat (CBOT, KCBT) markets—with soybeans futures sometimes expiring as much as 35 percent above cash. Aulerich, Fishe and Harris (2011) and Garcia, Irwin, and Smith (2015) are key contributors to this second body of work.

In the present paper, we seek instead to explain why and when deliveries happen, and to identify the consequences for futures prices when they do take place. We introduce the framework of the Delivery Value Equivalent (DVE), a concept from the grain trading business (*e.g.*, GSC 2011), that involves the possibility of using futures contracts as a means of facilitating physical trades. We estimate the DVE daily from January 2011 through April 2021 for the world's largest (FIA 2021a, 2021b) agricultural futures, the

CBOT #2 Yellow Corn futures, utilizing actual barge rates and contract specifications. We then compare the DVE estimate to the observed New Orleans (NOLA) CIF basis, and we show that the possibility of arbitrage based on the difference between the NOLA CIF basis and the DVE helps to explain intentions to deliver. This finding is strengthened—explaining all but 2 of 352 delivery episodes in our sample—by explicitly incorporating, into the computation of the no-arbitrage band, (a) approximations of the value of embedded options and (b) possible freight-cost measurement errors. Next, we show that the tightness of inventories, captured by the extent of market carry, is relevant to the timing of when deliveries begin (early *vs*. late in the two-week delivery period). Finally, we investigate whether an increase in intentions to deliver affects the price relation between the front-month and first-deferred futures. Notably, we do not find evidence that the close-to-next-open change in the nearby calendar spread price is significantly impacted by the exchange's publication (between the day-session close and the next-day night-session open) of information regarding new Shipping Certificates.

The paper is organized as follows. Section 2 reviews the literature related to the delivery of grain and oilseed commodity futures and other financial instruments. It starts by briefly describing the CBOT corn futures delivery system before turning to contract-embedded options, in particular options that are related to location, timing, and quality. It then discusses the process of futures-cash price convergence, how price convergence relates to those embedded options, and how convergence issues have affected the wheat and soybean markets more than the corn market (on which this paper focuses).

Section 3 describes in detail the delivery system for CBOT grain and oilseed futures. It explains how deliveries are made and the role of the delivery instrument (called Shipping Certificate) in connecting the cash and futures markets. Next, it explains the delivery period and illustrates the delivery process. It also introduces regular firms, and a map showing the delivery zones and their respective characteristics. Last, it discusses the advantages and disadvantages of the delivery system in its current form.

Section 4 builds on Sections 2 and 3. It develops the concept of the Delivery Value Equivalent (DVE), and it explains how the DVE framework relates (i) to the possibility of arbitrage between the futures and cash markets and (ii) to whether deliveries should be expected or not. It then describes how one should expect the relation between cash and futures prices to impact the timing of deliveries and thus the timing of convergence. It also raises the question of whether the deliveries themselves could feed back into the futures prices by impacting the futures calendar spreads. In all, Section 4 develops the three hypotheses that we formally test in Section 6 using data from Section 5.

Section 5 describes the data. It starts by describing salient features of the cash and CBOT futures markets for yellow corn. It provides context by comparing, throughout our sample period, futures prices with NOLA cash prices, NOLA CIF basis with barge freight rates, and number of Shipping Certificates outstanding with intentions of delivery. It also describes carry patterns in our sample, and the behavior of calendar spreads during the delivery periods.

Section 6 presents our statistical analyses. It establishes empirically that the DVE *vs*. NOLA basis framework helps explain the occurrence and timing of corn futures deliveries, and it shows that the results are strengthened by accounting for measurement errors and the value of embedded options. Next, it documents a link between physical market conditions (summarized by inventory levels and proxied by the futures term structure slope) and the timing of deliveries. Finally, it provides evidence regarding whether deliveries feed back into futures prices.

The last Section discusses the implications of our results and their limitations. It also provides suggestions for further research.

Terminology

To keep the discussion in the remainder of this paper clear and concise, we start with the definitions of several terms employed throughout the text:

1. **CIF**: "Cash, Insurance, Freight". CIF is a term commonly used in the context of freight transport that means the seller is responsible for moving the goods to the destination—see Appendix A for details. In this paper, the CIF price we use is the New Orleans CIF price, denoted CIF NOLA for short. CIF NOLA thus implies that the seller is responsible for taking the goods it has sold all the way to New Orleans.

2. **Basis**: The price difference between a grain's cash and futures prices in the form of:

$$\begin{aligned} Basis \;=\; & cash\ price\ at\ a\ specific\ location\ and\ quality \\ & - futures\ price\ with\ a\ specific\ expiration \end{aligned}$$

   In this paper, unless specified otherwise, the basis refers to the difference between the CIF NOLA #2 Yellow Corn futures price and the front-month futures price (denoted CP - F_1). Accordingly, we use the terms "CIF basis" and "basis" interchangeably when the context justifies the omission of "CIF".

3. **Spread**: Short for "calendar spread". The price difference between two equivalent futures contracts on the same commodity but with different expiration dates, in the form of:

$$Spread\ =\ closest\ to\ expiration - furthest\ from\ expiration$$

In this paper, unless specified otherwise, the spread refers the difference between the front-month and the first deferred futures (*i.e.*, $F_1 - F_2$).

4. **Negative/positive spread**: Since the spread is calculated by subtracting the price of the deferred contract from that of the nearby, if the market is in carry (contango), then the spread must be negative. Otherwise, if the market is inverted (backwardation), then the spread must be positive.

5. **Weaker/stronger spread**: A spread becomes "stronger" if it becomes less negative (contango) or more positive (backwardation). Likewise, it gets "weaker" by becoming more negative (contango) or less positive (backwardation). This terminology is used interchangeably with "widen/narrow".

6. **DCUR**: Deliverable Commodities Under Registration, i.e., the number of delivery instruments (Shipping Certificates) that are outstanding across all corn futures delivery locations at one point in time.

7. **Taker / stopper:** Someone who "stopped" a contract is someone who had a long futures position and stood for delivery, thus "taking" (accepting the delivery of) a Shipping Certificate.

8. **Maker / issuer:** An "issuer" is a trader who had a short futures position and subsequently "made" the delivery of a Shipping Certificate. Note that, in this context, "issuer" does not refer exclusively to regular firms, which are the only market participants allowed to register new Shipping Certificates with the Exchange Registrar—see Section 3 for details.

2. Literature Review

In this Section, we review the prior work regarding deliveries of futures contracts on commodities and (if relevant) on financial instruments, and we describe how we extend this literature. First, we describe the literature on the workings of the delivery system for CBOT commodity futures, and we introduce market participants and dynamics. Second, we discuss the literature on the embedded options that are intrinsic to the delivery system and that are central (i) in the decision process for making or taking delivery as well as (ii) for earning an economic return. This topic has been explored extensively for futures on both commodities and financial assets: we focus here on the work most directly related to this paper. Last, we turn to the literature on convergence. Because convergence is the whole purpose of deliveries' existence, this literature grew significantly in the past decade following numerous episodes of non-convergence between futures and cash prices (mainly in the U.S. soybean, soft red winter, and hard red winter wheat markets).

Only a small fraction of all the commodity futures contracts that are entered into is delivered and converted into cash. As Hieronymus (1977, pg. 340) notes, a "futures contract is a temporary substitute for an eventual cash transaction. In markets that work, delivery is rarely made and taken; futures contracts are entered into for reasons other than exchange of title." Nevertheless, deliveries do happen.

The terms for delivery of a futures contract specify the precise types and grade of the underlying deliverable, and the possible locations and times of delivery that must be met so as not to default on an outstanding contract (Pirrong *et al*., 2012). For CBOT corn, delivery at non-par locations is possible under fixed premiums or discounts specified by the contracts. If there existed something like costless delivery then, for a given place and a specific time, arbitrage would force the cash and futures prices to converge exactly at the expiration of the contract: if they were not the same, then market agents would buy what is cheaper and sell what is dearer, delivering or getting deliveries depending on the situation. This kind of riskless profit should prevent the law of one price from being violated. As such, both the holders of long positions and the holders of short positions should be indifferent to offsetting their futures positions rather than going or standing for physical delivery, and thus only a minimal number of actual deliveries would be needed (Garcia, Irwin, and Smith, 2015).

Of course, reality is more complex. In the case where the futures contract allows for several options of delivery (as is the case for CBOT corn futures), the short has the right to choose the "cheapest-to-deliver" date, location, and grade—that is, the cheapest possible alternative to satisfy the delivery obligations (Stulz 1982; Johnson 1987). While the cost of making a delivery may vary over time and space (Hranaiova *et al*., 2005), both the long and the short incur costs through the delivery process, which gives rise to no-arbitrage bands rather than exact equalities (Garcia *et al*. 2015).

For CBOT corn futures, deliveries are not made with the actual underlying commodity but rather with a financial instrument called a "Shipping Certificate." These "Certs" are issued by commercial firms registered with the exchange (the so-called "regular firms"). They are "Call on Demand" instruments that do not "require the short to hold grain at a warehouse, but rather to have grain readily available when called for load-out at a specific place and time defined by the exchange." In other words, Shipping Certificates are purely financial instruments that represents the link between the futures deliveries and the physical grain market (Joseph, Irwin, and Garcia, 2016, pg. 168). Because they are financial instruments, the Shipping Certificates can be traded—although there is no centralized market for those instruments. In turn, the receivers of deliveries are not required to cancel out the Shipping Certificates for load-out. Instead, a market participant who holds this instrument can either (i) hold the Cert while paying for storage; (ii) sell the Cert a combined price; (iii) use the Cert to fulfill a short futures position; or (iv) cancel the Cert and load the grain out (Irwin, Garcia, Good, and Kunda, 2011). Section 3 describes the delivery system in more detail than can be found in the extant literature, including the options available to the short and the long. As such, it provides the necessary foundation to understand the DVE framework developed in Section 4 and tested in Section 6 with data from Section 5.

Peck and Williams (1992, pg. 66) describe the decision-making process for deliveries as follows: "The decision whether to initiate delivery from available deliverable stocks depends upon the expected returns net of costs from doing so. Returns from delivery come from any difference in the futures price relative to the current market cash price (plus or minus premia or discounts for specific locations or grades, as applicable, and net of exchange-approved loadout fees) and the anticipated official warehouse returns from storage until the receipts are cancelled. Other things equal, a firm with grain in deliverable position will deliver proportionately more of its stocks the less is the cash price premium relative to the expiring future (*i.e*., the more the current cash price is below the futures price). The costs of continued ownership are interest and physical storage costs net of value attached to ownership and control of the stocks. Working (1948) identifies the benefit as the convenience yield; Williams (1986) describes it as the rental value of the commodity. Similarly, it can reflect the merchandizing opportunities of that specific lot. Other things equal, a firm will deliver more the higher its costs of storage and the less its yield from ownership."

When it comes to market dynamics, the relationship between cash and futures prices is essential to the understanding of how market participants operate. There is a temporal aspect to it and a spatial aspect to it. The first is simple: it is about the need to store the commodity for expected later use, which entails storage and interest costs. For the spatial aspect, grain located in a geographically distant region can be hedged in the Chicago futures market provided prices at the non-delivery region have a functional relation with the delivery regions. Transportation is the means that interconnects these prices, with grain merchants taking corrective action if prices fall out of equilibrium (Hieronymus, 1977).

Hieronymus (1977) also emphasizes that futures markets are not means for the principals in trades to make money. Rather, they are "tools for implementing speculative judgement and enabling specialization in some aspects of commodity trading while avoiding participating in others" (*ibid*., pg. 173). That author classifies the users of grain futures market as warehousemen and merchants, primary producers, users of raw materials, and speculators. Speculators simply wish to profit by riding favorable price movements, and do not view the underlying commodity as an end *per se* but rather as a speculating tool, independently of their willingness to handle it or not. Primary producers tend to go to the futures market as a means of hedging their natural long positions in the cash market. Merchants and users of raw material are similar in their demand for grain, but different in their ends. Since the regular firms registered with the exchange are also generally large integrated grain merchants, Hieronymus' extensive description of exporters is helpful in the context of our paper:

"Exporters buy grain, direct its movement to ports, load it aboard ships, and supervise its delivery to destination. Most grain (…) is sold CIF (cost, insurance, freight) destination ports. Exporters buy from terminal merchants and elevators, interior merchants, and country elevators.

In some seasons of the year, they accumulate supplies at a faster rate than they sell them and in others they sell faster than they accumulate. Thus, they sometimes have net long cash positions. These net positions are hedged in futures. Sales are always accompanied by hedge lifting in futures markets. The timing of hedge lifting against a large sale is an interesting tactical exercise. Large export sales are generally known in the market and the futures activities of exporters are closely watched by other traders. Their problem is to get the hedges out of the market without affecting the price. The ease with which they accomplish this feat depends upon the liquidity of the market (…).

One device that exporters use is the *ex*-pit exchange of futures. If the exporter is short futures and must buy in hedges when he sells (the physical), it may be that the purchasing importer is long futures. If so, they arrange an exchange and cancel the futures they hold. Exporters also remove hedges in anticipation of sales so that when sales are actually made, they are nearly, if not completely, through with pit activities." (Hieronymus 1977 pg. 197)

To the best of our knowledge, Peck and Williams (1992) are the first authors to formally ask the question of what should be considered "normal" when it comes to the level of deliveries on a futures market for physical commodities. Taking into consideration rule differences across five different commodity markets, those authors ask whether deliveries that can be considered large are linked to market problems or subsequent market failures. They answer the question empirically using 15 years of data (1974-1989) for five of the largest U.S. commodity futures markets that allow for physical delivery: Chicago Board of Trade (CBOT) corn, soybeans, and soft red winter (SRW) wheat; Kansas City Board of Trade (KCBT) hard red winter (HRW) wheat; and New York Commodity Exchange (COMEX) copper.

They observe that, although deliveries are limited by the amounts of stocks available, that constraint is relative because of redeliveries. A "redelivery" happens when a long market participant, who just stopped a contract, goes short futures, and uses the Shipping Certificate it received in the stop to fulfill that new short futures position (that is, to go for delivery). These redeliveries cause the total quantity of deliveries to be frequently multiples, rather than fractions, of the commodity stocks available in the delivery regions. Partly because of redeliveries, "variations in stocks account for only 30 per cent of the variation in wheat deliveries on the CBOT from 1972/73-1988/89, 45 per cent of the variation in corn deliveries from 1975/76-1988/89, and 50 per cent in soybean deliveries from 1979/80-1988/89." (Peck and Williams 1992, pg. 66). Including redeliveries, Peck and Williams find deliveries to represent 7 percent to 19 percent of the peak levels of open interest for agricultural commodities from 1973 to 1989; or 27 percent to 61 percent of the open interest right before the start of the delivery period. A later study by the CFTC (2005) report similar figures: deliveries represent 16.23 percent of the average month-end open interest for grain futures in 1999-2005. Our paper provides corn futures delivery figures for more recent years (2011-2021) while providing novel insights into why corn deliveries happen and how they vary over time.

Importantly, Peck and Williams (1992) also touch upon the subject of delivery-process embedded options. Those options relate to the alternatives that short participants have when exchanging their futures obligation for a delivery instrument. They are relevant for our work insofar as the value of those options affects the no-arbitrage band between cash and futures. Peck and Williams focus on three options: the act of delivery itself, since players can offset their positions if they do not want to deliver; timing, because the short decides when to deliver; and location, because the seller may choose between different delivery regions. Estimating models that relate the exercise of these indicators of economics value (for example spreads, basis, interest cost and available stocks), Peck and Williams conclude that these options have value and that the economic indicators they consider usually explain substantial proportions of the extent to which these options are exercised. We explain further below how we integrate those findings into our analysis.

Insofar as the delivery procedures for CBOT interest-rate futures (T-bonds and T-notes) are similar in many ways to those of CBOT grains and oilseeds futures, our paper is also related to a vast financial economics literature on financial futures. In a recent paper, Breton and Abdalla (2017) look at short traders' delivery strategies in the U.S. T-Bond futures market for the 1985-2016 period. In particular, they investigate the determinants of the delivery-timing decision.

After Peck and Williams (1992), Breton and Abdalla construct "a variable characterizing the delivery patterns in the U.S. T-Bond futures by computing the area under the curve representing the cumulated proportion of deliveries as a function of the proportion of time elapsed in the delivery month. This variable can be used to characterize delivery patterns with respect to an equal distribution over time" (Breton and Abdalla 2017, pg. 7). They find that, even though the sign of the basis on the first delivery day is correlated with early delivery, it is not the best predictor of the strategies applied by the traders. The authors attribute this to traders' expectations that the basis might move in a profitable direction, resulting often in late deliveries even when there are opportunities for immediate profits. Thus, what they call the "rule of thumb" that prescribes delivery at the first opportunity when the yield curve is negatively sloped is not generally applied by the shorts. We provide evidence that, in the corn market, the basis matters: deliveries tend to happen early in the 15-day delivery period when the market is contangoed and late when it is backwardated—still, in the same vein as Breton and Abdalla, we show that not all deliveries take place as early as would seem advantageous for a futures short to deliver.

Hranaiova *et al*. (2005) quantify the values of the timing and location options for 1989-1997 CBOT corn futures contracts. To evaluate the timing option alone, they use a binomial model; to evaluate the joint value of the options, they use a trinomial model. First, assuming a frictionless market and considering solely the timing option, the authors show that the payoff to early exercise always exceeds the payoff to waiting (which would rationalize Breton and Abdalla's "rule of thumb"). While the timing option alone is worth an average of 28 percent of the absolute value of the average basis (or 0.23 percent of the average futures price), the joint value of the timing and location options is only around 5 percent of the average basis on the first day of the maturity month for Chicago (more precisely, it averages 0.1 cents and ranges from 0 to 0.62 cents). For Central Illinois, they estimate an average option value of 0.15 cents, ranging from 0 to 0.72 cents. In other words, the value of the timing option is reduced by the presence of the location option.[1] In the present paper, we do not compute the value of the options in our sample period but instead

[1] After the end of period studied by Hranaiova *et al*. (2005), the CBOT allowed for several additional delivery locations, likely increasing the quantity of corn that could be delivered at a low cost. Still, based on those authors' results, the value of the joint options should remain small.

use the above estimates (as well as an estimate of the quality option, as described in the next paragraph) when computing no-arbitrage bands for deliveries.

In the corn futures market, the holder of a short position may deliver one of several grades. Peck and Williams (1992), however, note that it is not possible to value this quality option when the futures exchange does not keep record of the quality of the delivered commodities. In our analysis, we therefore rely on estimates for U.S. Treasury-Bond futures. Specifically, Boyle (1989) develops an extension of the put-call parity theorem after Stulz (1982) to arrive at estimates of the quality option depending on the assumed number n of deliverable assets (the number of different bonds allowed) and with the price correlation between them. With a high correlation of 0.995 between the prices of different assets, Boyle finds the embedded quality option's value to range from 0.86 percent to 3.39 percent of the price of the contract, a non-trivial value even for a scenario where $n = 2$. If the correlation coefficient is lowered to 0.95, the option value increases further, ranging from 2.73 percent to 10.4 percent of the price of the futures contract. We rely on the higher-correlation values for our empirical analysis.[2]

The options embedded in the CBOT corn delivery system helps explain the non-convergence of futures and cash prices observed for some U.S. grain and oilseeds markets in the past sixteen years: from 2005 to 2010, for example, soybean futures expired up to 35 percent above cash grain price (Garcia *et al*., 2015 pg. 40). Non-convergence is a critical problem, given that the futures market exists primarily for risk-shifting between parts and for efficient price discovery. Aulerich *et al*. (2011) provide evidence that the option to exchange the deliverable for a futures contract (that is, to use the deliverable to fulfill a short position in another futures contract, or an "exchange option") helps explain episodes of nonconvergence at expiration in the 2000-2008 period. Intuitively, when acquiring a long futures position, a trader agrees to pay the short for the commodity *plus* the value of the exchange option, thus increasing the futures price relative to the cash price and driving the two further apart when prices are more volatile (and the option is more valuable).

This result is complemented by Garcia *et al*. (2015), who use 1986-2013 data for CBOT corn, soybeans, and wheat, as well as KCBT wheat, to test a dynamic rational expectations model of commodity storage and explain, on an institutional basis, why and when the futures and cash markets may fail to converge. They show that, in a part of their sample period, the market price for physical grain storage continuously exceeded the (then-fixed) exchange-mandated maximum storage fee allowed by the contract

[2] Mansabdar and Yaganti (2020) replicate the analysis of Boyle (1989) for futures on Indian chana (a pulse crop). They find that the quality option embedded in the August 2014 contract is worth between 3.87 percent and 4.87 percent of that foreign commodity's futures price.

of the delivery instrument. They call this difference between the contractual (exchange-mandated) and market storage rates the "wedge" and they demonstrate, empirically and theoretically, that the level of non-convergence equals the expected present discounted value of a function of future wedges.

Lack of convergence makes for a problematic comparison between cash and futures prices. Moreover, it may affect the frequency of futures deliveries in a way that is difficult to model. Because the relation between futures prices and cash prices, as well as the number of deliveries, are central to our paper, we choose to perform our analysis for corn futures as that market is not only the largest agricultural futures market but is also the one that has witnessed the fewest convergence failures in our sample period (and none prior to 2018).

We also investigate the extent to which the occurrence and the timing of corn futures deliveries are related to market carry. In that respect, our findings are related to the work of Joseph *et al*. (2016) on the Working curve. Those authors investigate deliveries in the main CBOT and KCBT grains and oilseeds futures market, focusing on outstanding certificates figures during periods of inversion in the 1990-2010 period. Intuitively, speculators should not hold those tradable instruments while incurring storage fees and opportunity costs if the same can be purchased at a lower price sometime in the near future. The authors' prior was for no Shipping Certificates to be held amid backwardation "since they contain no immediate convenience yield gain", and thus for "the relationship between the certificates and the spreads" to look like "an 'L-shaped' curve rotated clock-wise (…) as opposed to the typical Working curve pattern for physical stocks with convenience yields" (*ibid*., pg. 168). Although they find that some certificates are in fact held during periods of inversion for both corn and soybeans, the authors conclude that these were negligible, with the Working curve appearing particularly clearly for KCBT wheat and soybeans. The authors reason that the justification for these outstanding certificates might be related to "strategic games" played at delivery defined by Peck and Williams (1991) and facilitated by the financial dimension of certificates.[3] Joseph *et al*. (2006) focus their analysis on the canceling of certificates during and after the delivery period. In the present paper, we focus instead on the issuance and delivery of certificates in the delivery period only, and then we connect early and late deliveries to the market's term structure. To our knowledge, our study is also the first to investigate whether deliveries can in turn feed back into the level of carry.

[3] Participants' expectations, as well as prices being at a level where selling or cancelling the certificates would result in significant loss, may have induced the owners to hold on to their positions.

3. The Delivery Process

This Section provides a detailed description of the delivery system for Chicago Board of Trade grain and oilseed futures contracts.

a. Delivery Process and Instruments in U.S. Grain and Oilseed Futures Markets

As noted in the Introduction, commodity futures markets are primarily tools to provide participants with the means for price risk transfer (hedging), price discovery, and capital allocation. The terms involved in a futures contract are all standardized and strictly fixed with one exception: the price. These terms are the delivery territory, the period of delivery and deliverable grades. All futures contracts have expiration dates, implying that all futures positions are, by definition, temporary.

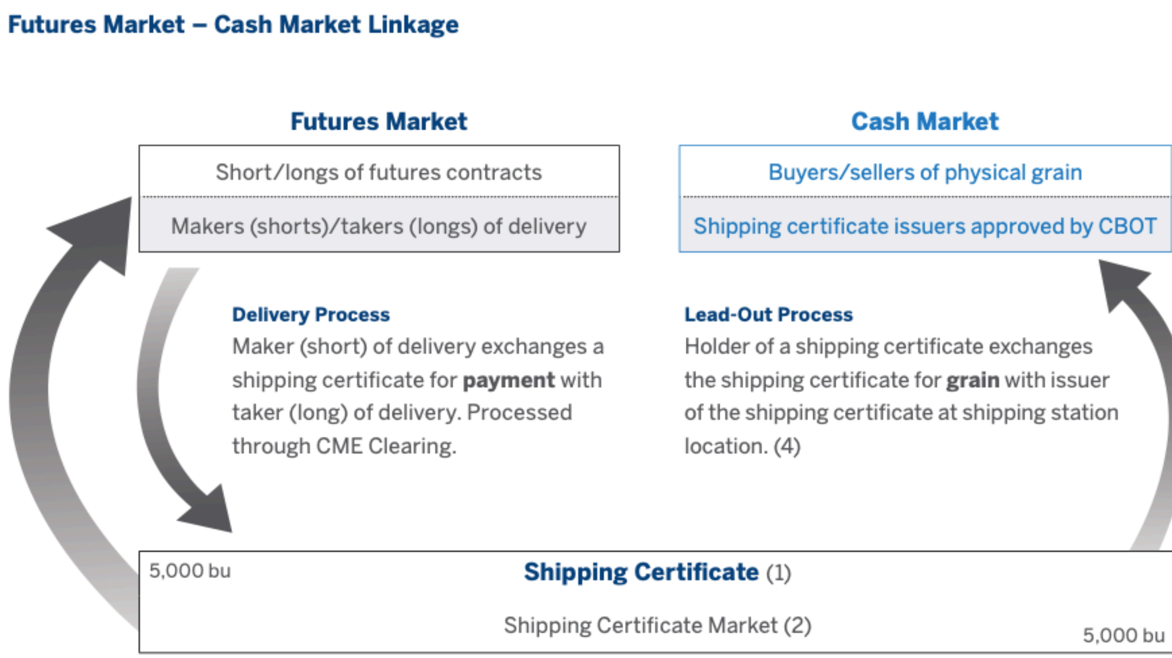
We can categorize futures users as speculators and hedgers. Hedgers take positions on the futures market to "counterbalance" opposite equivalent positions in the cash market (with the expectation that gains in one should help offset losses on the other). Speculators take naked futures positions with the expectation of profiting from favorable commodity price movements. For both types of players' expectations to be met, there needs to be a strong link between the cash markets in the specified delivery territories and the futures market.

When such a connection functions properly, both long and short futures will be indifferent between offsetting their positions in the futures market or making/taking delivery—that is, futures need not serve commodity merchandising needs. However, if the futures price is greater than the combined cash price and delivery transaction cost, then the holder of a short position will strictly prefer to make a delivery. If the situation is the opposite (with the futures price being less than the cash plus the costs of receiving a delivery), then a long would strictly prefer to get delivered.

Mostly, traders do not go as far as delivery, offsetting their positions prior to the beginning of the delivery period. When a delivery *is* made, it is up to the holder of the short position to initiate it at any point in the delivery period (for corn futures, the last two weeks of the life of a contract). If the long wants to force a delivery, it cannot do so for most of the delivery period: it must keep open the futures position until the last trading day (LTD), when prompt-month futures positions cannot be offset anymore. The delivery period and the three-day delivery process are described in detail in section 3.2.

As mentioned in Section 2, the instrument of delivery for CBOT grains and oilseeds futures contract is not the underlying commodity itself, but rather a Shipping Certificate. This Certificate gives its holder the right, but not the obligation, to load out the underlying commodity from a shipping station belonging to or controlled by the specific firm that issued the Certificate. This Certificate connects the futures and cash markets for Dry Distillers Grain (DDG), ethanol, rice, soybean meal, oats, soft and hard red winter wheats, soybean, and—our focus here—corn futures contracts. Figure 3-1 illustrates how the delivery instrument (the Shipping Certificate) links the futures and cash markets.

Figure 3-1: How the Shipping Certificate links the futures market and the cash market.



Source: CME Notes: Corn and Soybeans Delivery Terms (2017, pg. 7)

Someone who has stopped (*i.e.*, taken delivery of) a futures contract has the following options as the holder of a Certificate:

(1) Hold the Shipping Certificate for as long as it would like, paying the contract-defined storage charges for as long as it holds the delivery instrument.[4] The ability to demand load-out at any time is an advantage to the Cert holder, and a liability to the issuer.

[4] Storage charges for corn and soybeans were, for many years (including throughout most of our sample period), set at $0.00165/bushel/day. On July 10, 2018, the CME Group announced that the monthly storage rate would increase from approximately 5 cents to approximately 8 cents per bushel per month ($0.00265/bushel/day), starting with the November 2019 soybean (SX19) and December 2019 corn (CZ19) futures (CME Report SER8198:

(2) Sell the Shipping Certificate in a separate market at a negotiated price (there is no centralized market for Certs, but brokers can be found);

(3) Sell a futures contract and redeliver the Shipping Certificate by declaring an intention of delivery, through the process described above. A buyer who receives a delivery instrument can acquire a short futures position either in the current month or in a protracted one and use this Certificate to fulfill that short position.

(4) Load out the physical commodity and "cancel" the Shipping Certificate. In that case, the holder surrenders the Cert to the exchange, which takes it out of existence. Concomitantly, the owner hands the shipper or warehouse operator written orders identifying the conveyance (train, barge, or vessel) that will take delivery of the grain, along with the specific grade and estimated number of bushels involved. It is the Cert owner's responsibility to arrange proper conveyance for the grain about to be loaded out. It is the shipper's responsibility to order conveyance to the shipping station for actual placement. Loading-out must begin "within three business days from receiving the load-out orders or within one business day of the constructive placement, whichever occurs later" (CBOT Rule Book, Chapter 7, Section 703.C.A), at the shipping station's registered daily loading rate. Observation of the official weights and grades complete the final settlement charges.

To be able deliver, the short must control a Shipping Certificate. A Cert can be issued/registered only by firms that have been approved by the exchange as "regular for delivery". Thus, a "regular firm" is the only source for all the Certificates related to its own facilities and shipping stations; and only regular firms may perform an original delivery. If any other short position holder wishes to make a delivery, then it must acquire a Shipping Certificate either (a) from a regular firm or (b) in the secondary market.

Regular firms must control shipping stations within the delivery regions specified by the futures contract (*i.e.*, by the exchange). They are allowed to register certificates in accordance with these stations' loading capabilities, and the details of the load-out procedures are also specified by the futures contract.

Apart from the station ownership (or, at a minimum, station control) requirement, a firm that wants to be regular for delivery must meet additional physical and financial requirements that are specified

https://www.cmegroup.com/content/dam/cmegroup/notices/ser/2018/10/SER-8198RRR.pdf, dated October 23, 2018). In contrast, the storage charge for CBOT wheat has for over a decade been based on a Variable Storage Rate calculation dependent upon the percent of full-carry between the nearby and next-deferred futures contracts.

in Chapter 7 of the CBOT Rule Book. The supplementary requirements for contracts whose delivery instrument are Shipping Certificates are the following:

- The firm must possess a minimum net worth of $5 million.
- The firm must obtain a letter of credit payable to the Chicago Board of Trade for 110 percent of the value of its Shipping Certificates outstanding and maintain at least 100 percent of the value.
- The firm must limit the number of Shipping Certificates issued to at most 20 times the registered daily rate of load-out.
- The value of the Shipping Certificates issued must not exceed 50 percent of the firm's net worth.
- The firm needs to meet storage and daily load-out capacity requirements.

Trading of a CBOT grain or oilseed futures whose delivery instrument is a Shipping Certificate may continue into the delivery month, with CBOT grains and oilseeds contracts trading until the last business day before the 15th calendar day of the delivery month. That is because a Certificate may be carried through time without its owner's loading out the underlying commodity. For example, the September 2021 corn futures contract traded through Tuesday, September 14th, 2021. Also noteworthy is the fact that both the corn futures and its Shipping Certificates trade simultaneously (although in separate markets) until the futures expires, in which case the Certificates would continue to exist until canceled for load-out.

b. The three-day delivery process

Figure 3-2 summarizes the following process and uses a specific terminology:

- The First Intention Day (for shorts)/First Position Day (for longs) is the penultimate business day preceding the beginning of the delivery month in calendar terms (in the middle of which the futures contract is set to expire). At the close of trading that day, all longs must report their positions to the exchange's clearinghouse so that the latter can rank them from oldest (established the earliest) to youngest (established the latest). By 4 PM that day the shorts may, if they so desire, initiate delivery by notifying the exchange's clearinghouse of their intent to make delivery. The First Position Day (FPD) is thus an important date in the life of a CBOT corn futures contract since all outstanding longs become exposed to the risk of being assigned deliveries. Longs who do not want to risk being delivered a contract must either leave the market (by offsetting their nearby-futures position) or roll their positions (into the next contract month) before the close of trading that day. For the September 2021 corn futures, for example, the FPD was Monday, August 30th, 2021.

Importantly, the Spot-Month Speculative Position Limit comes into effect at the close of trading on First Position Day. This tighter limit means that speculative positions larger than the specified maximum need to be offset, and so the price limit that otherwise restricts daily price movements is removed for the remaining of the life of the contract. The invoices related to deliveries are priced at the settlement price on Intention/Position Day. When intentions of delivery are made, their volumes are discounted from the open interest.

- The First Notice Day is the business day preceding the first calendar day of the delivery month. On that day, the exchange clearinghouse matches sellers who have declared their intention of delivery to the buyers carrying the oldest outstanding positions. Shorts must submit invoices to the buyers, requesting payment for the delivery instruments. For the September 2021 corn futures contract, the FND was Tuesday, August 31st.
- The First Delivery Day is the first business day of the delivery month. The long must pay the invoice and the short must hand in the Shipping Certificate. For the September 2021 corn futures contract, the FDD was Wednesday, September 1st.

This three-day cycle repeats itself through the last day of trading for the contract, which is the last business day before the 15th calendar day of the delivery month. The terms used to describe the last three-day cycle of the delivery period are the following:

- Last Position Day, which is also the last trading day for the futures contract. In our September 2021 corn futures example, that would be Tuesday, the 14th of September.
- Last Notice Day, which is the first business day following the last trading day (Wednesday, the 15th of September for our example);
- Last Delivery Day, the second business day following the last trading day (Thursday, the 16th of September in our example).

For the September 2021 corn contract, a short position holder could initiate delivery at any time during the delivery period beginning on First Position Day (August 30th) and continuing through the Last Position Day (September 14th). A long position holder could be assigned delivery by the clearinghouse at any point between the First Notice Day (August 31st) and the Last Notice Day (September 15th). Finally, a

Shipping Certificate could be delivered any day between the First Delivery Day (September 1st) and the Last Delivery Day (September 16th).

Traders who still hold position at the futures market following the expiration of trading for a particular contract must either settle these positions through delivery no later than the Last Delivery Day or liquidate the positions by means of a *bona fide* exchange of futures for the actual cash commodity (EFP) no later than the business day following the last trading day.

Figure 3-2 – Delivery Period schedule for corn and soybeans

Deliver Month Trading Schedule for Corn and Soybeans

MARCH 2000						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	First Position Day	First Notice Day	1 First Delivery Day	2	3	4
5	6	7	8 Load-out begins three business days after the Deliver Day	9	10	11
12	13	14 Last Trading Day	15 Last Notice Day	16 Last Delivery Day	17	18
19	20	21	22 Load-out continues for a maximum of 30 days	23	24	25
26	27	28	29	30	31	

Source: CME Notes: Corn and Soybeans Delivery Terms (2017, pg. 5)

c. Advantages and disadvantages of the delivery system

CBOT grain and oilseeds futures contracts are not particularly well designed to serve as tools for merchandising. First, CBOT corn, soybean, and SRW wheat futures are standardized at 5,000 bushels, so any individual with a cash position under that quantity will be unable to use it for merchandising. Second, a standard barge carries 55,000 bushels or the equivalent of 11 contracts (as long as the river used for transportation is not running too low). Thus, any long position holder who wishes to load out fewer than 55,000 bushels cannot use Shipping Certificates issued for most shipping locations (there is only one delivery territory that is set up for rail-car loading, with locations in Chicago, IL and Burns Harbor, IN for corn, soybeans and wheat). Third and foremost, the long does not learn the location of the grain (of which it is gaining control through the Shipping Certificate) until it receives the invoice on Notice Day. By combining these three factors, one can readily imagine a situation where a long receives (say) six Shipping Certificates registered in a particular location and must then obtain five more Certs for the same location to able to load a barge. To do so, that long must proceed in either of the following (inconvenient) ways:

i. Acquire additional long positions on the futures market and hope to get delivered ("stop") an extra five Shipping Certificates pertaining to the location of interest. The specific location of the grain pertaining to a "stopped" contract is only learned upon receipt of the invoice, though. Thus, not only might it take time and multiple tries to find the appropriate five Certs, but this exercise also is almost sure to entail non-trivial transaction costs;
ii. Buy the additional five Certs from the regular firm that controls the shipping station. However, the regular firm is not required or guaranteed to agree to sell any of those;
iii. Enlist the help of a specialized broker in order to locate and buy the five "correct" Certs from individuals or companies who hold them (presuming those are even available for purchase);
iv. Enlist the help of a specialized broker to swap the six Certs owned at the specific location for eleven Certs at another location, paying for the difference and thus becoming able to load-out at that other location;
v. If, according to the CBOT's report of Deliverable Commodities Under Registration (DCUR), the six Certificates already owned are the only ones outstanding for that specific location, then (under regulation 703.C. Load Out, section G(10) of the CBOT Rulebook) the long has the right to demand from the regular firm controlling the delivery location that it propose a single price (not a bid, not an offer) at which the long can either sell back the six Certs to the regular firm or buy an extra five Certs to be issued by the regular firm (and thus become able to load a barge at that location).

Compared to other delivery mechanisms, Shipping Certificates have pros and cons.

Pros of the Shipping Certificates mechanism

- Flexibility for the Certificate holder to either demand load-out or, as described in detail in Section 3.1, pay storage charges and carry the Certificate;
- The Certificate issuer receives storage payments;

- The holder has the flexibility to re-tender the Cert, either for the current month or a future one;
- Deliveries and trading of futures contracts can happen simultaneously;
- May lead to better convergence (between cash prices and futures prices).[5]

Cons of the Shipping Certificate mechanism

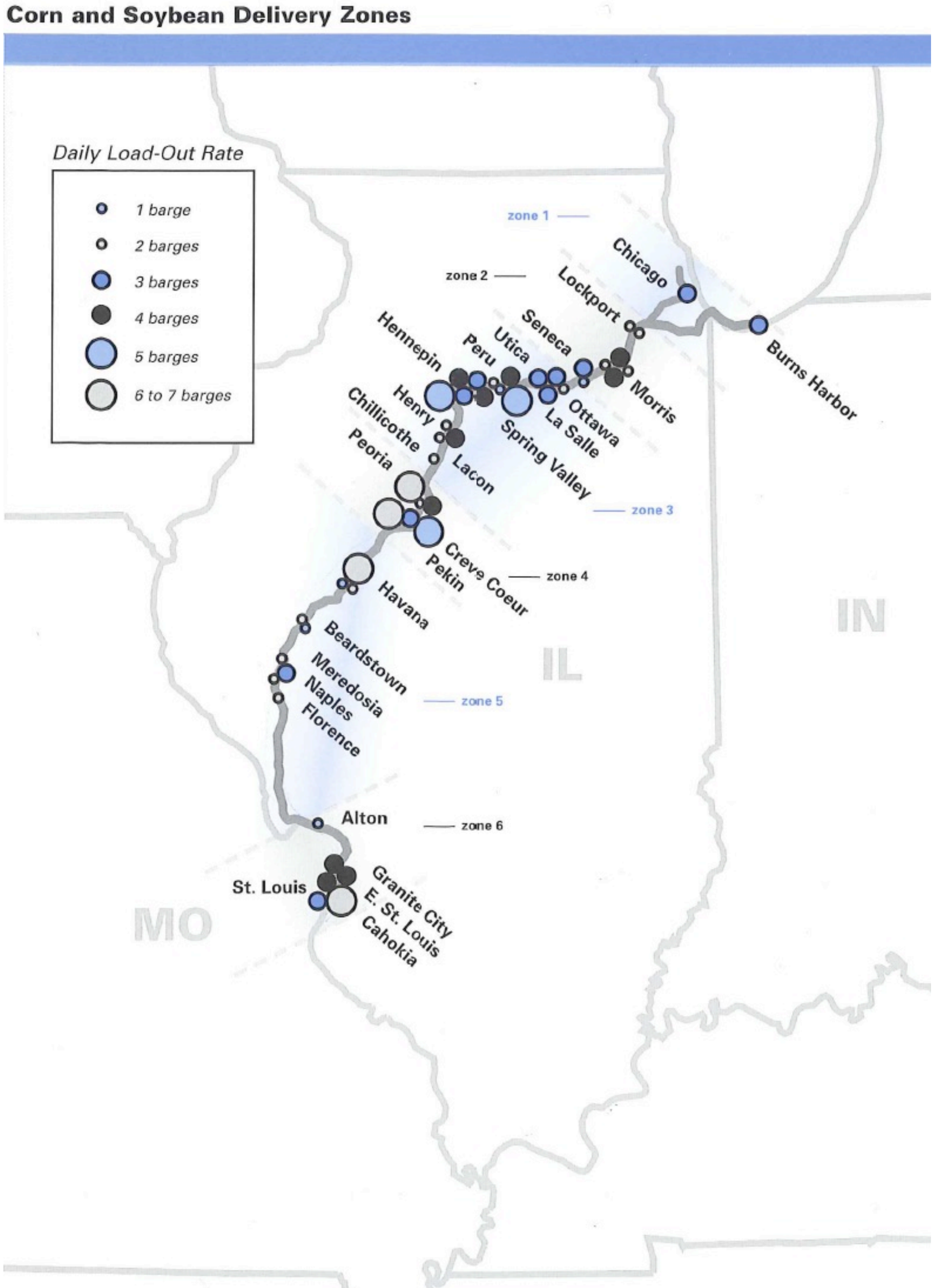
- Creates uncertainty for the regular firm that issues a Certificate about when it will be called out to load-out the underlying commodity;
- Does not convey title to the physical commodity, but instead gives the buyer the right (but not the obligation, *i.e.*, the option) to request load-out under the terms specified in the futures contract;
- May require increased financial requirements for regularity;[6]
- The holder of the certificate must pay storage charges.

Figure 3.3 displays the location of the exchange-approved delivery facilities for corn and soybeans. Only two approved facilities allow for load-out on trains (Chicago, IL) or vessels (Chicago, IL and Burns Harbor, IN); both are located in Zone 1. All the other facilities (those in Zones 2 to 6) only allow for load-out on barges. Grain loaded out on barges must, in practice, go downriver all the way to NOLA (from where the commodity is typically exported abroad).[7]

Table 3-1 provides summary information about the quantities that, as of July 2020, could be stored or loaded out at each facility, the number of Shipping Certificates that could be issued against the grain stored at each location, and the differential for futures delivery depending on location.

[5] Warehouse Receipts, which are used in some markets, can result in logistical problems, both getting grain in and possible uneconomic flows of grain back to delivery locations opposite the flow of grain and loading out problems with long lineups. The Shipping Certificate eliminates the need to have grain in store, and loadout economics are more closely related to export markets; however, this can result in its own problem if interior markets are more in demand than export markets. In contrast to Warehouse Receipt holders, furthermore, Shipping Certificate holders have a loadout preference and are placed at the front of the loadout lineup.
[6] The regular firm must post an irrevocable letter of credit (ILC) at 110 percent of grain value represented by the Shipping Certificate, whereas a Warehouse Receipt is collateral on its own. The cost of the ILC may be one or two percent.
[7] To the best of our knowledge, only once in the past two decades was a barge offloaded upstream from NOLA—and the company that did so was subjected to disciplinary action by the exchange. A major practical issue for such deliveries stems from difficulties in obtaining weight certification.

Figure 3-3 – Location of Illinois Waterways System CBOT corn futures delivery facilities.



Source: CME Notes: Corn and Soybeans Delivery Terms (2017, pg. 7)

Table 3-1: CBOT corn futures delivery facilities—terminal characteristics and location differentials.

CORN AND SOYBEAN SHIPPING STATIONS							
CCL Code	**Firm**	**Location**	**Mile Marker**	**Approved Capacity (bu)**	**Daily Loading Rate (bu/day)**	**Maximum Certificates**	**Location Differential (cents/bu)**
1750	Cargill, Inc.	Burns Harbor, IN	340	7,768,000	165,000	1,553	par
1705	COFCO International Grains US LLC	Chicago, IL	329.4R	12,313,000	165,000	2,462	par
1758	Cargill, Inc.	Morris, IL	263.3R	125,000	55,000	220	4.75
1749	CHS Inc.	Morris, IL	263.0R	683,000	55,000	220	4.75
1730	ADM Grain Company	Morris-E, IL	263.0R	992,000	55,000	220	4.75
1759	Cargill, Inc.	Seneca, IL	252.5R	1,381,000	55,000	220	4.75
1732	ADM Grain Company	Ottawa-N, IL	241.8R	1,627,000	110,000	440	6.25
1733	ADM Grain Company	Ottawa-S, IL	236.9L	605,000	55,000	220	6.25
1765	Maplehurst Farms, Inc.	Ottawa, IL	236.4R	THROUGH PUT	55,000	220	6.25
1709	Zen-Noh Grain Corporation	Utica, IL	229	THROUGH PUT	55,000	220	6.25
1701	Consolidated Grain and Barge Co.	Utica, IL	229L	3,571,000	55,000	220	6.25
1719	CHS Inc.	Peru, IL	221.5	251,000	55,000	220	6.25
1735	ADM Grain Company	Spring Valley, IL	218.4R	114,000	55,000	220	6.25
1754	Cargill, Inc.	Spring Valley, IL	218.3L	1,433,000	110,000	440	6.25
1736	ADM Grain Company	Hennepin, IL	207.7L	95,000	110,000	440	6.25
1707	Zen-Noh Grain Corporation	Hennepin, IL	207.4R	THROUGH PUT	55,000	220	6.25
1703	Consolidated Grain and Barge Co.	Hennepin, IL	207.4R	1,292,000	55,000	220	6.25
1738	ADM Grain Company	Lacon, IL	189.5L	199,000	55,000	220	6.25
1761	Cargill, Inc.	Lacon, IL	189.3L	487,000	110,000	440	6.25
1740	ADM Grain Company	Creve Coeur, IL	158.1L	1,401,000	110,000	440	8.75
1720	CHS Inc.	Pekin, IL	152.2	154,000	55,000	220	8.75
1755	Cargill, Inc.	Havana-N, IL	119.9L	3,967,000	55,000	220	10.25
1762	Cargill, Inc.	Havana-S, IL	119.8L	738,000	110,000	440	10.25
1742	ADM Grain Company	Havana-N, IL	119.6L	5,800,000	110,000	440	10.25
1743	ADM Grain Company	Havana-S, IL	119.3L	178,000	110,000	440	10.25
1769	CHS, Inc.	Havana, IL	119	1,185,000	55,000	220	10.25
1763	Cargill, Inc.	Beardstown, IL	88.1L	3,507,000	110,000	440	10.25
1744	Cargill, Inc.	Beardstown, IL (Frederick)	91.0 L	10,809,000	110,000	440	10.25
1768	CHS, Inc.	Beardstown, IL	88.4	THROUGH PUT	55,000	220	10.25
1756	Cargill, Inc.	Meredosia, IL	71.3L	2,172,000	110,000	440	10.25
1706	Zen-Noh Grain Corp.	Naples, IL	65L	THROUGH PUT	55,000	220	10.25
1704	Consolidated Grain and Barge Co.	Naples, IL	65L	6,826,000	55,000	220	10.25
1745	Cargill, Inc.	Naples, IL	66.1L	299,000	55,000	220	10.25
1757	Cargill, Inc.	Florence, IL	55.3R	1,733,000	110,000	440	10.25
1770	CHS, Inc.	Madison, IL	184.5	THROUGH PUT	55,000	220	16.25
1747	ADM Grain Company	St. Louis, MO	UM 184R	1,573,000	220,000	880	16.25
1767	CHS, Inc.	St. Louis, MO	UM 181.4	THROUGH PUT	55,000	220	16.25
1773	Bunge North America	Fairmont City, IL	181	1,117,000	110,000	440	16.25
1764	Cargill, Inc.	E. St. Louis, IL	UM 179L	2,481,000	110,000	440	16.25
1408	ADM Grain Company	Sauget, IL	177	615,000	55,000	220	16.25
1711	Consolidated Grain & Barge Co.	Cahokia, IL	UM 176.5L	899,000	55,000	220	16.25
1725	Louis Dreyfus Company River Elevators LLC	Cahokia, IL	175.6	750,000	55,000	220	16.25
1775	COFCO GROWMARK LLC	Cahokia, IL	175.6	THROUGH PUT	110,000	440	16.25
1712	Zen-Noh Grain Corp.	Cahokia, IL	175.6	THROUGH PUT	55,000	220	16.25
Note: Transportation conveyance is via barge.							
Updated 07/01/20							

Source: CBOT rulebook, Chapter 7—corn and soybean futures shipping stations. (pg. 24).

4. Hypothesis Development

This Section introduces the concept of Delivery Value Equivalent (DVE). It also develops three hypotheses regarding the occurrence of futures deliveries, their timing, and their impact on futures spreads that are then tested in Section 6 using data presented in Section 5.

a. Hypothesis 1 — Occurrence of Deliveries (Futures vs*. Cash: Which is the better Sale?)*

As discussed in Section 2, futures are not designed to be marketing contracts. This said, the short gets to decide the timing, location, and grade of the delivery: as a result, futures are particularly inconvenient marketing tool for buyers. For this reason, the analysis that follows takes chiefly the perspective of the short.

As mentioned in Section 3, regular firms may issue new Shipping Certificates at any point in time.[8] Thus, during each delivery period, the regular firms and the current holders of outstanding Certs get the choice between the cash market and the futures market for marketing grain (so do potential buyers in the case of origination, at the end of the delivery period). In other words, for the same commodity, and as long as the market is functioning properly, market participants face two prices and are free to choose the most advantageous.

Notice, though, that there is no such thing as "the" cash market. In reality, there are numerous distinct cash markets scattered around the country. Thus, when comparing the futures price with any cash price outside of the delivery zones, there is a spatial disconnect. Precisely, if the regular firm/Cert holder chooses to deliver (which results in tendering a Shipping Certificate to a long), then it gets paid the prompt futures price plus the delivery zone's location differential. If it chooses instead to sell the grain in the cash market, then it gets paid the cash price—but it is then responsible for taking the grain all the way to the point of sale (CIF—see Appendix A), incurring costs related to load-out (elevating at the shipping station, inspection, grading and weighing) as well as to transport. Thus, to be able to properly compare a cash price in a particular location with the futures price, any market participant (either long or short) needs to account for grain handling and freight costs. This is the role of the Delivery Value Equivalent.

In effect, the regular firm/Cert holder must either bring the cash price back to the shipping station, or bring the futures price to the cash market. In what follows, we do the latter.

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[8] Technically, a firm that is regular for delivery may register a Shipping Certificate outside of the delivery period, and can tender it through a private sale ("*ex*-pit"). In our sample period, however, we find just seven increases in corn Shipping Certificates Under Registration on days outside of delivery periods (in two instances, the increase is less than 11 Certs, suggesting that the action is to complete a barge; in several of the other cases, the number of Certs issued is not a multiple of the 11 needed for a barge loadout, and the fact that they were later cancelled suggests that they might have been part of a swap deal). We therefore restrict the rest of the discussion to delivery period episodes only. Note that decreases in Certs under Registration are not a concern, as Certs are routinely canceled by regular firms at various times.

The Grain Service Corporation's Glossary of Agribusiness Business and Futures Trading defines the DVE as a "basis level sufficient to allow moving into or out of a futures delivery position" (pg. 19).

$$DVE = Differentials + Costs \quad (1)$$

and

$$Differentials = QD + LD \quad (2)$$

$$Costs = Lo + S + I + Fr \quad (3)$$

Where:

- QD = Quality differential;
- LD = Delivery location differential;
- Lo = Load-out cost at the delivery location (*i.e.*, shipping station);
- S = Storage (minimum 3 days of storage for load-out per CBOT rules, *plus* actual increment);
- I = Inspection/grading/weighting at destination;
- Fr = Freight from the shipping station to destination.

By incorporating contract-defined differentials and handling/transportation costs, the DVE framework allows merchandisers to calculate what would be the future's equivalent price (hence the name) at the point of sale (*i.e.*, destination or cash market). More precisely, the relation between the basis at destination and the DVE is what determines whether the cash or the futures market is the most profitable means for a futures market participant to merchandise (or, for the long, to originate) its grain.

At this point, one characteristic of the futures delivery system is critical: the fact that most CBOT futures delivery-facilities' grain ends up in NOLA (indeed, it is called the Illinois Waterway Delivery System or IWDS for this reason). From Table 3-1, we know that the maximum number of Certs for Zone 1 facilities (Chicago, IL and Burns Harbor, IN) is less than a quarter (23.3 percent) of the total maximum number of Certs while the approved capacity of Zone 1 facilities is just over a quarter (25.4 percent) of the approved total capacity. Furthermore, we know from the discussion of Figure 3-3 that all facilities (including those in Zone 1) allow for barge load-out and that, once loaded, all barges in practice continue all the way to NOLA (as that port zone is where the main U.S. grain export terminals are located.[9] For this reason, in the rest of this paper we utilize NOLA CIF prices as the reference cash prices.

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[9] As noted in footnote 7, to the best of our knowledge, in only one occasion more than 15 years ago was an attempt ever made to unload a barge at a shipping station other than one of the export terminals in NOLA. The attempt

Below is an example for calculating the DVE for a Shipping Certificate registered for load-out in Morris, IL on March 18th, 2021, using CBOT futures contract-specified values:

QD = $0;

LD = $0.0475/bu (Morris, IL is in Zone 2; LD used to be 2 cents per bushel until March 2019);

Lo = $0.06/bu;

S = $0.00265/bu/day * 3 = $0.00795/bu (the CBOT requires minimum 3 days of storage);[10]

I = $0.01-0.02/bu;

Fr = $0.559/bu;

where, the freight cost ("Fr") is calculated as:

Tariff benchmark for freight in Morris, IL = $5.24/st;

Short ton/lbs = 1/2,000;

Lbs/bu = 56 (for corn; it would be 60 pounds for soybeans or wheat);

Barge freight rate = 381 percent;

$$5.24 * 1/2000 * 56 * 3.81 \; = \; \$0.559/bu$$

The benchmark for the delivery regions can be found in the USDA's weekly Grain Transportation Report. That Report tells us the Barge Freight Rate for each region.

In sum, the Morris, IL corn DVE is (in dollars per bushel):

$$DVE = \$(0.0475 + 0.06 + 0.00795 + 0.02 + 0.559)/bu \; = \$0.69445/bu$$

Suppose that the CIF basis at New Orleans on that day was $0.65895/bu. It follows that a regular firm in this situation could make a 3.55c/bu profit by issuing Shipping Certificates and going for delivery. A few cents per bushel might seem little, but that seemingly small figure would add up to a profit of $76,850

generated a number of logistical issues (it is not practical for traders to unload at such shipping stations for several reasons, first of among them the difficulty of finding an official scale outside of NOLA). As a result, the exchange subjected the company involved to disciplinary action following this episode.

[10] S used to be 5 cents per bushel per month, or $0.00165/bu/day, for corn futures expiring before December 2019.

to $111,782 on a fully-loaded Panamax export vessel, which takes from 55,000 to 80,000 metric tons of corn depending on the size of the ship.[11]

Note that, in the example above, we use differentials and costs determined by the CBOT Futures Rulebook. These are all fixed except for the freight rate, which is determined by the market and can be viewed as a commodity in itself (Wetztein *et al.*, 2021). These premiums and costs are the values that a Cert holder would face when attempting to deliver or load-out.[12]

Tables 4-1 and 4-2 detail the relation between the CIF basis, the futures price, and the DVE; as well how these concepts relate to arbitrage. According to this framework, come the delivery period, the relation between the DVE and the NOLA basis should be a major consideration for makers (and takers). Put more formally: our first testable hypothesis (which we expect our statistical tests to reject) is that this relation is of no importance to the occurrence of deliveries.

Table 4-1 – Theoretical framework illustrating the relation between the basis at destination and the Delivery Value Equivalent.

	basis @destination	=	cash @destination - futures	
	DVE	=	freight + costs	
(in equilibrium)	futures + DVE	=	cash @destination	
	futures + DVE	=	futures + basis @destination	
	DVE	=	basis @destination	
when	DVE	>	basis @destination	then: futures is the best sale
when	DVE	<	basis @destination	then: cash @destination is best sale

[11] If, on the other hand, the DVE was less than cash, then potential cash buyers would be interested in stopping a certificate (either to fulfill an already short cash position in NOLA or to perform arbitrage). Put differently, from the point of view of the "maker," the DVE *vs*. CIF basis relationship is important for revenue maximization. From the point of view of the "taker," the DVE constitutes an effective ceiling for the cost of buying the grain (*i.e.*, a "hedge" against a short cash position).

[12] To the extent that a regular firm owns a barge fleet and faces lower costs for grain handling and load-out, the DVE may in practice vary across market participants. Since those private figures are difficult or impossible for an outside observer to discover, and since they change from company to company, this paper focuses on contract values and market rates and prices. The NOLA market is the most liquid and very transparent (with lots of export terminals bidding explicitly and competitively for grain), which provides an additional reason to focus on NOLA rates and prices.

Table 4-2 - Theoretical framework illustrating the relation between the Delivery Value Equivalent and the basis at destination under the optic of location premium arbitrage.

By location arbitrage:			
	cash @origin + freight + costs	=	cash @destination
but			
	basis	=	cash - futures
	cash	=	basis + futures
so			
	basis @origin + fut. + freight + costs	=	basis @destination + fut
	basis @origin + freight + costs	=	basis @destination
Let DVE = premium + freight + costs			
if:			
	DVE	>	basis @destination
	premium + freight + costs	>	basis @destination
	premium + freight + costs	>	basis @origin + freight + costs
	(location) premium	>	basis @origin
or			
	fut. + fut premium @origin	>	cash @origin
thus			
Arbitrage opportunity: sell futures, buy cash @origin			
else:			
	DVE	<	basis @destination
then:			
	fut + premium @orig + freight + costs	<	cash @destination
Arbitrage opportunity: buy futures + freight, sell cash @destination			

b. Hypothesis 2—Timing: Early and Late Deliveries

The DVE framework gives market participants the signal of whether deliveries should happen or not, and whether arbitrage opportunities are available or not. But it does not say anything about the precise timing of these deliveries within the delivery period. For that question, we look at the term structure of futures prices.

In a hypothetical situation where the start of the delivery period is approaching, if the market is in carry, then futures prices are above cash prices. From the point of view of the physical grain seller, the futures market should thus be the better channel for marketing grain. If a delivery is optimal (as defined in Hypothesis 1), then this seller should therefore deliver as soon as possible to take advantage of that fact. Put differently, in contangoed markets, convergence should happen early.

In contrast, in an inverted ("backwardated") market, cash prices are higher than futures prices. In this situation, it is buyers who should be comparatively better off by sourcing grain from the futures market. Recall, however, that the short is the one that chooses when the delivery is taking place in the delivery period (except for the two last days of the life of the contract). Thus, if the long wants to stop futures, then it must wait until the end of the delivery period (when prompt-month futures positions can no longer be offset and the long is at last able to force deliveries). Moreover, if the term structure is inverted by the time the delivery period begins, then it is likely that grain stocks are already low (or falling) – which means that there is less physical commodity to be delivered. For those reasons, convergence should happen late (if at all) in inverted markets.

Put differently, deliveries should intuitively take place earlier in the delivery period, and they should also be more plentiful, in times of contango than in times of backwardation. That said, as noted by Peck and Williams (1992), the reality of redeliveries muddies this simple picture because deliveries can happen repetitively through many days. For this reason, we focus on the first (if any) intention of delivery that is declared for each contract (whether that first declaration takes place on First Intention/Position Day or later), and we ignore all the deliveries that come thereafter; this is what we call "first intention." Our second testable hypothesis, regarding the timing of deliveries (early *vs*. late), is that the first intention is declared early (*resp*. late) when the futures term structure is in contango (*resp*. backwardation).

c. Hypothesis 3—Feedback Effects: Does Issuing Certificates affect Futures Prices?

The ability to handle grain–and the costs of doing so–vary significantly across market participants. Commercial traders with developed logistics networks, storage facilities, and elevators in and around the delivery regions have an advantage in comparison to (say) a small origination business. At the same time, when the delivery period begins, position limits become tight for all traders save *bona-fide* hedgers. Nevertheless, some speculators remain present in the market. We also know that, when an intention of delivery is made, the exchange's clearinghouse assigns it to the oldest outstanding long. It is thus possible that long futures speculators (who are either unable to handle physical grain or are unwilling to hold Shipping Certificates and pay for storage) may immediately open a short futures position and retender those Certificates upon being forced to take delivery. Furthermore, as discussed in Section 4.1, the fact that deliveries are happening in the first place signals to the market that the futures is overpriced in comparison to the cash at the delivery location—regardless of whether the taker is a commercial trader (hedger) or a non-commercial trader (speculator). These two facts provide the background for our third hypothesis.

Corn futures are traded in two sessions every business day: a night session that opens at 7PM on the previous calendar day and closes at 7:45AM, and a day session that opens at 8:30AM and closes at 1:20PM. The CME Group (with which the CBOT merged in 2006, well before the start of our sample period) posts every day, at 4 PM—*i.e.,* between the day close and the next-day (night) open—a report of Deliverable Commodities Under Registration (DCUR)—see Figure 4-1. The DCUR informs the public about how many Shipping Certificates are outstanding at every delivery location, for every regular firm, and for every commodity. By the rules of the exchange, a regular firm may register Shipping Certificates at any time; however, if it decides not to tender a Certificate by 4 PM on the day when it is registered, then that regular firm must declare it withdrawn. Thus, if new certificates are recorded in the 4 PM update, then the market knows that deliveries are about to take place. Intuitively, insofar as this new information compels other agents to exit their long futures positions, then one should observe a price impact on the nearby futures (but not on other contracts) at the open of the night session. Of course, other news than that contained in the DCUR could impact futures prices, but there is no reason to believe that such news would affect the nearby and further-out contracts differentially. Thus, rather than looking at the returns from day-close to next-day (night) open of the nearby contract alone, our third hypothesis is that the spread between nearby and first-deferred futures prices should weaken when deliveries take place.

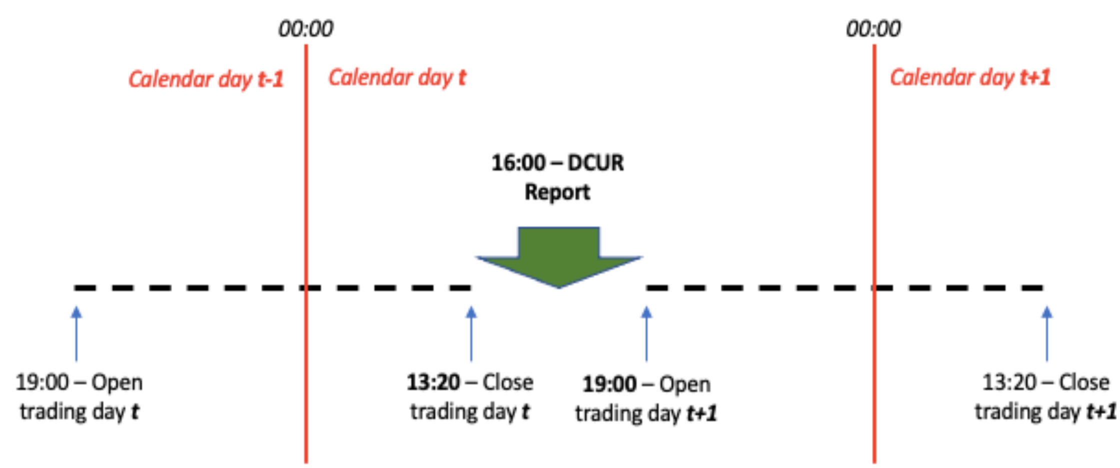

Figure 4-1 – Timeline of the market open & close, day & night sessions, and DCUR report publication. The CME Group uploads the DCUR report at 4PM, in between two trading days.

d. Hypotheses—Summary

Section 4 has laid down the concept of the DVE as a framework for traders to decide whether to "go for delivery" or not, when, and if deliveries impact prices. In a nutshell, our three hypotheses are:

1) The difference between the NOLA basis and the DVE impacts the occurrence and the quantity of corn futures deliveries (we expect to reject statistically the null hypothesis that it does not).
2) When the corn futures market is in carry, corn deliveries tend to start early. When carry is absent, deliveries tend to start late.
3) The issuance of new Shipping Certificates, which signals deliveries, weakens the price spread between the front-month and first-deferred futures contracts at the opening of the next trading session (we expect to reject statistically the null hypothesis that it does not).

5. Data

Testing the hypotheses from Section 4 requires historical data for corn cash and futures markets, plus data to estimate the DVE through the delivery periods in the sample. This Section details our sources.

a. Data sources and period of analysis

The analysis covers a ten-year period from January 3, 2011 to April 14, 2021. We use CBOT #2 Yellow Corn futures open prices (i.e., at the beginning of the overnight trading session, currently 7PM-7:45AM) and settlement prices at the end of the day session (currently 08:30AM-1:20PM). Those prices are obtained from Bloomberg.

We obtain daily New Orleans CIF basis quotes from the USDA's Department of Market News daily "Grain Report for Louisiana and Texas Export Bids." We use the average of each day's highest and lowest bids. As discussed in Sections 3.3 and 4.1, we focus on NOLA prices as our reference since NOLA is one of the most active cash markets and it is where the main U.S. corn export terminals are located. It is also the final destination for barges in the Illinois waterways, around which the CBOT corn and soybean delivery system is designed. The NOLA cash prices are CIF (Cost, Insurance, Freight), transported by barge, for current delivery (as opposed to deliveries protracted to a future calendar month) at the export elevator.

For the opportunity cost of money, an interest rate is needed. We use three-month London Interbank Offered Rates (LIBOR) rates obtained from Bloomberg.

We obtain freight end-of-the-week prices from the United States Department of Agriculture's Agricultural Marketing Service (USDA AMS) weekly Grain Transportation Report. We also obtain the percent barge freight rates by region, weekly, from USDA AMS. Contract-defined costs and premiums (such as fees for incremental storage, load-out, weighing, grading and inspection) come from the CBOT Rulebook (Chapters 7 and 10).[13] Among all delivery points in the Illinois waterways, we choose Zone 3 for the analysis because it is the Zone with the highest number of delivery facilities, the highest storage capacity across shipping stations, and the highest daily rate of load-out.

DCUR (Deliverable Commodities Under Registration) data are obtained from the CME Group's Historical Registrar Reports. These tables are updated daily and indicate the number of Certs outstanding by regular firm, delivery region, and commodity. From these tables, it is thus possible to deduce the number of Shipping Certificates that are newly issued and canceled on any given day. The daily number of delivery notices is obtained from the CME Group's Daily Receipt and Shipments report.

b. Descriptive statistics for selected variables

Table 5-1 provides full-sample (both delivery- and non-delivery-period days) descriptive statistics for our main variables: nearby corn futures closing price, number of intentions of delivery, percentage of full-carry, New Orleans cash prices and CIF basis, change in nearby calendar spread prices from the close of the day trading session to the open of the next-day overnight trading session, and freight rates. Table 5-2 provides the corresponding summary statistics for delivery-period days only.

Table 5-1: Summary statistics for selected variables.

	Futures ($/bu)	*%Full-carry*	*NOLA basis ($/bu)*	*DVE ($/bu)*	*Spread Return*	*# DCUR*	*# Intentions*
Mean	4.60	12.77905036	0.57	0.70	0.00013	404	44
Standard Error	0.0275	2.7015	0.0039	0.0034	0.0004	10.4464	3.6678
Median	3.85	54.61	0.55	0.67	-0.0004	97.5	0
Mode	3.48	0	0.53	0.68	0	0	0
Standard Deviation	1.4016	137.4830	0.1971	0.1746	0.0203	531.6390	186.6606
Sample Variance	1.9644	18901.6	0.0389	0.0305	0.0004	282640	34842.16
Kurtosis	-0.4141	33.1756	8.0926	2.4080	2288.97	1.7766	45.2538
Skewness	1.0467	-5.0042	1.7156	1.1141	-46.3533	1.4206	6.1835
Range	5.30	1507.07	1.78	1.23	1.0530	3102	2267
Minimum	3.02	-1407.07	0.15	0.42	-0.0419	0	0
Maximum	8.31	100	1.93	1.65	0.0530	3102	2267
Sum	11915.16	33097.74	1473.525	1810.66	-0.6559	1045691	112991
Count	2590	2590	2590	2590	2589	2590	2590

[13] We use the exchange storage rate and the Zone 3 location premiums applicable starting in 2011. As noted in footnote 4, the exchange figures were revised in 2018 (effective 2019). The changes are too small to affect our empirical results (and, in any event, the market was never at full carry even with the old, lower 5 cents figure in the period from December 2019 to April 2021).

Table 5-2: Summary statistics for selected variables, delivery period.

	Futures ($/bu)	%Full-carry	NOLA basis ($/bu)	DVE ($/bu)	Spread Return	# DCUR	# Intentions
Mean	4.57	-7.3798	0.55	0.68	0.00136	520	191
Standard Error	0.0604	8.0607	0.0074	0.0062	0.0003	27.6066	14.5021
Median	3.79	51.8559	0.54	0.67	0	220	19
Mode	3.55	100	0.55	0.59	0	0	0
Standard Deviation	1.4504	193.6245	0.1766	0.1509	0.0083	671.6970	352.8523
Sample Variance	2.1035	37490.45	0.0312	0.0228	0.0001	451176.85	124504.75
Kurtosis	-0.4413	27.4822	5.7454	-0.4789	8.5275	1.7342	8.0517
Skewness	1.0729	-4.8567	1.2009	0.4475	1.1236	1.4494	2.6986
Range	5.1	1507.07	1.725	0.65	0.08904	3102	2267
Minimum	3.02	-1407.07	0.15	0.42	-0.04194	0	0
Maximum	8.12	100	1.88	1.06	0.04710	3102	2267
Sum	2638.55	-4258.16	319.2	401.10	0.80412	307724	112955
Count	592	592	592	592	591	592	592

Tables 5-3 and 5-4 describe the correlations between our three main price variables. Our basis-DVE variable has a correlation of 0.26 to 0.27 with the nearby futures prices. The percentage of full-carry is highly correlated with both the nearby futures prices and the basis-DVE, both in the delivery period and in the whole sample; the strongly negative correlation with basis-DVE was predicted in Section 4.1.

Table 5-3: Correlations between price variables (all trading days, 2011-2021)

Whole sample	Futures	%Full-carry	Basis-DVE
Futures	1		
%Full-carry	-0.432669606	1	
Basis-DVE	0.270181875	-0.527663611	1

Table 5-4: Correlations between price variables (Delivery period days only, 2011-2021)

Deliv. Period	Futures	%Full-carry	Basis-DVE
Futures	1		
%Full-carry	-0.489543622	1	
Basis-DVE	0.26221801	-0.542023745	1

Figure 5-1 plots the CBOT #2 Yellow Corn nearby futures (F_1) quotes and the equivalent CIF prices for current delivery at New Orleans export terminals, in U.S. dollars per bushel. Prices are high in 2011 amid a drought, reaching a maximum of $8.31/bushel in 2013 in its aftermath. They remain strong until the beginning of 2014. Prices stabilize around or below $4/bushel for the next six years, reaching the periods' lowest point ($3.015/bushel) at the onset of the global COVID-19 pandemic. Since then, prices have soared past $6/bushel. The mean futures price for the entire 2011-2021 period is $4.6/bushel, very similar to the average of $4.57/bushel when considering delivery-period days only.

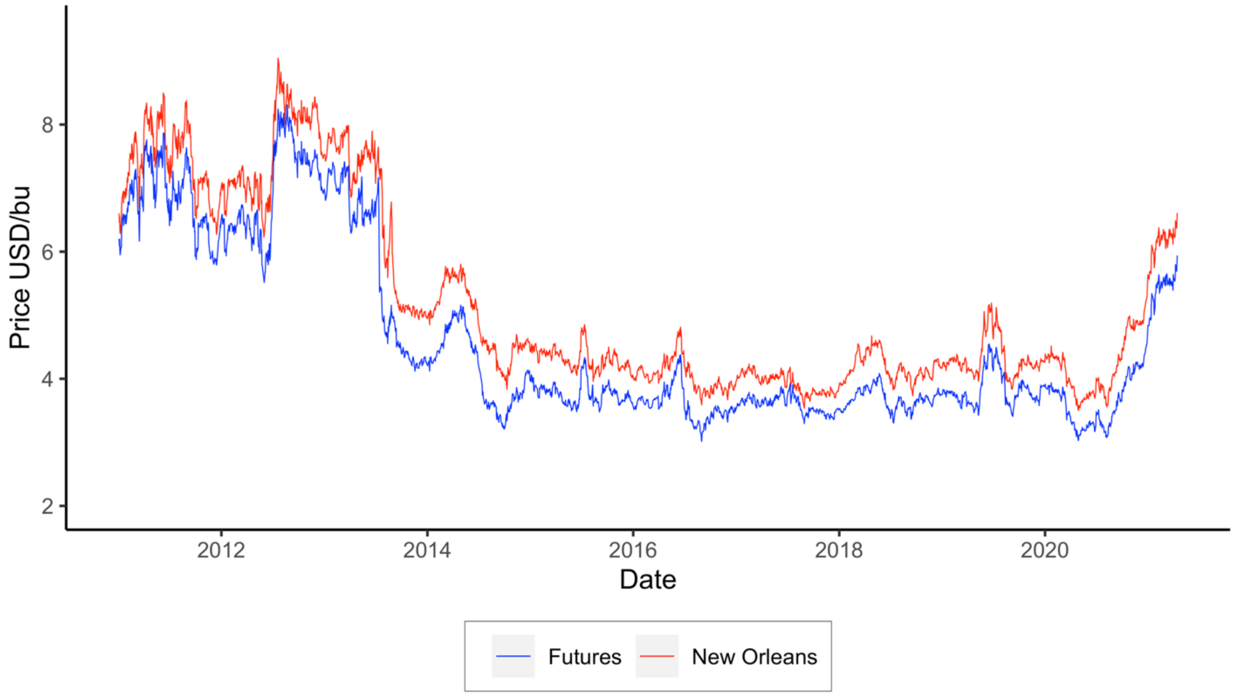

Figure 5-1 – Nearby CBOT corn futures price and NOLA cash corn bids, 2011-2021 ($/bushel).

The basis is the difference between cash and futures prices. Figure 5-2 plots historical NOLA CIF basis values against the DVE based on barge freight rates for Delivery Zone 3. Freight is the only variable component of the DVE, as described on session 4.1; and the exchange-specified fixed costs range from 12 to 13 cents/bushel. Note that the NOLA basis is recorded daily, whereas the USDA AMS freight rates are available only weekly. Figure 5-2 shows that, while the two series generally move together (the full-sample correlation is 0.27,see Table 5-3), the relation appears to break down during a number of episodes. Still, they both have fairly similar average values (57 cents/bushel for NOLA basis and 70 cents/bushel for DVE) and similar volatilities, with basis being slightly more volatile. The findings are similar for the delivery period only, with the NOLA CIF basis averaging 55 cents/bushel and the DVE 68 cents/bushel on delivery days in 2011-2021.

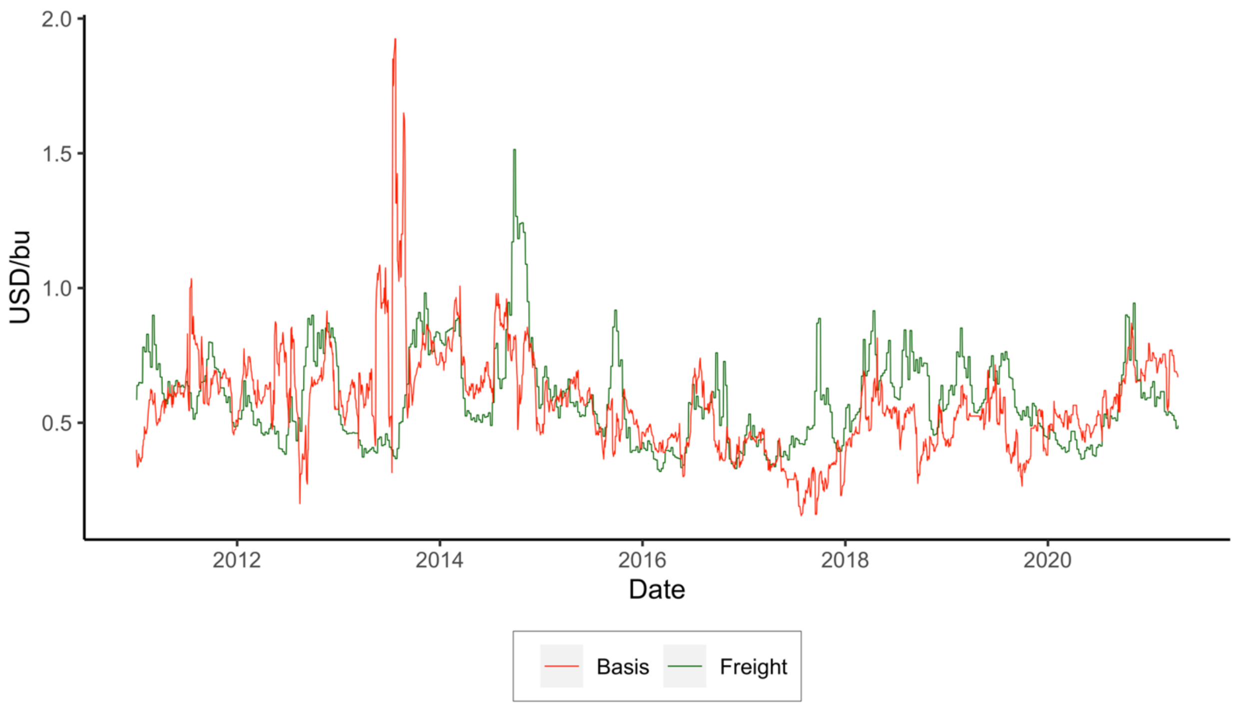

Figure 5-2: Daily values of the NOLA CIF basis (No.2 yellow corn) and of the DVE (based on Delivery Zone 3 weekly barge freight prices), 2011-2021.

We see from Tables 5-1 and 5-2 that Deliverable Commodities Under Registration (DCUR, *i.e.*, the Shipping Certificates outstanding) are 404 Certs on average across all days in our 2011-2021 sample, and 520 on average for delivery-period days. The higher average during the delivery period reflects the reality that, since a regular firm that registers a Shipping Certificate must make a delivery, those instruments are almost never issued outside of the delivery period (in contrast, Certs can be cancelled at any time thereafter by the holder).

Figure 5-3 plots the number of Certs outstanding and the number of deliveries over time. The number of Shipping Certificates tends to increase before delivery begins and to fall (*i.e.*, to be canceled) after it the end of the delivery period. The maximum number of Shipping Certificates outstanding is 3,102 in 2019.

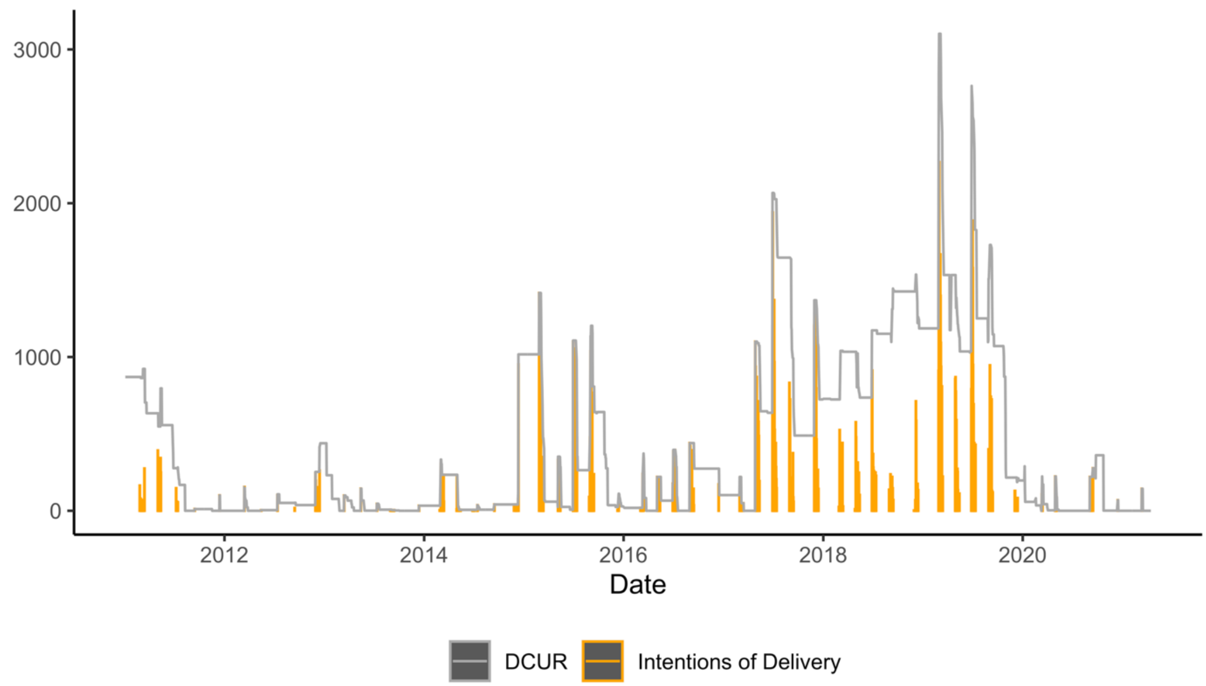

Figure 5-3: Deliverable Commodities Under Registration (DCUR) and Intentions to Deliver, 2011-2021.

Figure 5-4 illustrates the nearby calendar structure for the period, defined as the relation between the prices of the nearby and first deferred futures ($F_1 - F_2$). If that spread is negative, then the market is said to be in contango. If the spread is positive, then the market is classified as inverted or backwardated.

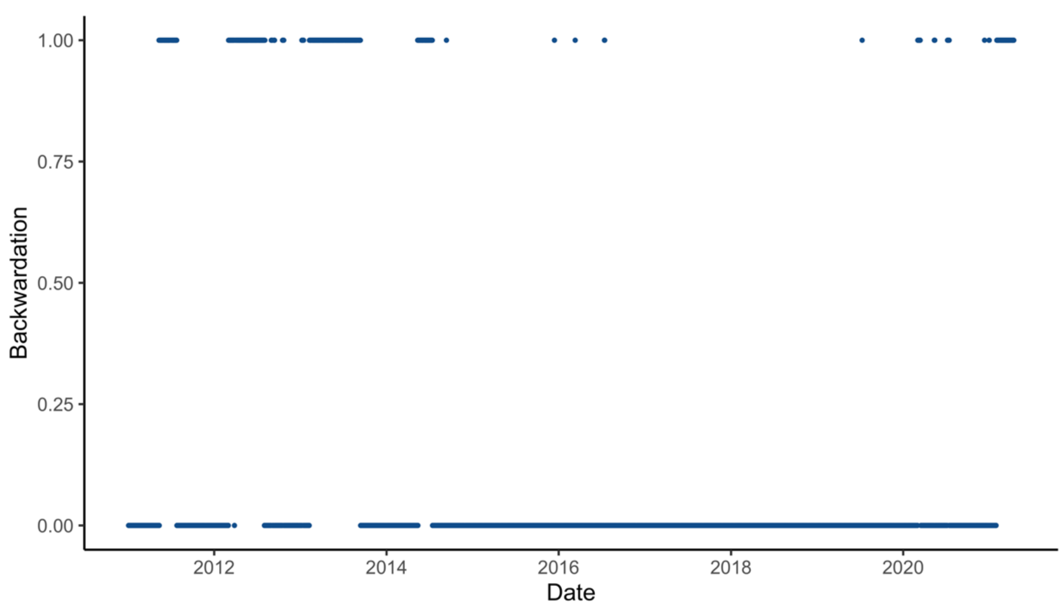

Figure 5-4 – Corn futures calendar term structure: 0 for Contango, 1 for Backwardation; 2011-2021.

Out of the 2,590 days sampled, the market is inverted on 456 days and contangoed on the remaining 2,134 days. At a first glance, high volumes of deliveries and high numbers of Certificates outstanding seem to be related to contango and low prices—which is consistent with Hypothesis 2.

The histogram in Figure 5-5 plots the relative changes in the nearby calendar spread ($F_1 - F_2$) in relation to the nearby futures from the close of the day trading session to the open of the following overnight session, for all delivery-period days in the sample period. It is calculated in the form: nearby spread price at the current trading-day open *minus* spread on the previous trading-day close. Albeit mostly positive, the typical spread return from the end of one trading session to the beginning of the next is very close to zero, with an average of 0.01%.

Formally, the return around a DCUR report release on calendar *t-1* is defined as:

$$Return_{(t-1)\ to\ t} = \frac{(F_1 - F_2)_{Open_t} - (F_1 - F_2)_{Settlement_{t-1}}}{F_{1_{Settlement_t}}}$$

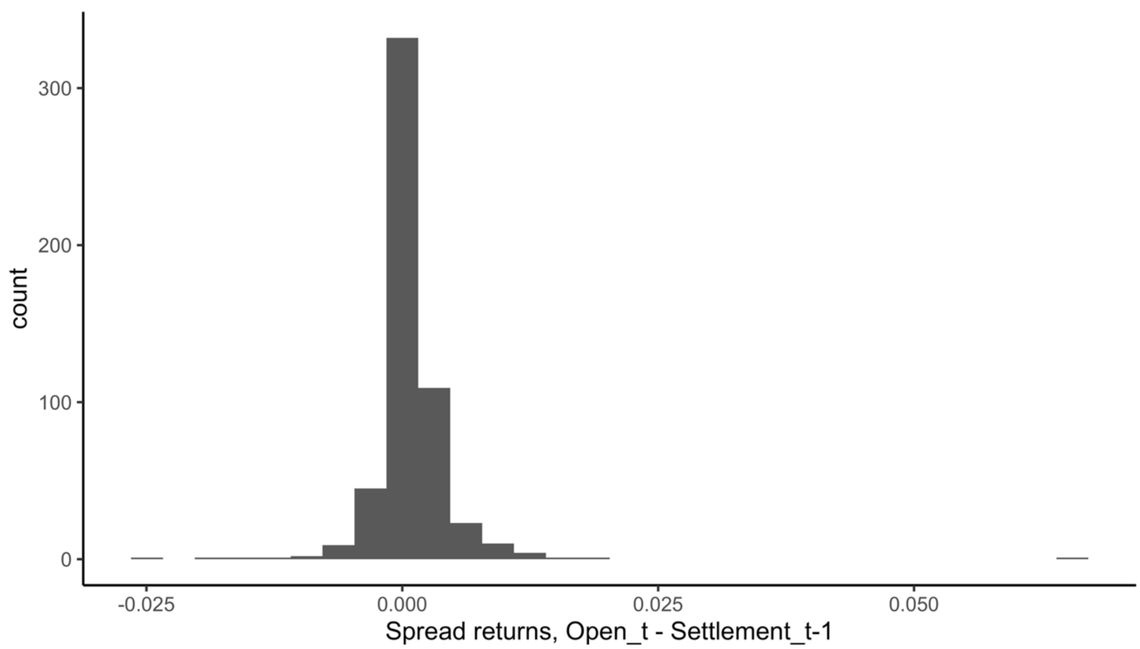

Figure 5-5 – Histogram of changes in the nearby calendar spread close-to-open return (F_1-F_2)/F_1. Sample period: all delivery-period days, January 2011 to April 2021.

In grain futures markets, carry is a particularly important concept. Full carry is defined as the interest opportunity cost plus the cost of storing ("carrying") the commodity.

$$Opportunity\ cost\ =\ F_1 * \left([LIBOR + 0.02] * \left(\frac{n}{360}\right)\right) \quad (4)$$

where the opportunity cost and F1 are expressed in cents per bushel, n is the number of days of carry (from the nearby futures to the next contract), and

$$Exchange\ set\ cost\ of\ carry\ = n * 0.165 \quad (5)$$

where 0.165 cents is the exchange-set daily premium for storage of a bushel of corn.[14]

We calculate the percentage deviations from full-carry using the price spread between the two nearest-dated corn futures contracts. If the relative cost of carry is 100 percent, then the market is paying fully for the commodity to be stored and carried through the next month. If it is less than or equal to zero, then there is enough convenience yield that the market is paying for the commodity to be sold immediately.

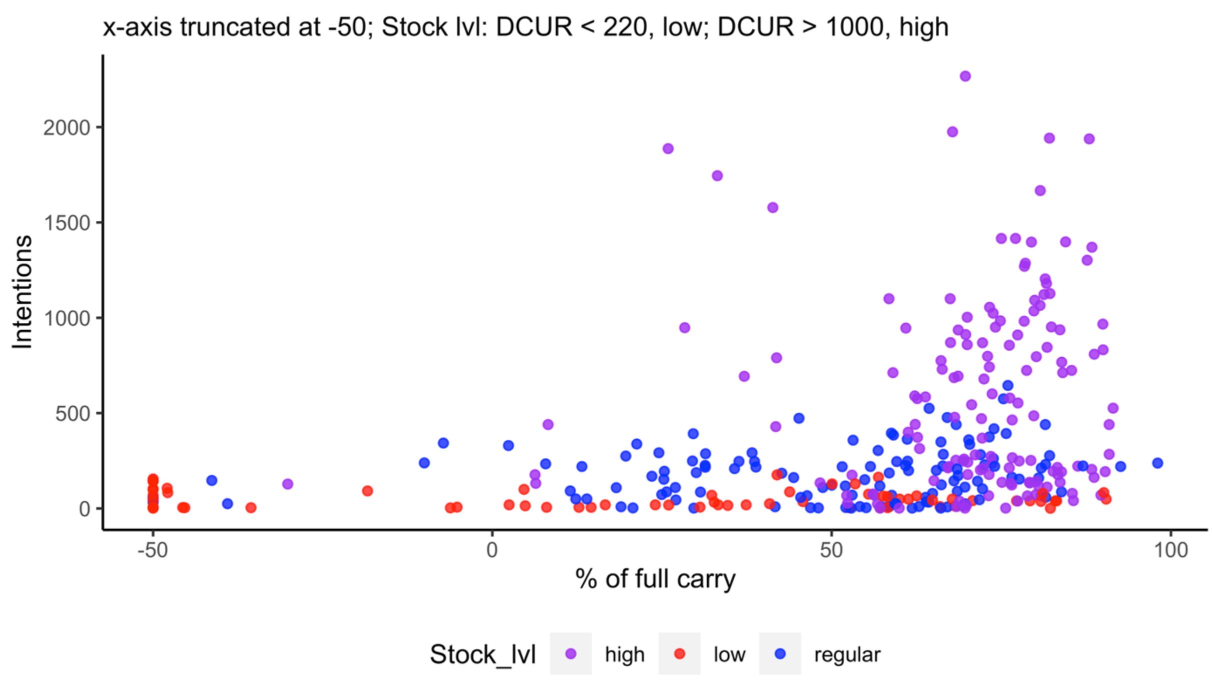

Figure 5-6 – Intentions of delivery and percentage of full carry; mapped for stock levels; 2011-2021.

[14] We use this figure for the entire analysis. This premium changed to 0.265 cents a bushel a day in 2018, effective in the fourth quarter of 2019. In future drafts of the paper, the analyses will be revised to account for the revision.

The median extent of carry is 55 percent of full-carry in our sample period (Table 5-1), and 52 percent on delivery-*period* days (Table 5-2). Figure 5-6 illustrates how, on days when intentions to deliver are *actually* declared, the percentage of full-carry relates to deliveries. The X-axis is truncated at *minus* 50 for better visualization.[15] Most intentions of delivery and of redelivery take place between 50 percent and 90 percent of full carry. Colors are used to relate DCUR to the figure as a proxy for stock levels. Stocks are considered "high" (plotted in purple) if DCUR is greater than 1,000 and "low" (plotted in red) if DCUR is less than 220 (220 is the maximum number of certificates registered for the minimum load-out rate of one barge per day for 22 days). Intuitively, numerous deliveries should happen when carry is higher, given that carry provides incentives to store the commodity.

Figure 5-7 plots the frequency of carry as a percentage of full-carry, only for days of the delivery period. The X-axis is truncated at *minus* 100 for the same reason as for Figure 5-6, *i.e.*, for better visualization. The median carry value for the multiple delivery periods is of 51.8%. Figure 5-7 resembles the distribution of intention of deliveries in Figure 5-6. This visual evidence provides casual support for the argument that carry (and therefore stocks) positively correlate with intentions of delivery.

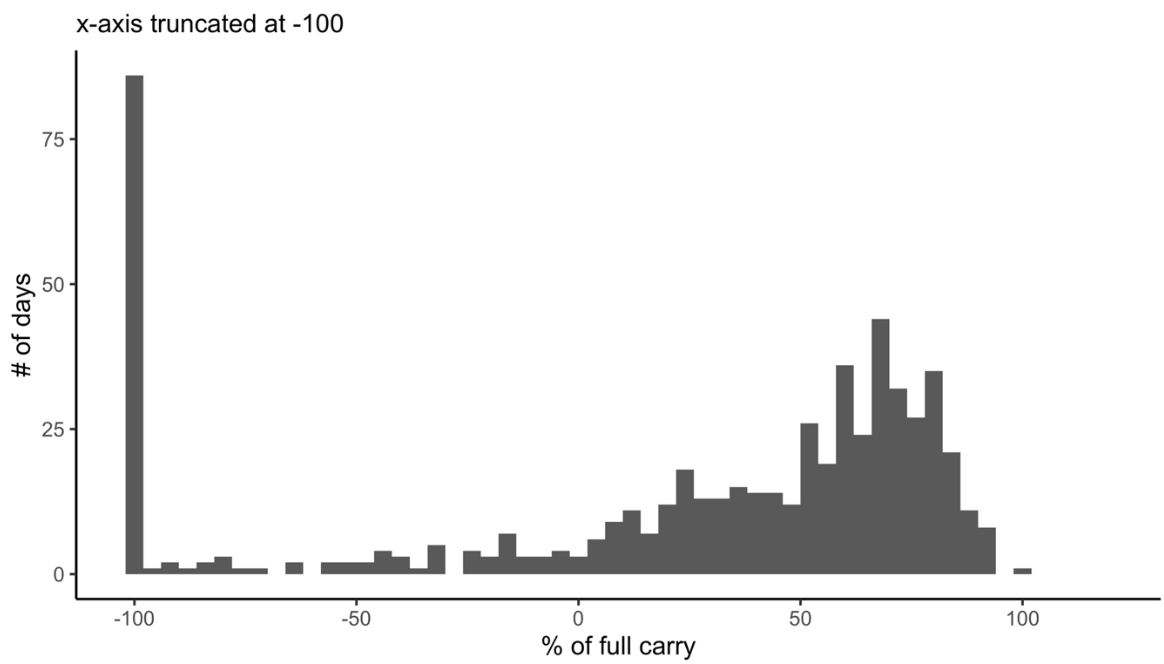

Figure 5-7 – Frequency distribution of percentage of full carry considering across all delivery-period days, January 2011 to April 2021.

[15] A few very negative values are all bunched up at -50 on the X axis.

6. Results

This Section tests the three hypotheses developed in Section 4, using the data described in Section 5. It first uses simple and multivariate Tobit regressions to assess whether the DVE explains the occurrence and the number of intentions of delivery. Second, it analyzes graphically and statistically the declarations of intentions to deliver, in order to assess whether market participants condition their deliveries on market conditions (as captured by whether the market is in carry or contangoed *vs*. inverted or backwardated). Third, it investigates whether issuing Shipping Certificates, which signals delivery and is publicly announced after a day session ends and the next-day overnight session starts, affects the price relation between the expiring futures and the first deferred contract.

a. DVE vs. *Basis*

Figure 6-1 illustrates the relationship between the New Orleans CIF basis and the estimated DVE for days in which intentions of delivery were declared. The 45-degree line shows DVE = NOLA Basis.

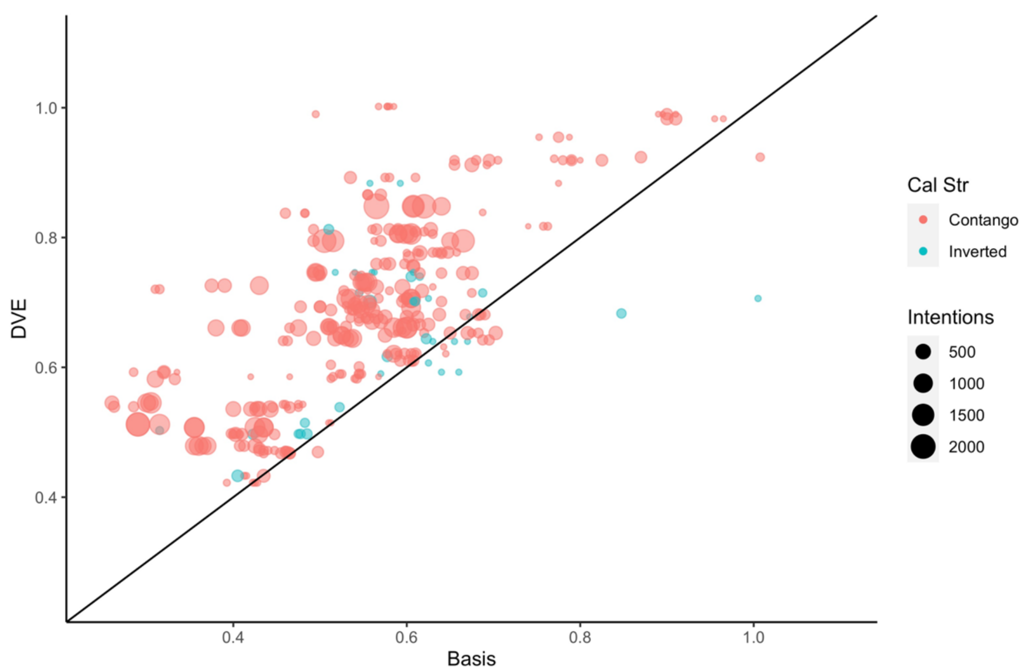

Figure 6-1 – DVE and Basis for on days with non-zero intentions of delivery, 2011-2021. The size of each dot indicates the number of intentions on each day.

Figure 6-1 shows that intentions tend to be declared when the basis is weak compared to the DVE.[16] Precisely, there is a total of 344 days with deliveries from January 2011 to April 2021. Of those 344 days, 318 had an estimated DVE greater than the NOLA CIF basis, and 108,318 contracts were delivered on those days. The remaining 26 days had a DVE less than or equal to the basis, with a mere 2,656 contracts delivered on those 26 days. In other words, the basis was greater than the estimated DVE on 7.5 percent of the days in which delivery intentions were declared; but those intentions amount to only 2.4 percent of the total number of contracts delivered in the entire sample.[17]

As observed by Peck and Williams (1992) and noted in Section 2, redeliveries are plentiful, often multiples of the number of Shipping Certificates outstanding. It is thus helpful to look only at the occasions of the first declaration of intention for each contract. Figure 6-2 does so. There were 46 1st intentions with a DVE greater than the New Orleans CIF basis, adding up to 15,628 contracts. In contrast, there were only five days with the basis greater than the DVE, with a total of just 141 contracts.

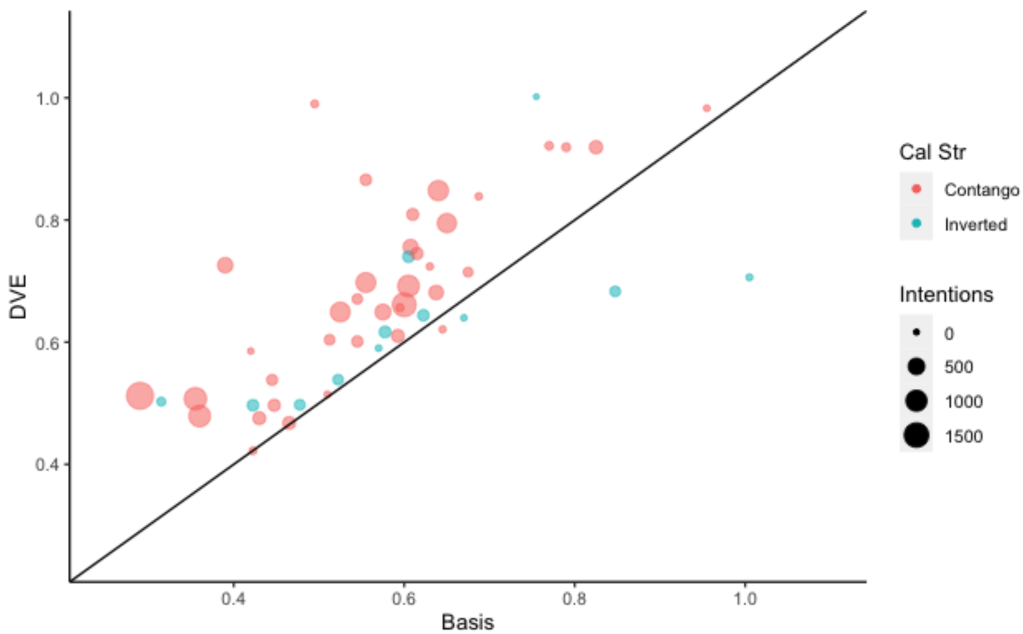

Figure 6-2 – DVE and Basis for each contract's first intentions of delivery, 2011-2021. The size of each dot indicates the number of first intentions on each day. The solid line indicates DVE = NOLA basis.

[16] As discussed in Section 4.1 and demonstrated formally in Table 4-2, a weak basis-DVE generally means that cash prices are weak compared to futures prices. Indeed, the sample correlation between our two variables (degree of full carry and basis-DVE) is -0.50 over the entire sample and -0.54 on delivery period days.

[17] Appendix B shows figure 6-1 split by year and by contract month. We find no clear pattern of seasonality within years or contract months.

To rule out other major factors than basis-DVE in explaining the occurrence of deliveries, we first investigate a period when grain shipments downriver were particularly difficult. Specifically, from August 17th, 2020 to October 14th, 2020 the Mississippi river was closed for repairs and maintenance of locks and dams and therefore closed for water transportation. The CBOT arranged for alternative temporary delivery locations for grains and oilseeds futures to be made available along the Missouri river. Figure 6-3 shows that this event did not change the pattern of deliveries (intentions of delivery that took place in this period are marked in green).

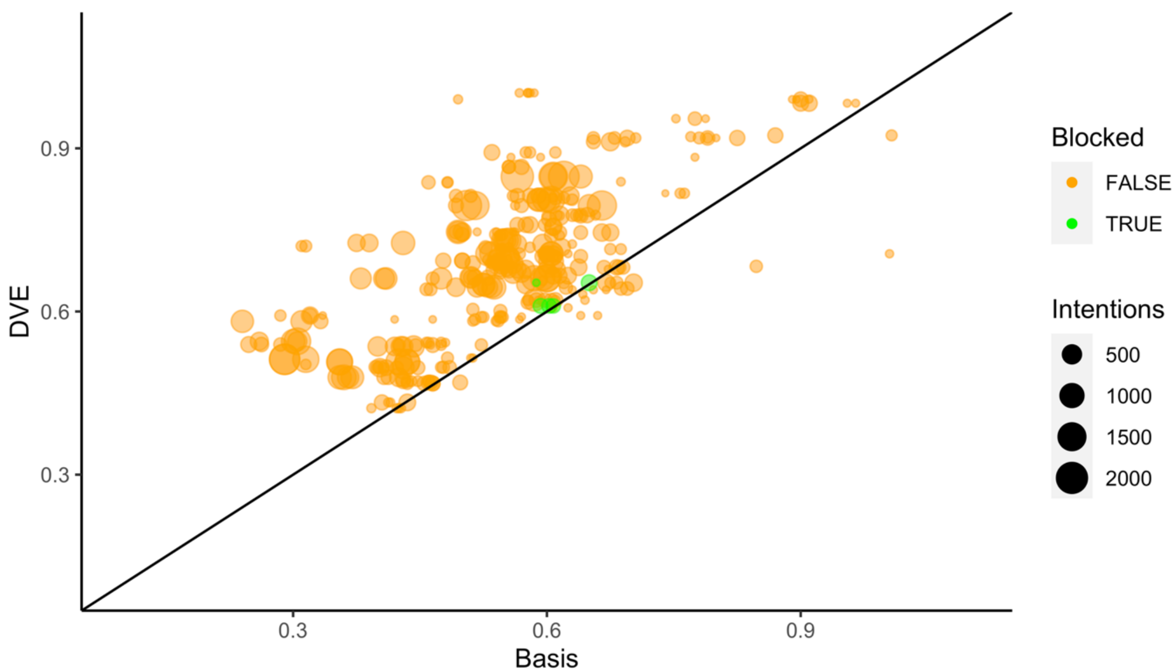

Figure 6-3 – DVE and Basis for all days with non-zero intentions of delivery. Dot size indicates the number of intentions; dot color indicates whether the Mississippi river was blocked (green) or not (orange) in 2011-2021.

According to the DVE framework, the area below the 45-degree line in Figure 6-1 (where the DVE is less than the CIF basis) is one where there should be *no* incentives for shorts to make deliveries. Yet, on 26 days in our sample, deliveries did take place even though the DVE was less than the NOLA CIF basis. We therefore take a more granular-level look to explain those 26 instances.

First, note that most of those 26 datapoints are within close proximity of the line (in Figure 6-1) where DVE equals Basis. This observation raises two possible concerns about the estimated DVE: (i) freight prices and (ii) delivery options.

(i) While freight prices along the Mississippi river are unregulated and quite volatile (Wetztein *et al.,* 2021), they are only reported weekly by the USDA Agricultural Marketing Service's Grain Transportation Report. CIF New Orleans basis quotes, on the other hand, are available daily. This creates a somewhat mismatched comparison. A variance analysis shows that the weekly freight rates for Delivery Zone 3 have a 9.9 percent standard deviation. Since volatility is linear in the square root of time, we estimate the average daily volatility (5-day week) to be 4.43 percent. We create a 99% confidence interval for our DVE estimates based on this figure.

(ii) We use results from Hranaiova *et al.* (2005) and Boyle (1989) to estimate values for the delivery options that are embedded in CBOT corn futures. Hranaiova *et al.* (2009) calculate the combined value of timing and location options to be around 5 percent of the average basis. Boyle's (2009) estimations is based on the number of deliverable assets and the correlation between those assets. CBOT corn futures are deliverable in three distinct grades. Yellow #2 is the standard; Yellow #1 is deliverable at a 1.5 cent/bu premium and Yellow #3 at a 1.5 cent/bu discount[18]. Assuming a 0.995 correlation between the deliverable asset prices, Boyle's method calculates the quality option to be 1.29 percent of the futures price. We add those option value estimates to the DVE.

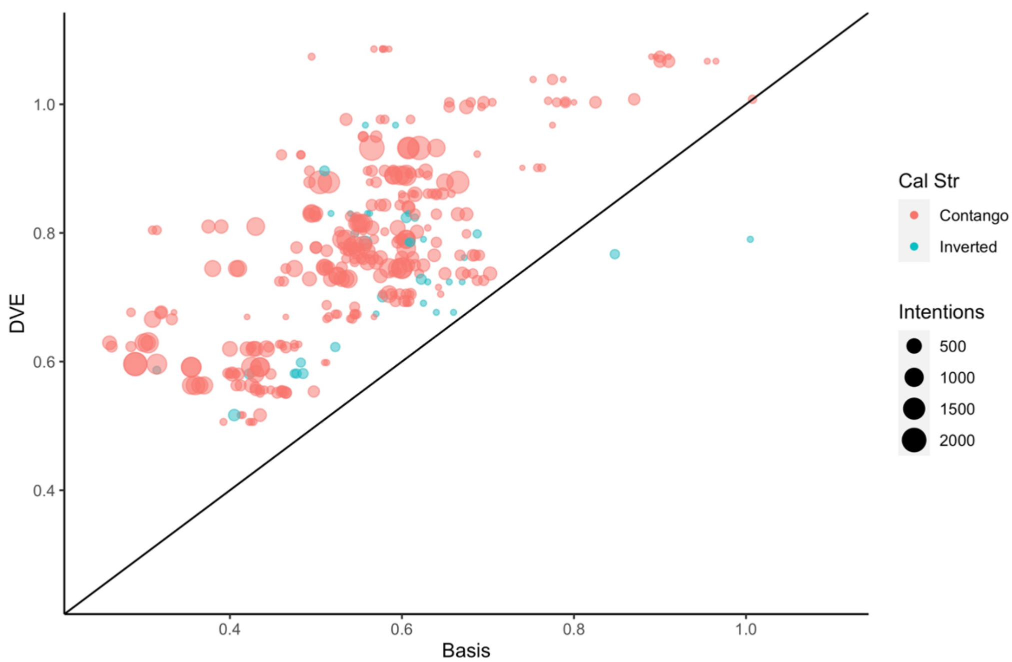

Figure 6-4 – DVE and Basis (cents/bushel) for days with intentions of delivery, accounting for measuring errors and embedded options.; 2011-2021.

[18] The 1.5 cent/bu #3 yellow corn discount was valid through December 2018. It changed in January 2019 to 2-4 cents/bu discount depending on damage grade factors and foreign material

Figure 6-4 incorporates the confidence interval and those options estimates to the DVE, in practice shifting down the line where the basis "equalizes" the DVE. Figure 6-4 shows that, after accounting for possible measurement errors and for the value of the embedded options, only two occurrences of intentions of delivery (out of an initial 26) remain in the area where they should be disadvantageous for the short (*i.e*., below the 45-degree line in Figure 6-4). Those two instances can be explained as follows:

- August 30th, 2013: Someone stopped seven Shipping Certificates on the last trading day (LTD) of the previous month. As explained in Section 3, a trader needs a complete set of 11 Certs to be able to cancel the Certs and load-out a barge. That trader was stuck with just seven Certs and was probably unwilling or unable to fill a barge, and so carried/redelivered the seven Certs—which kept being passed around until they ended up with the issuer for cancellation.
- July 13th, 2012: ADM delivered 103 Shipping Certificates on LTD, as seen in the DCUR report. Given the timing and circumstances of that event, it is likely that either ADM was forced to do so by a long that refused to sell or that it stepped in for another trader in the same situation but who was unable to deliver.

The DVE framework implies that the smaller the DVE is compared to the basis, the more appealing the futures market becomes for merchandisers in relation to the cash market. That is, there should be a negative relationship between the number of deliveries happening and the basis-DVE. In what follows, we formally test how well such measured distance can explain the number of certificates delivered through the period (including zero).

Because of redeliveries, the number of intentions of delivery declared in a particular day depends a lot on the number of intentions observed on the previous day. At the same time, according to the framework presented in Table 4-2, redeliveries will continue to happen until the basis and the DVE are brought to the same level. Absent publicly available information regarding redeliveries, we propose two approaches to establishing a statistical relation between deliveries and the basis-DVE.

(i) First, we run Tobit regressions in which we limit the sample, for each contract month, to the first day when deliveries take place for that month (whether that day is the First Intention Day or any of the other possible delivery days for that contract). The intuition for this approach is that, by construction, the only redeliveries that could take place on that first day would involve Certs carried from a previous month. Figure 6-5 and Table 6-1 summarize this analysis.

(ii) Second, for each day of the delivery period we look at the averages, up to that day, of the number of deliveries and of (basis-DVE). The idea is to estimate the impact of the latter on total number of intentions of delivery for a contract month, whether they are redeliveries or not. We have already shown that deliveries tend to be concentrated in the early days of the delivery period. We therefore compare the results across samples by gradually adding days of the delivery period to the sample. Table 6-2 summarizes this analysis.

Looking solely at the first day when deliveries actually take place (whether that day is the First Intention Day or not), several patterns are readily visible in Figure 6-5. The left panel of the Figure shows that, of the first deliveries initiated in the first half of the delivery period (*i.e.*, when only the short can start the process), all but one of the biggest first deliveries are on First Intention Day. The right Panel shows that, across the entire delivery period, deliveries increase with the extent to which the DVE exceeds the basis.

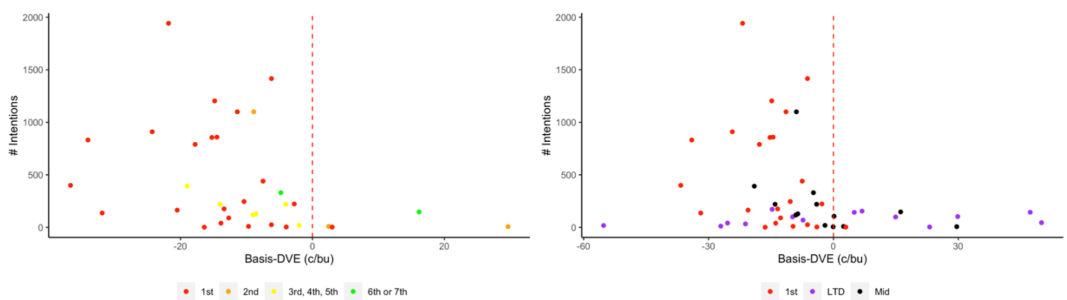

Figure 6-5 – Initial intentions to deliver, by day of the delivery period. The left panel plots the number of intentions first declared in the first half of the delivery period: on First Intention Day (**red**), on the second day of the delivery period (**orange**), the third, fourth or fifth day (yellow), or the 6th or 7th day (green). The right panel shows intentions first declared for all days in the delivery period, split between the First Intention Day (**red**, as in the left panel), the last trading day (**purple**), and the other nine or ten delivery days (**black**).

Table 6-1 provides formal support for the observations gleaned from Figure 6-5 by establishing two patterns. Columns 1 shows that, on the first day of any delivery period when deliveries start taking place, the number of deliveries on that initial day increases with the extent to which the DVE exceeds the basis that same day. Columns 2 and 3 document the same statistical relationship between (a) the total number of deliveries—including possible redeliveries—on that initial day and on the next two days and (b) the average value of (basis-VE) on those days.

Table 6-1: Intentions to Deliver at the Beginning of the Delivery Period.

		1	1+2	1+2+3
(1)	coef	-13.2445	-33.4971	-60.0946
	Std. Error	6.2323	15.418	24.2004
	p-value	0.0456**	0.0298**	0.013**
	r^2	0.1173	0.1300	0.1650
(2)	coef	-15.8011	-44.8066	-78.552
	Std. Error	6.7671	15.1484	23.439
	p-value	0.0195**	0.0031***	0.0001***
	r^2	0.2549	0.3069	0.3311

Notes: Tobit regressions of the number intentions to deliver on the first, first two, and first three days when deliveries actually take place (2011-2021). The explanatory variable is the average daily difference between the NOLA CIF basis and the DVE on those days. Model (1) regresses Intentions on (Basis-DVE) only. Model (2) also controls for possible contract-month effects. Statistical significance is denoted by: '***' for 0.001, '**' for 0.05, '*' for 0.1.

Table 6-2 displays results for a regression analysis of the relation between the total number of intentions on a given delivery period and the average value for (Basis – DVE) on that period. Since the dependent variable (*i.e.*, the sum of intentions) is left-censored (that is, has a minimum value of zero), we perform Tobit regressions (Tobin, 1958). Table 6-1 displays the coefficient, the standard error and the p-value for the average value of (Basis – DVE) for each of our four variations of such model: univariate (1), contract-month fixed effects (2), control for the average calendar slope (3), and model with controls for contract month and slope (4). For Tobit regressions, a useful way of comparing competing models is to calculate the squared correlation between predicted values and the observed values. Such squared correlation is what “r^2” refers to in Table 6-1.

Table 6-2: Total Intentions to Deliver and Average Basis-DVE.

		1	1+2	1+2+3	1+2+…+4	1+2+…+5	1+2+…+6	1+2+…+7	1+2+…+8	1+2+…+9	1+2+…+10	1+2+…+11	1+2+…+12
(1)	coef	-33.5451	-51.1917	-94.8228	-117.2466	-123.3423	-125.7354	-121.5131	-126.2081	-127.2816	-118.4214	-99.4037	-75.335
	Std. Error	9.6993	17.3639	26.089	29.4149	30.8327	31.825	32.4869	33.9404	33.5917	32.0541	28.5392	23.817
	p-value	0.0005***	0.0032***	0.0003***	0.0001***	0.0001***	0.0001***	0.0002***	0.0002***	0.0002***	0.0002***	0.0005***	0.0016***
	r^2	0.1281	0.1409	0.1843	0.1997	0.1964	0.1924	0.1887	0.1840	0.1921	0.1905	0.1020	0.1008
(2)	coef	-41.4413	-53.9627	-102.963	-138.2339	-146.471	-154.815	-157.448	-166.9408	-168.3238	-161.4371	-143.5223	-115.5563
	Std. Error	11.4152	17.8861	26.9681	30.3593	31.518	32.988	33.699	35.0266	34.6934	33.2244	29.2334	24.9345
	p-value	0.0003***	0.0026***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***	1.00E-04	0.0001***	0.0001***
	r^2	0.1767	0.2304	0.2856	0.3333	0.3416	0.3345	0.3355	0.3424	0.3483	0.3590	0.2429	0.2427

Notes: Tobit regressions of the number intentions to deliver up to the t^{th} (t=1,…,12) calendar day in the delivery period (2011-2021). The explanatory variable is the average daily difference between the NOLA CIF basis and the DVE up to the t^{th} day of each delivery period. Model (1) regresses Intentions on (Basis-DVE) only. Model (2) also controls for possible contract-month effects. For each model, the first column in the Table considers deliveries on the first day of the delivery period only; the second column considers deliveries on the first and second days only; and so forth. Statistical significance is denoted by: '***' for 0.001, '**' for 0.05, '*' for 0.1.

As we hypothesized in Section 3, we find a negative relation between (Basis-DVE) and Intentions – that is, as this difference approaches zero, the less likely deliveries are. The average (Basis-DVE) variable is significant at 5% in 45 of the 48 models, and significant at 10% in all of them. Interestingly, controlling for the slope of the futures term structure (Model 3) or for both the slope and the contract month (Model 4) tends to diminish the significance level of our main variable of interest. Likewise, adding days to the sample also seems to affect the significance level. In terms of fit, the best models are the ones controlling for the contract month, for the calendar slope, and including 4 to 11 days of the delivery period, with the predicted values sharing around 35% of their variance with the observed values.

b. Timing of deliveries

According to our framework, the presence or absence of carry should be central in the short's decision regarding when to make deliveries. Table 6-2 and Figure 6-5 describe each contract's first declarations of intention for the sample period. The results are separated between absolute numbers (left panel) and relative figures (right panel); and, for each panel, between days when the futures market is in carry *vs*. inverted. Day #1 corresponds to First Intention/Position Day, or two business days before the beginning of the delivery month in calendar terms. Day #2 corresponds to First Notice Day, and day #3 to First Delivery Day. We consider the delivery period from the First Position/Intention Day to the Last Trading Day, which is the period of time when intentions to deliver may be declared. Depending on holidays and weekends, the total number of days in a given delivery period can vary. Of all the futures in the sample, 20 contract/year months had exactly 11 days of delivery period, and 31 contracts had exactly 12 days of delivery period.

Table 6-3 – Sum of first intentions of delivery declared by day of the delivery period, separated by carry situation. Absolute terms (left) and relative terms (right).

# day of delivery	Carry	Inverse	Total
1	11866	3	11869
2	1109	7	1116
3	510		510
4	349		349
5	239		239
6	330		330
7		147	147
8			
9			
10	6	106	112
11	30	189	219
12	374	545	919
Total	14813	997	15810

# day of delivery	Carry	Inverse	Total
1	80.11%	0.30%	75.07%
2	7.49%	0.70%	7.06%
3	3.44%	0.00%	3.23%
4	2.36%	0.00%	2.21%
5	1.61%	0.00%	1.51%
6	2.23%	0.00%	2.09%
7		14.74%	0.93%
8			
9			
10	0.04%	10.63%	0.71%
11	0.20%	18.96%	1.39%
12	2.52%	54.66%	5.81%
Total	100.00%	100.00%	100.00%

For carry markets, Table 6-3 shows that 13,485 of the 14,813 first intentions of delivery (numbered in contracts) were declared within the first three days of the delivery period. When it comes to inverse markets, just 734 first intentions were declared on LTD (the only day when the long can force delivery), and a mere 263 intentions were declared prior to LTD.

Figure 6-6 provides a breakdown of the aggregated daily figures in the left panel of Table 6-2, using the number of days left before the end of the delivery period (as opposed to the number of days that have elapsed since the start of the period, as in Table 6-2) to present the disaggregated information

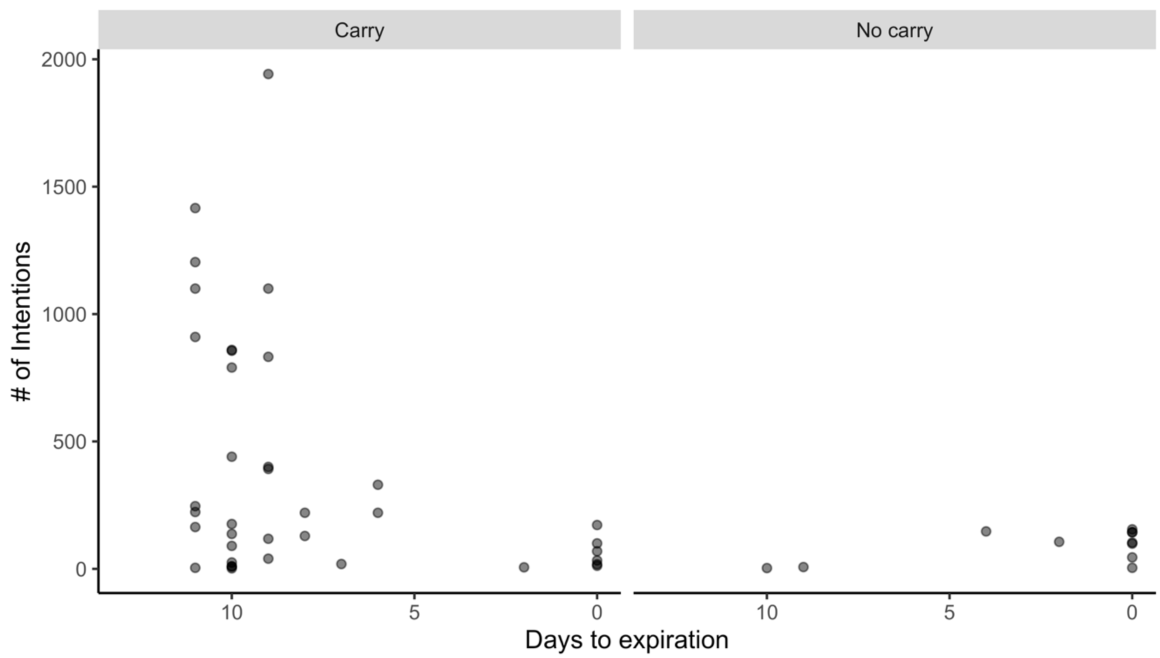

Figure 6-6 – Frequency and size of intentions of delivery, by day of the delivery period. Considering exclusively the first intentions to be made in each contract; 2011-2021.

Figure 6-7 provides the same information as in Figure 6-6, for both first deliveries and redeliveries. The left panel of Figure 6-7 illustrates both how redeliveries are plentiful (as noted already in Peck and Williams, 1992), but and how they tend to get smaller as time passes, in carry markets. In contrast, the right panel in the figure shows that, in inverse markets, redeliveries tend to increase both in size and in frequency towards the end of the life of the contract. All of those patterns are consistent with the hypotheses developed in Section 4.

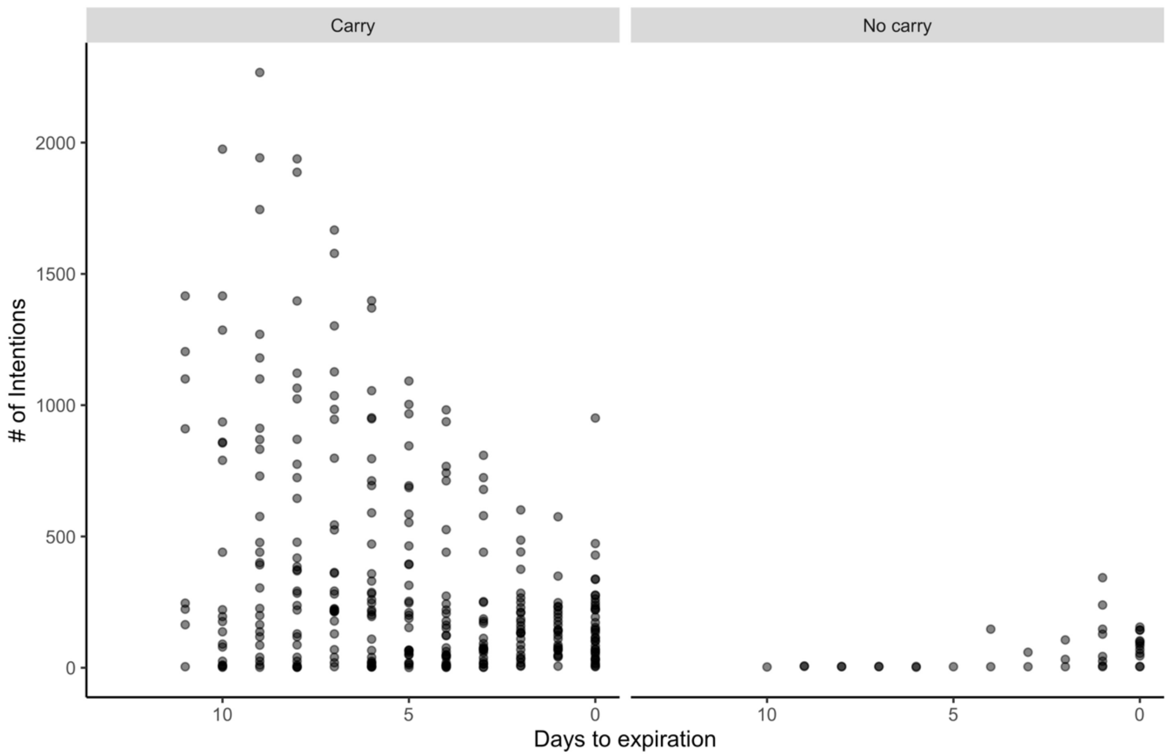

Figure 6-7 – Frequency and size of intentions of delivery, by day of the delivery period; 2011-2021.

We run a *t*-Test (Table 6-4) to compare the level of carry between early (first three days of the delivery period) and late (days 10 to 12 of the delivery period) first deliveries. Consistent with Hypothesis 2 and the graphical evidence presented thus far, the test rejects (at the 1% statistical significance level) the null hypothesis that the difference between the two means is 0.

Table 6-4 – t-Test, carry: early *vs*. late 1st deliveries.

	EARLY	*LATE*
Mean	58.2653	-156.104
Variance	1098.7739	134708.1
Observations	28	16
Pooled Variance	48816.38	
Hypothesized Mean Difference	0	
df	42	
t Stat	3.0959	
P(T<=t) one-tail	0.0017	
t Critical one-tail	1.6820	
P(T<=t) two-tail	0.0035	
t Critical two-tail	2.0181	

c. Do deliveries affect spreads?

Figure 6-8 displays the relation between cancellations (left)/registrations (right) of Deliverable Certificates and returns on the F_1-F_2 spread from settlement to open, for the sampled delivery periods. Figure 6-9 illustrates the relation between days of the delivery period with registration of Delivery Certificates and Settlement to Open returns on the F_1-F_2 spread but faceted by contract month.

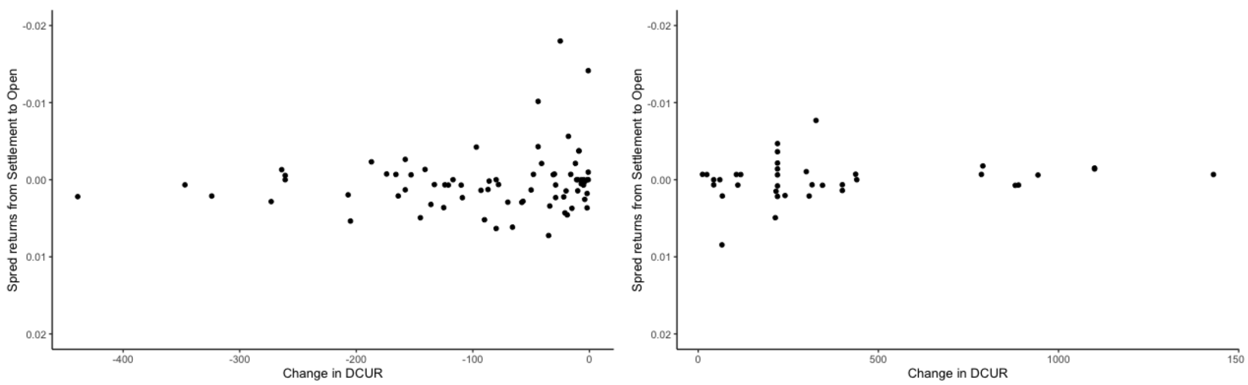

Figure 6-8 – Delivery period: Changes in DCUR *vs*. close-to-open nearby calendar spread price return (2011-2021)

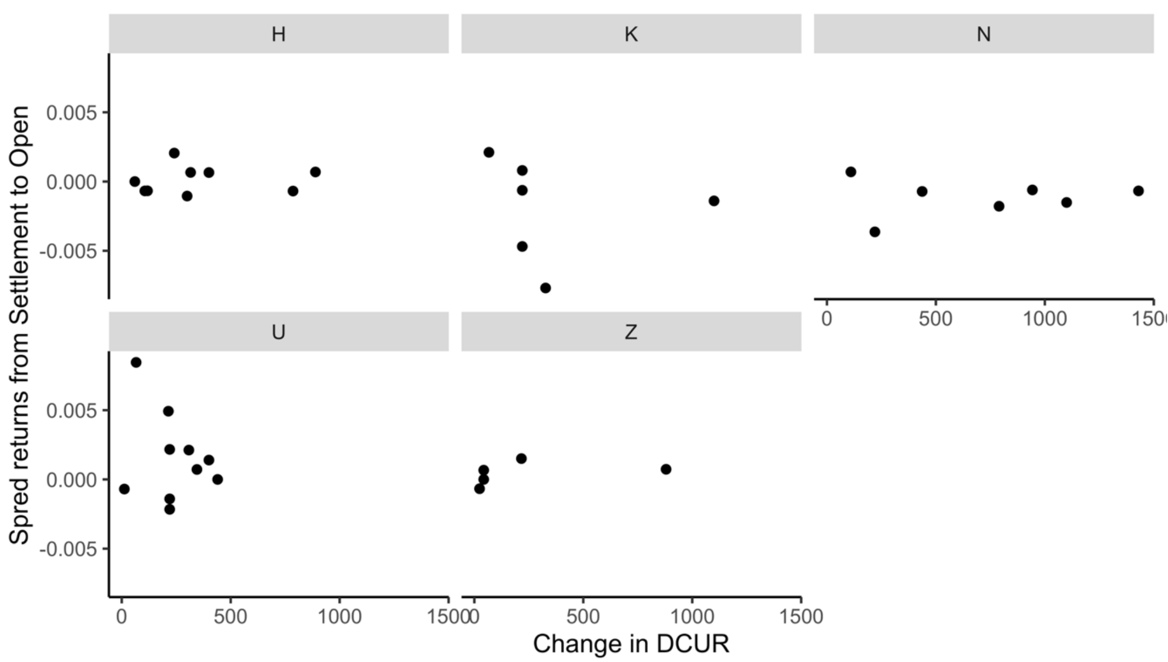

Figure 6-9 – Changes in the F_1-F_2 calendar spread price (from previous-day close to next-day open), on delivery-period days when Delivery Certificates were registered (January 2011 to April 2021). Delivery Certificates under Registration (DCUR) are published by the exchange at 4PM, between previous-day close and next-day open.

No pattern is seen in the returns of the spread related to either the registration or the cancellation of certificates. A simple *t*-Test confirms this first impression by comparing the spread returns of days when Delivery Certificates are registered and days when no Delivery Certificates are registered. The result is shown in Table 6-5. We cannot reject the null the hypothesis that the two means (returns on days where Certs are registered and on days where Certs are not registered) are the same. Both Figures 6-8, 6-9 and Table 6-5 go against Hypothesis #3. Put differently, it seems unlikely that there exists—*on average*—a causal relationship between the registration of Shipping Certificates and the prices of the expiring contract.

Table 6-5 – *t*-Test, nearby calendar spread price change, days when DCURs increase *vs*. do not increase.

	>0	*<=0*
Mean	-0.0040	0.00035
Variance	0.0010	0.00003
Observations	71	1546
Hypothesized	0	
df	70	
t Stat	-1.1758	
P(T<=t) one-ta	0.1218	
t Critical one-t	1.6669	
P(T<=t) two-ta	0.2437	
t Critical two-	1.9944	

7. Discussion and Conclusion

Convergence between cash and futures prices in the delivery regions is central for the sustained well-functioning of the futures market as a tool for hedging and price discovery. Physical deliveries are critical to convergence, which has implications for the use of futures as an origination and merchandising tool. Deliveries are tightly linked to commodity stock levels, arbitrage, and embedded options.

This paper investigates the physical deliveries for CBOT #2 Yellow Corn futures contracts from January 2011 through April of 2021. We first explain in detail the delivery process, including Shipping Certificates, the delivery period, and the freight system. Next, we formally derive the framework of Delivery Value Equivalent (DVE). We then link the DVE to the occurrence and to the number of intentions to deliver in our sample period. We also carry out an empirical analysis to show that physical market conditions, proxied by the term structure of futures prices, impact the timing of declarations of intentions of delivery, particularly for first intentions. Finally, we investigate whether the publication of information regarding the registration of Shipping Certificates (which imply deliveries) affects futures prices.

The DVE is a concept utilized by commercial firms involved in the grain trading business to compare the cash and futures markets as merchandising tools, thus allowing for profit maximization. When the DVE is greater than a particular location's CIF basis, it should be in the short's interest to make delivery. When the DVE is less than the basis, the long is the one with interest to take delivery. In this paper, we estimate the DVE in the 2011-2021 period using USDA's end-of-the-week barge freight quotes for delivery Zone 3, the most active area in terms of deliveries. We use NOLA CIF prices as reference because New Orleans has an active cash market and is the end destination, for grain barges around the Illinois waterways, where the export terminals are located. While our focus is on NOLA, there is no reason why the framework would not work just as well for other cash market locations.

We provide evidence that the difference between the New Orleans cash market's basis and the DVE explains the occurrence and number of deliveries. We identify 318 out of 344 days with intentions of delivery to be days when the estimated DVE was greater than the NOLA CIF basis (that is, when it was in the seller's interest to deliver) against only 26 when it is not. We relate 24 of those 26 instances to the value of embedded options and freight cost imprecisions, and the remaining 2 to idiosyncratic events unrelated to DVE considerations. Overall, our findings establish the importance of the DVE framework and also point to how the corn futures market is a more practical merchandising channel for sellers than it is for buyers. Through the estimation of a number of Tobit models, we then show formally that the average difference between the NOLA basis and the DVE is important in explaining the sum total of intentions to deliver declared over a given number of days in the delivery period.

From a timing perspective, we hypothesize that physical market conditions, embedded in the slope of the futures term structure at the start of the delivery period, should determine whether deliveries begin early or late in the delivery period. Our graphical and statistical analyses support this hypothesis. (1) When the market is in carry, first intentions are concentrated in the early days of the delivery period. Early deliveries are also generally bigger in terms of volume. The number of first intentions declines quickly as the delivery period advances, only to pick up on the Last Trading Day. This last observation may relate to the short's holding the timing option. (2) In inverted markets, deliveries are concentrated (both in quantity and frequency) in the last days of a contract's life, albeit generally in much smaller quantities. This points to convergence happening early in the first case and late in the second. Although subject to the effect of stock levels, the difference in frequency and size of deliveries between carry and inverted markets further underscores the greater practicality that sellers find in using the futures market as a merchandising tool in comparison to buyers.

Last but not least, we ask whether deliveries feed back into nearby futures prices and whether they affect the cost of rolling over a futures position from the nearby into the first-deferred contracts. We do not find statistical support for such an effect. Precisely, the data to not show any obvious causal relationship between the registration (or even the cancellation) of Delivery Certificates and changes in the price of the expiring contract in relation to the first-deferred futures.

Our analysis enriches the understanding of the functioning of futures markets (particularly toward the end of the life of a contract) where physical delivery of the underlying is involved. Illustrating the dynamics between the cash market, the futures market, and the market for Shipping Certificates (the instrument of delivery) helps to shed light on the incentives faced by market participants and underlines the importance that futures contract specifications regarding costs and premiums be closely related to the actual costs and premiums observed in the physical market.

As already mentioned, our DVE estimation reflects a number of imperfections. In particular, having cash prices through all different delivery regions and daily rates for barge freight rates would allow for the drawing of a more precise figure of how the DVE and the CIF basis interact at the daily frequency. To see the arbitrage between the DVE and the basis clearly bringing the prices together may demand intraday data on prices, including freight prices (assuming that such records exist). A daily or intra-day comparison between the DVE and the CIF basis would in turn be helpful in explaining the occurrence and intensity of redeliveries.

This observation ties into the notion that, by performing arbitrage between the cash and futures, market players are also bringing together the cash market basis and the DVE. They eventually cancel the Certs and load-out as arbitrage no longer becomes feasible, thus the decline of the number of contracts involved in those redeliveries. However, we ccannot easily observe this effect in our data: an investigation necessitates more granular information regarding freight rates and prices across different locations.

Another limitation of our dataset is that, since there are only five delivery periods every calendar year, the sampled ten years for the corn market comprise just over 50 delivery periods. Arguably, the same analysis could be applied to the soybeans and soft red winter wheat futures markets, which have an almost identical delivery system in place – particularly soybeans one. However, for those two other commodities, prolonged periods of non-convergence would have to be accounted for—a problem that this paper strove to avoid by focusing on corn in the first place.

In our sample, redeliveries appear to be numerous and seem to gradually decline (in terms of volume of contracts involved) towards the end of the contract's life. This pattern, which we cannot confirm in the absence of public data on redeliveries, looks similar to the decline in the number of Shipping Certificates outstanding (DCUR) towards and after the end of the delivery period. An interesting question for further research would be to formally investigate, with the proper data, whether those observations can be confirmed.

Finally, to the best of our knowledge, no study to date has tried to explain redeliveries. To do so, it would be helpful to know the proportion of commodity that each type of market participant (speculators, regular firms, not-regular commercials, etc.) answers for in each day's transactions. Although such records do exist, they are not publicly available—and so this inquiry must be left to researchers at the regulatory agency that controls the data.

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Data Availability Statement

The price data are from Bloomberg. The other data used in the present paper are freely available:

CBOT Registrar with DCUR reports

https://www.cmegroup.com/clearing/operations-and-deliveries/registrar-reports.html

CBOT Delivery reports

https://www.cmegroup.com/clearing/operations-and-deliveries/cbot-delivery-reports.html

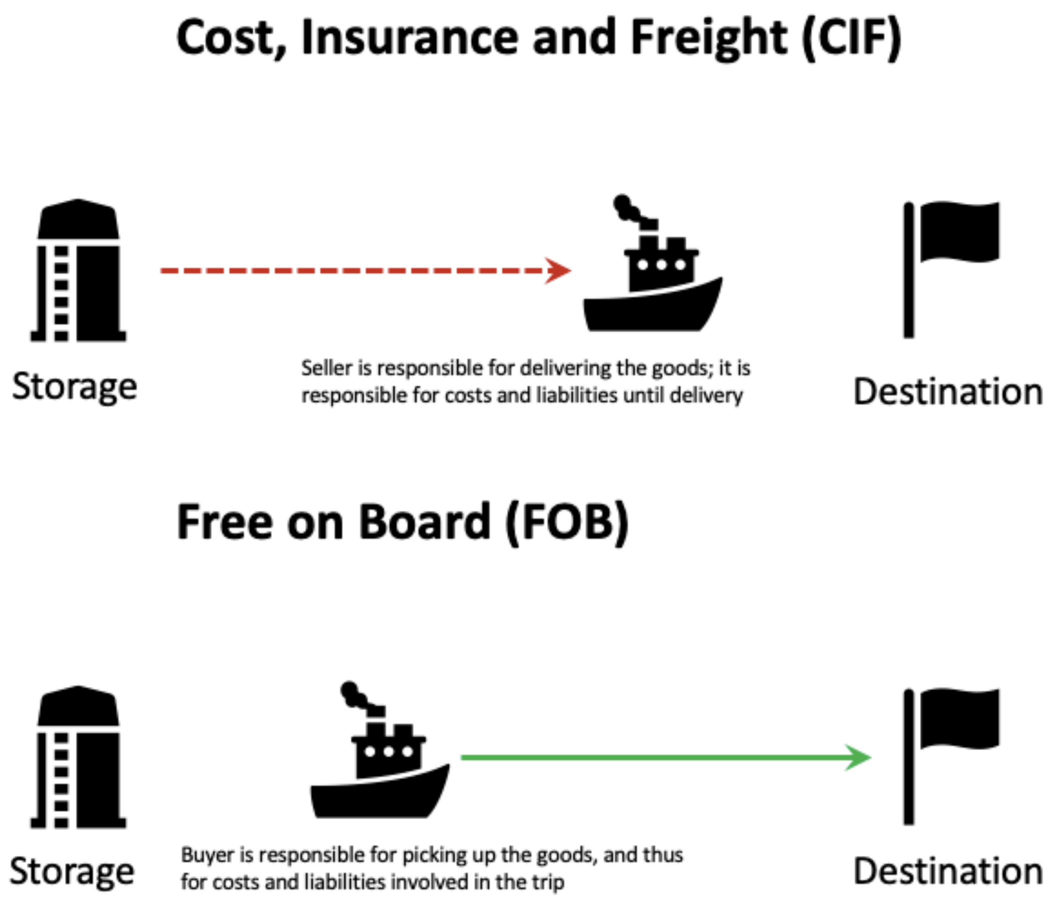
USDA NOLA prices

https://www.ams.usda.gov/mnreports/AMS_3147.pdf

APPENDIX A – CIF *vs*. FOB

CIF and FOB are trade terms used when goods have to be moved from one destination to another through shipping. Figure A-1 illustrates the difference between CIF and FOB; a textual explanation follows.

Figure A-1: CIF *vs*. FOB



CIF

CIF stands for cost, insurance, freight. In this mode of transaction, the seller is responsible for insuring the goods, loading them up, and transporting them to the delivery facility. To do so, it may choose a forwarder of its preference. This means a higher buying price for the buyer, and possibly higher margins for the seller. In the context of the present paper, CIF NOLA implies that the seller is to deal with shipping, loading and freight costs as well as insurance; while being responsible for delivering the commodity to the seller in a facility located in New Orleans. The USDA New Orleans cash bids we use are CIF.

FOB

FOB stands for Free on Board. In this mode of transaction, the buyer is responsible for picking up the goods at the seller's shipping facility; the buyer loads, insures, and delivers the goods at the final destination. In the context of the present paper, FOB would mean that the buyer loads up barges in the delivery regions and ships the grain down to Louisiana. We do not consider this type of transaction.

Key Differences

The main difference between CIF and FOB transactions is about who is responsible for the goods while in transit between origin and destination. The details can vary from contract to contract. For example, in some instances, the goods are only considered "delivered" once loaded-out at the buyer's facilities. In other cases, the goods are considered "delivered" as soon as they reach the port/facility of destination.

Each arrangement has its pros and cons. Some companies may have particular needs that require particular shipping agreements. The FOB agreement reduces complexity from the seller's point of view and adds complexity from the buyer's. The CIF agreement works in the opposite way. Agents' own abilities are relevant at this point. A seller who has expertise in the physical handling of grain and a good system in place for dealing with insurance and freight should prefer CIF as it allows for a higher margin of profit on the transaction. Likewise, a buyer of a small quantity of goods who has little know-how of the delivery system should prefer to pay more to avoid the risks and complications of handling and insuring goods.

APPENDIX B - Seasonality

Seasonality: Figures B-1 and B-2 illustrate deliveries year by year and by contract month, respectively.

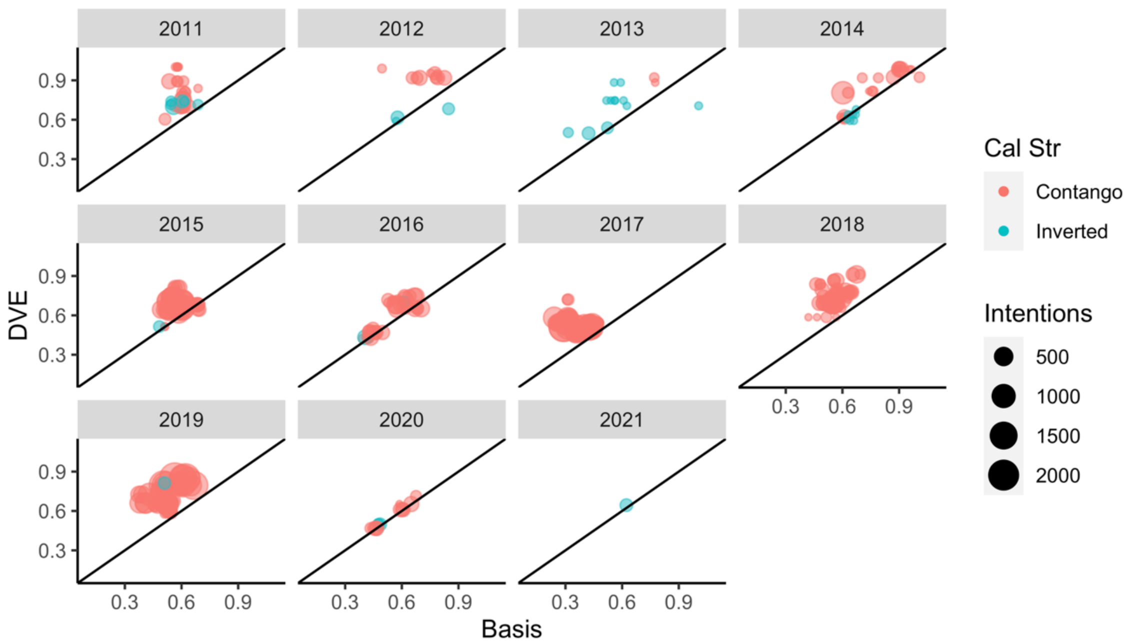


Figure B-1 – Delivery intentions in relation to NOLA CIF basis (X axis) and DVE (Y axis), plots for all contract months in each calendar year (2011-2021).

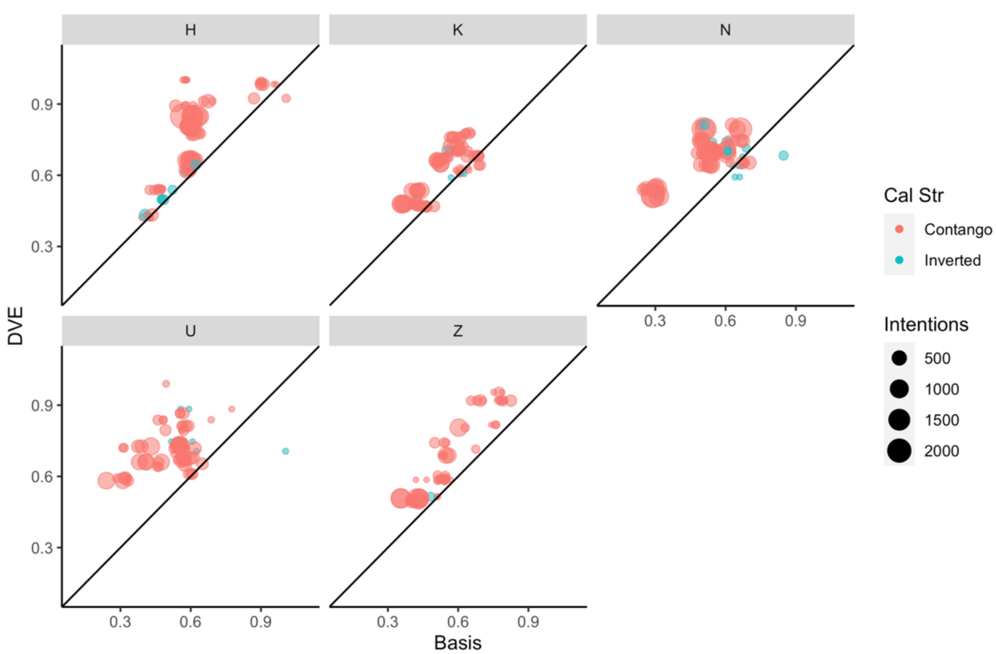


Figure B-2 – Delivery intentions (dots), NOLA CIF basis (X axis) and DVE (Y axis). Plots for all calendar years (2011-2021) by contract month: H = March, K = May, N = July, U = September, Z = December.