

SUBMISSION COVER SHEET

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Registered Entity Identifier Code (optional): 23-047

Organization Chicago Board of Trade Inc. ("CBOT")

Filing as a: DCM SEF DCO SDR

Please note - only ONE choice allowed.

Filing Date (mm/dd/yy): 01/30/23 Filing Description: Amendments to the Variable Storage Rate Mechanism for the Wheat, Mini-Sized Wheat, KC HRW Wheat, and Mini-Sized KC HRW Wheat Futures Contracts

SPECIFY FILING TYPE

Please note only ONE choice allowed per Submission.

Organization Rules and Rule Amendments

- | | | |
|--------------------------|-------------------------------------|------------|
| <input type="checkbox"/> | Certification | § 40.6(a) |
| <input type="checkbox"/> | Approval | § 40.5(a) |
| <input type="checkbox"/> | Notification | § 40.6(d) |
| <input type="checkbox"/> | Advance Notice of SIDCO Rule Change | § 40.10(a) |
| <input type="checkbox"/> | SIDCO Emergency Rule Change | § 40.10(h) |

Rule Numbers:

New Product

Please note only ONE product per Submission.

- | | | |
|--------------------------|---------------------------------------|------------|
| <input type="checkbox"/> | Certification | § 40.2(a) |
| <input type="checkbox"/> | Certification Security Futures | § 41.23(a) |
| <input type="checkbox"/> | Certification Swap Class | § 40.2(d) |
| <input type="checkbox"/> | Approval | § 40.3(a) |
| <input type="checkbox"/> | Approval Security Futures | § 41.23(b) |
| <input type="checkbox"/> | Novel Derivative Product Notification | § 40.12(a) |
| <input type="checkbox"/> | Swap Submission | § 39.5 |

Product Terms and Conditions (product related Rules and Rule Amendments)

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|-------------------------------------|---|----------------------|
| <input checked="" type="checkbox"/> | Certification | § 40.6(a) |
| <input type="checkbox"/> | Certification Made Available to Trade Determination | § 40.6(a) |
| <input type="checkbox"/> | Certification Security Futures | § 41.24(a) |
| <input type="checkbox"/> | Delisting (No Open Interest) | § 40.6(a) |
| <input type="checkbox"/> | Approval | § 40.5(a) |
| <input type="checkbox"/> | Approval Made Available to Trade Determination | § 40.5(a) |
| <input type="checkbox"/> | Approval Security Futures | § 41.24(c) |
| <input type="checkbox"/> | Approval Amendments to enumerated agricultural products | § 40.4(a), § 40.5(a) |
| <input type="checkbox"/> | "Non-Material Agricultural Rule Change" | § 40.4(b)(5) |
| <input type="checkbox"/> | Notification | § 40.6(d) |

Official Name(s) of Product(s) Affected: See filing.

Rule Numbers: See filing.

January 30, 2023

VIA ELECTRONIC PORTALMr. Christopher J. Kirkpatrick
Office of the Secretariat
Commodity Future Trading Commission
Three Lafayette Centre
1155 21st Street, N.W.
Washington, DC 20581

**Re: CFTC Regulation 40.6(a) Certification. Amendments to the Variable Storage Rate Mechanism for the Wheat, Mini-Sized Wheat, KC HRW Wheat, and Mini-Sized KC HRW Wheat Futures Contracts.
CBOT Submission No. 23-047**

Dear Mr. Kirkpatrick:

The Board of Trade of the City of Chicago, Inc. (“CBOT” or “Exchange”) certifies to the Commodity Futures Trading Commission (“CFTC” or “Commission”) amendments to the interest rate used in the Variable Storage Rate (“VSR”) mechanism¹ in the Wheat, Mini-Sized Wheat, KC HRW Wheat, and Mini-Sized KC HRW Wheat Futures contracts as noted in the table below (collectively, the “Contracts”) effective on February 14, 2023 and commencing with the May – July VSR observation period (collectively, the “Rule Amendments”).

Contract Title	CME Globex Code	CME ClearPort Code	Rulebook Chapter
Wheat Futures	ZW	W	14
Mini-Sized Wheat Futures	XW	YW	14B
KC HRW Wheat Futures	KE	KW	14H
Mini-Sized KC HRW Wheat Futures	MKC	MKC	14N

Specifically, the Exchange plans to start measuring financial full carry in the VSR mechanism using the 3M Term Secured Overnight Financing Rate (“SOFR”) plus 221.25 basis points rather than the 3M U.S. Dollar London Interbank Offered Rate (“LIBOR”) plus 200 basis points effective trade date Monday, March 20, 2023 for the May – July VSR observation period.

CBOT designates a maximum storage charge that an approved futures delivery elevator may charge holders of its outstanding shipping certificates of the Contracts. In order to encourage price convergence under certain conditions, maximum storage charges increase or decrease based on observed wheat price spreads relative to financial full carry, which is dependent on the general cost of money for agricultural handlers.

The mechanism that adjusts the maximum storage rate that an approved futures delivery elevator may charge holders of its outstanding shipping certificates, the VSR mechanism. Fundamental to the reasoning behind VSR is the concept of financial full carry, which represents the cost to take delivery of a shipping certificate and “carry” that certificate into the next delivery period. Financial full carry is currently calculated using 3-Month U.S. Dollar LIBOR plus 200 basis points to represent the cost of money for agricultural handlers.

The LIBOR rate is currently being phased out and the longest-surviving LIBOR settings, its Overnight, 1-month, 3-month, 6-month, and 12-month tenors, will cease publication in a manner that is “representative”

¹ A primer on the VSR mechanism is available at https://www.cmegroup.com/trading/agricultural/files/pm2307-grains-oilseeds_v2_web.pdf.

of the underlying market and economic reality each intends to measure after June 30, 2023. The Federal Reserve Bank of New York's Alternative Reference Rate Committee (ARRC) identified the Secured Overnight Financing Rate (SOFR) as the short-term interest rate (STIR) that, in its consensus view, would represent best practice for use as the underlying reference in new U.S. dollar interest rate derivatives and other U.S. dollar-denominated financial contracts in their June 2017 meeting. The Rule Amendments are designed to take place as a result of the upcoming [cessation of the LIBOR](#) benchmark. The Exchange conducted analysis comparing the daily values of Chicago Mercantile Exchange Inc. ("CME") Term Three-Month SOFR Index with the 3-Month U.S. Dollar LIBOR rate each day from January 3, 2019, to June 2, 2022. Among these 892 observations, the mean difference in the two rates was 0.2125. Further analysis demonstrated that had the Exchange used CME Term Three-Month SOFR Index + 221.25 basis points instead of 3-Month U.S. Dollar LIBOR + 200 basis points in its VSR calculation, at no point since the inception of the CME Term Three-Month SOFR Index would VSR have resulted in a different storage rate. In other words, using a SOFR-based rate instead of the preexisting LIBOR-based rate in CBOT's VSR mechanism would not have changed any storage and carry outcome since 2019.

Appendix A provides CBOT Rulebook chapters 14, 14B, 14H, and 14N in blackline format. Appendix B provides a detailed description of Exchange's comparable analysis.

The Exchange reviewed the designated contract market core principles ("Core Principles") as set forth in the Commodity Exchange Act ("CEA" or "Act") and identified that the Rule Amendments may impact the Core Principles as follows:

- **Prevention of Market Disruption:** Due to the cessation of the LIBOR benchmark, the interest rate measure in the VSR mechanism needs to be amended in order to maintain an orderly market.
- **Availability of General Information:** The Exchange will make publicly available the details of the revision and issue a Special Executive Report ("SER") to the marketplace. The SER and amended rules will be available on the CME Group website.
- **Execution of Transactions:** The Rule Amendments will further enable the Exchange to continue its current practice of providing a competitive, open, and efficient market mechanism for executing transactions.
- **Recordkeeping:** The Exchange will continue to publish daily updates to VSR results during VSR calculation periods.

Pursuant to Section 5c(c) of the Act and CFTC Regulation 40.6(a), the Exchange hereby certifies that Rule Amendments comply with the Act, including all regulations under the Act.

The Exchange certifies that this submission has been concurrently posted on the Exchange's website at <http://www.cmegroup.com/market-regulation/rule-filings.html>.

Should you have any questions concerning the above, please contact the undersigned at (212) 299-2200 or e-mail CMEGSubmissionInquiry@cmegroup.com.

Sincerely,

/s/Christopher Bowen
Managing Director and Chief Regulatory Counsel

Attachments: Appendix A Amendments to CBOT Rulebook Chapters 14, 14B, 14H, and 14N
Appendix B CBOT Analysis

Appendix A

Chapter 14 Wheat Futures

14108. PREMIUM CHARGES⁴

To be valid for delivery on futures contracts, all certificates covering wheat under obligation for shipment must indicate the applicable premium charge. No certificate shall be valid for delivery on futures contracts unless the premium charges on such wheat shall have been paid up to and including the 18th calendar day of the preceding month, and such payment is endorsed on the certificate. Unpaid accumulated premium charges at the posted rate applicable to the facility shall be allowed and credited to the buyer by the seller up to and including date of delivery.

The maximum premium charges on Wheat shall be determined prior to the nearby contract delivery period. The Exchange shall measure the nearby spread relative to financial full carry each business day from the 19th calendar day of the delivery month of the contract that expires prior to the nearby contract until the last Friday which precedes by at least two business days the last business day of the month preceding the nearby contract delivery month. For example, for a September expiration, the Exchange would measure the September – December spread relative to financial full carry each business day from July 19 until the last Friday in August which precedes by at least two business days the last business day in August. Financial full carry will be determined by the following formula:

$$N * \left[\left(\frac{i}{360} \right) * FP + P \right]$$

Where:

N = Number of calendar days from the first delivery day in the nearby contract to the first delivery day in the contract that follows the nearby contract

i = [~~3-Month LIBOR~~] [CME Group 3-Month Term SOFR](#) rate + [~~200~~] [221.25](#) basis points

FP = Settlement price for the nearby futures contract

P = Current daily premium charge

The percentage of the nearby spread to financial full carry is calculated each business day during the calculation period and a running average of each of these daily values is calculated. At the end of the calculation period (the last Friday which precedes by at least two business days the last business day of the month preceding the nearby contract delivery month), should the running average carry be 80 percent of financial full carry or greater, then the maximum daily premium charge shall increase 10/100's of one cent per bushel on the 18th calendar day of the nearby contract delivery month. Should the running average carry be 50 percent of financial full carry or less, then the maximum daily premium charge shall decrease 10/100's of one cent per bushel on the 18th calendar day of the nearby contract delivery month.

The Exchange may adjust how the observed nearby spread is measured relative to financial full carry should pending contract changes exist that have the potential to affect the normal nearby spread relationship. Any adjustments to how the observed spread is measured will attempt to remove the potential effects caused by the pending contract change. Any adjustments in how the nearby spread is measured will be communicated to market participants through a Special Executive Report or Exchange Advisory Notice prior to the beginning of the measurement period.

Premium charges shall not be reduced below 16.5/100's of one cent per bushel per day.

[Remainder of Chapter unchanged.]

⁴Revised May 2010.

Chapter 14B
Mini-Sized Wheat Futures

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14B08. PREMIUM CHARGES

To be valid for delivery on futures contracts, all certificates covering mini-sized wheat under obligation for shipment must indicate the applicable premium charge. No certificate shall be valid for delivery on futures contracts unless the premium charges on such wheat shall have been paid up to and including the 18th calendar day of the preceding month, and such payment is endorsed on the certificate. Unpaid accumulated premium charges at the posted rate applicable to the facility shall be allowed and credited to the buyer by the seller up to and including date of delivery.

The maximum premium charges on mini-sized Wheat shall be determined prior to the nearby contract delivery period. The Exchange shall measure the nearby spread relative to financial full carry each business day from the 19th calendar day of the delivery month of the contract that expires prior to the nearby contract until the last Friday which precedes by at least two business days the last business day of the month preceding the nearby contract delivery month. For example, for a September expiration, the Exchange would measure the September – December spread relative to financial full carry each business day from July 19 until the last Friday in August which precedes by at least two business days the last business day in August. Financial full carry will be determined by the following formula:

$$N * \left[\left(\frac{i}{360} \right) * FP + P \right]$$

Where:

N = Number of calendar days from the first delivery day in the nearby contract to the first delivery day in the contract that follows the nearby contract

i = [~~3-Month LIBOR~~] CME Group 3-Month Term SOFR rate + [~~200~~] 221.25 basis points

FP = Settlement price for the nearby futures contract

P = Current daily premium charge

The percentage of the nearby spread to financial full carry is calculated each business day during the calculation period and a running average of each of these daily values is calculated. At the end of the calculation period (the last Friday which precedes by at least two business days the last business day of the month preceding the nearby contract delivery month), should the running average carry be 80 percent of financial full carry or greater, then the maximum daily premium charge shall increase 10/100's of one cent per bushel on the 18th calendar day of the nearby contract delivery month. Should the running average carry be 50 percent of financial full carry or less, then the maximum daily premium charge shall decrease 10/100's of one cent per bushel on the 18th calendar day of the nearby contract delivery month.

The Exchange may adjust how the observed nearby spread is measured relative to financial full carry should pending contract changes exist that have the potential to affect the normal nearby spread relationship. Any adjustments to how the observed spread is measured will attempt to remove the potential effects caused by the pending contract change. Any adjustments in how the nearby spread is measured will be communicated to market participants through a Special Executive Report or Exchange Advisory Notice prior to the beginning of the measurement period.

Premium charges shall not be reduced below 16.5/100's of one cent per bushel per day.

[Remainder of Chapter unchanged.]

**Chapter 14H
KC HRW Wheat Futures**

14H08. PREMIUM CHARGES

To be valid for delivery on futures contracts, all certificates covering wheat under obligation for shipment must indicate the applicable premium charge. No certificate shall be valid for delivery on futures contracts unless the premium charges on such wheat shall have been paid up to and including the 18th calendar day of the preceding month, and such payment is endorsed on the certificate. Unpaid accumulated premium charges at the posted rate applicable to the facility shall be allowed and credited to the buyer by the seller up to and including date of delivery.

The maximum premium charges on Wheat shall be determined prior to the nearby contract delivery period. The Exchange shall measure the nearby spread relative to financial full carry each business day from the 19th calendar day of the delivery month of the contract that expires prior to the nearby contract until the last Friday which precedes by at least two business days the last business day of the month preceding the nearby contract delivery month. For example, for a September expiration, the Exchange would measure the September – December spread relative to financial full carry each business day from July 19 until the last Friday in August which precedes by at least two business days the last business day in August. Financial full carry will be determined by the following formula:

$$N * \left[\left(\frac{i}{360} \right) * FP + P \right]$$

Where:

N = Number of calendar days from the first delivery day in the nearby contract to the first delivery day in the contract that follows the nearby contract

i = [~~3-Month LIBOR~~] CME Group 3-Month Term SOFR rate + [~~200~~] 221.25 basis points

FP = Settlement price for the nearby futures contract

P = Current daily premium charge

The percentage of the nearby spread to financial full carry is calculated each business day during the calculation period and a running average of each of these daily values is calculated. At the end of the calculation period (the last Friday which precedes by at least two business days the last business day of the month preceding the nearby contract delivery month), should the running average carry be 80 percent of financial full carry or greater, then the maximum daily premium charge shall increase 10/100's of one cent per bushel on the 18th calendar day of the nearby contract delivery month. Should the running average carry be 50 percent of financial full carry or less, then the maximum daily premium charge shall decrease 10/100's of one cent per bushel on the 18th calendar day of the nearby contract delivery month.

The Exchange may adjust how the observed nearby spread is measured relative to financial full carry should pending contract changes exist that have the potential to affect the normal nearby spread relationship. Any adjustments to how the observed spread is measured will attempt to remove the potential effects caused by the pending contract change. Any adjustments in how the nearby spread is measured will be communicated to market participants through a Special Executive Report or Exchange Advisory Notice prior to the beginning of the measurement period.

Premium charges shall not be reduced below 16.5/100's of one cent per bushel per day.

[Remainder of Chapter unchanged.]

Chapter 14N
Mini-Sized KC HRW Wheat Futures

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14H08. PREMIUM CHARGES

To be valid for delivery on futures contracts, all certificates covering mini-sized wheat under obligation for shipment must indicate the applicable premium charge. No certificate shall be valid for delivery on futures contracts unless the premium charges on such wheat shall have been paid up to and including the 18th calendar day of the preceding month, and such payment is endorsed on the certificate. Unpaid accumulated premium charges at the posted rate applicable to the facility shall be allowed and credited to the buyer by the seller up to and including date of delivery.

The maximum premium charges on mini-Sized wheat shall be determined prior to the nearby contract delivery period. The Exchange shall measure the nearby spread relative to financial full carry each business day from the 19th calendar day of the delivery month of the contract that expires prior to the nearby contract until the last Friday which precedes by at least two business days the last business day of the month preceding the nearby contract delivery month. For example, for a September expiration, the Exchange would measure the September – December spread relative to financial full carry each business day from July 19 until the last Friday in August which precedes by at least two business days the last business day in August. Financial full carry will be determined by the following formula:

$$N * \left[\left(\frac{i}{360} \right) * FP + P \right]$$

Where:

N = Number of calendar days from the first delivery day in the nearby contract to the first delivery day in the contract that follows the nearby contract

i = [~~3-Month LIBOR~~] CME Group 3-Month Term SOFR rate + [~~200~~] 221.25 basis points

FP = Settlement price for the nearby futures contract

P = Current daily premium charge

The percentage of the nearby spread to financial full carry is calculated each business day during the calculation period and a running average of each of these daily values is calculated. At the end of the calculation period (the last Friday which precedes by at least two business days the last business day of the month preceding the nearby contract delivery month), should the running average carry be 80 percent of financial full carry or greater, then the maximum daily premium charge shall increase 10/100's of one cent per bushel on the 18th calendar day of the nearby contract delivery month. Should the running average carry be 50 percent of financial full carry or less, then the maximum daily premium charge shall decrease 10/100's of one cent per bushel on the 18th calendar day of the nearby contract delivery month.

The Exchange may adjust how the observed nearby spread is measured relative to financial full carry should pending contract changes exist that have the potential to affect the normal nearby spread relationship. Any adjustments to how the observed spread is measured will attempt to remove the potential effects caused by the pending contract change. Any adjustments in how the nearby spread is measured will be communicated to market participants through a Special Executive Report or Exchange Advisory Notice prior to the beginning of the measurement period.

Premium charges shall not be reduced below 16.5/100's of one cent per bushel per day.

[Remainder of Chapter unchanged.]

Appendix B

CBOT Analysis

Abstract

CBOT designates a maximum storage charge that an approved futures delivery elevator may charge holders of its outstanding shipping certificates of Wheat, Mini-Sized Wheat, KC HRW Wheat, and Mini-Sized KC HRW Wheat Futures contracts all wheat futures contracts. In order to encourage price convergence under certain conditions, maximum storage charges increase or decrease based on observed wheat price spreads relative to financial full carry, which is dependent on the general cost of money for agricultural handlers. This explores the history of CBOT's dynamic storage rate and confirms fitness of a Term SOFR in replacing LIBOR as a measure of the cost of money within the structure's calculation.

Glossary

ARRC – Federal Reserve Bank of New York's Alternative Reference Rate Committee

CBOT – The Board of Trade of the City of New York, Inc.

CME – Chicago Mercantile Exchange Inc.

FCA – UK Financial Conduct Authority

FFC – Financial Full Carry

IBOR – Inter-Bank Offered Rate

ICE – Intercontinental Exchange

ISDA – International Swaps and Derivatives Association

KC HRW – Kansas City Hard Red Winter

LIBOR – London Inter-Bank Offered Rate

RFR – Risk-Free Rate

SOFR – Secured Overnight Financing Rate

STIR – Short-Term Interest Rate

VSR – Variable Storage Rate

Introduction

The London Inter-Bank Offered Rate (LIBOR), which represents the rate at which banks lend to one another overnight and the methodology of which incorporates submissions from selected institutions, has achieved the status of the preeminent global interest rate benchmark since its inception in 1969 and its rise in the following decades. Marred by scandal in recent years (Enrich, 2017), the rate, however, is slated to cease publication in a manner "representative" of the underlying market and economic reality it intends to measure after June 2023. The United Kingdom Financial Conduct Authority (FCA) regulates the generation and dissemination of LIBOR, while the Intercontinental Exchange (ICE) Group subsidiary ICE Benchmark Administration Limited (IBA) publishes daily rates. LIBOR is one of a set of several Inter-Bank Offered Rates (IBORs) representing a range of currencies and tenors. Publication of the 1-week and 2-month USD LIBOR rates ceased on December 31, 2021, which began the phase-out of the benchmark. The longest-surviving LIBOR settings, its Overnight, 1-month, 3-month, 6-month, and 12-month tenors, will cease publication in a "representative" manner immediately after publication on June 30, 2023 (Financial Conduct Authority, 2021), although it may continue to be published in a "synthetic" or "non-representative" form for a short period after that date.

As the primary reference for the borrowing costs major banks face in international inter-bank markets for short-term loans, LIBOR is the basis for many consumer facing loans and a wide variety of financial products and instruments, including CME Group's Variable Storage Rate (VSR) mechanism for The Board of Trade of the City of Chicago, Inc. (CBOT) Wheat, Mini-Sized Wheat, KC HRW Wheat, and Mini-Sized KC HRW Wheat Futures contracts. In its current form, VSR references the 3-Month U.S. Dollar LIBOR rate + 200 basis points to represent the general costs of money for agricultural handlers in the mechanism's financial full carry (FFC) calculation. The VSR mechanism allows the maximum allowable storage charge to vary when certain conditions are met, which helps facilitate the convergence of cash-futures pricing. The VSR mechanism adjusts the maximum storage rate to reflect the true value of storage in the physical market by allowing storage costs to increase when stocks are abundant and demand for storage is high and allowing storage costs to decrease when stocks are small and demand for storage is low.

The Federal Reserve Bank of New York's Alternative Reference Rate Committee (ARRC) identified the Secured Overnight Financing Rate (SOFR) as the short-term interest rate (STIR) that, in its consensus view, would represent best practice for use as the underlying reference in new U.S. dollar interest rate derivatives and other U.S. dollar-denominated financial contracts in their June 2017 meeting (Gray, 2017). Accordingly, VSR and other U.S.-based

financial instruments that use LIBOR need to transition to new benchmarks such as SOFR before the relevant term LIBOR ceases publication or ceases to be published in a “representative” manner.

The Exchange explored the history of VSR and the appropriateness and fit of a Term SOFR in replacing LIBOR within the structure’s FFC calculation. To demonstrate the efficacy of SOFR, an analysis was undertaken replacing historic LIBOR values with representative SOFR values. This analysis finds that SOFR is an appropriate replacement for LIBOR in the VSR’s FFC calculation, which suggests that Term SOFR may be an appropriate replacement for LIBOR in other commodity applications that include the cost of money.

VSR and Financial Full Carry (FFC)

CBOT avails for trading and clearing Wheat, Mini-Sized Wheat, KC HRW Wheat, and Mini-Sized KC HRW Wheat Futures contracts. The Exchange has specified the maximum storage charge that an approved futures delivery elevator may charge holders of its outstanding (futures-delivered but not loaded out) shipping certificates for grain and oilseed futures contracts for the last three decades (Commodity Futures Trading Commission, 1992). The VSR mechanism was implemented in Chicago Wheat futures in 2010 and in KC HRW Wheat futures in 2018. VSR has been shown to be positively associated with liquidity and open interest in deferred-month Chicago Wheat futures (Shao, 2010).

The VSR mechanism allows the maximum storage rate that an approved delivery elevator may charge holders of outstanding shipping certificates to vary in response to market conditions. When stocks are large and calendar spreads approach 100% of the cost of taking delivery on a shipping certificate and carrying that certificate into the next calendar month, cash convergence improves under higher storage rates than other market conditions might demand (Irwin, Garcia , & Kunda, 2009). This adjustment of storage costs enhances cash-futures price convergence (CME Group, 2017).

Fundamental to the reasoning behind VSR is the concept of FFC (financial full carry). FFC represents the cost to take delivery of a shipping certificate and “carry” that certificate into the next delivery period. FFC is calculated as follows:

$$FFC = \# \text{ Days} * [(Interest \text{ Rate}/360 * \text{Futures Price}) + \text{Daily Storage}]$$

Where:

Days = Number of calendar days from first delivery day in the nearby contract to first delivery day in the contract following the nearby contract

Interest Rate = 3-Month LIBOR rate + 200 basis points

Futures Price = Settlement price for the nearby contract

Daily Storage = Current daily premium charge

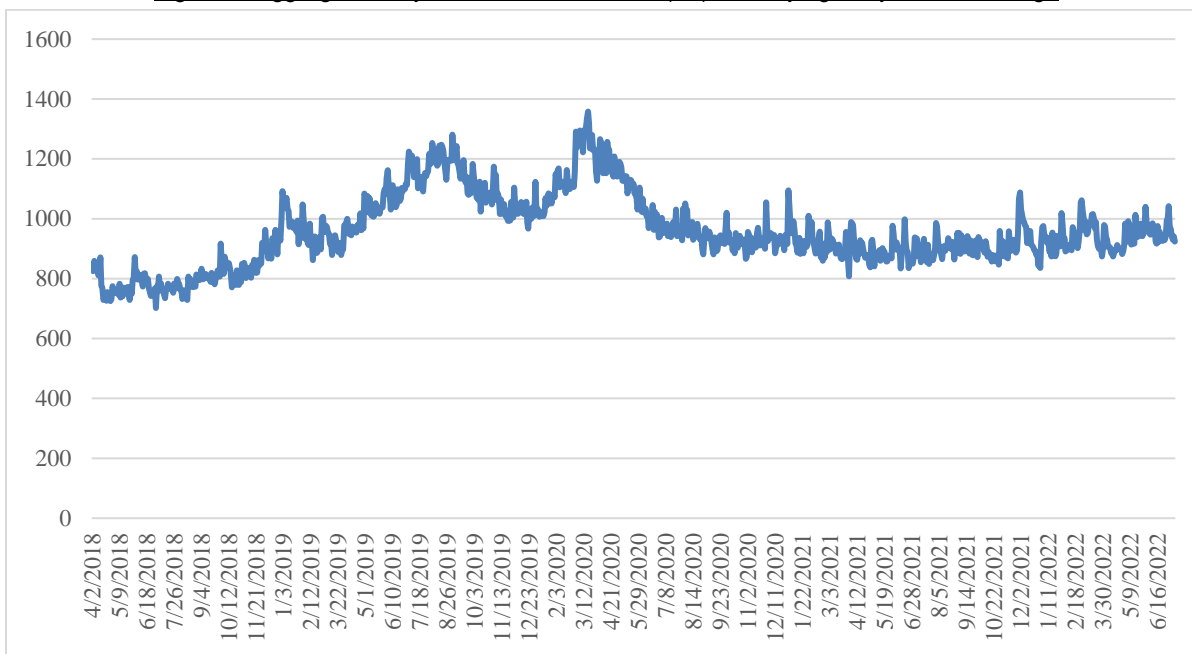
Calendar spreads comprised of the front month futures settlement price and the next-futures month settlement price are expressed as a percentage of FFC. Researchers at the University of Illinois Urbana-Champaign demonstrated that Chicago Wheat futures exhibited poor cash-futures convergence when calendar spreads are greater than 80% of FFC (Irwin, Garcia , & Kunda, 2009), when stocks tend to be high. Conversely, when calendar spreads are less than 80% of FFC and stocks are lower, convergence improves. To facilitate convergence, the VSR mechanism continually expands storage and FFC until calendar spreads fall below 80% of FFC. Alternatively, when stocks are very low and calendar spreads are less than 50% of FFC, the VSR mechanism reduces maximum storage rates. Note that low, or even negative ratios of spreads to FFC do not coincide with poor cash-futures convergence: the VSR mechanism reduces maximum storage rates when spreads are less than 50% of FFC in order allow storage rates to return to normal levels without hindering convergence. When calendar spreads are between 50% and 80% of FFC, the VSR mechanism does not trigger any change in maximum storage rates. This paper seeks to examine the impact of transitioning the interest rate used in the FFC calculation from LIBOR to SOFR.

SOFR Background

SOFR and LIBOR differ in several key aspects. While LIBOR is drawn from submissions from bankers, SOFR is determined by very liquid treasury repo markets, which have demonstrated resilience during times of financial crisis. Accordingly, SOFR is a secured rate while LIBOR is an unsecured rate; as such, LIBOR theoretically better approximates banks’ unsecured funding costs while SOFR represents a rate of near risk-free borrowing. Based on liquid repo markets rather than bankers’ submissions, SOFR is more resilient to market disruption and protected from manipulation (Jermann, 2019), though SOFR will be more responsive to repo market shocks, such as the one occurring in September 2019 (Baron, 2020). Some researchers argue that the qualitative, human element of LIBOR may make SOFR, which is derived only from market data, more susceptible to short-term volatility (Baron, 2020), as it is not a

forward-looking rate. Critics of this argument point out that human judgement is inherently biased and can be subject to groupthink and heuristic fallacies.

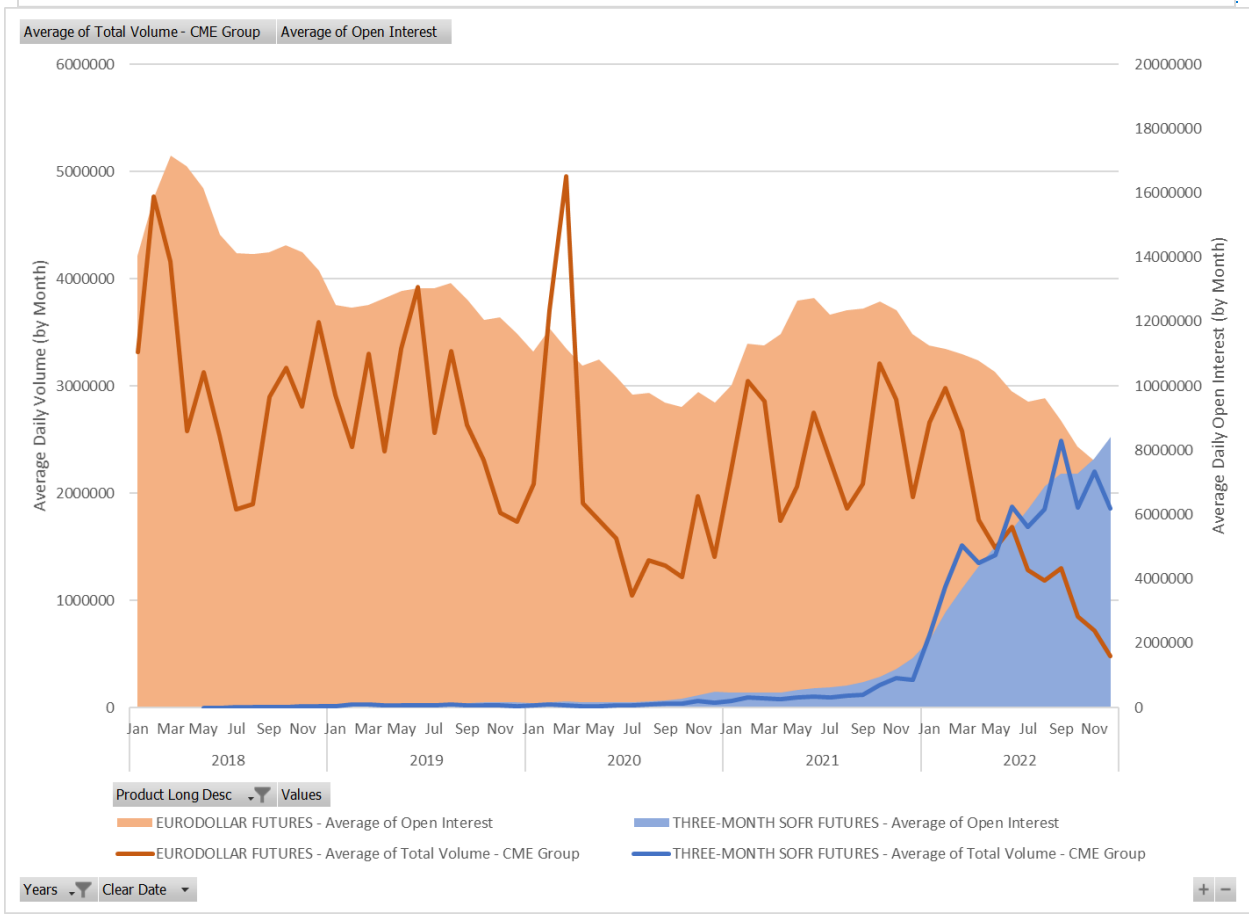
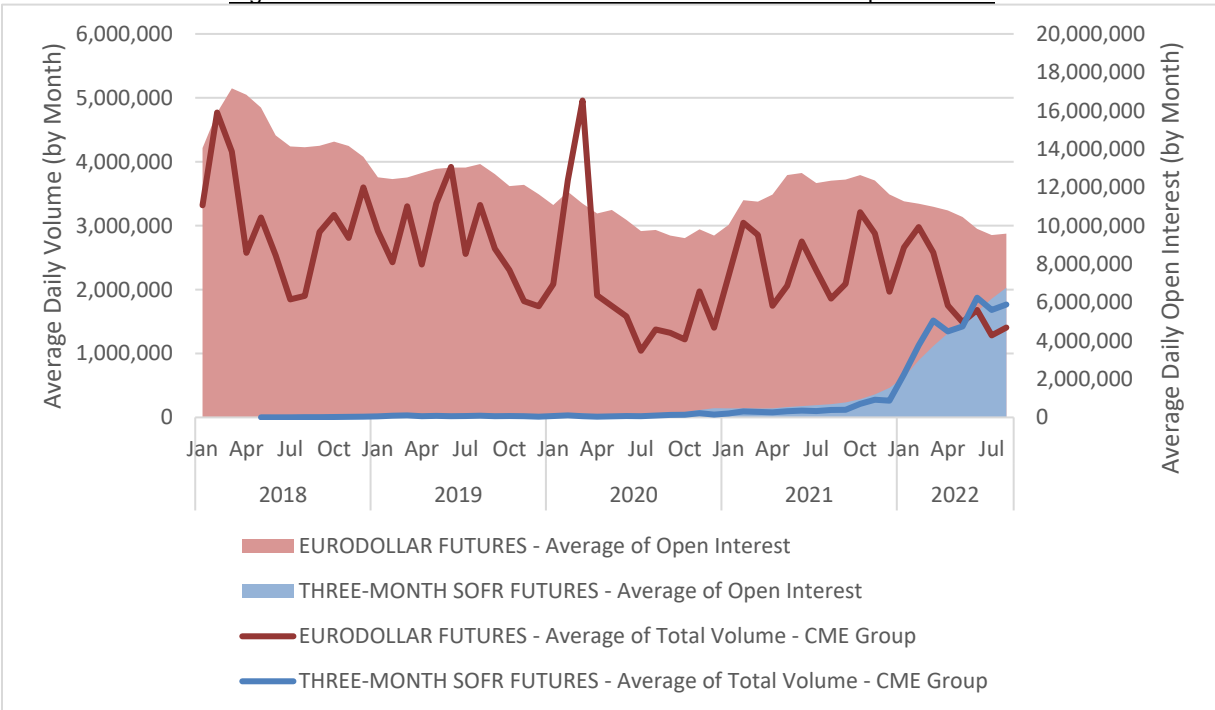
Figure 1: Aggregate Daily Transaction Volumes (\$B) Underlying Daily SOFR Settings



Critical from the standpoint of benchmark reliability and robustness is the magnitude of minimum daily transaction volume. The history of aggregate daily transaction volumes (\$B) that make up daily SOFR settings is depicted in Figure 1. Throughout this more than two-year period, daily volume never dropped below \$702 billion and peaked at \$1,358 billion.

Prior to the ascent of SOFR futures, Eurodollar futures, a three-month term instrument derived from a money market index conversion using ICE LIBOR, were seen as the most liquid interest rate futures product in the world and in 2020 retained that title despite the then-known winding down of LIBOR-based STIRs (COEX Partners, 2021). Since then, volume of Three-Month SOFR futures, listed on the Chicago Mercantile Exchange (CME), in June 2022 surpassed Eurodollar Futures volume and continues to grow and open interest for Three-Month SOFR futures also now exceeds that of Eurodollar futures. See Figure 2.

Figure 2: CME Eurodollar and SOFR Futures Volume and Open Interest



In contrast to the spot daily SOFR rate, the CME Term SOFR rates are forward rates implied by the deep and diverse liquidity pools of CME SOFR futures. CME Term SOFR is the only USD Term Rate formally endorsed and recommended for use by the ARRC. Through December 8, 2022, CME has issued greater than 7,130 licenses for CME Term SOFR to more than 1,860 firms. CME Term SOFR is referenced by \$661 billion in OTC derivative hedges and \$2.6 trillion in loans (CME Group, 2023).

Evaluating SOFR as a Replacement for LIBOR in VSR: A Retroactive Assessment

Adjusting SOFR

SOFR is a risk-free overnight rate, while IBORs have a term structure (reflected in the tenor of the rate); thus, to make SOFR applicable as a LIBOR replacement, a term structure must be introduced. Three-Month Term SOFR is a forward-looking reference rate approximating an implied prediction of compounded setting-in-arrears rate (Mercurio & Lyashenko, 2019), mimicking the term specifications of 3-Month U.S. Dollar LIBOR. Our analysis uses the CME Group Term Three-Month SOFR Index, which is administered by the CME Group Benchmark Administration Limited (CBA), began publication in April 2021 (CME Group, 2021), and was extrapolated backwards to January 2019 using Three-Month SOFR futures data. CME Three-Month SOFR futures were launched in May 2018 (CME Group, 2018).

VSR in its current form uses an additional 200 basis points on the 3-Month U.S. Dollar LIBOR rate to approximate the cost of capital faced by grain and oilseed handlers in the United States. CME Group's addition of 200 basis points to 3-Month U.S. Dollar LIBOR was determined from customer feedback. As discussed, LIBOR is comprised of bankers' submissions to represent the cost of unsecured borrowing. This differs from SOFR, which is calculated from secured repo transactions and thus signifies a near risk-free rate (RFR). Because LIBOR encompasses lending risk while SOFR does not, a greater adjustment to SOFR to account for lending risk is made. Analysis suggests that an additional 21.25 basis points to the 200-basis point addition to account for lending risk not already baked into the SOFR structure.

While opinions around the VSR mechanism vary among wheat traders, the authors are not aware of any critical feedback around the measure of interest cost in the methodology. Therefore, in this analysis, the CME Term Three-Month SOFR Index is adjusted to approximate 3-Month U.S. Dollar LIBOR with minimal disruption. The daily settlement price of the CME Term Three-Month SOFR Index was considered with respect to the 3-Month U.S. Dollar LIBOR rate each day from January 3, 2019, to June 2, 2022. Among these 892 observations, the mean difference in the two rates was 0.2125. Accordingly, for that time period, the mean difference between daily values of the CME Term Three-Month SOFR Index and 3-Month U.S. Dollar LIBOR + 200bp was 221.25 basis points for the 892 observations. An addition of 221.25 basis points was therefore chosen for the CME Term Three-Month SOFR Index adjustment.

VSR and Financial Full Carry

The VSR mechanism applies only to discrete, non-contiguous evaluation periods, beginning on each business day from the 19th calendar day of the recently expired delivery month until the nearby contract option expiration date. During these times, the spreads between the front and next-month Chicago and KC HRW Wheat futures daily settlement prices are considered. Table 1 shows the 17 VSR evaluation periods considered in this study: the first beginning on March 19, 2019, and the final period ending June 24, 2022. The first evaluation period applies to May-July 2019 Chicago and KC HRW Wheat futures spreads and begins on the 19th calendar day of March 2019, which follows the March 2019 futures contracts expiration and delivery period. During this 61-day period, the May-July spread is reported relative to FFC. This is the first evaluation period considered because the CME Group Term Three-Month SOFR Index, launched in April 2021 (CME Group, 2021), was extrapolated back only to January 3, 2019, and thus VSR evaluation periods prior to March 19, 2019, cannot be considered. Note that there are days of each year between evaluation periods during which VSR is not calculated and does not apply.

Table 1: VSR Periods, March 2019 to June 2022

Evaluation Period Number	Start Date	End Date	Number of Carry Days
1	3/19/2019	4/26/2019	61
2	5/20/2019	6/21/2019	64
3	7/19/2019	8/23/2019	90
4	9/19/2019	11/22/2019	91
5	12/19/2019	2/21/2020	60
6	3/19/2020	4/24/2020	61
7	5/19/2020	6/26/2020	62
8	7/20/2020	8/21/2020	91
9	9/21/2020	11/20/2020	90

10	12/21/2020	2/19/2021	61
11	3/19/2021	4/23/2021	61
12	5/19/2021	6/25/2021	62
13	7/19/2021	8/27/2021	91
14	9/20/2021	11/26/2021	90
15	12/20/2021	2/18/2022	62
16	3/21/2022	4/22/2022	60
17	5/19/2022	6/24/2022	62

The respective spread (Chicago or KC HRW Wheat futures) as a percentage of FFC is averaged for each period. Should the average carry during the observations period be 80% or more of FFC, the daily maximum storage charge would increase by 10/100s of one cent per bushel per day (approximately 3 cents per bushel per month) beginning on the 19th calendar day following the delivery period of the nearby contract.

VSR allows the maximum storage rate to vary each delivery period: if for example a spread as a percent of FFC persists above 80% for multiple consecutive periods, the VSR mechanism would theoretically allow the maximum storage rate to continue to increase by 10/100s of one cent per bushel each delivery period until the spread as percent of FFC drops below 80%. The VSR mechanism does, however, prescribe a storage floor of 16.5/100s of one cent per bushel: if a spread as a percent of FFC persists below 50% over one or more periods, the VSR will drop until it reaches 16.5/100s of one cent per bushel per day and remain at 16.5/100s of one cent per bushel until the mechanism is signaled to increase the rate.

Table 2 compares the VSR mechanism as calculated using 3-Month U.S. Dollar LIBOR rate + 200 basis points, to the rates that would have been prescribed by a VSR mechanism using Term Three-Month SOFR + 221.25 basis points. The second and fourth columns of Table 2 show the average spread percentages of FFC of Chicago Wheat futures and KC HRW Wheat futures as calculated by the VSR mechanism over 17 VSR periods (dates shown in Table 1) beginning March 19, 2019. Columns six and seven of the table show the storage rate as it applied to each respective period. For example, during Period 1 (March 19 – April 26, 2019), the May – July Chicago and KC HRW Wheat futures spread as a percent of FFC (again, using 3-Month U.S. Dollar LIBOR rate + 200 basis points) was calculated each trade date. The average of that number among the 61 carry days of Period 1 was 35.49% for Chicago Wheat futures (Column 2) and 36.97% for KC HRW Wheat futures (Column 4). For that period, the storage rate, which had been determined by the spread as percent of FFC of prior periods, was 16.5/100s of one cent per bushel for Chicago Wheat futures and 26.5/100s of one cent per bushel for KC HRW Wheat futures. For both Chicago and KC HRW Wheat futures, the spread as percent of FFC for Period 1 was below 50%, triggering a lowering of the storage rate. Because the Chicago Wheat futures storage rate was already at the floor of 16.5/100s of one cent per bushel, it went unchanged into Period 2, while the KC HRW Wheat futures storage rate was lowered from 26.5/100s of one cent per bushel to 16.5/100s of one cent per bushel.

Table 2 Actual VSR Results using LIBOR Compared to Theoretical VSR using SOFR, to June 2, 2022

1	2	3	4	5	6	7	8	9
Period	Mean of CHI 1-2 Spread as % of FFC (L)	Mean of CHI 1-2 Spread as % of FFC (S)	Mean of KC 1-2 Spread as % of FFC (L)	Mean of KC 1-2 Spread as % of FFC (S)	CHI Rate	KC Rate	CHI Tranche Mismatch	KC Tranche Mismatch
1	35.49%	35.40%	36.97%	36.91%	\$ 0.00165	\$ 0.00265	FALSE	FALSE
2	39.63%	39.37%	83.42%	82.95%	\$ 0.00165	\$ 0.00165	FALSE	FALSE
3	27.51%	27.44%	58.42%	58.33%	\$ 0.00165	\$ 0.00265	FALSE	FALSE
4	27.80%	27.94%	41.36%	41.48%	\$ 0.00165	\$ 0.00265	FALSE	FALSE
5	5.11%	5.19%	56.74%	56.82%	\$ 0.00165	\$ 0.00167	FALSE	FALSE
6	-25.24%	-27.39%	49.08%	52.24%	\$ 0.00165	\$ 0.00165	FALSE	TRUE
7	33.72%	33.79%	63.67%	63.81%	\$ 0.00165	\$ 0.00165	FALSE	FALSE
8	42.97%	42.86%	63.26%	63.13%	\$ 0.00165	\$ 0.00165	FALSE	FALSE
9	24.39%	24.25%	46.41%	46.17%	\$ 0.00165	\$ 0.00165	FALSE	FALSE
10	11.30%	11.24%	32.56%	32.41%	\$ 0.00165	\$ 0.00165	FALSE	FALSE
11	-10.15%	-10.14%	55.63%	55.41%	\$ 0.00165	\$ 0.00165	FALSE	FALSE

12	31.37%	31.05%	64.07%	63.47%	\$ 0.00165	\$ 0.00165	FALSE	FALSE
13	62.34%	61.53%	63.38%	62.58%	\$ 0.00165	\$ 0.00165	FALSE	FALSE
14	63.61%	62.81%	29.55%	29.17%	\$ 0.00165	\$ 0.00165	FALSE	FALSE
15	33.20%	32.87%	15.36%	15.19%	\$ 0.00165	\$ 0.00165	FALSE	FALSE
16	-1.70%	-2.21%	5.47%	5.30%	\$ 0.00165	\$ 0.00165	FALSE	FALSE
17	50.01%	49.84%	30.14%	30.04%	\$ 0.00165	\$ 0.00165	FALSE	FALSE

Columns three and five of Table 2 show the spread-percent of FFC calculated using the CME Group Term Three-Month SOFR Index. Columns eight and nine detect a “tranche mismatch,” meaning that carry percentages using LIBOR vs. SOFR fall into different VSR tranches (less than 50%, between 50% and 80%, and greater than 80%). During only one period in one product [KC HRW Wheat futures in Period 6 (March 19 – April 24, 2020)], was there a tranche mismatch: the carry percentage as calculated by LIBOR fell below 50%, while using SOFR the carry percentage exceeded 50%. In this case, however, this difference would not have resulted in a different storage rate because the KC HRW Wheat storage rate was already at its minimum of 16.5/100s of one cent per bushel. That is, had the VSR mechanism been calculated using the applicable SOFR rather than LIBOR, the storage rate would not have differed during any of the 17 periods analyzed. This observation is consistent with research demonstrating that LIBOR and SOFR differ most during periods of economic shock (Period 6 encompasses the early Covid-19 pandemic), though the liquid markets underlying SOFR make the rate relatively more robust to those shocks (Jermann, 2019).

Conclusion

Total market exposure to IBORs was estimated at \$370 trillion (Mercurio & Lyashenko, 2019) in 2019, despite the known fact that IBORs were slated for demise in the coming years. As LIBOR’s numbered days dwindle ever more, the need to replace IBORs with minimal market disruption grows ever urgent.

Our findings complement research conducted by researchers at the University of Pennsylvania and National Bureau of Economic Research (NBER) who conclude that under normal conditions, SOFR and LIBOR behave similarly (Jermann, 2019). Had CME Group used CME Group Term Three-Month SOFR Index + 221.25 basis points instead of 3-Month U.S. Dollar LIBOR + 200 basis points in its Variable Storage Rate (VSR) calculation, at no point since the inception of the CME Group Term Three-Month SOFR Index would VSR have resulted in a different storage rate. In other words, using a SOFR-based rate instead of the preexisting LIBOR-based rate in CBOT’s VSR mechanism would not have changed any storage and carry outcome since 2019.

Issues beyond the scope of this analysis, however, need be considered for the transition from LIBOR in other commodity applications. SOFR is the LIBOR replacement recommended by the Federal Reserve Bank ARRC and is appropriate in VSR applications because Chicago and KC HRW Wheat futures prices are quoted in U.S. dollars. Commodity applications that entail cross-currency risk face additional challenges in migrating from LIBOR, needing to adapt to a fractured landscape of individually administered interest rates having been chosen for respective major economies (Baron, 2020) (Mercurio & Lyashenko, 2019). Alternative RFRs recommended by respective regulatory bodies to replace LIBOR include Sterling Overnight Index Average (SONIA) in the United Kingdom, Swiss Average Rate Overnight (SARON) in Swiss Franc markets, Tokyo Overnight Average Rate (TONAR) for the Yen and Euro Short-Term Rate (€€STER) in the Eurozone (ISDA, 2022). Independent evaluation will be needed to assess appropriateness of fit for each RFR in replacing IBORs in respective commodity applications.

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