Required fields are shown with yellow backgrounds and asterisks.

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SECURITIES AND EXCHANGE COMMISSION
WASHINGTON, D.C. 20549
Form 19b-4

File No. * SR 2021 - * 89
Amendment No. (req. for Amendments *)

Filing by NYSE Arca, Inc.

Pursuant to Rule 19b-4 under the Securities Exchange Act of 1934

Initial * ☑ Amendment * ☐ Withdrawal ☐

Section 19(b)(2) * ☑ Section 19(b)(3)(A) * ☐ Section 19(b)(3)(B) * ☐

Pilot ☐

Extension of Time Period for Commission Action * ☐

Date Expires *

Rule
☐ 19b-4(f)(1) ☐ 19b-4(f)(4)
☐ 19b-4(f)(2) ☐ 19b-4(f)(5)
☐ 19b-4(f)(3) ☐ 19b-4(f)(6)

Notice of proposed change pursuant to the Payment, Clearing, and Settlement Act of 2010

Section 806(e)(1) * ☐ Section 806(e)(2) * ☐

Security-Based Swap Submission pursuant to the Securities Exchange Act of 1934
Section 3C(b)(2) * ☐

Exhibit 2 Sent As Paper Document ☐

Exhibit 3 Sent As Paper Document ☐

Description

Provide a brief description of the action (limit 250 characters, required when Initial is checked *).

Proposal to list and trade shares of the Bitwise Bitcoin ETP Trust

Contact Information

Provide the name, telephone number, and e-mail address of the person on the staff of the self-regulatory organization prepared to respond to questions and comments on the action.

First Name * David Last Name * De Gregorio

Title * Associate General Counsel, NYSE Group Inc.

E-mail * David.DeGregorio@ice.com

Telephone * (212) 656-4166 Fax (212) 656-8101

Signature

Pursuant to the requirements of the Securities Exchange of 1934, NYSE Arca, Inc.
has duty caused this filing to be signed on its behalf by the undersigned thereunto duty authorized.

Date 10/14/2021

By Clare Saperstein
(Name *)

(Title *)
Associate General Counsel

NOTE: Clicking the signature block at right will initiate digitally signing the form. A digital signature is as legally binding as a physical signature, and once signed, this form cannot be changed.

Clare Saperstein
Digitally signed by Clare Saperstein
Date: 2021.10.14 07:22:46 -04'00'

Required fields are shown with yellow backgrounds and astericks.

SECURITIES AND EXCHANGE COMMISSION
WASHINGTON, D.C. 20549

For complete Form 19b-4 instructions please refer to the EFFS website.

Form 19b-4 Information *

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SEC Sub of NYSE Arca Bitwise Bitcoi

The self-regulatory organization must provide all required information, presented in a clear and comprehensible manner, to enable the public to provide meaningful comment on the proposal and for the Commission to determine whether the proposal is consistent with the Act and applicable rules and regulations under the Act.

Exhibit 1 - Notice of Proposed Rule Change *

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Ex. 1 SEC Sub of NYSE Arca Bitwise

The Notice section of this Form 19b-4 must comply with the guidelines for publication in the Federal Register as well as any requirements for electronic filing as published by the Commission (if applicable). The Office of the Federal Register (OFR) offers guidance on Federal Register publication requirements in the Federal Register Document Drafting Handbook, October 1998 Revision. For example, all references to the federal securities laws must include the corresponding cite to the United States Code in a footnote. All references to SEC rules must include the corresponding cite to the Code of Federal Regulations in a footnote. All references to Securities Exchange Act Releases must include the release number, release date, Federal Register cite, Federal Register date, and corresponding file number (e.g., SR-[SRO]-xx-xx). A material failure to comply with these guidelines will result in the proposed rule change being deemed not properly filed. See also Rule 0-3 under the Act (17 CFR 240.0-3)

Exhibit 1A - Notice of Proposed Rule Change, Security-Based Swap Submission, or Advanced Notice by Clearing Agencies *

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The Notice section of this Form 19b-4 must comply with the guidelines for publication in the Federal Register as well as any requirements for electronic filing as published by the Commission (if applicable). The Office of the Federal Register (OFR) offers guidance on Federal Register publication requirements in the Federal Register Document Drafting Handbook, October 1998 Revision. For example, all references to the federal securities laws must include the corresponding cite to the United States Code in a footnote. All references to SEC rules must include the corresponding cite to the Code of Federal Regulations in a footnote. All references to Securities Exchange Act Releases must include the release number, release date, Federal Register cite, Federal Register date, and corresponding file number (e.g., SR-[SRO]-xx-xx). A material failure to comply with these guidelines will result in the proposed rule change being deemed not properly filed. See also Rule 0-3 under the Act (17 CFR 240.0-3)

Exhibit 2- Notices, Written Comments, Transcripts, Other Communications

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Copies of notices, written comments, transcripts, other communications. If such documents cannot be filed electronically in accordance with Instruction F, they shall be filed in accordance with Instruction G.

☐ Exhibit Sent As Paper Document

Exhibit 3 - Form, Report, or Questionnaire

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Ex. 3A SEC Sub of NYSE Arca Bitwise
Ex. 3B SEC Sub of NYSE Arca Bitwise

Copies of any form, report, or questionnaire that the self-regulatory organization proposes to use to help implement or operate the proposed rule change, or that is referred to by the proposed rule change.

☐ Exhibit Sent As Paper Document

Exhibit 4 - Marked Copies

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The full text shall be marked, in any convenient manner, to indicate additions to and deletions from the immediately preceding filing. The purpose of Exhibit 4 is to permit the staff to identify immediately the changes made from the text of the rule with which it has been working.

Exhibit 5 - Proposed Rule Text

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The self-regulatory organization may choose to attach as Exhibit 5 proposed changes to rule text in place of providing it in Item I and which may otherwise be more easily readable if provided separately from Form 19b-4. Exhibit 5 shall be considered part of the proposed rule change

Partial Amendment

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If the self-regulatory organization is amending only part of the text of a lengthy proposed rule change, it may, with the Commission's permission, file only those portions of the text of the proposed rule change in which changes are being made if the filing (i.e. partial amendment) is clearly understandable on its face. Such partial amendment shall be clearly identified and marked to show deletions and additions.

1. Text of the Proposed Rule Change

(a) Pursuant to the provisions of Section 19(b)(1) of the Securities Exchange Act of 1934 ("Act"),[1] and Rule 19b-4 thereunder,[2] NYSE Arca, Inc. ("NYSE Arca" or the "Exchange"), proposes to list and trade shares of the Bitwise Bitcoin ETP Trust under NYSE Arca Rule 8.201-E (Commodity-Based Trust Shares).

A notice of the proposed rule change for publication in the Federal Register is attached hereto as Exhibit 1.

(b) The Exchange does not believe that the proposed rule change will have any direct effect, or any significant indirect effect, on any other Exchange rule in effect at the time of this filing.

(c) Not applicable.

2. Procedures of the Self-Regulatory Organization

The proposed rule change is being submitted to the Securities and Exchange Commission (the "Commission" or "SEC") by Exchange staff pursuant to authority delegated to it by the NYSE Arca Board of Directors.

The person on the Exchange staff prepared to respond to questions and comments on the proposed rule change is:

David De Gregorio
Associate General Counsel
NYSE Group, Inc.
(212) 656-4166

3. Self-Regulatory Organization's Statement of the Purpose of, and Statutory Basis for, the Proposed Rule Change

(a) Purpose

The Exchange proposes to list and trade shares ("Shares") of the Bitwise Bitcoin ETP Trust (the "Trust"),[3] under NYSE Arca Rule 8.201-E, which governs the

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1 15 U.S.C. 78s(b)(1).

2 17 CFR 240.19b-4.

3 The Trust is a Delaware statutory trust that was formerly known as the Bitwise Bitcoin ETF Trust. On October 14, 2021, the Trust filed with the Commission an initial registration statement (the "Registration Statement") on Form S-1 under the Securities Act of 1933 (15 U.S.C. 77a). The description of the operation of the Trust herein is based, in part, on the Registration Statement.

listing and trading of Commodity-Based Trust Shares.[4]

According to the Registration Statement, the Trust will not be registered as an investment company under the Investment Company Act of 1940,[5] and is not required to register thereunder. The Trust is not a commodity pool for purposes of the Commodity Exchange Act.[6]

The Exchange represents that the Shares satisfy the requirements of NYSE Arca Rule 8.201-E and thereby qualify for listing on the Exchange.[7]

Bitwise Bitcoin ETP Trust

Operation of the Trust[8]

The Trust will issue the Shares, which represent units of undivided beneficial ownership of the Trust. The Trust is a Delaware statutory trust and will operate pursuant to a trust agreement (the "Trust Agreement") between Bitwise Investment Advisers, LLC (the "Sponsor" or "Bitwise") and Delaware Trust Company, as the Trust's trustee (the "Trustee"). The Trust will engage a third party custodian to act as the bitcoin custodian for the Trust (the "Bitcoin Custodian") to maintain custody of the Trust's bitcoin assets.[9] The Trust will engage a third party service provider to serve as the administrator and transfer agent (in such capacities, the "Administrator" and the "Transfer Agent").

According to the Registration Statement, the investment objective of the Trust is to seek to provide exposure to the value of bitcoin held by the Trust, less the expenses of the Trust's operations. In seeking to achieve its investment objective, the Trust will hold bitcoin and establish its Net Asset Value ("NAV") at the end of every business day by reference to the CF Bitcoin-Dollar US Settlement Price

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4 Commodity-Based Trust Shares are securities issued by a trust that represents investors' discrete identifiable and undivided beneficial ownership interest in the commodities deposited into the trust.

5 15 U.S.C. 80a-1.

6 17 U.S.C. 1.

7 With respect to the application of Rule 10A-3 (17 CFR 240.10A-3) under the Act, the Trust relies on the exemption contained in Rule 10A-3(c)(7).

8 The description of the operation of the Trust, the Shares and the bitcoin market contained herein are based, in part, on the Registration Statement. See note 3, supra.

9 When capitalized, references to "Bitcoin" are to the Bitcoin network or the Bitcoin protocol. When lowercase, references to "bitcoin" are to the digital asset native to the Bitcoin network, which asset is the underlying commodity held by the Trust.

("CME US Reference Rate").[10]

Under normal circumstances, the Trust's only asset will be bitcoin, and, under limited circumstances, cash. The Trust will not use derivatives that may subject the Trust to counterparty and credit risks.[11] The Trust will process all creations and redemptions in-kind, and accrue all ordinary fees in bitcoin (rather than cash), as a way of seeking to ensure that the Trust holds the desired amount of bitcoin-per-share. The Trust will not purchase or sell bitcoin, other than if the Trust liquidates or must pay expenses not contractually assumed by the Sponsor. Instead, financial institutions authorized to create and redeem Shares (each, an "Authorized Participant") will deliver, or cause to be delivered, bitcoin to the Trust in exchange for Shares of the Trust, and the Trust will deliver bitcoin to Authorized Participants when those Authorized Participants redeem Shares of the Trust.

Bitcoin, Bitcoin Market, Bitcoin Trading Platforms and Regulation of Bitcoin

The following sections, drawn from the Registration Statement, describe bitcoin, including the historical development of bitcoin and the Bitcoin network, how a person holds bitcoin, how to use bitcoin in transactions, the "exchange" market

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10 The CME US Reference Rate is a daily reference rate of the US Dollar price of one bitcoin, calculated at 4:00 p.m. E.T. The CME US Reference Rate utilizes the same methodology as the CME CF Bitcoin Reference Rate (the "CME UK Reference Rate"), which is calculated at 4:00 p.m. London time and was designed by the CME Group and Crypto Facilities Ltd to facilitate the development of financial products, including the cash settlement of Bitcoin Futures traded on the Chicago Mercantile Exchange ("CME"). Andrew Paine and William J. Knottenbelt, "Analysis of the CME CF Bitcoin Reference Rate and CME CF Bitcoin Real Time Index," Imperial College Centre for Cryptocurrency Research and Engineering, November 14, 2016, available at https://www.cmegroup.com/trading/files/bitcoin-white-paper.pdf.

11 The Trust may sell bitcoin and temporarily hold cash as part of a liquidation of the Trust or to pay certain extraordinary expenses not assumed by the Sponsor. Under the Trust Agreement, the Sponsor has agreed to assume the normal operating expenses of the Trust, subject to certain limitations. For example, the Trust will bear any indemnification or litigation liabilities as extraordinary expenses.

In addition, the Trust may, from time to time, passively receive, by virtue of holding bitcoin, certain additional digital assets ("IR Assets") or rights to receive IR Assets ("Incidental Rights") through a fork of the Blockchain or an airdrop of assets. The Trust Agreement requires that the Sponsor analyze as soon as possible, whether or not such Incidental Rights and IR Assets should be disclaimed. In the event the Sponsor instructs the Bitcoin Custodian to claim such Incidental Rights and IR Assets, it will immediately distribute such Incidental Rights and IR Assets to shareholders of record.

where bitcoin can be bought, held and sold, and the bitcoin "over-the-counter" ("OTC") market.

Bitcoin

Bitcoin was first described in a white paper released in 2008 and published under the name "Satoshi Nakamoto." The protocol underlying Bitcoin was subsequently released in 2009 as open source software and currently operates on a worldwide network of computers.

The Bitcoin network utilizes a digital asset known as "bitcoin," which can be transferred among parties via the Internet. Unlike other means of electronic payments such as credit card transactions, one of the advantages of bitcoin is that it can be transferred without the use of a central administrator or clearing agency. As a central party is not necessary to administer bitcoin transactions or maintain the bitcoin ledger, the term decentralized is often used in descriptions of bitcoin. Unless it is using a third party service provider, a party transacting in bitcoin is generally not afforded some of the protections that may be offered by intermediaries.

The first step in using the Bitcoin network for transactions is to download specialized software referred to as a "bitcoin wallet." A user's bitcoin wallet can run on a computer or smartphone, and can be used both to send and to receive bitcoin. Within a bitcoin wallet, a user can generate one or more unique "bitcoin addresses," which are conceptually similar to bank account numbers. After establishing a bitcoin address, a user can send or receive bitcoin from his or her bitcoin address to another user's bitcoin address. Sending bitcoin from one bitcoin address to another is similar in concept to sending a bank wire from one person's bank account to another person's bank account; however, such transactions are not managed by an intermediary and erroneous transactions generally may not be reversed or remedied once sent.

The amount of bitcoin associated with each bitcoin address, as well as each bitcoin transaction to or from such bitcoin address, is transparently reflected in the Bitcoin network's distributed ledger ("Blockchain") and can be viewed by websites that operate as "Blockchain explorers." Copies of the Blockchain exist on thousands of computers on the Bitcoin network throughout the Internet. A user's bitcoin wallet will either contain a copy of the Blockchain or be able to connect with another computer that holds a copy of the Blockchain. The innovative design of the Bitcoin network protocol allows each Bitcoin user to trust that their copy of the Blockchain will generally be updated consistent with each other user's copy.

When a Bitcoin user wishes to transfer bitcoin to another user, the sender must first request a Bitcoin address from the recipient. The sender then uses his or her Bitcoin wallet software to create a proposed transaction that is confirmed and settles when included in the Blockchain. The transaction would reduce the amount of bitcoin allocated to the sender's address and increase the amount

allocated to the recipient's address, in each case by the amount of bitcoin desired to be transferred. The transaction is completely digital in nature, similar to a file on a computer, and it can be sent to other computers participating in the Bitcoin network; however, the use of cryptographic verification is believed to prevent the ability to duplicate or counterfeit bitcoin.

Bitcoin Protocol

The Bitcoin protocol is built using open source software allowing for any developer to review the underlying code and suggest changes. There is no official company or group responsible for making modifications to Bitcoin. There are, however, a number of individual developers that regularly contribute to the reference software known as "Bitcoin Core," a specific distribution of Bitcoin software that provides the *de-facto* standard for the Bitcoin protocol.

Significant changes to the Bitcoin protocol are typically accomplished through a so-called "Bitcoin Improvement Proposal" or BIP. Such proposals are generally posted on websites, and the proposals explain technical requirements for the protocol change as well as reasons why the change should be accepted by users. Because Bitcoin has no central authority, updating the reference software's Bitcoin protocol will not immediately change the Bitcoin network's operations. Instead, the implementation of a change is achieved by users (including transaction validators known as "miners") downloading and running the updated versions of Bitcoin Core or other Bitcoin software that abides by the new Bitcoin protocol. Users and miners must accept any changes made to the Bitcoin source code by downloading a version of their Bitcoin software that incorporates the proposed modification of the Bitcoin network's source code. A modification of the Bitcoin network's source code or protocol is only effective with respect to those Bitcoin users and miners who download it. If an incompatible modification is accepted by a less than overwhelming percentage of users and miners, a division in the Bitcoin network will occur such that one network will run the pre-modification source code and the other network will run the modified source code. Such a division is known as a "fork" in the Bitcoin network.

Bitcoin Transactions

A bitcoin transaction is similar in concept to an irreversible digital check. The transaction contains the sender's bitcoin address, the recipient's bitcoin address, the amount of bitcoin to be sent, a transaction fee and the sender's digital signature. Bitcoin transactions are secured by cryptography known as "public-private key cryptography," represented by the bitcoin addresses and digital signature in a transaction's data file. Each Bitcoin network address, or wallet, is associated with a unique "public key" and "private key" pair, both of which are lengthy alphanumeric codes, derived together and possessing a unique relationship.

The use of key pairs is a cornerstone of the Bitcoin network technology. This is because the use of a private key is the only mechanism by which a bitcoin

transaction can be signed. If a private key is lost, the corresponding bitcoin is thereafter permanently non-transferable. Moreover, the theft of a private key provides the thief immediate and unfettered access to the corresponding bitcoin. Bitcoin users must therefore understand that in this regard, bitcoin is similar to cash: that is, the person or entity in control of the private key corresponding to a particular quantity of bitcoin has *de facto* control of the bitcoin.

The public key is visible to the public and analogous to the Bitcoin network address. The private key is a secret and is used to digitally sign a transaction in a way that proves the transaction has been signed by the holder of the public-private key pair, and without having to reveal the private key. A user's private key must be kept safe in accordance with appropriate controls and procedures to ensure it is used only for legitimate and intended transactions. If an unauthorized third person learns of a user's private key, that third person could apply the user's digital signature without authorization and send the user's bitcoin to their or another bitcoin address, thereby stealing the user's bitcoin. Similarly, if a user loses his private key and cannot restore such access (e.g., through a backup), the user may permanently lose access to the bitcoin associated with that private key and bitcoin address.

To prevent the possibility of double-spending of bitcoin, each validated transaction is recorded, time stamped and publicly displayed in a "block" in the Blockchain, which is publicly available. Thus, the Bitcoin network provides confirmation against double-spending by memorializing every transaction in the Blockchain, which is publicly accessible and downloaded in part or in whole by all users of the Bitcoin network software program. Any user may validate, through their Bitcoin wallet or a Blockchain explorer, that each transaction in the Bitcoin network was authorized by the holder of the applicable private key, and Bitcoin network mining software consistent with reference software requirements validates each such transaction before including it in the Blockchain. This cryptographic security ensures that bitcoin transactions may not generally be counterfeited, although it does not protect against the "real world" theft or coercion of use of a Bitcoin user's private key, including the hacking of a Bitcoin user's computer or a service provider's systems.

A Bitcoin transaction between two parties is recorded if included in a valid block added to the Blockchain, when that block is accepted as valid through consensus formation among Bitcoin network participants. A block is validated by confirming the cryptographic hash value included in the block's data and by the block's addition to the longest confirmed Blockchain on the Bitcoin network. For a transaction, inclusion in a block in the Blockchain constitutes a "confirmation" of validity. As each block contains a reference to the immediately preceding block, additional blocks appended to and incorporated into the Blockchain constitute additional confirmations of the transactions in such prior blocks, and a transaction included in a block for the first time is confirmed once against double-spending. This layered confirmation process makes changing historical blocks (and reversing transactions) exponentially more difficult the further back one goes

in the Blockchain.

The process by which bitcoin are created and bitcoin transactions are verified is called “mining.” To begin mining, a user, or “miner,” can download and run a mining “client,” which, like regular Bitcoin network software programs, turns the user’s computer into a “node” on the Bitcoin network, and in this case has the ability to validate transactions and add new blocks of transactions to the Blockchain.

Miners, through the use of the bitcoin software program, engage in a set of prescribed, complex mathematical calculations in order to verify transactions and compete for the right to add a block of verified transactions to the Blockchain and thereby confirm bitcoin transactions included in that block’s data. The miner who successfully “solves” the complex mathematical calculations has the right to add a block of transactions to the Blockchain and is then rewarded by a grant of bitcoin, known as a “coinbase,” plus any transaction fees paid for the transactions included in such block. Bitcoin is created and allocated by the Bitcoin network protocol and distributed through mining, subject to a strict, well-known issuance schedule. The supply of bitcoin is programmatically limited to 21 million bitcoin in total. As of March 1, 2021, approximately 18,643,000 bitcoin had been mined.

Confirmed and validated bitcoin transactions are recorded in blocks added to the Blockchain. Each block contains the details of some or all of the most recent transactions that are not memorialized in prior blocks, as well as a record of the award of bitcoin to the miner who added the new block. Each unique block can only be solved and added to the Blockchain by one miner, therefore, all individual miners and mining pools on the Bitcoin network must engage in a competitive process of constantly increasing their computing power to improve their likelihood of solving for new blocks. As more miners join the Bitcoin network and its processing power increases, the Bitcoin network adjusts the complexity of a block-solving equation to maintain a predetermined pace of adding a new block to the Blockchain approximately every ten minutes.

The Bitcoin Market and Bitcoin Trading Platforms

In addition to using bitcoin to engage in transactions, investors may purchase and sell bitcoin to speculate as to the value of bitcoin in the bitcoin market, or as a long-term investment to diversify their portfolio. The value of bitcoin within the market is determined, in part, by (i) the supply of and demand for bitcoin in the bitcoin market, (ii) market expectations for the expansion of investor interest in bitcoin and the adoption of bitcoin by users, (iii) the number of merchants that accept bitcoin as a form of payment, and (iv) the volume of private end-user-to-end-user transactions.

Although the value of bitcoin is determined by the value that two transacting market participants place on bitcoin through their transaction, the most common means of determining a reference value is by surveying one or more trading platforms where secondary markets for bitcoin exist. The most prominent bitcoin

trading platforms are often referred to as “exchanges”, although they neither report trade information nor are they regulated in the same way as a national securities exchange. As such, there is some difference in the form, transparency and reliability of trading data from bitcoin trading platforms. Generally speaking, bitcoin data is available from these trading platforms with publicly disclosed valuations for each executed trade, measured against a fiat currency such as the US Dollar or Euro, or against another digital asset (for example, bitcoin trades against the US Dollar are reflected in the “USD-BTC Pair”).

Currently, there are many bitcoin trading platforms operating worldwide and trading platforms represent a substantial percentage of bitcoin buying and selling activity, and, therefore, provide large data sets for the market valuation of bitcoin. A bitcoin trading platform provides investors with a way to purchase and sell bitcoin, similar to stock exchanges like the New York Stock Exchange or NASDAQ, which provide ways for investors to buy stocks and bonds in the so-called “secondary market.” Unlike stock exchanges, which are regulated to monitor securities trading activity, bitcoin trading platforms are largely regulated as money services businesses (or a foreign regulatory equivalent) and are required to monitor for and detect money-laundering and other illicit financing activities that may take place on their platform. Bitcoin trading platforms operate websites designed to permit investors to open accounts with the trading platform and then purchase and sell bitcoin.

As with conventional stock exchanges, an investor opening a trading account and wishing to transact at a bitcoin trading platform must deposit an accepted government-issued currency into their account, or a previously acquired digital asset. The process of establishing an account with a bitcoin trading platform and trading bitcoin is different from, and should not be confused with, the process of users sending bitcoin from one bitcoin address to another bitcoin address, such as to pay for goods and services. This latter process is an activity that occurs wholly within the confines of the Bitcoin network, while the former is an activity that occurs largely on private websites and databases owned by the trading platform.

In addition to the bitcoin trading platforms that provide spot markets for bitcoin, an OTC trading market has emerged for digital assets. The bitcoin OTC market demonstrates flexibility in terms of quotes, price, size, and other factors. The OTC market has no formal structure and no open-outcry meeting place, and typically involves bilateral agreements on a principal-to-principal basis. Parties engaging in OTC transactions will agree upon a price – often via phone, email, or chat – and then one of the two parties will initiate the transaction. For example, a seller of bitcoin could initiate the transaction by sending the bitcoin to the buyer’s bitcoin address. The buyer would then wire US Dollars to the seller’s bank account. OTC trading tends to occur in large blocks of bitcoin. All risks and issues related to creditworthiness are between the parties directly involved in the transaction. OTC market participants include institutional entities, such as hedge funds, family offices, private wealth managers, high-net-worth individuals that trade bitcoin on a proprietary basis, and brokers that offer two-sided liquidity for

bitcoin.

Beyond the spot bitcoin trading platforms and the OTC market, a number of unregulated bitcoin derivatives trading platforms exist that offer traders the ability to gain leveraged and/or short exposure to the price of bitcoin through perpetual futures, quarterly futures, and other derivative contracts.

Finally, the trading of regulated bitcoin futures contracts launched on the CME in December 2017.[12] A further discussion of the CME bitcoin futures market ("CME Market") is included in the section entitled "Standard for Approval—The CME Market," below.

Authorized Participants will have the option of purchasing and selling bitcoin used in Creation Unit transactions with the Trust either on bitcoin trading platforms, in the OTC markets, or in direct bilateral transactions. In addition, Authorized Participants may utilize futures to hedge bitcoin exposure relating to the purchase and redemption of Creation Units.

Valuation of the Trust's Bitcoin

The CME US Reference Rate, CME UK Reference Rate and CME Bitcoin Real Time Price

According to the Registration Statement, the CME UK Reference Rate was established by the CME Group and Crypto Facilities Ltd. to be used in the creation of financial products tied to bitcoin. The CME UK Reference Rate is fixed once per day at 4:00 p.m. London time, based on the methodology set forth below and applying data from constituent trading platforms ("Constituent Platforms"). The CME US Reference Rate was introduced in February 2021 and is designed to apply the CME UK Reference Rate methodology, but with a fix once per day at 4:00 p.m. Eastern time ("E.T."). Although the CME UK Reference Rate has a longer history and is used to settle bitcoin futures on the CME Market, the Trust has determined to utilize the CME US Reference Rate to establish the NAV because the CME US Reference Rate is calculated as of the same time as the NAV and is based on the same methodology and data sources as the CME UK Reference Rate.

The CME Group and Crypto Facilities Ltd. also publish a continuous real-time bitcoin price index, known as the "CME Bitcoin Real Time Price," using data from the Constituent Platforms.

The CME US Reference Rate, CME UK Reference Rate and CME Bitcoin Real Time Price are administered by Crypto Facilities Ltd., with the selection of Constituent Platforms performed by an oversight committee.[13] A trading platform

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12 See note 24, infra.

13 This summary does not represent a complete description of the CME US Reference Rate, the CME UK Reference Rate and CME Bitcoin Real Time Price.

is eligible to be selected as a Constituent Platform if it facilitates spot trading of bitcoin against the USD-BTC Pair and makes trade data and order data available through an Automatic Programming Interface with sufficient reliability, detail and timeliness. Additional initial and continuing eligibility requirements apply to the Constituent Platforms.

Each of the CME US Reference Rate, which has been calculated and published since February 2021, and CME UK Reference Rate, which has been calculated and published since November 2016, aggregates during a calculation window the trade flow of several spot bitcoin trading platforms into the US Dollar price of one bitcoin as of their respective calculation time. Specifically, the CME US Reference Rate is calculated based on the "Relevant Transactions" (as defined below) of each of its Constituent Platforms, which are currently Bitstamp, Coinbase, Gemini, itBit and Kraken, as follows:

1. All Relevant Transactions are added to a joint list, recording the trade price and size for each transaction.

2. The list is partitioned into a number of equally-sized time intervals.

3. For each partition separately, the volume-weighted median trade price is calculated from the trade prices and sizes of all Relevant Transactions. A volume-weighted median differs from a standard median in that a weighting factor, in this case trade size, is factored into the calculation.

4. The CME US Reference Rate or CME UK Reference Rate, as applicable, is then determined by the equally-weighted average of the volume-weighted medians of all partitions.

The CME Bitcoin Real Time Price uses similar data sources, but is calculated once per second based on the weighted mid-price-volume curve, which is a measure of the active bid and ask volume present on a Constituent Platform's order book.

The CME US Reference Rate, CME UK Reference Rate, and CME Bitcoin Real Time Price do not include any bitcoin futures prices in their respective methodologies. A "Relevant Transaction" is any "cryptocurrency versus legal tender spot trade that occurs during the TWAP [Time Weighted Average Price] Period" on a Constituent Platform in the USD-BTC Pair that is reported and

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Additional information on administration and methodologies, may be found at CF Benchmarks' website, available at https://www.cfbenchmarks.com/indices/XBTUSD_US_RR, https://www.cfbenchmarks.com/indices/BRR, and https://www.cfbenchmarks.com/indices/BRTI. The CME US Reference Rate, the CME UK Reference Rate and CME Bitcoin Real Time Price are registered benchmarks under the European Benchmarks Regulation.

disseminated by Crypto Facilities Ltd., as calculation agent for the CME US Reference Rate, CME UK Reference Rate and CME Bitcoin Real Time Price.

Net Asset Value

Under normal circumstances, the Trust's only asset will be bitcoin. The Trust's bitcoin are carried, for financial statement purposes, at fair value, as required by the U.S. generally accepted accounting principles ("GAAP"). The Trust's NAV and NAV per Share will be determined by the Administrator once each Exchange trading day as of 4:00 p.m. E.T., or as soon thereafter as practicable. The Administrator will calculate the NAV by multiplying the number of bitcoin held by the Trust by the CME US Reference Rate for such day, and subtracting the accrued but unpaid expenses and liabilities of the Trust. The NAV per Share is calculated by dividing the NAV by the number of Shares then outstanding. The Administrator will determine the price of the Trust's bitcoin by reference to the CME US Reference Rate, which is published and calculated as set forth above.

Intraday Trust Value

In order to provide updated pricing information relating to the Shares for use by investors and market professionals throughout the domestic trading day, the Exchange will calculate and disseminate throughout the core trading session, every 15 seconds each trading day, an intraday trust value ("ITV"). The ITV will be calculated throughout the trading day by using the prior day's holdings at close of business and the most recently reported price level of the CME Bitcoin Real Time Price as reported by Bloomberg, L.P. or another reporting service, or another price of bitcoin derived from updated bids and offers indicative of the spot price of bitcoin. The ITV will be widely disseminated by one or more major market data vendors during the NYSE Arca Core Trading Session.

Creation and Redemption of Shares; In-Kind Transaction Activity

The Trust Shares

According to the Registration Statement, the Shares shall represent undivided beneficial ownership of the Trust. The Trust creates and redeems Shares from time to time, but only in one or more Creation Units. A Creation Unit is only made in exchange for delivery to the Trust or the distribution by the Trust of the amount of bitcoin represented by the Creation Unit being created or redeemed, the amount of which is representative of the combined NAV of the number of Shares included in the Creation Units being created or redeemed determined as of 4:00 p.m. E.T. on the day the order to create or redeem Creation Units is properly received. Except when aggregated in Creation Units or under extraordinary circumstances permitted under the Trust Agreement, the Shares are not redeemable securities. A Creation Unit will initially consist of at least 25,000 Shares, but may be subject to change.

Authorized Participants are the only persons that may place orders to create and redeem Creation Units. Authorized Participants must be (i) registered broker-

dealers or other securities market participants, such as banks and other financial institutions, that are not required to register as broker-dealers to engage in securities transactions described below, and (ii) Depository Trust Company ("DTC") Participants. To become an Authorized Participant, a person must enter into an Authorized Participant Agreement with the Trust and/or the Trust's marketing agent (the "Marketing Agent").

Creation Procedures

On any business day, an Authorized Participant may create Shares by placing an order to purchase one or more Creation Units with the Transfer Agent through the Marketing Agent. Such orders are subject to approval by the Marketing Agent and the Transfer Agent. For purposes of processing creation and redemption orders, a "business day" means any day other than a day when the Exchange is closed for regular trading. To be processed on the date submitted, creation orders generally must be placed before 4 p.m. E.T. or the close of regular trading on the Exchange, whichever is earlier. The day on which an order is received by the Transfer Agent and approved by the Marketing Agent, is considered the creation order date.

All Creation Units are processed in-kind. By placing a creation order, an Authorized Participant agrees to deposit, or cause to be deposited, bitcoin with the Trust by initiating a Bitcoin transaction to a Bitcoin network address identified by the Trust. Prior to the delivery of Creation Units for a creation order, the Authorized Participant must also have wired to the Transfer Agent the nonrefundable transaction fee due for the creation order. Authorized Participants may not withdraw a creation request. If an Authorized Participant fails to consummate the foregoing, the order may be cancelled.

The total creation deposit amount required to create each Creation Unit is an amount of bitcoin that is in the same proportion to the total assets of the Trust, net of accrued expenses and other liabilities, on the date the order to purchase is properly received, as the number of Shares to be created under the creation order is in proportion to the total number of Shares outstanding on the date the order is received. The Sponsor causes to be published each business day morning, prior to the commencement of trading on the Exchange, the amount of bitcoin that will be required to be deposited in exchange for one Creation Unit for such business day.

Redemption Procedures

According to the Registration Statement, the procedures by which an Authorized Participant can redeem one or more Creation Units mirror the procedures for the creation of Creation Units. On any business day, an Authorized Participant may place an order with the Transfer Agent through the Marketing Agent to redeem one or more Creation Units. To be processed on the date submitted, redemption orders generally must be placed before 4 p.m. E.T. or the close of regular trading on the Exchange, whichever is earlier. A redemption order will be effective on the date it is received by the Administrator and approved by the Marketing Agent

("Redemption Order Date"). The redemption procedures allow Authorized Participants to redeem Creation Units and do not entitle an individual shareholder to redeem any Shares in an amount less than a Creation Unit, or to redeem Creation Units other than through an Authorized Participant.

The redemption distribution from the Trust will consist of a transfer to the redeeming Authorized Participant, or its agent, of an amount of bitcoin representing the amount of bitcoin held by the Trust evidenced by the Shares being redeemed. The redemption distribution amount is determined in the same manner as the determination of the bitcoin deposit amount discussed above. The Sponsor causes to be published each business day morning, prior to the commencement of trading on the Exchange, the redemption distribution amount relating to a Creation Unit applicable for such business day.

The redemption distribution due from the Trust will be delivered once the Transfer Agent notifies the Bitcoin Custodian and the Sponsor that the Authorized Participant has delivered the Shares represented by the Creation Units to be redeemed to the Trust's DTC account. If the Trust's DTC account has not been credited with all of the Shares of the Creation Units to be redeemed, the redemption distribution will be delayed until such time as the Transfer Agent confirms receipt of all such Shares.

Once the Transfer Agent notifies the Bitcoin Custodian and the Sponsor that the Shares have been received in the Trust's DTC account, the Sponsor will instruct the Bitcoin Custodian to transfer the redemption bitcoin amount from the Trust Bitcoin Account to the Authorized Participant's bitcoin custody account. All redemption orders are processed in-kind. By placing a redemption order, an Authorized Participant agrees to receive bitcoin. If an Authorized Participant fails to consummate the foregoing, the order may be cancelled.

Fee Accrual

According to the Registration Statement, the only ordinary expense of the Trust is expected to be the Sponsor's fee, which shall accrue daily in bitcoin and be payable monthly in bitcoin.

Impact of the Exclusive Use of In-Kind Creations, Redemptions and Fee Accruals

The Sponsor believes that the exclusive use of in-kind creations, redemptions and fee accruals, in all situations except when the Trust is required to liquidate or to pay extraordinary expenses, provides long-term investors in the Trust with redundant but strong protection. The in-kind structure ensures that the Trust maintains the appropriate amount of bitcoin-per-Share in all scenarios, regardless of the US Dollar calculation of NAV or the CME US Reference Rate.

Standard for Approval

How the Exchange's Proposed Rule Conforms to the Requirements of the Act

To date, the Commission has considered and published disapproval orders relating to numerous proposed exchange-traded products ("ETPs") providing exposure to the price of bitcoin, including a prior proposal in respect of the Trust.[14] In each of these disapprovals, the Commission determined that the filing failed to demonstrate that the proposal was consistent with the requirements of Section 6(b)(5) of the Act[15] and, in particular, the requirement that the rules of a national securities exchange be designed to prevent fraudulent and manipulative acts and practices.[16]

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14 See, e.g., Order Disapproving a Proposed Rule Change, as Modified by Amendments No. 1 and 2, to BZX Rule 14.11(e)(4), Commodity-Based Trust Shares, to List and Trade Shares Issued by the Winklevoss Bitcoin Trust, Release No. 34-80206 (Mar. 10, 2017), 82 FR 14076 (March 16, 2017); Order Disapproving a Proposed Rule Change, as Modified by Amendment No. 1, Relating to the Listing and Trading of Shares of the SolidX Bitcoin Trust under NYSE Arca Equities Rule 8.201, Release No. 34-80319 (Mar. 28, 2017), 82 FR 16247 (April 3, 2017); Order Setting Aside Action by Delegated Authority and Disapproving a Proposed Rule Change, as Modified by Amendments No. 1 and 2, to List and Trade Shares of the Winklevoss Bitcoin Trust ("Second Winklevoss Order"), Release No. 34-83723 (July 26, 2018), 83 FR 37579 (August 1, 2018); Order Disapproving a Proposed Rule Change to List and Trade the Shares of the ProShares Bitcoin ETF and the ProShares Short Bitcoin ETF, Release No. 34-83904 (Aug. 22, 2018), 83 FR 43934 (August 28, 2018); Order Disapproving a Proposed Rule Change Relating to Listing and Trading of the Direxion Daily Bitcoin Shares, Release No. 34-83912 (Aug. 22, 2018), 83 FR 43912 (August 28, 2018); Order Disapproving a Proposed Rule Change to List and Trade the Shares of the GraniteShares Bitcoin ETF and the GraniteShares Short Bitcoin ETF ("GraniteShares Order"), Release No. 34-83913 (Aug. 22, 2018), 83 FR 43923 (August 28, 2018); Order Disapproving a Proposed Rule Change, as Modified by Amendment No. 1, Relating to the Listing and Trading of Shares of the Bitwise Bitcoin ETF Trust Under NYSE Arca Rule 8.201-E ("Bitwise Order"), Release No. 34-87267 (Oct. 9, 2019), 84 FR 55382 (October 16, 2019) (subsequently withdrawn while the delegated action was under review by the Commission on Jan. 13, 2020; see SR-NYSEArca-2019-01, 85 FR 73819 (November 19, 2020); Order Disapproving a Proposed Rule Change, as Modified by Amendment No. 1, to Amend NYSE Arca Rule 8.201-E (Commodity-Based Trust Shares) and to List and Trade Shares of the United States Bitcoin and Treasury Investment Trust Under NYSE Arca Rule 8.201-E, Release No. 34-88284 (February 26, 2020), 85 FR 12595 (March 3, 2020) ("USBT Order").

15 15 U.S.C. 78f(b)(5).

16 In the Second Winklevoss Order, Bitwise Order and USBT Order, the Commission determined that the proposing exchange had not established that bitcoin markets were uniquely resistant to fraud or manipulation, which unique resistance might provide protections such that the proposing exchange "would not

The principal means by which a national securities exchange may satisfy the requirements of Section 6(b)(5) of the Act[17] is through entry into comprehensive surveillance-sharing agreements that "help to ensure the availability of information necessary to detect and deter potential manipulations and other trading abuses, thereby making [the ETP] less readily susceptible to manipulation."[18] These comprehensive surveillance-sharing agreements enable the Exchange to obtain information necessary to detect and deter market manipulation and other trading abuses upon request of information from one party to the other.[19]

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necessarily need to enter into a surveillance sharing agreement with a regulated significant market." Second Winklevoss Order 83 FR at 37591, Bitwise Order 84 FR at 55386, and USBT Order 85 FR at 12597. In the Second Winklevoss Order, GraniteShares Order, Bitwise Order and USBT Order, the Commission determined that, while the existing, regulated derivatives markets (including the CME Market) was a regulated market, the proposing exchanges had not demonstrated that the regulated derivatives markets had achieved significant size. See Second Winklevoss Order 83 FR at 37601, Bitwise Order 84 FR at 55410, and USBT Order 85 FR at 12597. In the Second Winklevoss Order, Bitwise Order and USBT Order, the Commission determined that a proposing exchange had established neither that it had a surveillance sharing agreement with a group of underlying bitcoin trading platforms, nor that such bitcoin trading platforms constituted regulated markets of significant size with respect to bitcoin. See Second Winklevoss Order 83 FR 37590-37591, Bitwise Order 84 FR at 55407 and USBT Order 85 FR at 12615.

17 15 U.S.C. 78f(b)(5).

18 See Notice of Filing and Order Granting Immediate Effectiveness of Proposed Rule Change by American Stock Exchange, Incorporated Relating to the Listing of Commodity Indexed Preferred or Debt Securities, Exchange Act Release No. 35518 (Mar. 21, 1995), 60 FR 15804, 15807, 15807 n.21 (Mar. 27, 1995) (SR-Amex-94-30). See also Notice of Filing and Order Granting Immediate Effectiveness of Proposed Rule Change by American Stock Exchange, Incorporated Relating to the Listing of Commodity Indexed Preferred or Debt Securities, Exchange Act Release No. 36885 (Feb. 26, 1996), 61 FR 8315, 8319 n.17 (Mar. 4, 1996) (SR-Amex-95-50).

19 The Commission has described a comprehensive surveillance sharing agreement as including an agreement under which a self-regulatory organization may expressly obtain information on (i) market trading activity, (ii) clearing activity and (iii) customer identity, and where existing rules, laws or practices would not impede access to such information. See Letter from Brandon Becker, Director, Division of Market Regulation, Commission, to Gerard D. O'Connell, Chairman, Intermarket Surveillance Group (June 3, 1994), available at https://www.sec.gov/divisions/marketreg/mr-noaction/isg060394.htm ("ISG Letter").

In the Second Winklevoss Order, the Commission laid out both the importance and definition of a surveilled, regulated market of significant size. Specifically, the Commission explained that:

> [for all] commodity-trust ETPs approved to date for listing and trading, there has been in every case at least one significant, regulated market for trading futures on the underlying commodity—whether gold, silver, platinum, palladium, or copper — and the ETP listing exchange has entered into surveillance-sharing agreements with, or held Intermarket Surveillance Group membership in common with, that market.[20]

Further, on an illustrative and not exclusive basis, the Commission interpreted

> the terms 'significant market' and 'market of significant size' to include a market (or group of markets) as to which (a) there is a reasonable likelihood that a person attempting to manipulate the ETP would also have to trade on that market to successfully manipulate the ETP, so that a surveillance-sharing agreement would assist the ETP listing market in detecting and deterring misconduct, and (b) it is unlikely that trading in the ETP would be the predominant influence on prices in that market.[21]

This two-prong definition of the term "significant market" came to be known as the "Winklevoss Standard," and will be referred to as such in this proposal. In the Bitwise Order, the Commission built upon the Winklevoss Standard and provided important additional guidance on how a listing exchange might demonstrate that a bitcoin derivatives market meets the Commission's definition of "significant":

> [T]he lead-lag relationship between the bitcoin futures market and the spot market ... is central to understanding whether it is reasonably likely that a would-be manipulator of the ETP would need to trade on the bitcoin futures market to successfully manipulate prices on those spot platforms that feed into the proposed ETP's pricing mechanism. In particular, if the spot market leads the futures market, this would indicate that it would not be necessary to trade on the futures market to manipulate the proposed

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The Commission has emphasized the importance of surveillance sharing agreements, noting that "[s]uch agreements provide a necessary deterrent to manipulation because they facilitate the availability of information needed to fully investigate a manipulation if it were to occur." Amendment to Rule Filing Requirements for Self-Regulatory Organizations Regarding New Derivative Securities Products, Exchange Act Release No. 40761 (Dec. 8, 1998), 63 FR 70952, 70954, 70959 (Dec. 22, 1998) (File No. S7-13-98) ("NDSP Adopting Release").

20 Second Winklevoss Order, 83 FR 37594.

21 Id. The Commission further noted that "[t]here could be other types of ''significant markets'' and ''markets of significant size,'' but this definition is an example that will provide guidance to market participants."

> ETP, even if arbitrage worked efficiently, because the futures price would move to meet the spot price.[22]

In response to this, in the rule proposal disapproved in the USBT Order, the sponsor and listing exchange attempted to establish that the CME Market satisfied the requirements of a regulated market of significant size as laid out in the Bitwise Order. The rule change proposal referenced, among other items, a statistical analysis conducted by the Sponsor examining whether the CME Market led the bitcoin spot market from a price discovery perspective. The Commission rejected this argument for specific reasons, noting (among other things) that:

> the [s]ponsor has not provided sufficient details supporting this conclusion, and unquestioning reliance by the Commission on representations in the record is an insufficient basis for approving a proposed rule change in circumstances where, as here, the proponent's assertion would form such an integral role in the Commission's analysis and the assertion is subject to several challenges. For example, the [s]ponsor has not provided sufficient information explaining its underlying analysis, including detailed information on the analytic methodology used, the specific time period analyzed, or any information that would enable the Commission to evaluate whether the findings are statistically significant or time varying.

Nonetheless, the Commission made it clear that a future ETP application could potentially meet the Winklevoss Standard through identifying a regulated market of significant size. Specifically, the Commission noted that an existing or new bitcoin futures market could achieve significant size such that an Exchange might demonstrate, through a surveillance sharing agreement, that a proposed rule change could satisfy the requirements of the Act.[23]

As discussed in detail below, the Sponsor's analysis demonstrates that the Exchange can meet the burden presented by Section 6(b)(5) of the Act and, in particular, the requirement that the rules of a national securities exchange be designed to prevent fraudulent and manipulative acts and practices by demonstrating that the CME Market (i) is a regulated market; (ii) participates in a surveillance sharing agreement with the Exchange; and (iii) satisfies the Commission's "significant market" definition under the Winklevoss Standard.

The CME Market

The CME Group announced the planned launch of bitcoin futures on October 31,

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22 Bitwise Order, 84 FR at 55411. See also USBT Order 85 FR at 12612.

23 In past disapproval orders for bitcoin ETPs, the Commission acknowledged that the CME, and therefore the CME Market, is regulated by the CFTC, but that the proposing exchanges had not demonstrated that the CME Market represented a significant market. See note 16, supra.

2017, the trading of which began on December 17, 2017.[24] The futures are cash-settled based on the CME UK Reference Rate, the methodology of which is described above. Since inception, the CME Market has seen significant growth in average daily volume traded, open interest, and the number of large participants, as demonstrated in the charts below.[25]

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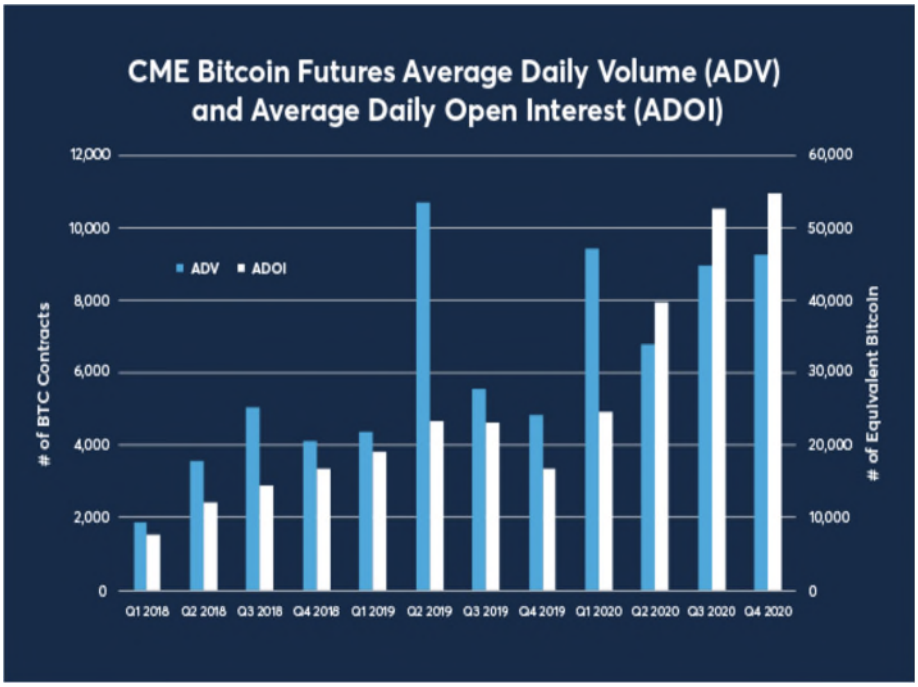
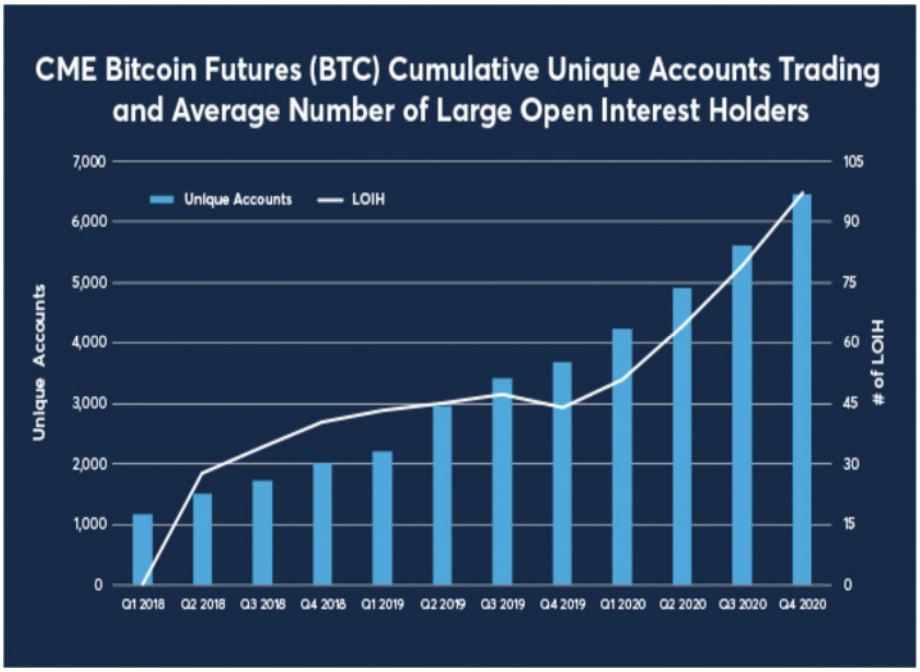
[24] "CME Group Announces Launch of Bitcoin Futures," October 31, 2017, available at https://www.cmegroup.com/media-room/press-releases/2017/10/31/cme_group_announceslaunchofbitcoinfutures.html. At the same time as the launch of the CME Market, the Cboe Futures Exchange, LLC announced and subsequently launched Cboe bitcoin futures. See "CFE to Commence Trading in Cboe Bitcoin (USD) Futures Soon," December 01, 2017, available at cdn.cboe.com/resources/release_notes/2017/Cboe-Bitcoin-USD-Futures-Launch-Notification.pdf. Each future was cash settled, with the CME Market tracking the CME UK Reference Rate and the Cboe bitcoin futures tracking a bitcoin trading platform daily auction price. The Cboe Futures Exchange, LLC subsequently discontinued its bitcoin futures market effective June 2019. "Cboe put the brakes on bitcoin futures," March 15, 2019, available at https://www.reuters.com/article/us-cboe-bitcoin/cboe-puts-the-brakes-on-bitcoin-futures-idUSKCN1QW261. The Trust uses the CME US Reference Rate to calculate its NAV.

[25] CME Group, CME bitcoin futures celebrate third anniversary: The year in review (December 31, 2020). "Cumulative unique accounts" refers to the number of unique accounts that had, prior to or on the date measured, entered on a CME Group venue into at least one bitcoin futures contract. "Large open interest holders" refers to a party that has entered into at least twenty-five (25) bitcoin futures contracts that have not yet offset by delivery.





The Commission has previously recognized that the CME Market qualifies as a regulated market[26] and that surveillance-sharing agreements are in place with the CME by virtue of common membership in the Intermarket Surveillance Group

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26 See Bitwise Order, 84 FR at 55410, n. 456 ("the Commission recognizes that the CFTC comprehensively regulates CME ..."). See also Second Winklevoss Order, 83 FR at 37594 & at note 202, GraniteShares Order 83 FR at 43929, and USBT Order, 85 FR at 12597.

("ISG").[27] Both the Exchange and the CME are members of the ISG.[28]

The CME Market Meets the Commission's Definition of a "Significant Market"

As the following analysis based on the Sponsor's research demonstrates, the CME Market satisfies the Commission's definition of a "significant market."[29] Specifically, the Sponsor's analysis shows that prices on the CME Market consistently lead prices on the bitcoin spot market and the unregulated bitcoin futures market, such that it is reasonably likely that a would-be manipulator of the ETP would need to trade bitcoin futures on the CME Market. The Sponsor's analysis also demonstrates that it is unlikely that trading in the ETP would be the predominant influence on prices in the CME Market.

Data Sources for Evaluating the Bitcoin Market

In evaluating whether the CME Market qualifies as a significant market, the Sponsor has engaged in an extensive research effort to evaluate the lead-lag relationship between the CME Market and both the bitcoin spot market and the unregulated bitcoin futures market. Given that lead-lag and price discovery research is sensitive to data quality, it was critical from the beginning that the Sponsor gather high-quality bitcoin trading data on a historical and an ongoing basis.

Bitcoin trading platforms exist in multiple countries and operate under a variety of regulatory regimes. There are generally no requirements for these platforms to provide data on their trading activity in a uniform fashion to a centralized database. As a result, there currently is no equivalent to the Consolidated Tape Association ("CTA") in the US, which offers a single source of agreed upon trading data for publicly traded equities in the US.

Over the years, however, a variety of private data providers have emerged that consolidate trading data from large numbers of bitcoin trading platforms. The Sponsor undertook a detailed survey of these data providers in May 2020, evaluating them on metrics including data quality, trading platform coverage,

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27 As the Commission explained in the Bitwise Order, common membership between a proposing exchange and a futures market such as the CME (and therefore the CME Market) in the ISG functions as "the equivalent of a comprehensive surveillance sharing agreement." See Bitwise Order, 84 FR at 55410, n.456.

28 A list of the current members of ISG is available at https://www.isgportal.org.

29 This proposal details the data sources, time periods, and statistical methods used by the Sponsor to demonstrate that the CME Market qualifies as a significant market relative to the Trust. As such, the surveillance sharing agreement, in place through common membership in the ISG, will allow the Exchange to detect and deter potential manipulations and other misconduct and to satisfy its obligations under Section 6(b)(5) of the Act. See 15 U.S.C. 78f(b)(5).

cost, service quality, and reputation. The goal of this survey was to determine which provider or set of providers the Sponsor would use in its research.

The Sponsor cataloged bitcoin data providers commonly referenced in the industry, and supplemented this list by conducting broad web searches to identify additional bitcoin data providers and by consulting a third-party survey.[30] Aggregating these steps resulted in a total of 29 firms examined by the Sponsor, of which 14 offered the specific type of data (bitcoin tick data) needed to conduct lead-lag analysis. The Sponsor evaluated these 14 firms on four separate criteria:

- *Data coverage.* All else equal, more trading platforms are better than fewer.
- *Data quality.* Data gathered by third-party providers should match the actual activity that takes place on each trading platform, with as few errors as possible.
- *Cost.* The cost of licensing the data from a given provider should be reasonable.
- *Corporate Factors.* Available facts should give confidence that the provider in question will continue to operate in a robust manner over a meaningful period of time.

Data quality was weighted heavily in the assessment of data providers, as it has a direct impact on the output of price discovery research. Still, the other three factors were important as well. Based on this analysis, the Sponsor elected to use Coin Metrics as the core data provider. At the time, Coin Metrics offered coverage of 26 trading platforms, and had exceptionally high data quality based on the statistical analysis performed by the Sponsor.[31]

To supplement Coin Metrics' data, the Sponsor evaluated data providers that covered a large number (>100) of bitcoin trading platforms. Of these providers, CoinAPI scored the best on its four-factor evaluation system, including scoring well on data quality. Based on this analysis, the Sponsor elected to use CoinAPI

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30 See The Block, "The State of Digital Asset Data and Infrastructure," May 14, 2020, available at https://www.theblockcrypto.com/post/63689/research-report-the-state-of-the-digital-asset-data-and-infrastructure-commissioned-by-blockset.

31 For instance, in one portion of the study, the Sponsor downloaded the full record of trades (2,523,481 trades) directly from Bitfinex, a spot bitcoin trading platform, for the month of March 2020. It then compared these trades with data pulled from participating data providers, looking for three types of data errors: duplicated trades, erroneous trades, and missing trades. Coin Metrics had zero data errors; its competitors had between two and 4,929 errors in their data samples. The Sponsor repeated the analysis using trade data from Coinbase and LBank, two additional bitcoin trading platforms; Coin Metrics again had zero data errors.

data to supplement Coin Metrics data where necessary to conduct its analysis.

Data on the CME Market was obtained directly from the CME Group.

Winklevoss Standard Prong 1: Reasonable Likelihood

The first prong of the Winklevoss Standard requires demonstrating a reasonable likelihood that a person attempting to manipulate a bitcoin ETP would also have to trade on the CME Market.[32] In prior disapproval orders, the Commission stated that demonstrating a "lead-lag relationship" between prices on the CME Market and the underlying bitcoin spot market is "central" to understanding this reasonable likelihood.[33]

As detailed below, through extensive statistical analysis and careful consideration of third-party evaluations of these markets, the Sponsor has demonstrated that the CME Market leads the bitcoin spot market and the unregulated bitcoin futures market, such that it is reasonably likely that a person attempting to manipulate the ETP would also have to trade on the CME Market, thus satisfying the first prong of the Winklevoss Standard.

The Statistical Approaches to Demonstrating a Lead-Lag Relationship

The Sponsor conducted a detailed review of both academic and practitioner papers that focus on lead-lag relationships in financial markets. The literature review revealed that there are two primary approaches to conducting such analysis:

- *Information Share (IS) / Component Shares (CS) Price Discovery Analysis.* This type of analysis is based on the principle that there is a common "efficient" price for any asset being traded on multiple platforms. It allows you to construct a model of the relationship between different platforms by comparing their price series against this common efficient price, and testing which price series is faster to incorporate new information; and

- *Time-Shift Lead-Lag Analysis (TSLL).* TSLL is a more intuitive approach to evaluating lead-lag relationships between markets. It involves taking two time series of price data and offsetting (or "shifting") them against each other to determine what offset, or "lag," produces the highest cross-correlation between the two series.

Both IS/CS price discovery analysis and TSLL have an extensive history in the financial literature, and each comes with its own strengths and weaknesses. As such, the Sponsor has evaluated the CME Market using both of the major

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32 See note 21, supra, and accompanying text.

33 See note 22, supra, and accompanying text.

academic approaches.

IC/CS Price Discovery Research on the Bitcoin Spot Market vs. the CME Market

Information share (IS) and component share (CS) are two variants of a core analytical approach to price discovery research that traces its roots back to 1995.[34] It is sometimes referred to in the literature as "common efficient price"-based analysis, "fundamental price"-based analysis, or simply "price discovery" analysis.

Price discovery analysis is based on the idea that, in a perfectly efficient market, new information should be reflected simultaneously in the price of an asset as it trades on different platforms. In practice, however, this is not the case; some platforms move before others. In addition, some market moves are simply "noise" that do not reflect a change in the fundamental price at all. Price discovery analysis attempts to measure the speed and accuracy with which each trading platform incorporates new information into its price. Platforms that are faster to incorporate new information while being better at avoiding noise are considered to have a "higher share" of price discovery.

Despite the paired nature of IS/CS values, the convention in the literature is to present only one value in the results tables, leaving the other implied. The Sponsor followed that convention, only reporting the IS/CS value of the CME Market, as it is compared to each spot bitcoin trading platform. Therefore, an IS/CS value above 50% indicates that the CME Market leads price discovery compared with the spot bitcoin trading platform in question.

The Sponsor's review of the historical literature surrounding IS/CS price discovery analysis comparing the CME Market and the bitcoin spot market identified ten academic and practitioner studies evaluating the two markets, which are itemized and summarized in the table below (a single long horizontal table has been divided here into two parts).[35]

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[34] Hasbrouck, J. (1995), One security, many markets: Determining the contributions to price discovery. The Journal of Finance, 5050(4), 1175-1199. Gonzalo, J., and Granger, C. (1995), Estimation of common long-memory components in cointegrated systems. Journal of Business & Economic Statistics, 13(1), 27-35.

[35] This table is replicated from material previously provided to the Commission. See Matthew Hougan, Hong Kim and Satyajeet Pal, Price discovery in the modern bitcoin market: Examining lead-lag relationships between the bitcoin spot and bitcoin futures market, February 16, 2021, as amended and supplemented ("Bitwise Prong One Paper").

#	Title	Year	Authors
1	Bitcoin futures—What use are they?[36]	2018	Corbet, Lucey, et al.
2	Price discovery in bitcoin spot or futures?[37]	2019	Baur and Dimpfl
3	An analysis of price discovery between bitcoin futures and spot markets[38]	2019	Kapar and Olmo
4	Price discovery, high-frequency trading and jumps in bitcoin markets[39]	2019	Alexander and Heck
5	What role do futures markets play in bitcoin pricing? Causality, cointegration and price discovery from a time-varying perspective[40]	2019	Hu, Hou, and Oxley
6	The development of bitcoin futures: Exploring the interactions between cryptocurrency derivatives[41]	2019	Akyildirim, Corbet, et al.
7	Price discovery in bitcoin futures[42]	2020	Fassas, Papadamou, and Koulis
8	The determinants of price discovery on bitcoin markets[43]	2020	Entrop, Frijns, and Seruset
9	Bitcoin spot and futures market microstructure[44]	2020	Aleti and Mizrach
10	Efficient price discovery in the bitcoin markets[45]	2020	Chang, Herrmann,

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[36] Corbet, S., Lucey, B., Peat, M., and Vigne, S. (2018), Bitcoin futures—What use are they? Economics Letters (172), 23-27.

[37] Baur, D.G., and Dimpfl, T. (2019), Price discovery in bitcoin spot or futures? The Journal of Futures Markets (39)7, 803-817.

[38] Kapar, B., and Olmo, J. (2019). An analysis of price discovery between bitcoin futures and spot markets. Economics Letters, (174), 62-64.

[39] Alexander, C., and Heck, D. (2019), Price discovery, high-frequency trading and jumps in bitcoin markets. SSRN Electronic Journal.

[40] Hu, Y., Hou, Y.G., Oxley, L. (2020), What role do futures markets play in bitcoin pricing? Causality, cointegration and price discovery from a time-varying perspective. International Review of Financial Analysis (72).

[41] Akyildirim, E., Corbet, S., Katsiampa, P., Kellard, N., and Sensoy, A. (2020), The development of bitcoin futures: Exploring the interactions between cryptocurrency derivatives. Finance Research Letters (34).

[42] Fassas, A., Papadamou, S., Koulis, A. (2020), Price discovery in bitcoin futures. Research in International Business and Finance (52).

[43] Entrop, O., Frijns B., Seruset, M. (2020), The determinants of price discovery on bitcoin markets. The Journal of Futures Markets, (40)5, 816-837.

[44] Aleti, S., and Mizrach, B. (2020), Bitcoin spot and futures market microstructure. The Journal of Futures Markets (41)2, 194-225.

[45] Chang, A., Herrmann, W, and Cai, W. (2020), Efficient price discovery in the bitcoin markets. Wilshire Phoenix, October 14, 2020, available at

			and Cai

#	Authors	CME IS	CME CS	Intervals	Time Period	Result
1	Corbet, Lucey, et al.	15%	18%	1 min	--[46]	Spot leads
2	Baur and Dimpfl	14%	14%	15 min	12/18/2017 - 10/18/2018	Spot leads
3	Kapar and Olmo	89%	--	1 day	12/18/2017 - 05/16/2018	Futures lead
4	Alexander and Heck	66%	73%	30 min	12/18/2017 - 06/30/2019	Futures lead
5	Hu, Hou, and Oxley	55%	--	1 day	12/18/2017 - 06/16/2019	Futures lead
6	Akyildirim, Corbet, et al.	91-97%	67-87%	1/5/10/15/30/60 min	12/18/2017 - 02/26/2018	Futures lead
7	Fassas, Papadamou, and Koulis	97%	77%	1 hour	01/01/2018 - 12/31/2018	Futures lead
8	Entrop, Frijns, and Seruset	50%	53%	1 min	12/18/2017 - 03/31/2019	Mixed
9	Aleti and Mizrach	53-55%	68-91%	5 min	01/02/2019 - 02/28/2019	Futures lead
10	Chang, Herrmann, and Cai	--	63%	1 min	07/01/2019 - 12/31/2019	Futures lead

As the above table indicates, a majority of papers support the notion that the CME Market leads price discovery using IS and/or CS when compared to the bitcoin spot market.

Because the methodologies and findings of each paper are nuanced, the Sponsor examined each paper in detail. The analysis begins with the majority opinion that the CME Market leads the bitcoin spot market:

- Kapar and Olmo (2019) was the first paper to assert that, contrary to the two studies that came before it (Corbet et al. (2018) and Baur and Dimpfl (2019)), the data "clearly reflect the leadership of the Bitcoin futures markets with respect to the spot market." The paper attributed 89% of IS to the futures market.

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https://www.wilshirephoenix.com/efficient-price-discovery-in-the-bitcoin-markets/.

46 Corbet et al (2018) do not specify the time period of the price discovery analysis presented. See note 52, infra, and accompanying text.

Kapar and Olmo (2019) relies on daily price data, which means the study may not capture intraday information flow. Still, long-run relationships are relevant in holistically describing the relative strength one market has compared with another. The authors illustrated the importance of long-run relationships, saying, "when the market is in contango we can expect increases in the spot price in the next period. In contrast, when the market is in backwardation, the VECM suggests a fall in spot prices to correct departures from equilibrium." In other words, the authors found that if there is a gap between the spot and futures price on a given day, the spot price is more likely to correct toward the futures price than vice versa.

- Alexander and Heck (2019) similarly found that there was "strong evidence that both CME and CBOE futures have played the leading role in price discovery." Unlike Kapar and Olmo (2019), Alexander and Heck (2019) used intraday data with a 30-minute timing interval. Their analysis ran from December 18, 2017 to June 30, 2019, the longest time period among the ten studies the Sponsor discovered. It showed that the CME Market led the bitcoin spot market with 66% of IS and 73% of CS during that time.

  Interestingly, the authors noted strong price leadership from the CME Market during Q2 2019, the last quarter they studied. In fact, Q2 2019 boosted the overall IS from the study from 57% to 66%, and CS from 50% to 73%. This increase in the CME Market's contribution to price discovery aligned with significant growth in volume on the CME Market after Q1 2019.[47]

  In 2020, Alexander and Heck published a second paper in which the authors highlight the role unregulated futures and perpetual swaps from trading platforms such as Bitmex, Huobi, and OKEx play in the bitcoin market.[48] The analysis involves a complex, multidimensional approach to price discovery analysis conducted across eight different markets and four different exposure types (unregulated futures, regulated futures, perpetual swaps, and spot markets), each with different levels of microstructure friction and data integrity. These complications make it difficult to draw a direct comparison of this paper's results with the ten studies included in the table above.[49]

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47 The monthly ADV in the CME Market grew from $60 million in March 2019 to $230 million in April 2019, according to data from the CME Group. In Q3 2020, the CME Market had a $365 million ADV.

48 Alexander, C., and Heck, D. (2020), Price discovery in bitcoin: the impact of unregulated markets. Journal of Financial Stability (50), Article Number 100776.

49 The direct question around whether the CME Market leads or lags price discovery compared to the unregulated bitcoin futures market is explored in detail in a

- Hu et al. (2020) added to the literature, saying, "What we contribute to this literature here, especially compared to Alexander & Heck (2019), is that we consider price discovery in the Bitcoin futures markets that allow for time-varying approaches," noting that cointegrating relationships can be interrogated more comprehensively using time-varying approaches. The authors conclude that, "Bitcoin futures markets dominate the price discovery process using a time-varying version of an information share measures of the IS and GIS types." This finding provides additional clarity around the time-dependency of other price discovery analytical results.

- Akyildirim, Corbet et al. (2019) conducted its analysis in five-, ten-, 15-, 30-, and 60-min price data intervals to reach a range of IS and CS outcomes in order to test robustness across different data time intervals. The finding that the CME Market led the bitcoin spot market was consistent across all studied time intervals.

- Fassas et al. (2020) added another record to the body of literature finding that the CME Market led the bitcoin spot market, saying, "Our study confirms [the] Akyildirim et al. (2019), Alexander et al. (2019) and Kapar and Olmo (2019) conclusion that bitcoin futures markets, while in their relative youth, have portrayed evidence of price discovery leadership compared to the spot market." Fassas et al. (2020) arrives at this conclusion after applying price discovery measures to the entire year of 2018 with hourly price data.

- Aleti and Mizrach (2020) explores the market microstructure of four spot trading platforms (Bitstamp, Coinbase, Kraken, and itBit) and the CME Market over a relatively narrow two-month time period (January 2, 2019 to February 28, 2019). The paper reports separate CME Market IS values for each of the four spot trading platforms, ranging from 53% versus itBit to 55% versus Bitstamp, and four CME Market CS values ranging from 68% versus itBit to 91% versus Kraken. All of these tests find that the CME Market led price discovery against each of the spot trading platforms.

- Chang et al. (2020) explored a more recent time period (the "second half of 2019") and found that the CME Market led the spot market in price discovery with a CS of 63%.

It is worth noting that – as explored in Putnins (2013)[50] – IS and CS price discovery metrics can face challenges when comparing markets that differ by tick size, trade frequency, and other microstructure frictions. Specifically, these

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following sub-section titled "Examining Lead-Lag Relationships Between The Unregulated Bitcoin Futures Market And The CME Bitcoin Futures Market."

50 Putnins, T., What do price discovery metrics really measure? Journal of Empirical Finance, 23 (9), September 2013.

measures bias against finding price formation in markets like the CME Market that have larger tick sizes or less frequent trades. In spite of these headwinds, a majority of the studies in the table above found the CME Market led price discovery against bitcoin spot market.[51]

The Sponsor also evaluated three studies where the authors noted that the spot market led the CME Market or had mixed results:

- Corbet et al. (2018) is the earliest study examining whether the futures or spot market lead in the bitcoin market. It reached the conclusion that the spot market led, with IS and CS values assigned to the CME Market of just 15% and 18%, respectively. The time period of the price discovery analysis is not clear from the paper, and it is possible that, being the earliest paper, the period was very short. Akyildirim, Corbet, et al. (2019), a study that shares the same co-author (Corbet) but examines different data sets, arrived at the opposite conclusion, as noted above, determining that the futures market had the dominant share of price discovery. Discussing the difference between the two papers, Akyildirim, Corbet, et al. (2019) notes that Corbet et al. (2018) was based on a shorter time period, and for that reason, could have found a relationship that has since reversed.[52]

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51 The Commission has previously cited mixed or unsettled academic literature on lead-lag analysis in its bitcoin ETP disapproval orders. See USBT Order, 84 FR at 12613. Of course, the existence of variable results in IS/CS analysis, either within one study or a group of studies, is not in isolation sufficient to determine that a commodity futures market does not satisfy the concerns of the Act. There are multiple commodity markets where the Commission has approved ETPs based in part on the existence of a regulated derivatives market of significant size where select IS/CS studies find that the related derivatives market is not the main source of price discovery. For instance, Dimpfl et al. (2017) found that futures markets account for less than 10% of IS price discovery in markets like corn, wheat, soybeans, cattle, and lean hogs. Dimpfl, T., Flad, M., and Jung, R. (2017), Price discovery in agricultural commodity markets in the presence of futures speculation. Journal of Commodity Markets, March 2017. Similarly, Narayan and Sharma (2018), examined data on 15 commodities markets from 1977 to 2012, found that spot led futures in nine commodities (canola, cocoa, coffee, corn, gold, platinum, silver, soybean oil, and soybean yellow), and that futures dominated in just six commodities (copper, crude oil, platinum, soybean meal, sugar and wheat). Narayan, P. and Sharma, S. (2018), An analysis of time-varying commodity market price discovery. International Review of Financial Analysis, May 2018.

52 Akyildirim, Corbet, et al. (2019) notes that "in contrast to results based on a shorter period as in Corbet et al. (2018a), it appears that as the new cryptocurrency futures markets developed, they presented substantial leadership

- Baur and Dimpfl (2019) is the other study that found the bitcoin spot market led the bitcoin futures market. This paper, however, has an important methodological flaw that led the CME Market contribution to appear artificially low: the authors conducted their price discovery analysis on a per-lifetime-of-each-contract basis, rather than a standard rolling-contract basis.

  Alexander and Heck (2019) explore this issue extensively, going as far as running a similar per-lifetime-of-each-contract analysis to observe how much lower the futures market contribution can appear. The authors concluded that "[t]his apparently leading role of the spot market is not surprising since, during the first few months after the introduction of a contract, there is always another contract with a nearer maturity where almost all trading activity occurs. So any finding that the spot market dominates the price discovery process is merely an artefact of very low trading volumes when the contract is first issued."

  Baur and Dimpfl (2019) acknowledge this issue and run a rolling-futures model of the same analysis for contracts traded on the Cboe, using a fairly standard methodology where the studied contract is rolled over one day prior to maturity. This led to a significantly higher share of price discovery for the Cboe contract, albeit one that still did not dominate the bitcoin spot market. Unfortunately, the authors were unable to do the same analysis for CME futures, noting that the continuous price data approach was "only feasible for the Cboe futures as there are short gaps in our CME data."

  It is not clear why such data gaps existed, as CME data is readily available. Additionally, it is not appropriate to assume that, if the authors had studied a rolling-futures version of the CME analysis, the result would also have aligned with the findings of the rolling-futures version of the Cboe analysis. There were fewer CME bitcoin futures contracts in the data set than in the Cboe data set (four versus seven), and each of the CME contracts had a longer lifetime (or "Sample Period," as shown in Table 1 of the paper), likely leading to a stronger bias from this methodological flaw.

  Therefore, the Sponsor concluded that Baur and Dimpfl (2019) failed to address whether the CME Market as a whole leads price discovery versus the bitcoin spot market.

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in price discovery over spot Bitcoin markets." This view is repeated in the conclusion, which says, "while earlier research found that information flows and price discovery were transmitted from spot to futures markets, this research verifies that this relationship has since reversed, most likely explained by the influx of institutional and sophisticated investors."

- Entrop et al. (2020) arrives at a mixed result. In aggregate, the paper finds that the CME Market leads, noting that the futures exchange has an average IS value of 50% and average CS value of 53%. The paper also found that the CME Market led price discovery in a majority of months studied, noting, "We find that, on average, the futures market leads the price formation process in 9 (contract) months, while the spot market is the leader in the remaining (6) months." The paper, however, does note that the spot market led the CME Market in a statistically significant way in the last two months of the study (February and March 2019), and in nonsignificant ways in select other months. These findings led the authors to the claim that "the leading market has changed."

  The Sponsor noted that Aleti and Mizrach (2020) and Alexander and Heck (2019) explored price discovery in overlapping time periods and reached a different conclusion.

In summary, the Sponsor concluded that the majority of academic and practitioner papers support the view that the CME Market leads price discovery as compared with the bitcoin spot market. Of the ten available papers, seven clearly find that the CME Market leads, and an eighth (Entrop et al. (2020)) has aggregate results in favor of the CME Market leading. Of the two papers that conclude that the spot market leads, one was an early paper that potentially studied a very limited time period (Corbet et al. (2018)) and the other (Baur and Dimpfl (2019)) has an important methodological flaw that limits its applicability to the question at hand.

In addition to the literature review above, the Sponsor conducted its own analysis of IS/CS price discovery between the CME Market and the bitcoin spot market. In preparing its analysis, the Sponsor considered that the academic literature on bitcoin price discovery does not have a single approach to defining "the bitcoin spot market." Many studies, such as Baur and Dimpfl (2019), use a single bitcoin trading platform as a proxy for all existing spot platforms; others, such as Aleti and Mizrach (2020), evaluate a small number (typically two to five) of bitcoin trading platforms as representative of the bitcoin spot market; still others, like Kapar and Olmo (2019), use an aggregated price (in their case, the Coindesk Bitcoin USD Price Index, which draws on a screened subset of global bitcoin trading platforms).

The Sponsor evaluated the CME Market and ten bitcoin trading platforms, more than the number used in other studies encountered in the Sponsor's academic literature review. These trading platforms included all five Constituent Platforms represented in the CME US Reference Rate and the CME UK Reference Rate (Bitstamp, Coinbase, Gemini, itBit and Kraken), along with five additional bitcoin trading platforms with high reported trading volume (Binance, Bitfinex, Huobi, LBank, and OKEx). These trading platforms include both the largest USD-BTC Pair trading platform by reported volume (Coinbase) and the largest tether-BTC

pair trading platform by reported volume (Binance).[53]

The Sponsor used available trade data, from the inception of the CME bitcoin futures contract on December 18, 2017 through the end of September 30, 2020. The results aligned with the majority of academic and practitioner research in finding that the CME Market leads the bitcoin spot market. The results are statistically significant for all ten trading platforms when evaluated from both an IS and a CS perspective.

The Sponsor presents the results in both full time period and monthly formats. Academic literature commonly presents results as full time period results; however, the Sponsor noted that shorter time periods such as the monthly results may be more appropriate given the potential for time variation in the bitcoin trading market.

The table below shows the IS and CS for the CME Market versus each of the ten spot trading platforms averaged across the entire time period (December 18, 2017 to September 30, 2020), along with a 95% confidence interval for those results. The * indicates that the results are statistically significant (p-value < 0.05). Note that all of the IS and CS values and their confidence intervals are above the 50% mark, indicating that CME Market led all of the ten spot trading platforms across this time period.

	CME IS	**Confidence Interval**	**CME CS**	**Confidence Interval**
Binance	58.32%*	56.78% - 59.86%	57.38%*	55.45% - 59.32%
Bitfinex	65.75%*	64.22% - 67.29%	65.08%*	63.28% - 66.89%
Bitstamp	64.10%*	62.74% - 65.47%	68.03%*	66.21% - 69.86%
Coinbase	60.60%*	59.20% - 62.00%	60.88%*	58.99% - 62.77%
Gemini	56.44%*	55.03% - 57.84%	56.73%*	54.73% - 58.72%
Huobi	60.91%*	59.34% - 62.49%	58.97%*	56.96% - 60.98%
itBit	53.33%*	51.91% - 54.75%	52.97%*	50.93% - 55.00%
Kraken	63.17%*	61.58% - 64.76%	63.24%*	61.29% - 65.19%
LBank	66.03%*	63.95% - 68.11%	63.51%*	61.34% - 65.68%

53 While reported volumes on bitcoin trading platforms need to be considered with caution, Coinbase and Binance regularly appear as the top trading platform for the USD-BTC Pair and tether-BTC pair, respectively, on CoinMarketcap.com (https://coinmarketcap.com/currencies/bitcoin/markets/). Tether is a digital asset used as a “stablecoin” that has an intended value of $1.

OKEx	56.19%*	54.74% - 57.64%	53.60%*	51.73% - 55.47%

To provide additional context to this finding, the Sponsor also examined each market on a calendar-month-by-calendar-month basis. This calendar-month-segmented approach allowed the Sponsor to evaluate the potential for time variation in price discovery leadership between the CME Market and the bitcoin spot market over shorter periods.

The table below displays the percentage of months that the CME Market led price discovery versus each of the ten evaluated spot trading platforms since the launch of the CME bitcoin futures contract in December 2017. The exact numbers vary by exchange, but on average, the CME Market has led spot trading platforms from an IS perspective in 89% of evaluated months, and from a CS perspective in 80% of evaluated months.

	% of Months CME Led IS	**% of Months CME Led CS**
Binance	85%	79%
Bitfinex	94%	91%
Bitstamp	94%	91%
Coinbase	91%	85%
Gemini	82%	76%
Huobi	94%	84%
itBit	79%	62%
Kraken	94%	91%
LBank	90%	80%
OKEX	85%	65%
Average	**89%**	**80%**

Taken together, these findings support the conclusion that the CME Market leads price discovery compared with the bitcoin spot market, and that leadership is generally persistent across the full time period.

Time-Shift Lead-Lag Analysis on the Bitcoin Spot Market vs. the CME Market

The Sponsor also examined time-shift lead-lag analysis (TSLL), the other popular academic approach to investigating market leadership. TSLL is an attempt to find the direction and length of the lead-lag relationship between two price series that maximizes the predictive strength of one price series against another. The analysis is performed by shifting one price series forward or backward in time relative to another series and calculating the cross-correlation between the two series and is repeated for many different lag periods to see which amount of lag of

one price series results in the highest cross-correlation between the two price series. The amount of lead or lag that results in the highest cross-correlation is referred to as “lead-lag time.”

The Sponsor analyzed the TSLL relationship between the CME Market and the same ten bitcoin spot trading platforms evaluated using IS/CS price discovery analysis. The analysis utilized available trade data from the inception of the CME bitcoin futures contract on December 18, 2017 through the end of the study on September 30, 2020.

The results of the Sponsor’s TSLL analysis align with the results of its IS/CS analysis and demonstrate that the CME Market leads all evaluated spot trading platforms over the duration of the study.

The table below shows the lead-lag time (the amount of lead or lag that results in the highest cross-correlation between two price series) for the CME Market versus each of the ten spot trading platforms, calculated daily, and averaged across the entire time period (December 18, 2017 to September 30, 2020). The table also shows the 95% confidence interval for those results. A positive value indicates the CME Market leading by that amount of seconds. A negative value would indicate CME Market lagging by that amount of seconds. The * indicates the result being statistically significant (p-value < 0.05), meaning the lead-lag time for the entire time period lies squarely within the positive (or negative) value territory.

	Lead-Lag Time (seconds)	**Confidence Interval (seconds)**
Binance	7.28*	6.53 – 8.03
Bitfinex	9.03*	8.33 – 9.73
Bitstamp	6.52*	5.96 – 7.08
Coinbase	8.42*	7.65 – 9.18
Gemini	6.51*	5.91 – 7.11
Huobi	7.57*	6.96 – 8.18
itBit	8.63*	7.89 – 9.37
Kraken	17.19*	16.00 – 18.38
Lbank	16.62*	15.37 – 17.87
OKEx	8.27*	7.41 – 9.13

The lead-lag times vary slightly by trading platform, but are all contained within a positive value band of 6.51–17.19 seconds, indicating CME leading. All results are statistically significant.

The results of our TSLL analysis support the conclusion of our IS/CS analysis, showing that the CME Market leads each of the ten evaluated spot trading platforms in a statistically significant manner over the duration of the study.

These findings across both types of statistical analysis are, perhaps, unsurprising. Futures markets often lead price discovery when compared to spot markets. As described in papers like Garbade and Silver (1983),[54] Chan (1992),[55] and Fleming et al. (1996),[56] futures benefit from leverage, lower transaction costs, and access to short exposure. In addition, in the bitcoin market, the regulated nature of the CME Market may attract more professional investors than unregulated spot markets. These professional investors may have advantages over retail investors from an available capital, technology, information flow, and trading speed perspective. Such conditions may be expected to continue into the future, particularly as bitcoin sees continued and expanded adoption as an investable asset among professional and institutional investors.

Examining Lead-Lag Relationships Between the Unregulated Bitcoin Futures Market and the CME Bitcoin Futures Market

After completing its analysis showing that the CME Market leads price discovery compared to the bitcoin spot market, the Sponsor considered whether the CME Market leads price discovery compared to the unregulated bitcoin futures market.

A number of unregulated bitcoin futures trading platforms ("Unregulated Futures Platforms") exist, so the first step in this analysis was to determine which Unregulated Futures Platforms to consider.

The Sponsor gathered data from CoinGecko, a popular crypto data provider, which maintains an extensive list of Unregulated Futures Platforms and their futures contracts.[57] CoinGecko tracks two categories of contracts: perpetual futures and quarterly futures. Perpetual futures are cash-settled futures that do not have an expiration date, while quarterly futures settle on a calendar basis and must be rolled forward to maintain exposure. Aggregating these two categories generated a list of 33 Unregulated Futures Platforms. The Sponsor elected to evaluate the seven largest Unregulated Futures Platforms based on open interest:

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54 Garbade, K. and Silber, W. (1983), Price movements and price discovery in futures and cash markets. The Review of Economics and Statistics 65(2), 289-297.

55 Chan, K. (1992), A further analysis of the lead-lag relationship between the cash market and stock index futures market. The Review of Financial Studies (5)1, 123-152.

56 Fleming et al. (1996), Trading Costs and the relative rates of price discovery in stock, futures, and option markets. Journal of Futures Markets 16(4), 353-387.

57 CoinGecko (https://www.coingecko.com/en/coins/bitcoin#markets). Navigate to the "Perpetuals" (perpetual futures) and "Futures" (predominantly quarterly futures) sub tabs within the "Markets" tab.

Binance, BitMEX, Bybit, Deribit, FTX, Huobi, and OKEx. Together, these Unregulated Futures Platforms accounted for approximately 80% of all open interest captured by CoinGecko at the time of the analysis on May 4, 2021.

Because some offer both perpetual and quarterly contracts, the Sponsor selected from each Unregulated Futures Platform the contract type and specific contract with the highest level of open interest: perpetual futures for Binance, BitMEX, Bybit, Deribit, and FTX, and quarterly futures for Huobi and OKEx.

The Sponsor used the full period of data available for each Unregulated Futures Platform, through the end of Q1, 2021. The data start month for each Unregulated Futures Platform was:

- Binance: September 2019
- BitMEX: December 2017[58]
- Bybit: October 2019
- Deribit: August 2018
- FTX: July 2019
- Huobi: August 2019
- OKEx: October 2018

As with the CME Market's monthly futures contract, Huobi and OKEx's quarterly futures contracts were rolled one day prior to expiration in order to create a continuous price series.

The table below highlights key statistics for the highest open interest contract on each of the evaluated Unregulated Futures Platforms, plus the CME Market, for the month of May 2021: Open Interest, Trading Volume, and Required Margin. The CME Market row is highlighted in light blue.

	Open Interest	Trading Volume	Required Margin
Bybit	$1,666,878,515	$7,438,356,443	1%
Binance	$1,575,326,903	$21,718,058,270	<1%
CME	$1,404,125,298	$1,840,129,468	33%
FTX	$1,232,139,553	$4,423,394,792	1%
OKEx	$842,460,775	$2,112,965,793	<1%

58 BitMEX was the only platform that existed and has data available from the inception of the CME bitcoin futures market on December 17, 2017. OKEx claims to have launched bitcoin futures trading as early as June 2013, but historical data for OKEx is not available before October 2018. Binance, Bybit, Deribit, FTX, and Huobi all launched bitcoin futures trading after the inception of the CME bitcoin futures market, between 2018 and 2019.

Huobi	$680,431,607	$5,823,998,157	<1%
BitMEX	$664,421,615	$2,656,967,907	1%
Deribit	$599,004,598	$1,264,134,910	1%

The contracts differ significantly along each of these tracked metrics. For instance, Bybit perpetual futures have the highest open interest, while Binance perpetual futures have the highest trading volume.

The Sponsor noted the stark difference in required margin between the CME Market and all of the evaluated Unregulated Futures Platforms. The Unregulated Futures Platforms in this study offer clients leverage at ratios ranging from 100-to-1 to 125-to-1, meaning the required margin is 1% or less of the notional value of open contract positions. By comparison, the maximum leverage ratio for the CME bitcoin futures contract is 3-to-1, meaning a 33% required margin ratio.

While traders on a given Unregulated Futures Platform do not always make use of the full amount of potential leverage, industry reports suggest that the level of realized leverage on Unregulated Futures Platforms is high. For instance, a 2019 report from BitMEX found that the average level of realized leverage for BitMEX bitcoin perpetual futures for the year ending April 2019 was approximately 27-to-1, meaning an average maintained margin of less than 4%.[59]

The high leverage ratios offered by Unregulated Futures Platforms mean that, at any given moment, the amount of capital committed to any one of these unregulated futures contracts is likely significantly lower than the amount of capital committed to the CME bitcoin futures contract. As a hypothetical example, assuming an average margin of 4% (i.e., 25-to-1 leverage), the amount of capital backing the $7.26 billion in aggregate open interest across the seven unregulated futures contracts can be estimated at $363 million. By comparison, assuming a 33% margin (the minimum required), the capital backing the $1.40 billion of open interest on the CME bitcoin futures contract is at least $462 million. In other words, it is possible that the amount of capital committed to the CME bitcoin futures contract is larger than the capital committed to all of the evaluated Unregulated Futures Platform futures contracts, combined.

The Sponsor's analysis noted that it is not clear, looking just at these top-level statistics alone, that the CME Market or any of the Unregulated Futures Platforms is likely to lead price discovery. To make this determination, the Sponsor compared data from the CME Market and each of the Unregulated Futures Platformsusing the same statistical techniques used to evaluate price discovery between the CME Market and spot bitcoin trading platforms.

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59 BitMEX Leverage Statistics, April 2019 (https://blog.bitmex.com/bitmex-leverage-statistics-april-2019/).

The table below shows the results of the Sponsor's IS and CS analysis, comparing the CME Market with each of the seven Unregulated Futures Platforms over the duration of the study. Each Unregulated Futures Platform evaluation has its own date range, based on the length of data available for such platform.

As in the spot market analysis, IS and CS values above 50% indicate that the CME Market led price discovery against a given Unregulated Futures Platformover the duration of the study period. A * indicates that the results are statistically significant (p-value < 0.05). The confidence interval column shows a 95% confidence interval for the context.

The results show that the CME Market has led price discovery against each of the seven Unregulated Futures Platforms across the duration of the study. The results are statistically significant for all platforms when evaluated from an IS perspective, and for six of seven platforms from a CS perspective.

	CME IS	Confidence Interval	CME CS	Confidence Interval	Data Range
Binance	55.30%*	53.64% - 56.96%	54.01%*	51.41% - 56.61%	Sept 2019 - Mar 2021
BitMEX	63.67%*	62.30% - 65.04%	63.33%*	61.68% - 64.99%	Dec 2017 - Mar 2021
Bybit	61.50%*	59.69% - 63.30%	60.26%*	57.75% - 62.77%	Oct 2019 - Mar 2021
Deribit	56.91%*	55.56% - 58.26%	56.20%*	54.23% - 58.17%	Aug 2018 - Mar 2021
FTX	56.73%*	55.13% - 58.32%	58.72%*	56.33% - 61.10%	July 2019 - Mar 2021
Huobi	55.25%*	53.33% - 57.17%	53.85%*	51.36% - 56.33%	Aug 2019 - Mar 2021
OKEx	53.04%*	51.45% - 54.63%	51.22%	49.14% - 53.31%	Oct 2018 - Mar 2021

The Sponsor also compared the CME Market against each Unregulated Futures Platform on a month-by-month basis. The table below shows the percentage of months that the CME Market led IS/CS price discovery against each Unregulated Futures Platform:

	% of Months CME Led IS	% of Months CME Led CS	Data Range
Binance	84%	74%	Sept 2019 - Mar 2021
BitMEX	93%	90%	Dec 2017 - Mar 2021
Bybit	100%	94%	Oct 2019 - Mar 2021
Deribit	88%	78%	Aug 2018 - Mar 2021
FTX	90%	95%	July 2019 - Mar 2021
Huobi	85%	70%	Aug 2019 - Mar 2021
OKEx	73%	60%	Oct 2018 - Mar 2021

These monthly results support the conclusion of the Sponsor's full duration analysis in finding that the CME Market leads each of the seven Unregulated Futures Platforms from an IS and CS perspective.

In addition to its IS/CS analysis, the Sponsor also examined the CME Market and each of the Unregulated Futures Platforms using TSLL analysis. The table below shows the lead-lag time (the amount of lead or lag that results in the highest cross-correlation between two price series) for the CME Market versus each of the seven Unregulated Futures Platforms, calculated daily and averaged across the entire time period applicable to the Unregulated Futures Platform. The table also shows the 95% confidence interval for those results.

A positive value indicates the CME Market leading by that amount of seconds. A negative value would indicate CME Market lagging. The * indicates the result being statistically significant (p-value < 0.05), meaning the lead-lag time for the entire time period lies squarely within the positive (or negative) value territory.

	Lead-Lag Time (seconds)	**Confidence Interval (seconds)**	**Data Range**
Binance	3.07*	2.50 - 3.65	Sept 2019 - Mar 2021
BitMEX	7.23*	6.76 - 7.70	Dec 2017 - Mar 2021
Bybit	5.13*	4.56 - 5.70	Oct 2019 - Mar 2021
Deribit	4.98*	4.47 - 5.49	Aug 2018 - Mar 2021
FTX	2.27*	2.08 - 2.46	July 2019 - Mar 2021
Huobi	2.34*	2.21 - 2.47	Aug 2019 - Mar 2021
OKEx	3.47*	2.94 - 4.00	Oct 2018 - Mar 2021

The results show that prices on the CME Market led prices on the Unregulated Futures Platforms by 2-7 seconds in a statistically significant manner. These results are in-line with the results of the IS/CS analysis, and support the finding that the CME Market leads price discovery compared to the unregulated bitcoin futures market.

That these findings demonstrating that the CME Market leads the unregulated bitcoin futures market in price discovery might surprise some market observers, given the higher total notional volumes on the Unregulated Futures Platforms. Besides the possibility that the self-reported trading volumes on Unregulated Futures Platforms could be inflated, the Sponsor theorizes that highly levered retail investors with limited capital on the Unregulated Futures Platforms may be opening and closing positions more frequently, resulting in higher notional volumes, but with lesser impact on price discovery relative to well capitalized, long-term oriented professional investors on the CME Market. In addition, professional investors may have advantages over retail investors from a technology, information flow, and trading speed perspective. Such conditions

may be expected to continue into the future, particularly as bitcoin sees continued and expanded adoption as an investable asset among professional and institutional investors.

Conclusion of Winklevoss Standard Prong 1: Reasonable Likelihood

The first prong of the Winklevoss Standard requires demonstrating a reasonable likelihood that a person attempting to manipulate a bitcoin ETP would also have to trade on the CME Market. In prior disapproval orders, the Commission has stated that demonstrating a lead-lag relationship between prices on the CME Market and the underlying bitcoin spot market is "central" to understanding this reasonable likelihood.

As detailed herein, through extensive statistical analysis and careful consideration of third-party evaluations of these markets, the Sponsor has demonstrated that the CME Market leads the bitcoin spot market and the unregulated bitcoin futures market, such that it is reasonably likely that a person attempting to manipulate the ETP would also have to trade on the CME Market, thus satisfying the first prong of the Winklevoss Standard.

Winklevoss Standard Prong 2: Predominant Influence

The second prong of the Winklevoss Standard requires demonstrating that it is unlikely that trading in the Trust would become the predominant influence on prices in the CME Market. As detailed below, the Sponsor's analysis shows that trading in the Trust is unlikely to become the predominant influence on prices in the CME Market, even when assuming aggressive estimates of first-year flows of $4.7 billion and average daily trading volume of $143 million.[60]

Estimating the Likely First-Year Flows into a Bitcoin ETP

The Sponsor examined extensive data from other ETPs and a well-known, publicly traded bitcoin trust to estimate the likely first-year flows into a newly approved bitcoin ETP.

First, the Sponsor examined first-year flows into all ETPs currently listed on the market, using data from FactSet.[61] The Sponsor excluded ETPs with negative first-year flows.

Of the more than 2,200 ETPs with positive or flat first-year flows:

- The median ETP attracted $28 million in flows during its first year on the

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60 See Matthew Hougan, Hong Kim, and Satyajeet Pal, Is it likely that a US bitcoin ETP, if approved, will become the predominant influence on prices in the CME bitcoin futures market? February 16, 2021, as amended and supplemented ("Bitwise Prong Two Paper").

61 Data obtained from FactSet on November 30, 2020.

market.

- The ETP with the highest first-year flows in history—the Invesco QQQ Trust (Nasdaq: QQQ)—attracted $5.35 billion in flows.

The table below highlights the ten ETPs with the highest first-year flows in ETP history.

Fund	Ticker	Year-One Flows ($M)
Invesco QQQ Trust	QQQ	5,351
Communication Services Select Sector SPDR	XLC	5,186
iShares MSCI EAFE ETF	EFA	4,292
JPMorgan BetaBuilders Europe ETF	BBEU	4,187
PIMCO Active Bond ETF	BOND	4,116
JPMorgan BetaBuilders Japan ETF	BBJP	3,755
JPMorgan BetaBuilders Canada ETF	BBCA	3,656
iShares Select Dividend ETF	DVY	3,245
Real Estate Select Sector SPDR Fund	XLRE	3,171
SPDR Gold Shares	GLD	3,010

As the analysis shows, $5.35 billion is the outer limit of historical first-year flows into a bitcoin ETP. There is no precedent for an ETP attracting more than this in its first year on the market. The Sponsor concluded it is unlikely that a bitcoin ETP will experience the highest first-year flows in history, particularly given the relative size of the bitcoin market compared to the markets captured by the ETPs above, which target parts or all of the equity, bond, real estate, and gold markets.[62]

To provide a more detailed comparison, the Sponsor also examined first-year flows into first-to-market single-commodity ETPs. Bitcoin is considered a

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62 At year-end 2020, the total market capitalization of bitcoin was $539 billion, according to blockchain.com. By comparison, the global market capitalization of the equity market was $95 trillion and the outstanding value of the global bond market was $106 trillion in 2019, according to the most recently published SIFMA Capital Markets Fact Book (September 2020), available at https://www.sifma.org/wp-content/uploads/2020/09/US-Fact-Book-2020-SIFMA.pdf; the professionally managed global real estate market was $9.6 trillion in 2019, according to MSCI's Market Size Report on Global Real Estate, available at https://www.msci.com/real-estate/market-size-report; and the total value of above-ground gold was $10 trillion on December 31, 2020, according to the World Gold Council available at https://www.gold.org/goldhub/data/above-ground-stocks.

commodity by the Commodity Futures Trading Commission,[63] and one way to view a potential bitcoin ETP is as a first-to-market single-commodity ETP offering exposure to bitcoin in the same manner that the SPDR Gold Shares (NYSEArca: GLD) was a first-to-market single-commodity ETP offering exposure to gold, and the iShares Silver Trust (NYSEArca: SLV) was a first-to-market single-commodity ETP offering exposure to silver.

The following table shows the first-year flows into every first-to-market single-commodity ETP currently available in the U.S., again using data from FactSet.[64] First-year flows range from $3.01 billion for GLD to negative $1 million for the iPath Bloomberg Lead Subindex Total Return ETN (NYSEArca: LD).[65]

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63 The Commodity Futures Trading Commission has argued successfully in federal courts that digital assets such as bitcoin are commodities. See, e.g., Commodity Futures Trading Commission v McDonnell and CabbageTech, Corp., 18-CV-361 (E.D.N.Y. March 6, 2018) and Commodity Futures Trading Commission v My Big Coin Pay, Inc., 18-cv-10077-RWZ (D. Mass. Sept. 26, 2018).

64 Data obtained from FactSet on November 30, 2020.

65 Negative flows occur when a product is seeded with a certain amount of capital but some of that capital is redeemed over time, and there are no offsetting creations.

Commodity	Ticker	Year-One Flows ($M)
Gold	GLD	$3,010
Silver	SLV	$1,730
Crude Oil	USO	$827
Platinum	PPLT	$708
Palladium	PALL	$603
Natural Gas	UNG	$374
Corn	CORN	$115
Coffee	JO	$48
Gasoline	UGA	$28
Sugar	SSG	$12
Soybeans	SOYB	$10
Cotton	BAL	$7
Nickel	JJN	$2
Copper	CPER	$2
Wheat	WEAT	$1
Cocoa	NIB	$1
Aluminum	JJU	$1
Carbon Credits	GRN	$0
Tin	JJT	$0
Lead	LD	-$1

These figures provide additional context on the likely upper bound of potential flows into a bitcoin ETP.

Finally, the Sponsor examined the Grayscale Bitcoin Trust (OTCQX: GBTC), a publicly traded grantor trust that holds bitcoin directly with a third-party custodian. As of December 31, 2020, GBTC was the only product that provided investors with readily accessible exposure to bitcoin through traditional brokerage accounts, and has been available to U.S. investors since May 2015.[66] A bitcoin

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66 See OTC Markets Group Inc., press release, May 5, 2015. OTC Markets Group Welcomes Bitcoin Investments Trust to OTCQX, available at https://www.prnewswire.com/news-releases/otc-markets-group-welcomes-bitcoin-investment-trust-to-otcqx-300077150.html.

ETP and GBTC will likely compete for investor allocations.

GBTC is different from an ETP in certain ways, including that the structure does not allow for redemptions, that it has a different regulatory status than an ETP, and that shares of GBTC are materially more likely to trade at significant and variable premiums and/or discounts to the net asset value of the trust. GBTC does, however, permit creations, allowing it to accommodate flows to reflect investor demand. As such, it can be a useful data set for analyzing investor demand for exposure to bitcoin through a traditional brokerage window and what impact flows from such demand can have on prices in the CME Market.[67]

In its most successful year, GBTC attracted a record $4.7 billion in flows in 2020, according to Grayscale Investments.[68] The fund's previous record was $472 million, set in 2019. 2020's record flows occurred during a sustained bull market for bitcoin, as bitcoin's price rose 306% in 2020.[69]

Based on the foregoing assessments, the Sponsor utilized $4.7 billion as its working estimate for first-year flows into a new bitcoin ETP. The Sponsor believed this estimate to be aggressive, as it assumes that a bitcoin ETP will:

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67 The Sponsor notes that one difference between the creation/redemption and arbitrage mechanism between GBTC and an ETP is that newly created shares in GBTC are not immediately available to be sold in the secondary market. Instead, after purchasing shares, an investor must hold the shares for 6-months before they are permitted to be traded on the secondary market. This creates a longer holding period for an arbitrageur, as compared to a typical ETP arbitrage trade where an authorized participant may immediately trade newly created shares into the secondary market. For example, to capture arbitrage on GBTC shares trading at a premium, an arbitrageur would need to short sell GBTC shares while buying spot bitcoin, deliver the bitcoin for creation of GBTC shares, and hold those shares for six months until they are released from transfer restriction and can be delivered to the short sellers to close out the trade. But while the holding period of the GBTC share premium arbitrage is at minimum 6 months, the buying in the spot bitcoin market occurs, in this case, right before the creation date, which is the date inflows into GBTC are recorded.

In addition, institutional arbitrageurs are not the only cohort that can create shares for GBTC. Accredited investors may also subscribe for GBTC shares either by contributing bitcoin or delivering cash. For cash orders, Genesis Trading Global, Inc., the "authorized participant" of the trust, purchases the bitcoin for the given cash amount by 6 p.m. ET on the day the cash is provided by the subscriber.

68 See Grayscale Investments, Digital Asset Investment Report, Q4 2020 (grayscale.co/insights/grayscale-q4-2020-digital-asset-investment-report/).

69 Bitcoin's price rose from $7,147 on December 31, 2019 to $29,026 on December 31, 2020 according to the Coin Metrics bitcoin reference rate, available at https://coinmetrics.io/reference-rates/.

- be the third-fastest-growing ETP in history, out of more than 2,200 products with positive year-one flows;
- significantly surpass (by more than 50%) the first-year flows into GLD, which experienced the highest first-year flows in first-to-market single-commodity ETP history; and
- match the highest annual flow in GBTC's history, achieved during a strong bull market, all while the new ETP is forced to compete for market share with GBTC itself.

Evaluating the Potential Influence of ETP Flows on Prices in the CME Market

The Sponsor analyzed whether such flows into a first-to-market bitcoin ETP would cause such ETP to be the predominant influence on prices in the CME Market.

Based on information on the flows into GBTC that are publicly available from multiple sources,[70] the Sponsor analyzed with historical data whether $4.7 billion in flows into a bitcoin investment product in a single year would be likely to cause that product to become the predominant influence on prices in the CME Market.

The Sponsor's statistical analysis examined the relationship of flows into GBTC in 2020 and the changes in the price of bitcoin, using both daily and weekly flows.[71] Daily (or weekly) flows were calculated from Bloomberg data by multiplying the change in outstanding shares of the trust by the net asset value per share of that day (or week). Daily (or weekly) percentage price changes of bitcoin were calculated using the 4:00 p.m. E.T. bitcoin reference rate from Coin Metrics.[72]

The charts below show the results of the Sponsor's analysis. Each dot represents a daily (or weekly) flow into GBTC and the corresponding daily (or weekly) change in the price of bitcoin. As such, there are 253 dots in the first chart representing each trading day, and 52 dots in the second chart representing each week in 2020.

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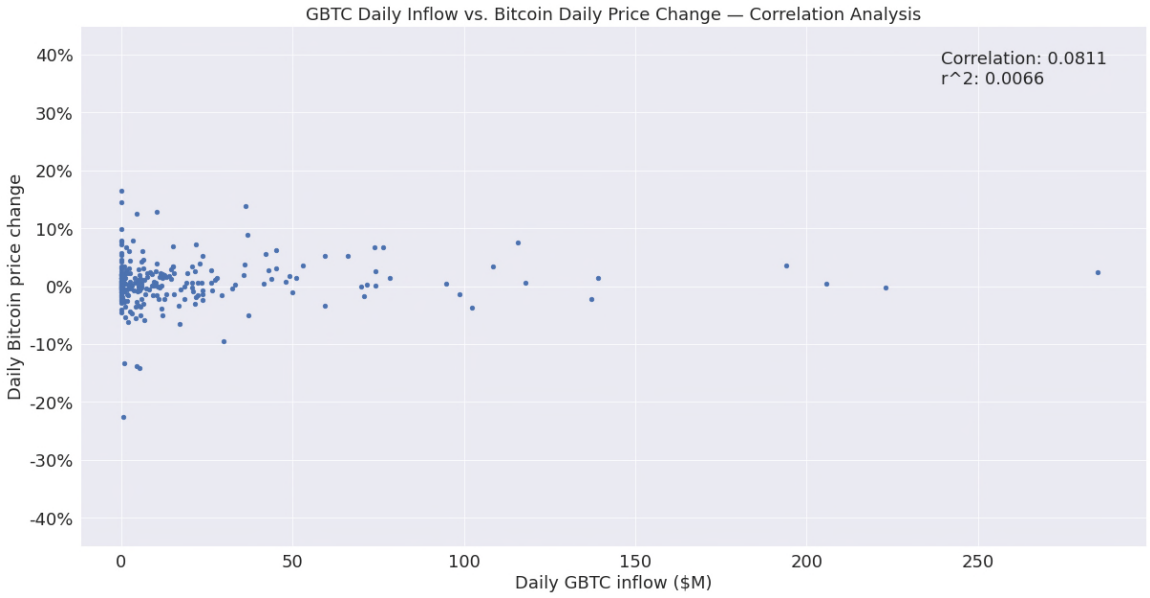
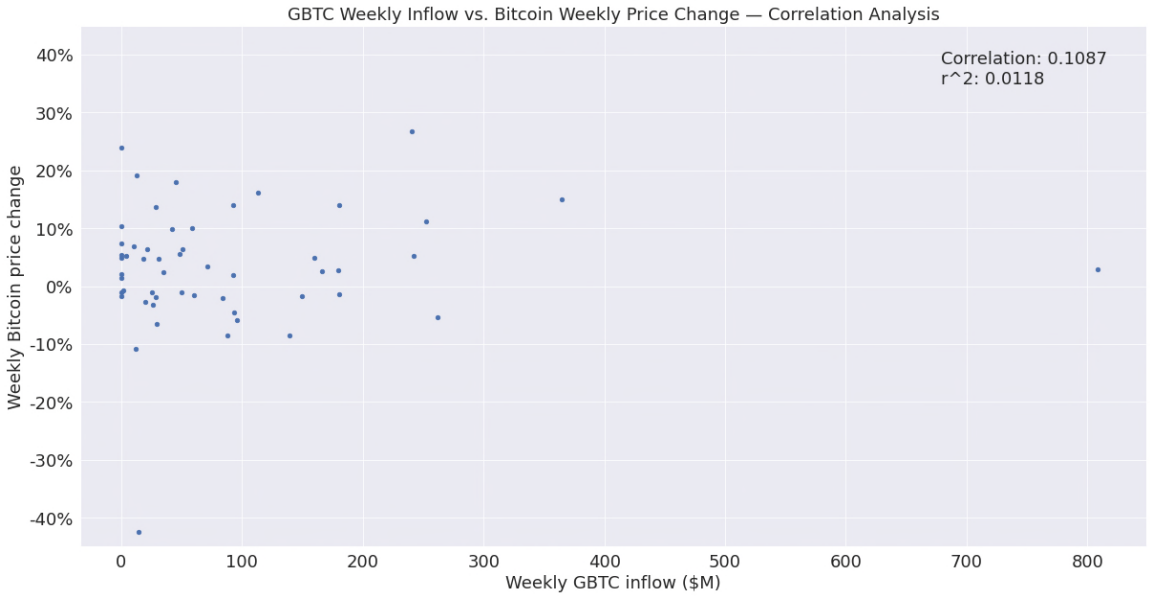
70 Information on GBTC creation of shares is available from the issuer, reports on Form 8-K filed by the issuer on sec.gov, and third party websites such as Bloomberg.

71 The Sponsor has used both single day and weekly flows, acknowledging that the buying activity for an in-kind creation may not necessarily occur in a single day leading up to the creation date. Instead, an investor might build their position over time. Using both daily and weekly flows helps to capture more of this extended possibility.

72 See note 69, supra.





The data shows there is no meaningful relationship between daily and weekly flows into GBTC and changes in the price of bitcoin, despite the aggregate flows being $4.7 billion: The correlation for daily results is 0.08 and the correlation for weekly results is 0.11, both of which are low.

The experience of outlier days and weeks with large flows supports this conclusion. For instance, the largest one-day flow occurred on December 22, 2020, when $285 million flowed into the fund; bitcoin's price moved up 2.3% that day, within the normal daily range for a bitcoin price move.[73]

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73 The standard deviation of the daily percentage price change of bitcoin in 2020 using the Coin Metrics bitcoin reference rate was 4.38%.

Similarly, the largest one-week flow occurred for the week ending December 27, 2020, when GBTC attracted approximately $809 million in flows; bitcoin's price settled up just 2.9% that week, again within the normal range for a weekly price move.[74]

Based on this statistical analysis, the Sponsor concluded that it is unlikely that the aggressive estimate of first-year flows into a bitcoin ETP ($4.7 billion) would cause it to become the predominant influence on prices in the CME Market.

Estimating the Likely Trading Volume of a Bitcoin ETP

Beyond the impact of investment flows, the Sponsor considered whether secondary market trading in the Shares would be likely to become the predominant influence on prices in the CME Market. The Sponsor was able to draw on two relevant comparisons to create estimates of the likely trading volume of a bitcoin ETP.

First, the Sponsor considered trading in GBTC, using secondary market data from Bloomberg. Shares of GBTC are publicly quoted on the OTCQX Best Market and are widely available to U.S. investors through traditional brokerage accounts. As such, although GBTC operates under a different regulatory structure than an ETP and has historically traded at significant and variable premiums and discounts to its net asset value, the historical turnover of GBTC provide one estimate of the future turnover of a bitcoin ETP. GBTC's average daily trading volume (ADV) in 2020 was $103 million. On a monthly basis, that figure ranged from $37 million in April 2020 to $368 million December 2020, as reported in the table below.

Examining ADV in isolation offers only a partial picture, however. Trading activity in GBTC is correlated with the product's assets under management (AUM), which is in turn linked to bitcoin's price. The table below shows the "ADV/AUM Ratio" for GBTC for each month in 2020, using the month-end AUM as the denominator. Although the absolute size of the ADV ranges widely across 2020, the ADV/AUM ratio stays fairly consistent, running from 1.10% (April and September) to 2.21% (February). The average ADV/AUM ratio for the year was 1.54%.

Month	**ADV (M)**	**AUM (M)**	**ADV / AUM RATIO**
Jan 2020	$43	$3,191	1.36%
Feb 2020	$66	$2,997	2.21%
Mar 2020	$44	$2,249	1.96%
Apr 2020	$37	$3,313	1.10%

74 The standard deviation of the weekly percentage price change of bitcoin in 2020 using the Coin Metrics bitcoin reference rate was 10.35%.

May 2020	$68	$4,034	1.68%
Jun 2020	$52	$3,870	1.33%
Jul 2020	$65	$5,264	1.23%
Aug 2020	$89	$6,018	1.47%
Sep 2020	$57	$5,167	1.10%
Oct 2020	$95	$7,728	1.23%
Nov 2020	$259	$13,060	1.98%
Dec 2020	$368	$20,445	1.80%
Average	***$103***	***$6,445***	***1.54%***

Applying this average ADV/AUM ratio to the $4.7 billion working estimate of first-year flows into a bitcoin ETP, the estimated daily trading volume would be approximately $72 million at the end of the ETP's first year.

A second comparison that may be useful is to examine the case of other first-to-market commodity ETPs. GLD is the largest such ETP, and therefore trading activity of GLD[75] may provide a useful comparison. Using the same methodology as with GBTC, the Sponsor examined the ADV/AUM ratio of GLD for every month in 2020. The ratio value ranged from 1.65% (September) to 5.93% (March). The average ratio was 3.04%.

Month	**ADV (M)**	**AUM (M)**	**ADV / AUM RATIO**
Jan 2020	$1,206	$46,053	2.62%
Feb 2020	$2,010	$47,348	4.25%
Mar 2020	$2,903	$48,916	5.93%
Apr 2020	$1,828	$57,343	3.19%
May 2020	$1,819	$62,557	2.91%
Jun 2020	$1,606	$67,484	2.38%
Jul 2020	$2,215	$78,789	2.81%
Aug 2020	$3,312	$79,163	4.18%
Sep 2020	$1,272	$76,941	1.65%
Oct 2020	$1,376	$75,889	1.81%
Nov 2020	$1,855	$73,285	2.53%

75 See GLD historical market data, available at https://www.spdrgoldshares.com/usa/historical-data/.

Dec 2020	$1,369	$71,558	1.91%
Average	***$1,901***	***$65,022***	***3.04%***

Applying GLD's ADV/AUM ratio to the $4.7 billion working estimate of first-year flows into a bitcoin ETP, the estimated daily trading volume would be approximately $143 million. The Sponsor elected to use this estimate of $143 million as its working estimate for average daily trading volume of a new bitcoin ETP at the end of its first year. The Sponsor believes this estimate to be aggressive, as it assumes that a bitcoin ETP will:

- be the third-fastest-growing ETP in history, out of more than 2,200 products with positive year-one flows.
- have an ADV/AUM ratio approximately two times higher than that of GBTC, which also offers exposure to bitcoin through traditional brokerage accounts.

Evaluating the Potential Influence of Secondary Market Trading in ETP Shares on Prices in the CME Market

The CME Market had an average daily trading volume of $392 million in 2020. The lowest month, April 2020, had an average daily trading volume of $176 million, and the highest month, December 2020, had an average daily trading volume of $935 million. The table below shows the ADV of the CME Market each month in 2020.

Month	**CME ADV (M)**
Jan 2020	$408
Feb 2020	$401
Mar 2020	$202
Apr 2020	$176
May 2020	$305
Jun 2020	$223
Jul 2020	$252
Aug 2020	$455
Sep 2020	$397
Oct 2020	$329
Nov 2020	$665
Dec 2020	$935

Given that the average daily trading volume of the CME Market in 2020 was 174% higher at $392 million than the Sponsor's aggressive estimate of a new bitcoin ETP's potential trading volume of $143 million, the Sponsor found that it is unlikely that trading in a new bitcoin ETP will cause such ETP to become the predominant influence on prices in the CME Market.

Conclusion of Winklevoss Standard Prong 2: Predominant Influence

The second prong of the Winklevoss Standard requires demonstration that it is unlikely that trading in the Trust would become the predominant influence on prices in the CME Market.

As detailed herein, the Sponsor's analysis shows that trading in the Trust is unlikely to become the predominant influence on prices in the CME Market, even when assuming aggressive estimates of first-year flows of $4.7 billion and average daily trading volume of $143 million.

* * *

In conclusion, as the foregoing analysis and data demonstrates, the proposal has met its burden presented by Section 6(b)(5) of the Act[76] and, in particular, the requirement that the rules of a national securities exchange be designed to prevent fraudulent and manipulative acts and practices, by demonstrating that the CME Market (i) is a regulated market; (ii) participates in a surveillance sharing agreement with the Exchange; and (iii) satisfies the Commission's "significant market" definition under the Winklevoss Standard.

Availability of Information Regarding the Shares and Bitcoin

The NAV will be disseminated daily to all market participants at the same time. Quotation and last-sale information regarding the Shares will be disseminated through the facilities of the CTA. The ITV will be calculated every 15 seconds throughout the core trading session each trading day, and available through online information services.

The Sponsor will cause information about the Shares to be posted to the Trust's website (https://www.bitwiseinvestments.com/): (i) the NAV and NAV per Share for each Exchange trading day, posted at end of day; (ii) the daily holdings of the Trust, before 9:30 a.m. E.T. on each Exchange trading day; (iii) the Trust's effective prospectus, in a form available for download; and (iv) the Shares' ticker and CUSIP information, along with additional quantitative information updated on a daily basis for the Trust. For example, the Trust's website will include (i) the prior business day's trading volume, the prior business day's reported NAV and closing price, and a calculation of the premium and discount of the closing price or mid-point of the bid/ask spread at the time of NAV calculation ("Bid/Ask Price") against the NAV; and (ii) data in chart format displaying the frequency

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76 15 U.S.C. 78f(b)(5).

distribution of discounts and premiums of the daily closing price or Bid/Ask Price against the NAV, within appropriate ranges, for at least each of the four previous calendar quarters. The Trust's website will be publicly available prior to the public offering of Shares and accessible at no charge.

Investors may obtain on a 24-hour basis bitcoin pricing information based on the CME US Reference Rate, CME UK Reference Rate and CME Bitcoin Real Time Price, bitcoin spot market prices and bitcoin futures price from various financial information service providers. Current bitcoin spot market prices are also generally available with bid/ask spreads from bitcoin trading platforms, including the Constituent Platforms of the CME US Reference Rate.

Trading Halts

With respect to trading halts, the Exchange may consider all relevant factors in exercising its discretion to halt or suspend trading in the Shares of the Trust.[77] Trading in Shares of the Trust will be halted if the circuit breaker parameters in NYSE Arca Rule 7.12-E have been reached. Trading also may be halted because of market conditions or for reasons that, in the view of the Exchange, make trading in the Shares inadvisable.

The Exchange may halt trading during the day in which an interruption to the dissemination of the ITV occurs.[78] If the interruption to the dissemination of the ITV persists past the trading day in which it occurred, the Exchange will halt trading no later than the beginning of the trading day following the interruption. In addition, if the Exchange becomes aware that the NAV with respect to the Shares is not disseminated to all market participants at the same time, it will halt trading in the Shares until such time as the NAV is available to all market participants. The Exchange may also halt trading if the value of the underlying commodity is no longer calculated or available on at least a 15-second delayed basis from a source unaffiliated with the Sponsor, Trust, Bitcoin Custodian or the Exchange or if the Exchange stops providing a hyperlink on its Web site to any such unaffiliated commodity value.

Trading Rules

The Exchange deems the Shares to be equity securities, thus rendering trading in the Shares subject to the Exchange's existing rules governing the trading of equity securities. Shares will trade on the NYSE Arca Marketplace from 4 a.m. to 8 p.m. E.T. in accordance with NYSE Arca Rule 7.34-E (Early, Core, and Late Trading Sessions). The Exchange has appropriate rules to facilitate transactions in the Shares during all trading sessions. As provided in NYSE Arca Rule 7.6-E, the minimum price variation ("MPV") for quoting and entry of orders in equity

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77 See NYSE Arca Rule 7.12-E.

78 A limit up/limit down condition in the futures market would not be considered an interruption requiring the Trust to be halted.

securities traded on the NYSE Arca Marketplace is $0.01, with the exception of securities that are priced less than $1.00 for which the MPV for order entry is $0.0001.

The Shares will conform to the initial and continued listing criteria under NYSE Arca Rule 8.201-E. The trading of the Shares will be subject to NYSE Arca Rule 8.201-E(g), which sets forth certain restrictions on Equity Trading Permit ("ETP") Holders acting as registered Market Makers in Commodity-Based Trust Shares to facilitate surveillance.[79] The Exchange represents that, for initial and continued listing, the Trust will be in compliance with Rule 10A-3 under the Act,[80] as provided by NYSE Arca Rule 5.3-E. A minimum of 100,000 Shares of the Trust will be outstanding at the commencement of trading on the Exchange.

Surveillance

The Exchange represents that trading in the Shares of the Trust will be subject to the existing trading surveillances administered by the Exchange, as well as cross-market surveillances administered by FINRA on behalf of the Exchange, which are designed to detect violations of Exchange rules and applicable federal securities laws.[81] The Exchange represents that these procedures are adequate to properly monitor Exchange trading of the Shares in all trading sessions and to deter and detect violations of Exchange rules and federal securities laws

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79 Under NYSE Arca Rule 8.201-E(g), an ETP Holder acting as a registered Market Maker in the Shares is required to provide the Exchange with information relating to its trading in the underlying commodity, related futures or options on futures, or any other related derivatives. Commentary .04 of NYSE Arca Rule 11.3-E requires an ETP Holder acting as a registered Market Maker, and its affiliates, in the Shares to establish, maintain and enforce written policies and procedures reasonably designed to prevent the misuse of any material nonpublic information with respect to such products, any components of the related products, any physical asset or commodity underlying the product, applicable currencies, underlying indexes, related futures or options on futures, and any related derivative instruments (including the Shares).

As a general matter, the Exchange has regulatory jurisdiction over its ETP Holders and their associated persons, which include any person or entity controlling an ETP Holder. To the extent the Exchange may be found to lack jurisdiction over a subsidiary or affiliate of an ETP Holder that does business only in commodities or futures contracts , the Exchange could obtain information regarding the activities of such subsidiary or affiliate through surveillance sharing agreements with regulatory organizations of which such subsidiary or affiliate is a member.

80 17 CFR 240.10A-3.

81 FINRA conducts cross-market surveillances on behalf of the Exchange pursuant to a regulatory services agreement. The Exchange is responsible for FINRA's performance under this regulatory services agreement.

applicable to trading on the Exchange.

The Exchange further represents that it may obtain information regarding trading in the Shares and the CME Market from the CME and other markets and other entities that are members of the ISG or with which the Exchange has in place a comprehensive surveillance sharing agreement.[82] The Exchange or FINRA, on behalf of the Exchange, or both, will communicate as needed regarding trading in the Shares and the CME Market with the CME and other markets and entities that are members of the ISG, and the Exchange or FINRA, on behalf of the Exchange, or both, may obtain trading information regarding trading in the Shares, the CME Market and the underlying commodity, as applicable, from such markets and other entities.

Also, pursuant to NYSE Arca Rule 8.201-E(g), the Exchange is able to obtain information regarding trading in the Shares, bitcoin futures and the underlying bitcoin through ETP Holders acting as registered Market Makers, in connection with such ETP Holders' proprietary or customer trades through ETP Holders which they effect on any relevant market.

In addition, the Exchange has a general policy prohibiting the improper distribution of material, non-public information by its employees.

All statements and representations made in this filing regarding (i) the description of the index, portfolio or referenced asset, (ii) limitations on index or portfolio holdings or reference assets, or (iii) the applicability of Exchange listing rules specified in this rule filing will constitute continued listing requirements for listing the Shares on the Exchange.

The Sponsor has represented to the Exchange that it will advise the Exchange of any failure by the Trust to comply with the continued listing requirements, and, pursuant to its obligations under Section 19(g)(1) of the Act, the Exchange will monitor for compliance with the continued listing requirements. If the Trust is not in compliance with the applicable listing requirements, the Exchange will commence delisting procedures under NYSE Arca Rule 9.2-E(a).

(b) Statutory Basis

The basis under the Act for this proposed rule change is the requirement under Section 6(b)(5)[83] that an exchange have rules that are designed to prevent fraudulent and manipulative acts and practices, to promote just and equitable principles of trade, to remove impediments to, and perfect the mechanism of a

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82 For a list of the current members of ISG, see https://isgportal.org/. The Exchange notes that not all components of the Trust may trade on markets that are members of ISG or with which the Exchange has in place a comprehensive surveillance sharing agreement.

83 15 U.S.C. 78f(b)(5).

free and open market and, in general, to protect investors and the public interest.

The Exchange believes that the proposed rule change is designed to prevent fraudulent and manipulative acts and practices and to protect investors and the public interest in that the Shares will be listed and traded on the Exchange pursuant to the initial and continued listing criteria in NYSE Arca Rule 8.201-E. Further, the Exchange has demonstrated that the proposed rule change satisfies the Winklevoss Standard with respect to the CME Market.

As discussed above, both existing academic literature and the Sponsor's own studies show that the CME Market leads price discovery relative to the bitcoin spot market. As a result, and given that the Sponsor has demonstrated that it is unlikely that trading in the Shares will become the predominant influence upon prices in the CME Market, the CME Market represents a regulated market of significant size, and that there is a reasonable likelihood that a person attempting to manipulate the Shares would also have to trade on that market to successfully manipulate the Shares.[84]

The Exchange has in place surveillance procedures that are adequate to properly monitor trading in the Shares and the CME Market in all trading sessions and to deter and detect attempted manipulation of the Shares or other violations of Exchange rules and applicable federal securities laws. The Exchange or FINRA, on behalf of the Exchange, or both, will communicate as needed regarding trading in the Shares and bitcoin futures with the CME and other markets and other entities that are members of the ISG, and the Exchange or FINRA, on behalf of the Exchange, or both, may obtain trading information regarding trading in the Shares from such markets and other entities. In addition, the Exchange may obtain information regarding trading in the Shares from markets and other entities that are members of ISG or with which the Exchange has in place a comprehensive surveillance sharing agreement. The Exchange is also able to obtain information regarding trading in the Shares and bitcoin futures or the underlying bitcoin through ETP Holders, in connection with such ETP Holders' proprietary or customer trades which they effect through ETP Holders on any relevant market.

Quotation and last-sale information regarding the Shares will be disseminated through the facilities of the CTA. The Trust's website will also include a form of the prospectus for the Trust that may be downloaded. The website will include the Shares' ticker and CUSIP information, along with additional quantitative information updated on a daily basis for the Trust. The Trust's website will include (i) daily trading volume, the prior business day's reported NAV and closing price, and a calculation of the premium and discount of the closing price or mid-point of the Bid/Ask Price against the NAV; and (ii) data in chart format displaying the frequency distribution of discounts and premiums of the daily closing price or Bid/Ask Price against the NAV, within appropriate ranges, for at

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84 See notes 211 and 22, supra, and accompanying text.

least each of the four previous calendar quarters. The Trust's website will be publicly available prior to the public offering of Shares and accessible at no charge.

Trading in Shares of the Trust will be halted if the circuit breaker parameters in NYSE Arca Rule 7.12-E have been reached or because of market conditions or for reasons that, in the view of the Exchange, make trading in the Shares inadvisable.

The proposed rule change is designed to perfect the mechanism of a free and open market and, in general, to protect investors and the public interest in that it will facilitate the listing and trading of a new type of exchange-traded product based on the price of bitcoin that will enhance competition among market participants, to the benefit of investors and the marketplace. As noted above, the Exchange has in place surveillance procedures that are adequate to properly monitor trading in the Shares in all trading sessions and to deter and detect violations of Exchange rules and applicable federal securities laws.

4. Self-Regulatory Organization's Statement on Burden on Competition

The Exchange does not believe that the proposed rule change will impose any burden on competition that is not necessary or appropriate in furtherance of the purpose of the Act. The Exchange notes that the proposed rule change will facilitate the listing and trading of a new type of Commodity-Based Trust Share based on the price of bitcoin that will enhance competition among market participants, to the benefit of investors and the marketplace.

5. Self-Regulatory Organization's Statement on Comments on the Proposed Rule Change Received from Members, Participants or Others

The Exchange has neither solicited nor received written comments on the proposed rule change.

6. Extension of Time Period for Commission Action

The Exchange does not consent at this time to an extension of any time period for Commission action.

7. Basis for Accelerated Effectiveness Pursuant to Section 19(b)(2)

Not applicable.

8. Proposed Rule Change Based on Rules of Another Self-Regulatory Organization or of the Commission

The proposed rule change is not based on the rules of another self-regulatory organization or of the Commission.

9. Security-Based Swap Submissions Filed Pursuant to Section 3C of the Act

Not applicable.

10. Advance Notices Filed Pursuant to Section 806(e) of the Payment, Clearing and Settlement Supervision Act

Not applicable.

11. Exhibits

Exhibit 1 – Form of Notice of Proposed Rule Change for Federal Register.

Exhibit 3A – Matthew Hougan, Hong Kim, & Satyajeet Pal, Price Discovery In The Modern Bitcoin Market: Examining Lead-Lag Relationships Between The Bitcoin Spot And Bitcoin Futures Market, June 11, 2021.

Exhibit 3B – Matthew Hougan, Hong Kim, & Satyajeet Pal, Is It Likely That A US Bitcoin ETP, If Approved, Will Become The Predominant Influence On Prices In The CME Bitcoin Futures Market?, June 11, 2021.

EXHIBIT 1

SECURITIES AND EXCHANGE COMMISSION
(Release No. 34- ; File No. SR-NYSEARCA-2021-89)

[Date]

Self-Regulatory Organizations; NYSE Arca, Inc.; Notice of Filing of Proposed Rule Change to List and Trade Shares of the Bitwise Bitcoin ETP Trust

Pursuant to Section 19(b)(1)[1] of the Securities Exchange Act of 1934 (the "Act")[2] and Rule 19b-4 thereunder,[3] notice is hereby given that, on October 14, 2021, NYSE Arca, Inc. ("NYSE Arca" or the "Exchange") filed with the Securities and Exchange Commission (the "Commission") the proposed rule change as described in Items I, II, and III below, which Items have been prepared by the self-regulatory organization. The Commission is publishing this notice to solicit comments on the proposed rule change from interested persons.

I. Self-Regulatory Organization's Statement of the Terms of Substance of the Proposed Rule Change

The Exchange proposes to list and trade shares of the Bitwise Bitcoin ETP Trust under NYSE Arca Rule 8.201-E (Commodity-Based Trust Shares). The proposed change is available on the Exchange's website at www.nyse.com, at the principal office of the Exchange, and at the Commission's Public Reference Room.

II. Self-Regulatory Organization's Statement of the Purpose of, and Statutory Basis for, the Proposed Rule Change

In its filing with the Commission, the self-regulatory organization included

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1 15 U.S.C. 78s(b)(1).

2 15 U.S.C. 78a.

3 17 CFR 240.19b-4.

statements concerning the purpose of, and basis for, the proposed rule change and discussed any comments it received on the proposed rule change. The text of those statements may be examined at the places specified in Item IV below. The Exchange has prepared summaries, set forth in sections A, B, and C below, of the most significant parts of such statements.

A. Self-Regulatory Organization's Statement of the Purpose of, and the Statutory Basis for, the Proposed Rule Change

1. Purpose

The Exchange proposes to list and trade shares ("Shares") of the Bitwise Bitcoin ETP Trust (the "Trust"),[4] under NYSE Arca Rule 8.201-E, which governs the listing and trading of Commodity-Based Trust Shares.[5]

According to the Registration Statement, the Trust will not be registered as an investment company under the Investment Company Act of 1940,[6] and is not required to register thereunder. The Trust is not a commodity pool for purposes of the Commodity Exchange Act.[7]

The Exchange represents that the Shares satisfy the requirements of NYSE Arca Rule 8.201-E and thereby qualify for listing on the Exchange.[8]

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4 The Trust is a Delaware statutory trust that was formerly known as the Bitwise Bitcoin ETF Trust. On October 14, 2021, the Trust filed with the Commission an initial registration statement (the "Registration Statement") on Form S-1 under the Securities Act of 1933 (15 U.S.C. 77a). The description of the operation of the Trust herein is based, in part, on the Registration Statement.

5 Commodity-Based Trust Shares are securities issued by a trust that represents investors' discrete identifiable and undivided beneficial ownership interest in the commodities deposited into the trust.

6 15 U.S.C. 80a-1.

7 17 U.S.C. 1.

8 With respect to the application of Rule 10A-3 (17 CFR 240.10A-3) under the Act,

Bitwise Bitcoin ETP Trust

Operation of the Trust[9]

The Trust will issue the Shares, which represent units of undivided beneficial ownership of the Trust. The Trust is a Delaware statutory trust and will operate pursuant to a trust agreement (the "Trust Agreement") between Bitwise Investment Advisers, LLC (the "Sponsor" or "Bitwise") and Delaware Trust Company, as the Trust's trustee (the "Trustee"). The Trust will engage a third party custodian to act as the bitcoin custodian for the Trust (the "Bitcoin Custodian") to maintain custody of the Trust's bitcoin assets.[10] The Trust will engage a third party service provider to serve as the administrator and transfer agent (in such capacities, the "Administrator" and the "Transfer Agent").

According to the Registration Statement, the investment objective of the Trust is to seek to provide exposure to the value of bitcoin held by the Trust, less the expenses of the Trust's operations. In seeking to achieve its investment objective, the Trust will hold bitcoin and establish its Net Asset Value ("NAV") at the end of every business day by reference to the CF Bitcoin-Dollar US Settlement Price ("CME US Reference Rate").[11]

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the Trust relies on the exemption contained in Rule 10A-3(c)(7).

9 The description of the operation of the Trust, the Shares and the bitcoin market contained herein are based, in part, on the Registration Statement. See note 4, supra.

10 When capitalized, references to "Bitcoin" are to the Bitcoin network or the Bitcoin protocol. When lowercase, references to "bitcoin" are to the digital asset native to the Bitcoin network, which asset is the underlying commodity held by the Trust.

11 The CME US Reference Rate is a daily reference rate of the US Dollar price of one bitcoin, calculated at 4:00 p.m. E.T. The CME US Reference Rate utilizes the same methodology as the CME CF Bitcoin Reference Rate (the "CME UK Reference Rate"), which is calculated at 4:00 p.m. London time and was designed by the CME Group and Crypto Facilities Ltd to facilitate the development of financial products, including the cash settlement of Bitcoin Futures traded on the

Under normal circumstances, the Trust's only asset will be bitcoin, and, under limited circumstances, cash. The Trust will not use derivatives that may subject the Trust to counterparty and credit risks.[12] The Trust will process all creations and redemptions in-kind, and accrue all ordinary fees in bitcoin (rather than cash), as a way of seeking to ensure that the Trust holds the desired amount of bitcoin-per-share. The Trust will not purchase or sell bitcoin, other than if the Trust liquidates or must pay expenses not contractually assumed by the Sponsor. Instead, financial institutions authorized to create and redeem Shares (each, an "Authorized Participant") will deliver, or cause to be delivered, bitcoin to the Trust in exchange for Shares of the Trust, and the Trust will deliver bitcoin to Authorized Participants when those Authorized Participants redeem Shares of the Trust.

Bitcoin, Bitcoin Market, Bitcoin Trading Platforms and Regulation of Bitcoin

The following sections, drawn from the Registration Statement, describe bitcoin,

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Chicago Mercantile Exchange ("CME"). Andrew Paine and William J. Knottenbelt, "Analysis of the CME CF Bitcoin Reference Rate and CME CF Bitcoin Real Time Index," Imperial College Centre for Cryptocurrency Research and Engineering, November 14, 2016, available at https://www.cmegroup.com/trading/files/bitcoin-white-paper.pdf.

[12] The Trust may sell bitcoin and temporarily hold cash as part of a liquidation of the Trust or to pay certain extraordinary expenses not assumed by the Sponsor. Under the Trust Agreement, the Sponsor has agreed to assume the normal operating expenses of the Trust, subject to certain limitations. For example, the Trust will bear any indemnification or litigation liabilities as extraordinary expenses.

In addition, the Trust may, from time to time, passively receive, by virtue of holding bitcoin, certain additional digital assets ("IR Assets") or rights to receive IR Assets ("Incidental Rights") through a fork of the Blockchain or an airdrop of assets. The Trust Agreement requires that the Sponsor analyze as soon as possible, whether or not such Incidental Rights and IR Assets should be disclaimed. In the event the Sponsor instructs the Bitcoin Custodian to claim such Incidental Rights and IR Assets, it will immediately distribute such Incidental Rights and IR Assets to shareholders of record.

including the historical development of bitcoin and the Bitcoin network, how a person holds bitcoin, how to use bitcoin in transactions, the "exchange" market where bitcoin can be bought, held and sold, and the bitcoin "over-the-counter" ("OTC") market.

Bitcoin

Bitcoin was first described in a white paper released in 2008 and published under the name "Satoshi Nakamoto." The protocol underlying Bitcoin was subsequently released in 2009 as open source software and currently operates on a worldwide network of computers.

The Bitcoin network utilizes a digital asset known as "bitcoin," which can be transferred among parties via the Internet. Unlike other means of electronic payments such as credit card transactions, one of the advantages of bitcoin is that it can be transferred without the use of a central administrator or clearing agency. As a central party is not necessary to administer bitcoin transactions or maintain the bitcoin ledger, the term decentralized is often used in descriptions of bitcoin. Unless it is using a third party service provider, a party transacting in bitcoin is generally not afforded some of the protections that may be offered by intermediaries.

The first step in using the Bitcoin network for transactions is to download specialized software referred to as a "bitcoin wallet." A user's bitcoin wallet can run on a computer or smartphone, and can be used both to send and to receive bitcoin. Within a bitcoin wallet, a user can generate one or more unique "bitcoin addresses," which are conceptually similar to bank account numbers. After establishing a bitcoin address, a user can send or receive bitcoin from his or her bitcoin address to another user's bitcoin address. Sending bitcoin from one bitcoin address to another is similar in concept to

sending a bank wire from one person's bank account to another person's bank account; however, such transactions are not managed by an intermediary and erroneous transactions generally may not be reversed or remedied once sent.

The amount of bitcoin associated with each bitcoin address, as well as each bitcoin transaction to or from such bitcoin address, is transparently reflected in the Bitcoin network's distributed ledger ("Blockchain") and can be viewed by websites that operate as "Blockchain explorers." Copies of the Blockchain exist on thousands of computers on the Bitcoin network throughout the Internet. A user's bitcoin wallet will either contain a copy of the Blockchain or be able to connect with another computer that holds a copy of the Blockchain. The innovative design of the Bitcoin network protocol allows each Bitcoin user to trust that their copy of the Blockchain will generally be updated consistent with each other user's copy.

When a Bitcoin user wishes to transfer bitcoin to another user, the sender must first request a Bitcoin address from the recipient. The sender then uses his or her Bitcoin wallet software to create a proposed transaction that is confirmed and settles when included in the Blockchain. The transaction would reduce the amount of bitcoin allocated to the sender's address and increase the amount allocated to the recipient's address, in each case by the amount of bitcoin desired to be transferred. The transaction is completely digital in nature, similar to a file on a computer, and it can be sent to other computers participating in the Bitcoin network; however, the use of cryptographic verification is believed to prevent the ability to duplicate or counterfeit bitcoin.

Bitcoin Protocol

The Bitcoin protocol is built using open source software allowing for any

developer to review the underlying code and suggest changes. There is no official company or group responsible for making modifications to Bitcoin. There are, however, a number of individual developers that regularly contribute to the reference software known as "Bitcoin Core," a specific distribution of Bitcoin software that provides the *de-facto* standard for the Bitcoin protocol.

Significant changes to the Bitcoin protocol are typically accomplished through a so-called "Bitcoin Improvement Proposal" or BIP. Such proposals are generally posted on websites, and the proposals explain technical requirements for the protocol change as well as reasons why the change should be accepted by users. Because Bitcoin has no central authority, updating the reference software's Bitcoin protocol will not immediately change the Bitcoin network's operations. Instead, the implementation of a change is achieved by users (including transaction validators known as "miners") downloading and running the updated versions of Bitcoin Core or other Bitcoin software that abides by the new Bitcoin protocol. Users and miners must accept any changes made to the Bitcoin source code by downloading a version of their Bitcoin software that incorporates the proposed modification of the Bitcoin network's source code. A modification of the Bitcoin network's source code or protocol is only effective with respect to those Bitcoin users and miners who download it. If an incompatible modification is accepted by a less than overwhelming percentage of users and miners, a division in the Bitcoin network will occur such that one network will run the pre-modification source code and the other network will run the modified source code. Such a division is known as a "fork" in the Bitcoin network.

Bitcoin Transactions

A bitcoin transaction is similar in concept to an irreversible digital check. The transaction contains the sender's bitcoin address, the recipient's bitcoin address, the amount of bitcoin to be sent, a transaction fee and the sender's digital signature. Bitcoin transactions are secured by cryptography known as "public-private key cryptography," represented by the bitcoin addresses and digital signature in a transaction's data file. Each Bitcoin network address, or wallet, is associated with a unique "public key" and "private key" pair, both of which are lengthy alphanumeric codes, derived together and possessing a unique relationship.

The use of key pairs is a cornerstone of the Bitcoin network technology. This is because the use of a private key is the only mechanism by which a bitcoin transaction can be signed. If a private key is lost, the corresponding bitcoin is thereafter permanently non-transferable. Moreover, the theft of a private key provides the thief immediate and unfettered access to the corresponding bitcoin. Bitcoin users must therefore understand that in this regard, bitcoin is similar to cash: that is, the person or entity in control of the private key corresponding to a particular quantity of bitcoin has *de facto* control of the bitcoin.

The public key is visible to the public and analogous to the Bitcoin network address. The private key is a secret and is used to digitally sign a transaction in a way that proves the transaction has been signed by the holder of the public-private key pair, and without having to reveal the private key. A user's private key must be kept safe in accordance with appropriate controls and procedures to ensure it is used only for legitimate and intended transactions. If an unauthorized third person learns of a user's

private key, that third person could apply the user's digital signature without authorization and send the user's bitcoin to their or another bitcoin address, thereby stealing the user's bitcoin. Similarly, if a user loses his private key and cannot restore such access (e.g., through a backup), the user may permanently lose access to the bitcoin associated with that private key and bitcoin address.

To prevent the possibility of double-spending of bitcoin, each validated transaction is recorded, time stamped and publicly displayed in a "block" in the Blockchain, which is publicly available. Thus, the Bitcoin network provides confirmation against double-spending by memorializing every transaction in the Blockchain, which is publicly accessible and downloaded in part or in whole by all users of the Bitcoin network software program. Any user may validate, through their Bitcoin wallet or a Blockchain explorer, that each transaction in the Bitcoin network was authorized by the holder of the applicable private key, and Bitcoin network mining software consistent with reference software requirements validates each such transaction before including it in the Blockchain. This cryptographic security ensures that bitcoin transactions may not generally be counterfeited, although it does not protect against the "real world" theft or coercion of use of a Bitcoin user's private key, including the hacking of a Bitcoin user's computer or a service provider's systems.

A Bitcoin transaction between two parties is recorded if included in a valid block added to the Blockchain, when that block is accepted as valid through consensus formation among Bitcoin network participants. A block is validated by confirming the cryptographic hash value included in the block's data and by the block's addition to the longest confirmed Blockchain on the Bitcoin network. For a transaction, inclusion in a

block in the Blockchain constitutes a "confirmation" of validity. As each block contains a reference to the immediately preceding block, additional blocks appended to and incorporated into the Blockchain constitute additional confirmations of the transactions in such prior blocks, and a transaction included in a block for the first time is confirmed once against double-spending. This layered confirmation process makes changing historical blocks (and reversing transactions) exponentially more difficult the further back one goes in the Blockchain.

The process by which bitcoin are created and bitcoin transactions are verified is called "mining." To begin mining, a user, or "miner," can download and run a mining "client," which, like regular Bitcoin network software programs, turns the user's computer into a "node" on the Bitcoin network, and in this case has the ability to validate transactions and add new blocks of transactions to the Blockchain.

Miners, through the use of the bitcoin software program, engage in a set of prescribed, complex mathematical calculations in order to verify transactions and compete for the right to add a block of verified transactions to the Blockchain and thereby confirm bitcoin transactions included in that block's data. The miner who successfully "solves" the complex mathematical calculations has the right to add a block of transactions to the Blockchain and is then rewarded by a grant of bitcoin, known as a "coinbase," plus any transaction fees paid for the transactions included in such block. Bitcoin is created and allocated by the Bitcoin network protocol and distributed through mining, subject to a strict, well-known issuance schedule. The supply of bitcoin is programmatically limited to 21 million bitcoin in total. As of March 1, 2021, approximately 18,643,000 bitcoin had been mined.

Confirmed and validated bitcoin transactions are recorded in blocks added to the Blockchain. Each block contains the details of some or all of the most recent transactions that are not memorialized in prior blocks, as well as a record of the award of bitcoin to the miner who added the new block. Each unique block can only be solved and added to the Blockchain by one miner, therefore, all individual miners and mining pools on the Bitcoin network must engage in a competitive process of constantly increasing their computing power to improve their likelihood of solving for new blocks. As more miners join the Bitcoin network and its processing power increases, the Bitcoin network adjusts the complexity of a block-solving equation to maintain a predetermined pace of adding a new block to the Blockchain approximately every ten minutes.

The Bitcoin Market and Bitcoin Trading Platforms

In addition to using bitcoin to engage in transactions, investors may purchase and sell bitcoin to speculate as to the value of bitcoin in the bitcoin market, or as a long-term investment to diversify their portfolio. The value of bitcoin within the market is determined, in part, by (i) the supply of and demand for bitcoin in the bitcoin market, (ii) market expectations for the expansion of investor interest in bitcoin and the adoption of bitcoin by users, (iii) the number of merchants that accept bitcoin as a form of payment, and (iv) the volume of private end-user-to-end-user transactions.

Although the value of bitcoin is determined by the value that two transacting market participants place on bitcoin through their transaction, the most common means of determining a reference value is by surveying one or more trading platforms where secondary markets for bitcoin exist. The most prominent bitcoin trading platforms are often referred to as “exchanges”, although they neither report trade information nor are

they regulated in the same way as a national securities exchange. As such, there is some difference in the form, transparency and reliability of trading data from bitcoin trading platforms. Generally speaking, bitcoin data is available from these trading platforms with publicly disclosed valuations for each executed trade, measured against a fiat currency such as the US Dollar or Euro, or against another digital asset (for example, bitcoin trades against the US Dollar are reflected in the "USD-BTC Pair").

Currently, there are many bitcoin trading platforms operating worldwide and trading platforms represent a substantial percentage of bitcoin buying and selling activity, and, therefore, provide large data sets for the market valuation of bitcoin. A bitcoin trading platform provides investors with a way to purchase and sell bitcoin, similar to stock exchanges like the New York Stock Exchange or NASDAQ, which provide ways for investors to buy stocks and bonds in the so-called "secondary market." Unlike stock exchanges, which are regulated to monitor securities trading activity, bitcoin trading platforms are largely regulated as money services businesses (or a foreign regulatory equivalent) and are required to monitor for and detect money-laundering and other illicit financing activities that may take place on their platform. Bitcoin trading platforms operate websites designed to permit investors to open accounts with the trading platform and then purchase and sell bitcoin.

As with conventional stock exchanges, an investor opening a trading account and wishing to transact at a bitcoin trading platform must deposit an accepted government-issued currency into their account, or a previously acquired digital asset. The process of establishing an account with a bitcoin trading platform and trading bitcoin is different from, and should not be confused with, the process of users sending bitcoin from one

bitcoin address to another bitcoin address, such as to pay for goods and services. This latter process is an activity that occurs wholly within the confines of the Bitcoin network, while the former is an activity that occurs largely on private websites and databases owned by the trading platform.

In addition to the bitcoin trading platforms that provide spot markets for bitcoin, an OTC trading market has emerged for digital assets. The bitcoin OTC market demonstrates flexibility in terms of quotes, price, size, and other factors. The OTC market has no formal structure and no open-outcry meeting place, and typically involves bilateral agreements on a principal-to-principal basis. Parties engaging in OTC transactions will agree upon a price – often via phone, email, or chat – and then one of the two parties will initiate the transaction. For example, a seller of bitcoin could initiate the transaction by sending the bitcoin to the buyer's bitcoin address. The buyer would then wire US Dollars to the seller's bank account. OTC trading tends to occur in large blocks of bitcoin. All risks and issues related to creditworthiness are between the parties directly involved in the transaction. OTC market participants include institutional entities, such as hedge funds, family offices, private wealth managers, high-net-worth individuals that trade bitcoin on a proprietary basis, and brokers that offer two-sided liquidity for bitcoin.

Beyond the spot bitcoin trading platforms and the OTC market, a number of unregulated bitcoin derivatives trading platforms exist that offer traders the ability to gain leveraged and/or short exposure to the price of bitcoin through perpetual futures, quarterly futures, and other derivative contracts.

Finally, the trading of regulated bitcoin futures contracts launched on the CME in December 2017.[13] A further discussion of the CME bitcoin futures market ("CME Market") is included in the section entitled "Standard for Approval—The CME Market," below.

Authorized Participants will have the option of purchasing and selling bitcoin used in Creation Unit transactions with the Trust either on bitcoin trading platforms, in the OTC markets, or in direct bilateral transactions. In addition, Authorized Participants may utilize futures to hedge bitcoin exposure relating to the purchase and redemption of Creation Units.

Valuation of the Trust's Bitcoin

The CME US Reference Rate, CME UK Reference Rate and CME Bitcoin Real Time Price

According to the Registration Statement, the CME UK Reference Rate was established by the CME Group and Crypto Facilities Ltd. to be used in the creation of financial products tied to bitcoin. The CME UK Reference Rate is fixed once per day at 4:00 p.m. London time, based on the methodology set forth below and applying data from constituent trading platforms ("Constituent Platforms"). The CME US Reference Rate was introduced in February 2021 and is designed to apply the CME UK Reference Rate methodology, but with a fix once per day at 4:00 p.m. Eastern time ("E.T."). Although the CME UK Reference Rate has a longer history and is used to settle bitcoin futures on the CME Market, the Trust has determined to utilize the CME US Reference Rate to establish the NAV because the CME US Reference Rate is calculated as of the

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13 See note 25, infra.

same time as the NAV and is based on the same methodology and data sources as the CME UK Reference Rate.

The CME Group and Crypto Facilities Ltd. also publish a continuous real-time bitcoin price index, known as the "CME Bitcoin Real Time Price," using data from the Constituent Platforms.

The CME US Reference Rate, CME UK Reference Rate and CME Bitcoin Real Time Price are administered by Crypto Facilities Ltd., with the selection of Constituent Platforms performed by an oversight committee.[14] A trading platform is eligible to be selected as a Constituent Platform if it facilitates spot trading of bitcoin against the USD-BTC Pair and makes trade data and order data available through an Automatic Programming Interface with sufficient reliability, detail and timeliness. Additional initial and continuing eligibility requirements apply to the Constituent Platforms.

Each of the CME US Reference Rate, which has been calculated and published since February 2021, and CME UK Reference Rate, which has been calculated and published since November 2016, aggregates during a calculation window the trade flow of several spot bitcoin trading platforms into the US Dollar price of one bitcoin as of their respective calculation time. Specifically, the CME US Reference Rate is calculated based on the "Relevant Transactions" (as defined below) of each of its Constituent

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[14] This summary does not represent a complete description of the CME US Reference Rate, the CME UK Reference Rate and CME Bitcoin Real Time Price. Additional information on administration and methodologies, may be found at CF Benchmarks' website, available at https://www.cfbenchmarks.com/indices/XBTUSD_US_RR, https://www.cfbenchmarks.com/indices/BRR, and https://www.cfbenchmarks.com/indices/BRTI. The CME US Reference Rate, the CME UK Reference Rate and CME Bitcoin Real Time Price are registered benchmarks under the European Benchmarks Regulation.

Platforms, which are currently Bitstamp, Coinbase, Gemini, itBit and Kraken, as follows:

1. All Relevant Transactions are added to a joint list, recording the trade price and size for each transaction.
2. The list is partitioned into a number of equally-sized time intervals.
3. For each partition separately, the volume-weighted median trade price is calculated from the trade prices and sizes of all Relevant Transactions. A volume-weighted median differs from a standard median in that a weighting factor, in this case trade size, is factored into the calculation.
4. The CME US Reference Rate or CME UK Reference Rate, as applicable, is then determined by the equally-weighted average of the volume-weighted medians of all partitions.

The CME Bitcoin Real Time Price uses similar data sources, but is calculated once per second based on the weighted mid-price-volume curve, which is a measure of the active bid and ask volume present on a Constituent Platform's order book.

The CME US Reference Rate, CME UK Reference Rate, and CME Bitcoin Real Time Price do not include any bitcoin futures prices in their respective methodologies. A "Relevant Transaction" is any "cryptocurrency versus legal tender spot trade that occurs during the TWAP [Time Weighted Average Price] Period" on a Constituent Platform in the USD-BTC Pair that is reported and disseminated by Crypto Facilities Ltd., as calculation agent for the CME US Reference Rate, CME UK Reference Rate and CME Bitcoin Real Time Price.

Net Asset Value

Under normal circumstances, the Trust's only asset will be bitcoin. The Trust's bitcoin are carried, for financial statement purposes, at fair value, as required by the U.S. generally accepted accounting principles ("GAAP"). The Trust's NAV and NAV per Share will be determined by the Administrator once each Exchange trading day as of 4:00 p.m. E.T., or as soon thereafter as practicable. The Administrator will calculate the NAV by multiplying the number of bitcoin held by the Trust by the CME US Reference Rate for such day, and subtracting the accrued but unpaid expenses and liabilities of the Trust. The NAV per Share is calculated by dividing the NAV by the number of Shares then outstanding. The Administrator will determine the price of the Trust's bitcoin by reference to the CME US Reference Rate, which is published and calculated as set forth above.

Intraday Trust Value

In order to provide updated pricing information relating to the Shares for use by investors and market professionals throughout the domestic trading day, the Exchange will calculate and disseminate throughout the core trading session, every 15 seconds each trading day, an intraday trust value ("ITV"). The ITV will be calculated throughout the trading day by using the prior day's holdings at close of business and the most recently reported price level of the CME Bitcoin Real Time Price as reported by Bloomberg, L.P. or another reporting service, or another price of bitcoin derived from updated bids and offers indicative of the spot price of bitcoin. The ITV will be widely disseminated by one or more major market data vendors during the NYSE Arca Core Trading Session.

Creation and Redemption of Shares; In-Kind Transaction Activity

The Trust Shares

According to the Registration Statement, the Shares shall represent undivided beneficial ownership of the Trust. The Trust creates and redeems Shares from time to time, but only in one or more Creation Units. A Creation Unit is only made in exchange for delivery to the Trust or the distribution by the Trust of the amount of bitcoin represented by the Creation Unit being created or redeemed, the amount of which is representative of the combined NAV of the number of Shares included in the Creation Units being created or redeemed determined as of 4:00 p.m. E.T. on the day the order to create or redeem Creation Units is properly received. Except when aggregated in Creation Units or under extraordinary circumstances permitted under the Trust Agreement, the Shares are not redeemable securities. A Creation Unit will initially consist of at least 25,000 Shares, but may be subject to change.

Authorized Participants are the only persons that may place orders to create and redeem Creation Units. Authorized Participants must be (i) registered broker-dealers or other securities market participants, such as banks and other financial institutions, that are not required to register as broker-dealers to engage in securities transactions described below, and (ii) Depository Trust Company ("DTC") Participants. To become an Authorized Participant, a person must enter into an Authorized Participant Agreement with the Trust and/or the Trust's marketing agent (the "Marketing Agent").

Creation Procedures

On any business day, an Authorized Participant may create Shares by placing an order to purchase one or more Creation Units with the Transfer Agent through the Marketing Agent. Such orders are subject to approval by the Marketing Agent and the Transfer Agent. For purposes of processing creation and redemption orders, a "business

day" means any day other than a day when the Exchange is closed for regular trading. To be processed on the date submitted, creation orders generally must be placed before 4 p.m. E.T. or the close of regular trading on the Exchange, whichever is earlier. The day on which an order is received by the Transfer Agent and approved by the Marketing Agent, is considered the creation order date.

All Creation Units are processed in-kind. By placing a creation order, an Authorized Participant agrees to deposit, or cause to be deposited, bitcoin with the Trust by initiating a Bitcoin transaction to a Bitcoin network address identified by the Trust. Prior to the delivery of Creation Units for a creation order, the Authorized Participant must also have wired to the Transfer Agent the nonrefundable transaction fee due for the creation order. Authorized Participants may not withdraw a creation request. If an Authorized Participant fails to consummate the foregoing, the order may be cancelled.

The total creation deposit amount required to create each Creation Unit is an amount of bitcoin that is in the same proportion to the total assets of the Trust, net of accrued expenses and other liabilities, on the date the order to purchase is properly received, as the number of Shares to be created under the creation order is in proportion to the total number of Shares outstanding on the date the order is received. The Sponsor causes to be published each business day morning, prior to the commencement of trading on the Exchange, the amount of bitcoin that will be required to be deposited in exchange for one Creation Unit for such business day.

Redemption Procedures

According to the Registration Statement, the procedures by which an Authorized Participant can redeem one or more Creation Units mirror the procedures for the creation

of Creation Units. On any business day, an Authorized Participant may place an order with the Transfer Agent through the Marketing Agent to redeem one or more Creation Units. To be processed on the date submitted, redemption orders generally must be placed before 4 p.m. E.T. or the close of regular trading on the Exchange, whichever is earlier. A redemption order will be effective on the date it is received by the Administrator and approved by the Marketing Agent ("Redemption Order Date"). The redemption procedures allow Authorized Participants to redeem Creation Units and do not entitle an individual shareholder to redeem any Shares in an amount less than a Creation Unit, or to redeem Creation Units other than through an Authorized Participant.

The redemption distribution from the Trust will consist of a transfer to the redeeming Authorized Participant, or its agent, of an amount of bitcoin representing the amount of bitcoin held by the Trust evidenced by the Shares being redeemed. The redemption distribution amount is determined in the same manner as the determination of the bitcoin deposit amount discussed above. The Sponsor causes to be published each business day morning, prior to the commencement of trading on the Exchange, the redemption distribution amount relating to a Creation Unit applicable for such business day.

The redemption distribution due from the Trust will be delivered once the Transfer Agent notifies the Bitcoin Custodian and the Sponsor that the Authorized Participant has delivered the Shares represented by the Creation Units to be redeemed to the Trust's DTC account. If the Trust's DTC account has not been credited with all of the Shares of the Creation Units to be redeemed, the redemption distribution will be delayed until such time as the Transfer Agent confirms receipt of all such Shares.

Once the Transfer Agent notifies the Bitcoin Custodian and the Sponsor that the Shares have been received in the Trust's DTC account, the Sponsor will instruct the Bitcoin Custodian to transfer the redemption bitcoin amount from the Trust Bitcoin Account to the Authorized Participant's bitcoin custody account. All redemption orders are processed in-kind. By placing a redemption order, an Authorized Participant agrees to receive bitcoin. If an Authorized Participant fails to consummate the foregoing, the order may be cancelled.

Fee Accrual

According to the Registration Statement, the only ordinary expense of the Trust is expected to be the Sponsor's fee, which shall accrue daily in bitcoin and be payable monthly in bitcoin.

Impact of the Exclusive Use of In-Kind Creations, Redemptions and Fee Accruals

The Sponsor believes that the exclusive use of in-kind creations, redemptions and fee accruals, in all situations except when the Trust is required to liquidate or to pay extraordinary expenses, provides long-term investors in the Trust with redundant but strong protection. The in-kind structure ensures that the Trust maintains the appropriate amount of bitcoin-per-Share in all scenarios, regardless of the US Dollar calculation of NAV or the CME US Reference Rate.

Standard for Approval

How the Exchange's Proposed Rule Conforms to the Requirements of the Act

To date, the Commission has considered and published disapproval orders relating to numerous proposed exchange-traded products ("ETPs") providing exposure to

the price of bitcoin, including a prior proposal in respect of the Trust.[15] In each of these disapprovals, the Commission determined that the filing failed to demonstrate that the proposal was consistent with the requirements of Section 6(b)(5) of the Act[16] and, in particular, the requirement that the rules of a national securities exchange be designed to prevent fraudulent and manipulative acts and practices.[17]

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15 See, e.g., Order Disapproving a Proposed Rule Change, as Modified by Amendments No. 1 and 2, to BZX Rule 14.11(e)(4), Commodity-Based Trust Shares, to List and Trade Shares Issued by the Winklevoss Bitcoin Trust, Release No. 34-80206 (Mar. 10, 2017), 82 FR 14076 (March 16, 2017); Order Disapproving a Proposed Rule Change, as Modified by Amendment No. 1, Relating to the Listing and Trading of Shares of the SolidX Bitcoin Trust under NYSE Arca Equities Rule 8.201, Release No. 34-80319 (Mar. 28, 2017), 82 FR 16247 (April 3, 2017); Order Setting Aside Action by Delegated Authority and Disapproving a Proposed Rule Change, as Modified by Amendments No. 1 and 2, to List and Trade Shares of the Winklevoss Bitcoin Trust ("Second Winklevoss Order"), Release No. 34-83723 (July 26, 2018), 83 FR 37579 (August 1, 2018); Order Disapproving a Proposed Rule Change to List and Trade the Shares of the ProShares Bitcoin ETF and the ProShares Short Bitcoin ETF, Release No. 34-83904 (Aug. 22, 2018), 83 FR 43934 (August 28, 2018); Order Disapproving a Proposed Rule Change Relating to Listing and Trading of the Direxion Daily Bitcoin Shares, Release No. 34-83912 (Aug. 22, 2018), 83 FR 43912 (August 28, 2018); Order Disapproving a Proposed Rule Change to List and Trade the Shares of the GraniteShares Bitcoin ETF and the GraniteShares Short Bitcoin ETF ("GraniteShares Order"), Release No. 34-83913 (Aug. 22, 2018), 83 FR 43923 (August 28, 2018); Order Disapproving a Proposed Rule Change, as Modified by Amendment No. 1, Relating to the Listing and Trading of Shares of the Bitwise Bitcoin ETF Trust Under NYSE Arca Rule 8.201-E ("Bitwise Order"), Release No. 34-87267 (Oct. 9, 2019), 84 FR 55382 (October 16, 2019) (subsequently withdrawn while the delegated action was under review by the Commission on Jan. 13, 2020; see SR-NYSEArca-2019-01, 85 FR 73819 (November 19, 2020); Order Disapproving a Proposed Rule Change, as Modified by Amendment No. 1, to Amend NYSE Arca Rule 8.201-E (Commodity-Based Trust Shares) and to List and Trade Shares of the United States Bitcoin and Treasury Investment Trust Under NYSE Arca Rule 8.201-E, Release No. 34-88284 (February 26, 2020), 85 FR 12595 (March 3, 2020) ("USBT Order").

16 15 U.S.C. 78f(b)(5).

17 In the Second Winklevoss Order, Bitwise Order and USBT Order, the Commission determined that the proposing exchange had not established that bitcoin markets were uniquely resistant to fraud or manipulation, which unique

The principal means by which a national securities exchange may satisfy the requirements of Section 6(b)(5) of the Act[18] is through entry into comprehensive surveillance-sharing agreements that "help to ensure the availability of information necessary to detect and deter potential manipulations and other trading abuses, thereby making [the ETP] less readily susceptible to manipulation."[19] These comprehensive surveillance-sharing agreements enable the Exchange to obtain information necessary to detect and deter market manipulation and other trading abuses upon request of information from one party to the other.[20]

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resistance might provide protections such that the proposing exchange "would not necessarily need to enter into a surveillance sharing agreement with a regulated significant market." Second Winklevoss Order 83 FR at 37591, Bitwise Order 84 FR at 55386, and USBT Order 85 FR at 12597. In the Second Winklevoss Order, GraniteShares Order, Bitwise Order and USBT Order, the Commission determined that, while the existing, regulated derivatives markets (including the CME Market) was a regulated market, the proposing exchanges had not demonstrated that the regulated derivatives markets had achieved significant size. See Second Winklevoss Order 83 FR at 37601, Bitwise Order 84 FR at 55410, and USBT Order 85 FR at 12597. In the Second Winklevoss Order, Bitwise Order and USBT Order, the Commission determined that a proposing exchange had established neither that it had a surveillance sharing agreement with a group of underlying bitcoin trading platforms, nor that such bitcoin trading platforms constituted regulated markets of significant size with respect to bitcoin. See Second Winklevoss Order 83 FR 37590-37591, Bitwise Order 84 FR at 55407 and USBT Order 85 FR at 12615.

18 15 U.S.C. 78f(b)(5).

19 See Notice of Filing and Order Granting Immediate Effectiveness of Proposed Rule Change by American Stock Exchange, Incorporated Relating to the Listing of Commodity Indexed Preferred or Debt Securities, Exchange Act Release No. 35518 (Mar. 21, 1995), 60 FR 15804, 15807, 15807 n.21 (Mar. 27, 1995) (SR-Amex-94-30). See also Notice of Filing and Order Granting Immediate Effectiveness of Proposed Rule Change by American Stock Exchange, Incorporated Relating to the Listing of Commodity Indexed Preferred or Debt Securities, Exchange Act Release No. 36885 (Feb. 26, 1996), 61 FR 8315, 8319 n.17 (Mar. 4, 1996) (SR-Amex-95-50).

20 The Commission has described a comprehensive surveillance sharing agreement as including an agreement under which a self-regulatory organization may

In the Second Winklevoss Order, the Commission laid out both the importance and definition of a surveilled, regulated market of significant size. Specifically, the Commission explained that:

> [for all] commodity-trust ETPs approved to date for listing and trading, there has been in every case at least one significant, regulated market for trading futures on the underlying commodity—whether gold, silver, platinum, palladium, or copper — and the ETP listing exchange has entered into surveillance-sharing agreements with, or held Intermarket Surveillance Group membership in common with, that market.[21]

Further, on an illustrative and not exclusive basis, the Commission interpreted

> the terms 'significant market' and 'market of significant size' to include a market (or group of markets) as to which (a) there is a reasonable likelihood that a person attempting to manipulate the ETP would also have to trade on that market to successfully manipulate the ETP, so that a

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expressly obtain information on (i) market trading activity, (ii) clearing activity and (iii) customer identity, and where existing rules, laws or practices would not impede access to such information. See Letter from Brandon Becker, Director, Division of Market Regulation, Commission, to Gerard D. O'Connell, Chairman, Intermarket Surveillance Group (June 3, 1994), available at https://www.sec.gov/divisions/marketreg/mr-noaction/isg060394.htm ("ISG Letter").

The Commission has emphasized the importance of surveillance sharing agreements, noting that "[s]uch agreements provide a necessary deterrent to manipulation because they facilitate the availability of information needed to fully investigate a manipulation if it were to occur." Amendment to Rule Filing Requirements for Self-Regulatory Organizations Regarding New Derivative Securities Products, Exchange Act Release No. 40761 (Dec. 8, 1998), 63 FR 70952, 70954, 70959 (Dec. 22, 1998) (File No. S7-13-98) ("NDSP Adopting Release").

21 Second Winklevoss Order, 83 FR 37594.

> surveillance-sharing agreement would assist the ETP listing market in detecting and deterring misconduct, and (b) it is unlikely that trading in the ETP would be the predominant influence on prices in that market.[22]

This two-prong definition of the term "significant market" came to be known as the "Winklevoss Standard," and will be referred to as such in this proposal. In the Bitwise Order, the Commission built upon the Winklevoss Standard and provided important additional guidance on how a listing exchange might demonstrate that a bitcoin derivatives market meets the Commission's definition of "significant":

> [T]he lead-lag relationship between the bitcoin futures market and the spot market ... is central to understanding whether it is reasonably likely that a would-be manipulator of the ETP would need to trade on the bitcoin futures market to successfully manipulate prices on those spot platforms that feed into the proposed ETP's pricing mechanism. In particular, if the spot market leads the futures market, this would indicate that it would not be necessary to trade on the futures market to manipulate the proposed ETP, even if arbitrage worked efficiently, because the futures price would move to meet the spot price.[23]

In response to this, in the rule proposal disapproved in the USBT Order, the sponsor and listing exchange attempted to establish that the CME Market satisfied the requirements of a regulated market of significant size as laid out in the Bitwise Order.

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22 Id. The Commission further noted that "[t]here could be other types of ''significant markets'' and ''markets of significant size,'' but this definition is an example that will provide guidance to market participants."

23 Bitwise Order, 84 FR at 55411. See also USBT Order 85 FR at 12612.

The rule change proposal referenced, among other items, a statistical analysis conducted by the Sponsor examining whether the CME Market led the bitcoin spot market from a price discovery perspective. The Commission rejected this argument for specific reasons, noting (among other things) that:

> the [s]ponsor has not provided sufficient details supporting this conclusion, and unquestioning reliance by the Commission on representations in the record is an insufficient basis for approving a proposed rule change in circumstances where, as here, the proponent's assertion would form such an integral role in the Commission's analysis and the assertion is subject to several challenges. For example, the [s]ponsor has not provided sufficient information explaining its underlying analysis, including detailed information on the analytic methodology used, the specific time period analyzed, or any information that would enable the Commission to evaluate whether the findings are statistically significant or time varying.

Nonetheless, the Commission made it clear that a future ETP application could potentially meet the Winklevoss Standard through identifying a regulated market of significant size. Specifically, the Commission noted that an existing or new bitcoin futures market could achieve significant size such that an Exchange might demonstrate, through a surveillance sharing agreement, that a proposed rule change could satisfy the requirements of the Act.[24]

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[24] In past disapproval orders for bitcoin ETPs, the Commission acknowledged that the CME, and therefore the CME Market, is regulated by the CFTC, but that the proposing exchanges had not demonstrated that the CME Market represented a

As discussed in detail below, the Sponsor's analysis demonstrates that the Exchange can meet the burden presented by Section 6(b)(5) of the Act and, in particular, the requirement that the rules of a national securities exchange be designed to prevent fraudulent and manipulative acts and practices by demonstrating that the CME Market (i) is a regulated market; (ii) participates in a surveillance sharing agreement with the Exchange; and (iii) satisfies the Commission's "significant market" definition under the Winklevoss Standard.

The CME Market

The CME Group announced the planned launch of bitcoin futures on October 31, 2017, the trading of which began on December 17, 2017.[25] The futures are cash-settled based on the CME UK Reference Rate, the methodology of which is described above. Since inception, the CME Market has seen significant growth in average daily volume traded, open interest, and the number of large participants, as demonstrated in the charts below.[26]

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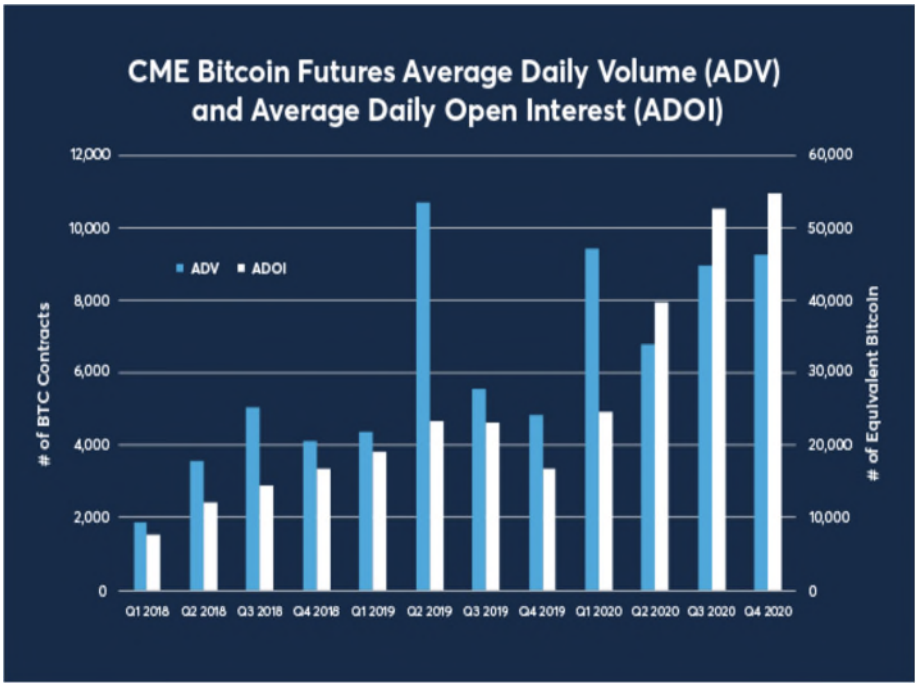
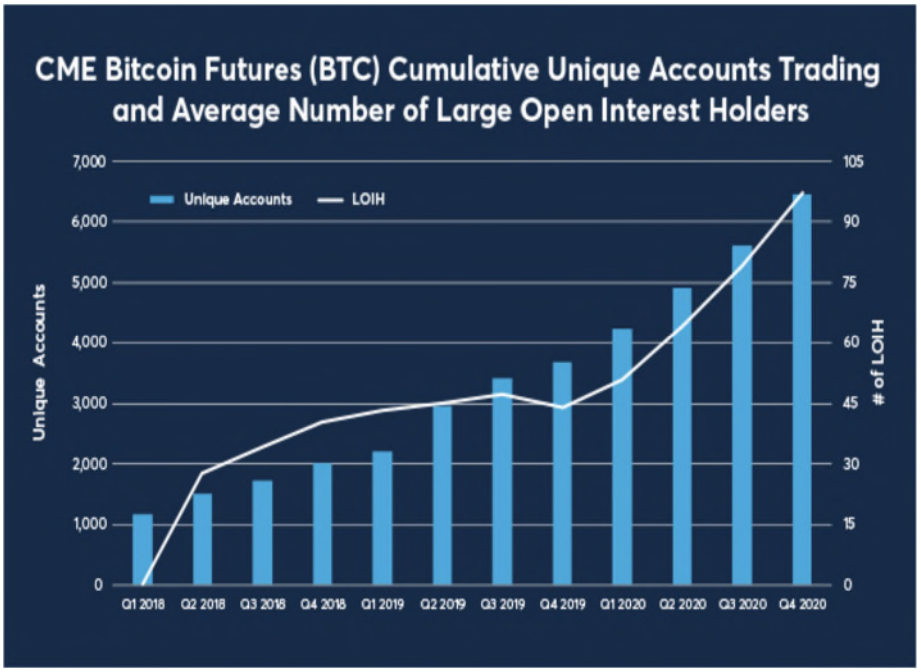
significant market. See note17, supra.

25 "CME Group Announces Launch of Bitcoin Futures," October 31, 2017, available at https://www.cmegroup.com/media-room/press-releases/2017/10/31/cme_group_announceslaunchofbitcoinfutures.html. At the same time as the launch of the CME Market, the Cboe Futures Exchange, LLC announced and subsequently launched Cboe bitcoin futures. See "CFE to Commence Trading in Cboe Bitcoin (USD) Futures Soon," December 01, 2017, available at cdn.cboe.com/resources/release_notes/2017/Cboe-Bitcoin-USD-Futures-Launch-Notification.pdf. Each future was cash settled, with the CME Market tracking the CME UK Reference Rate and the Cboe bitcoin futures tracking a bitcoin trading platform daily auction price. The Cboe Futures Exchange, LLC subsequently discontinued its bitcoin futures market effective June 2019. "Cboe put the brakes on bitcoin futures," March 15, 2019, available at https://www.reuters.com/article/us-cboe-bitcoin/cboe-puts-the-brakes-on-bitcoin-futures-idUSKCN1QW261. The Trust uses the CME US Reference Rate to calculate its NAV.

26 CME Group, CME bitcoin futures celebrate third anniversary: The year in review





(December 31, 2020). "Cumulative unique accounts" refers to the number of unique accounts that had, prior to or on the date measured, entered on a CME Group venue into at least one bitcoin futures contract. "Large open interest holders" refers to a party that has entered into at least twenty-five (25) bitcoin futures contracts that have not yet offset by delivery.

The Commission has previously recognized that the CME Market qualifies as a regulated market[27] and that surveillance-sharing agreements are in place with the CME by virtue of common membership in the Intermarket Surveillance Group ("ISG").[28] Both the Exchange and the CME are members of the ISG.[29]

The CME Market Meets the Commission's Definition of a "Significant Market"

As the following analysis based on the Sponsor's research demonstrates, the CME Market satisfies the Commission's definition of a "significant market."[30] Specifically, the Sponsor's analysis shows that prices on the CME Market consistently lead prices on the bitcoin spot market and the unregulated bitcoin futures market, such that it is reasonably likely that a would-be manipulator of the ETP would need to trade bitcoin futures on the CME Market. The Sponsor's analysis also demonstrates that it is unlikely that trading in the ETP would be the predominant influence on prices in the CME Market.

Data Sources for Evaluating the Bitcoin Market

In evaluating whether the CME Market qualifies as a significant market, the

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27 See Bitwise Order, 84 FR at 55410, n. 456 ("the Commission recognizes that the CFTC comprehensively regulates CME ..."). See also Second Winklevoss Order, 83 FR at 37594 & at note 202, GraniteShares Order 83 FR at 43929, and USBT Order, 85 FR at 12597.

28 As the Commission explained in the Bitwise Order, common membership between a proposing exchange and a futures market such as the CME (and therefore the CME Market) in the ISG functions as "the equivalent of a comprehensive surveillance sharing agreement." See Bitwise Order, 84 FR at 55410, n.456.

29 A list of the current members of ISG is available at https://www.isgportal.org.

30 This proposal details the data sources, time periods, and statistical methods used by the Sponsor to demonstrate that the CME Market qualifies as a significant market relative to the Trust. As such, the surveillance sharing agreement, in place through common membership in the ISG, will allow the Exchange to detect and deter potential manipulations and other misconduct and to satisfy its obligations under Section 6(b)(5) of the Act. See 15 U.S.C. 78f(b)(5).

Sponsor has engaged in an extensive research effort to evaluate the lead-lag relationship between the CME Market and both the bitcoin spot market and the unregulated bitcoin futures market. Given that lead-lag and price discovery research is sensitive to data quality, it was critical from the beginning that the Sponsor gather high-quality bitcoin trading data on a historical and an ongoing basis.

Bitcoin trading platforms exist in multiple countries and operate under a variety of regulatory regimes. There are generally no requirements for these platforms to provide data on their trading activity in a uniform fashion to a centralized database. As a result, there currently is no equivalent to the Consolidated Tape Association ("CTA") in the US, which offers a single source of agreed upon trading data for publicly traded equities in the US.

Over the years, however, a variety of private data providers have emerged that consolidate trading data from large numbers of bitcoin trading platforms. The Sponsor undertook a detailed survey of these data providers in May 2020, evaluating them on metrics including data quality, trading platform coverage, cost, service quality, and reputation. The goal of this survey was to determine which provider or set of providers the Sponsor would use in its research.

The Sponsor cataloged bitcoin data providers commonly referenced in the industry, and supplemented this list by conducting broad web searches to identify additional bitcoin data providers and by consulting a third-party survey.[31] Aggregating these steps resulted in a total of 29 firms examined by the Sponsor, of which 14 offered

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31 See The Block, "The State of Digital Asset Data and Infrastructure," May 14, 2020, available at https://www.theblockcrypto.com/post/63689/research-report-the-state-of-the-digital-asset-data-and-infrastructure-commissioned-by-blockset.

the specific type of data (bitcoin tick data) needed to conduct lead-lag analysis. The Sponsor evaluated these 14 firms on four separate criteria:

- *Data coverage.* All else equal, more trading platforms are better than fewer.
- *Data quality.* Data gathered by third-party providers should match the actual activity that takes place on each trading platform, with as few errors as possible.
- *Cost.* The cost of licensing the data from a given provider should be reasonable.
- *Corporate Factors.* Available facts should give confidence that the provider in question will continue to operate in a robust manner over a meaningful period of time.

Data quality was weighted heavily in the assessment of data providers, as it has a direct impact on the output of price discovery research. Still, the other three factors were important as well. Based on this analysis, the Sponsor elected to use Coin Metrics as the core data provider. At the time, Coin Metrics offered coverage of 26 trading platforms, and had exceptionally high data quality based on the statistical analysis performed by the Sponsor.[32]

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[32] For instance, in one portion of the study, the Sponsor downloaded the full record of trades (2,523,481 trades) directly from Bitfinex, a spot bitcoin trading platform, for the month of March 2020. It then compared these trades with data pulled from participating data providers, looking for three types of data errors: duplicated trades, erroneous trades, and missing trades. Coin Metrics had zero data errors; its competitors had between two and 4,929 errors in their data samples. The Sponsor repeated the analysis using trade data from Coinbase and LBank, two additional bitcoin trading platforms; Coin Metrics again had zero data errors.

To supplement Coin Metrics' data, the Sponsor evaluated data providers that covered a large number (>100) of bitcoin trading platforms. Of these providers, CoinAPI scored the best on its four-factor evaluation system, including scoring well on data quality. Based on this analysis, the Sponsor elected to use CoinAPI data to supplement Coin Metrics data where necessary to conduct its analysis.

Data on the CME Market was obtained directly from the CME Group.

Winklevoss Standard Prong 1: Reasonable Likelihood

The first prong of the Winklevoss Standard requires demonstrating a reasonable likelihood that a person attempting to manipulate a bitcoin ETP would also have to trade on the CME Market.[33] In prior disapproval orders, the Commission stated that demonstrating a "lead-lag relationship" between prices on the CME Market and the underlying bitcoin spot market is "central" to understanding this reasonable likelihood.[34]

As detailed below, through extensive statistical analysis and careful consideration of third-party evaluations of these markets, the Sponsor has demonstrated that the CME Market leads the bitcoin spot market and the unregulated bitcoin futures market, such that it is reasonably likely that a person attempting to manipulate the ETP would also have to trade on the CME Market, thus satisfying the first prong of the Winklevoss Standard.

The Statistical Approaches to Demonstrating a Lead-Lag Relationship

The Sponsor conducted a detailed review of both academic and practitioner papers that focus on lead-lag relationships in financial markets. The literature review revealed that there are two primary approaches to conducting such analysis:

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33 See note 22, supra, and accompanying text.

34 See note 23, supra, and accompanying text.

- *Information Share (IS) / Component Shares (CS) Price Discovery Analysis.* This type of analysis is based on the principle that there is a common "efficient" price for any asset being traded on multiple platforms. It allows you to construct a model of the relationship between different platforms by comparing their price series against this common efficient price, and testing which price series is faster to incorporate new information; and
- *Time-Shift Lead-Lag Analysis (TSLL).* TSLL is a more intuitive approach to evaluating lead-lag relationships between markets. It involves taking two time series of price data and offsetting (or "shifting") them against each other to determine what offset, or "lag," produces the highest cross-correlation between the two series.

Both IS/CS price discovery analysis and TSLL have an extensive history in the financial literature, and each comes with its own strengths and weaknesses. As such, the Sponsor has evaluated the CME Market using both of the major academic approaches.

IC/CS Price Discovery Research on the Bitcoin Spot Market vs. the CME Market

Information share (IS) and component share (CS) are two variants of a core analytical approach to price discovery research that traces its roots back to 1995.[35] It is sometimes referred to in the literature as "common efficient price"-based analysis, "fundamental price"-based analysis, or simply "price discovery" analysis.

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[35] Hasbrouck, J. (1995), One security, many markets: Determining the contributions to price discovery. The Journal of Finance, 5050(4), 1175-1199. Gonzalo, J., and Granger, C. (1995), Estimation of common long-memory components in cointegrated systems. Journal of Business & Economic Statistics, 13(1), 27-35.

Price discovery analysis is based on the idea that, in a perfectly efficient market, new information should be reflected simultaneously in the price of an asset as it trades on different platforms. In practice, however, this is not the case; some platforms move before others. In addition, some market moves are simply "noise" that do not reflect a change in the fundamental price at all. Price discovery analysis attempts to measure the speed and accuracy with which each trading platform incorporates new information into its price. Platforms that are faster to incorporate new information while being better at avoiding noise are considered to have a "higher share" of price discovery.

Despite the paired nature of IS/CS values, the convention in the literature is to present only one value in the results tables, leaving the other implied. The Sponsor followed that convention, only reporting the IS/CS value of the CME Market, as it is compared to each spot bitcoin trading platform. Therefore, an IS/CS value above 50% indicates that the CME Market leads price discovery compared with the spot bitcoin trading platform in question.

The Sponsor's review of the historical literature surrounding IS/CS price discovery analysis comparing the CME Market and the bitcoin spot market identified ten academic and practitioner studies evaluating the two markets, which are itemized and summarized in the table below (a single long horizontal table has been divided here into two parts).[36]

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[36] This table is replicated from material previously provided to the Commission. See Matthew Hougan, Hong Kim and Satyajeet Pal, Price discovery in the modern bitcoin market: Examining lead-lag relationships between the bitcoin spot and bitcoin futures market, February 16, 2021, as amended and supplemented ("Bitwise Prong One Paper").

#	Title	Year	Authors
1	Bitcoin futures—What use are they?[37]	2018	Corbet, Lucey, et al.
2	Price discovery in bitcoin spot or futures?[38]	2019	Baur and Dimpfl
3	An analysis of price discovery between bitcoin futures and spot markets[39]	2019	Kapar and Olmo
4	Price discovery, high-frequency trading and jumps in bitcoin markets[40]	2019	Alexander and Heck
5	What role do futures markets play in bitcoin pricing? Causality, cointegration and price discovery from a time-varying perspective[41]	2019	Hu, Hou, and Oxley
6	The development of bitcoin futures: Exploring the interactions between cryptocurrency derivatives[42]	2019	Akyildirim, Corbet, et al.
7	Price discovery in bitcoin futures[43]	2020	Fassas, Papadamou, and Koulis
8	The determinants of price discovery on bitcoin markets[44]	2020	Entrop, Frijns, and Seruset
9	Bitcoin spot and futures market microstructure[45]	2020	Aleti and Mizrach
10	Efficient price discovery in the bitcoin markets[46]	2020	Chang, Herrmann,

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37 Corbet, S., Lucey, B., Peat, M., and Vigne, S. (2018), Bitcoin futures—What use are they? Economics Letters (172), 23-27.

38 Baur, D.G., and Dimpfl, T. (2019), Price discovery in bitcoin spot or futures? The Journal of Futures Markets (39)7, 803-817.

39 Kapar, B., and Olmo, J. (2019). An analysis of price discovery between bitcoin futures and spot markets. Economics Letters, (174), 62-64.

40 Alexander, C., and Heck, D. (2019), Price discovery, high-frequency trading and jumps in bitcoin markets. SSRN Electronic Journal.

41 Hu, Y., Hou, Y.G., Oxley, L. (2020), What role do futures markets play in bitcoin pricing? Causality, cointegration and price discovery from a time-varying perspective. International Review of Financial Analysis (72).

42 Akyildirim, E., Corbet, S., Katsiampa, P., Kellard, N., and Sensoy, A. (2020), The development of bitcoin futures: Exploring the interactions between cryptocurrency derivatives. Finance Research Letters (34).

43 Fassas, A., Papadamou, S., Koulis, A. (2020), Price discovery in bitcoin futures. Research in International Business and Finance (52).

44 Entrop, O., Frijns B., Seruset, M. (2020), The determinants of price discovery on bitcoin markets. The Journal of Futures Markets, (40)5, 816-837.

45 Aleti, S., and Mizrach, B. (2020), Bitcoin spot and futures market microstructure. The Journal of Futures Markets (41)2, 194-225.

46 Chang, A., Herrmann, W, and Cai, W. (2020), Efficient price discovery in the bitcoin markets. Wilshire Phoenix, October 14, 2020, available at

			and Cai

#	Authors	CME IS	CME CS	Intervals	Time Period	Result
1	Corbet, Lucey, et al.	15%	18%	1 min	--[47]	Spot leads
2	Baur and Dimpfl	14%	14%	15 min	12/18/2017 - 10/18/2018	Spot leads
3	Kapar and Olmo	89%	--	1 day	12/18/2017 - 05/16/2018	Futures lead
4	Alexander and Heck	66%	73%	30 min	12/18/2017 - 06/30/2019	Futures lead
5	Hu, Hou, and Oxley	55%	--	1 day	12/18/2017 - 06/16/2019	Futures lead
6	Akyildirim, Corbet, et al.	91-97%	67-87%	1/5/10/15/30/60 min	12/18/2017 - 02/26/2018	Futures lead
7	Fassas, Papadamou, and Koulis	97%	77%	1 hour	01/01/2018 - 12/31/2018	Futures lead
8	Entrop, Frijns, and Seruset	50%	53%	1 min	12/18/2017 - 03/31/2019	Mixed
9	Aleti and Mizrach	53-55%	68-91%	5 min	01/02/2019 - 02/28/2019	Futures lead
10	Chang, Herrmann, and Cai	--	63%	1 min	07/01/2019 - 12/31/2019	Futures lead

As the above table indicates, a majority of papers support the notion that the CME Market leads price discovery using IS and/or CS when compared to the bitcoin spot market.

Because the methodologies and findings of each paper are nuanced, the Sponsor examined each paper in detail. The analysis begins with the majority opinion that the CME Market leads the bitcoin spot market:

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https://www.wilshirephoenix.com/efficient-price-discovery-in-the-bitcoin-markets/.

47 Corbet et al (2018) do not specify the time period of the price discovery analysis presented. See note 53, infra, and accompanying text.

- Kapar and Olmo (2019) was the first paper to assert that, contrary to the two studies that came before it (Corbet et al. (2018) and Baur and Dimpfl (2019)), the data "clearly reflect the leadership of the Bitcoin futures markets with respect to the spot market." The paper attributed 89% of IS to the futures market.

  Kapar and Olmo (2019) relies on daily price data, which means the study may not capture intraday information flow. Still, long-run relationships are relevant in holistically describing the relative strength one market has compared with another. The authors illustrated the importance of long-run relationships, saying, "when the market is in contango we can expect increases in the spot price in the next period. In contrast, when the market is in backwardation, the VECM suggests a fall in spot prices to correct departures from equilibrium." In other words, the authors found that if there is a gap between the spot and futures price on a given day, the spot price is more likely to correct toward the futures price than vice versa.
- Alexander and Heck (2019) similarly found that there was "strong evidence that both CME and CBOE futures have played the leading role in price discovery." Unlike Kapar and Olmo (2019), Alexander and Heck (2019) used intraday data with a 30-minute timing interval. Their analysis ran from December 18, 2017 to June 30, 2019, the longest time period among the ten studies the Sponsor discovered. It showed that the CME Market led the bitcoin spot market with 66% of IS and 73% of CS during that time.

Interestingly, the authors noted strong price leadership from the CME Market during Q2 2019, the last quarter they studied. In fact, Q2 2019 boosted the overall IS from the study from 57% to 66%, and CS from 50% to 73%. This increase in the CME Market's contribution to price discovery aligned with significant growth in volume on the CME Market after Q1 2019.[48]

In 2020, Alexander and Heck published a second paper in which the authors highlight the role unregulated futures and perpetual swaps from trading platforms such as Bitmex, Huobi, and OKEx play in the bitcoin market.[49] The analysis involves a complex, multidimensional approach to price discovery analysis conducted across eight different markets and four different exposure types (unregulated futures, regulated futures, perpetual swaps, and spot markets), each with different levels of microstructure friction and data integrity. These complications make it difficult to draw a direct comparison of this paper's results with the ten studies included in the table above.[50]

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48 The monthly ADV in the CME Market grew from $60 million in March 2019 to $230 million in April 2019, according to data from the CME Group. In Q3 2020, the CME Market had a $365 million ADV.

49 Alexander, C., and Heck, D. (2020), Price discovery in bitcoin: the impact of unregulated markets. Journal of Financial Stability (50), Article Number 100776.

50 The direct question around whether the CME Market leads or lags price discovery compared to the unregulated bitcoin futures market is explored in detail in a following sub-section titled "Examining Lead-Lag Relationships Between The Unregulated Bitcoin Futures Market And The CME Bitcoin Futures Market."

- Hu et al. (2020) added to the literature, saying, “What we contribute to this literature here, especially compared to Alexander & Heck (2019), is that we consider price discovery in the Bitcoin futures markets that allow for time-varying approaches,” noting that cointegrating relationships can be interrogated more comprehensively using time-varying approaches. The authors conclude that, “Bitcoin futures markets dominate the price discovery process using a time-varying version of an information share measures of the IS and GIS types.” This finding provides additional clarity around the time-dependency of other price discovery analytical results.
- Akyildirim, Corbet et al. (2019) conducted its analysis in five-, ten-, 15-, 30-, and 60-min price data intervals to reach a range of IS and CS outcomes in order to test robustness across different data time intervals. The finding that the CME Market led the bitcoin spot market was consistent across all studied time intervals.
- Fassas et al. (2020) added another record to the body of literature finding that the CME Market led the bitcoin spot market, saying, “Our study confirms [the] Akyildirim et al. (2019), Alexander et al. (2019) and Kapar and Olmo (2019) conclusion that bitcoin futures markets, while in their relative youth, have portrayed evidence of price discovery leadership compared to the spot market.” Fassas et al. (2020) arrives at this conclusion after applying price discovery measures to the entire year of 2018 with hourly price data.

- Aleti and Mizrach (2020) explores the market microstructure of four spot trading platforms (Bitstamp, Coinbase, Kraken, and itBit) and the CME Market over a relatively narrow two-month time period (January 2, 2019 to February 28, 2019). The paper reports separate CME Market IS values for each of the four spot trading platforms, ranging from 53% versus itBit to 55% versus Bitstamp, and four CME Market CS values ranging from 68% versus itBit to 91% versus Kraken. All of these tests find that the CME Market led price discovery against each of the spot trading platforms.
- Chang et al. (2020) explored a more recent time period (the "second half of 2019") and found that the CME Market led the spot market in price discovery with a CS of 63%.

It is worth noting that – as explored in Putnins (2013)[51] – IS and CS price discovery metrics can face challenges when comparing markets that differ by tick size, trade frequency, and other microstructure frictions. Specifically, these measures bias against finding price formation in markets like the CME Market that have larger tick sizes or less frequent trades. In spite of these headwinds, a majority of the studies in the table above found the CME Market led price discovery against bitcoin spot market.[52]

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51 Putnins, T., What do price discovery metrics really measure? Journal of Empirical Finance, 23 (9), September 2013.

52 The Commission has previously cited mixed or unsettled academic literature on lead-lag analysis in its bitcoin ETP disapproval orders. See USBT Order, 84 FR at 12613. Of course, the existence of variable results in IS/CS analysis, either within one study or a group of studies, is not in isolation sufficient to determine that a commodity futures market does not satisfy the concerns of the Act. There are multiple commodity markets where the Commission has approved ETPs based

The Sponsor also evaluated three studies where the authors noted that the spot market led the CME Market or had mixed results:

- Corbet et al. (2018) is the earliest study examining whether the futures or spot market lead in the bitcoin market. It reached the conclusion that the spot market led, with IS and CS values assigned to the CME Market of just 15% and 18%, respectively. The time period of the price discovery analysis is not clear from the paper, and it is possible that, being the earliest paper, the period was very short. Akyildirim, Corbet, et al. (2019), a study that shares the same co-author (Corbet) but examines different data sets, arrived at the opposite conclusion, as noted above, determining that the futures market had the dominant share of price discovery. Discussing the difference between the two papers, Akyildirim, Corbet, et al. (2019) notes that Corbet et al. (2018) was based on a shorter time period, and for that reason, could have found a relationship that has since reversed.[53]

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in part on the existence of a regulated derivatives market of significant size where select IS/CS studies find that the related derivatives market is not the main source of price discovery. For instance, Dimpfl et al. (2017) found that futures markets account for less than 10% of IS price discovery in markets like corn, wheat, soybeans, cattle, and lean hogs. Dimpfl, T., Flad, M., and Jung, R. (2017), Price discovery in agricultural commodity markets in the presence of futures speculation. Journal of Commodity Markets, March 2017. Similarly, Narayan and Sharma (2018), examined data on 15 commodities markets from 1977 to 2012, found that spot led futures in nine commodities (canola, cocoa, coffee, corn, gold, platinum, silver, soybean oil, and soybean yellow), and that futures dominated in just six commodities (copper, crude oil, platinum, soybean meal, sugar and wheat). Narayan, P. and Sharma, S. (2018), An analysis of time-varying commodity market price discovery. International Review of Financial Analysis, May 2018.

53 Akyildirim, Corbet, et al. (2019) notes that “in contrast to results based on a

- Baur and Dimpfl (2019) is the other study that found the bitcoin spot market led the bitcoin futures market. This paper, however, has an important methodological flaw that led the CME Market contribution to appear artificially low: the authors conducted their price discovery analysis on a per-lifetime-of-each-contract basis, rather than a standard rolling-contract basis.

  Alexander and Heck (2019) explore this issue extensively, going as far as running a similar per-lifetime-of-each-contract analysis to observe how much lower the futures market contribution can appear. The authors concluded that "[t]his apparently leading role of the spot market is not surprising since, during the first few months after the introduction of a contract, there is always another contract with a nearer maturity where almost all trading activity occurs. So any finding that the spot market dominates the price discovery process is merely an artefact of very low trading volumes when the contract is first issued."

  Baur and Dimpfl (2019) acknowledge this issue and run a rolling-futures model of the same analysis for contracts traded on the Cboe, using a fairly standard methodology where the studied contract is rolled over one day prior to maturity. This led to a significantly higher share of price

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shorter period as in Corbet et al. (2018a), it appears that as the new cryptocurrency futures markets developed, they presented substantial leadership in price discovery over spot Bitcoin markets." This view is repeated in the conclusion, which says, "while earlier research found that information flows and price discovery were transmitted from spot to futures markets, this research verifies that this relationship has since reversed, most likely explained by the influx of institutional and sophisticated investors."

discovery for the Cboe contract, albeit one that still did not dominate the bitcoin spot market. Unfortunately, the authors were unable to do the same analysis for CME futures, noting that the continuous price data approach was "only feasible for the Cboe futures as there are short gaps in our CME data."

It is not clear why such data gaps existed, as CME data is readily available. Additionally, it is not appropriate to assume that, if the authors had studied a rolling-futures version of the CME analysis, the result would also have aligned with the findings of the rolling-futures version of the Cboe analysis. There were fewer CME bitcoin futures contracts in the data set than in the Cboe data set (four versus seven), and each of the CME contracts had a longer lifetime (or "Sample Period," as shown in Table 1 of the paper), likely leading to a stronger bias from this methodological flaw.

Therefore, the Sponsor concluded that Baur and Dimpfl (2019) failed to address whether the CME Market as a whole leads price discovery versus the bitcoin spot market.

- Entrop et al. (2020) arrives at a mixed result. In aggregate, the paper finds that the CME Market leads, noting that the futures exchange has an average IS value of 50% and average CS value of 53%. The paper also found that the CME Market led price discovery in a majority of months studied, noting, "We find that, on average, the futures market leads the price formation process in 9 (contract) months, while the spot market is

> the leader in the remaining (6) months." The paper, however, does note that the spot market led the CME Market in a statistically significant way in the last two months of the study (February and March 2019), and in nonsignificant ways in select other months. These findings led the authors to the claim that "the leading market has changed."
>
> The Sponsor noted that Aleti and Mizrach (2020) and Alexander and Heck (2019) explored price discovery in overlapping time periods and reached a different conclusion.

In summary, the Sponsor concluded that the majority of academic and practitioner papers support the view that the CME Market leads price discovery as compared with the bitcoin spot market. Of the ten available papers, seven clearly find that the CME Market leads, and an eighth (Entrop et al. (2020)) has aggregate results in favor of the CME Market leading. Of the two papers that conclude that the spot market leads, one was an early paper that potentially studied a very limited time period (Corbet et al. (2018)) and the other (Baur and Dimpfl (2019)) has an important methodological flaw that limits its applicability to the question at hand.

In addition to the literature review above, the Sponsor conducted its own analysis of IS/CS price discovery between the CME Market and the bitcoin spot market. In preparing its analysis, the Sponsor considered that the academic literature on bitcoin price discovery does not have a single approach to defining "the bitcoin spot market." Many studies, such as Baur and Dimpfl (2019), use a single bitcoin trading platform as a proxy for all existing spot platforms; others, such as Aleti and Mizrach (2020), evaluate a small number (typically two to five) of bitcoin trading platforms as representative of the bitcoin

spot market; still others, like Kapar and Olmo (2019), use an aggregated price (in their case, the Coindesk Bitcoin USD Price Index, which draws on a screened subset of global bitcoin trading platforms).

The Sponsor evaluated the CME Market and ten bitcoin trading platforms, more than the number used in other studies encountered in the Sponsor's academic literature review. These trading platforms included all five Constituent Platforms represented in the CME US Reference Rate and the CME UK Reference Rate (Bitstamp, Coinbase, Gemini, itBit and Kraken), along with five additional bitcoin trading platforms with high reported trading volume (Binance, Bitfinex, Huobi, LBank, and OKEx). These trading platforms include both the largest USD-BTC Pair trading platform by reported volume (Coinbase) and the largest tether-BTC pair trading platform by reported volume (Binance).[54]

The Sponsor used available trade data, from the inception of the CME bitcoin futures contract on December 18, 2017 through the end of September 30, 2020. The results aligned with the majority of academic and practitioner research in finding that the CME Market leads the bitcoin spot market. The results are statistically significant for all ten trading platforms when evaluated from both an IS and a CS perspective.

The Sponsor presents the results in both full time period and monthly formats. Academic literature commonly presents results as full time period results; however, the Sponsor noted that shorter time periods such as the monthly results may be more

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[54] While reported volumes on bitcoin trading platforms need to be considered with caution, Coinbase and Binance regularly appear as the top trading platform for the USD-BTC Pair and tether-BTC pair, respectively, on CoinMarketcap.com (https://coinmarketcap.com/currencies/bitcoin/markets/). Tether is a digital asset used as a "stablecoin" that has an intended value of $1.

appropriate given the potential for time variation in the bitcoin trading market.

The table below shows the IS and CS for the CME Market versus each of the ten spot trading platforms averaged across the entire time period (December 18, 2017 to September 30, 2020), along with a 95% confidence interval for those results. The * indicates that the results are statistically significant (p-value < 0.05). Note that all of the IS and CS values and their confidence intervals are above the 50% mark, indicating that CME Market led all of the ten spot trading platforms across this time period.

	CME IS	**Confidence Interval**	**CME CS**	**Confidence Interval**
Binance	58.32%*	56.78% - 59.86%	57.38%*	55.45% - 59.32%
Bitfinex	65.75%*	64.22% - 67.29%	65.08%*	63.28% - 66.89%
Bitstamp	64.10%*	62.74% - 65.47%	68.03%*	66.21% - 69.86%
Coinbase	60.60%*	59.20% - 62.00%	60.88%*	58.99% - 62.77%
Gemini	56.44%*	55.03% - 57.84%	56.73%*	54.73% - 58.72%
Huobi	60.91%*	59.34% - 62.49%	58.97%*	56.96% - 60.98%
itBit	53.33%*	51.91% - 54.75%	52.97%*	50.93% - 55.00%
Kraken	63.17%*	61.58% - 64.76%	63.24%*	61.29% - 65.19%
LBank	66.03%*	63.95% - 68.11%	63.51%*	61.34% - 65.68%
OKEx	56.19%*	54.74% - 57.64%	53.60%*	51.73% - 55.47%

To provide additional context to this finding, the Sponsor also examined each market on a calendar-month-by-calendar-month basis. This calendar-month-segmented approach allowed the Sponsor to evaluate the potential for time variation in price discovery leadership between the CME Market and the bitcoin spot market over shorter periods.

The table below displays the percentage of months that the CME Market led price discovery versus each of the ten evaluated spot trading platforms since the launch of the

CME bitcoin futures contract in December 2017. The exact numbers vary by exchange, but on average, the CME Market has led spot trading platforms from an IS perspective in 89% of evaluated months, and from a CS perspective in 80% of evaluated months.

	% of Months CME Led IS	% of Months CME Led CS
Binance	85%	79%
Bitfinex	94%	91%
Bitstamp	94%	91%
Coinbase	91%	85%
Gemini	82%	76%
Huobi	94%	84%
itBit	79%	62%
Kraken	94%	91%
LBank	90%	80%
OKEX	85%	65%
Average	**89%**	**80%**

Taken together, these findings support the conclusion that the CME Market leads price discovery compared with the bitcoin spot market, and that leadership is generally persistent across the full time period.

Time-Shift Lead-Lag Analysis on the Bitcoin Spot Market vs. the CME Market

The Sponsor also examined time-shift lead-lag analysis (TSLL), the other popular academic approach to investigating market leadership. TSLL is an attempt to find the direction and length of the lead-lag relationship between two price series that maximizes the predictive strength of one price series against another. The analysis is performed by shifting one price series forward or backward in time relative to another series and calculating the cross-correlation between the two series and is repeated for many different lag periods to see which amount of lag of one price series results in the highest cross-

correlation between the two price series. The amount of lead or lag that results in the highest cross-correlation is referred to as "lead-lag time."

The Sponsor analyzed the TSLL relationship between the CME Market and the same ten bitcoin spot trading platforms evaluated using IS/CS price discovery analysis. The analysis utilized available trade data from the inception of the CME bitcoin futures contract on December 18, 2017 through the end of the study on September 30, 2020.

The results of the Sponsor's TSLL analysis align with the results of its IS/CS analysis and demonstrate that the CME Market leads all evaluated spot trading platforms over the duration of the study.

The table below shows the lead-lag time (the amount of lead or lag that results in the highest cross-correlation between two price series) for the CME Market versus each of the ten spot trading platforms, calculated daily, and averaged across the entire time period (December 18, 2017 to September 30, 2020). The table also shows the 95% confidence interval for those results. A positive value indicates the CME Market leading by that amount of seconds. A negative value would indicate CME Market lagging by that amount of seconds. The * indicates the result being statistically significant (p-value < 0.05), meaning the lead-lag time for the entire time period lies squarely within the positive (or negative) value territory.

	Lead-Lag Time (seconds)	**Confidence Interval (seconds)**
Binance	7.28*	6.53 – 8.03
Bitfinex	9.03*	8.33 – 9.73
Bitstamp	6.52*	5.96 – 7.08
Coinbase	8.42*	7.65 – 9.18

Gemini	6.51*	5.91 – 7.11
Huobi	7.57*	6.96 – 8.18
itBit	8.63*	7.89 – 9.37
Kraken	17.19*	16.00 – 18.38
Lbank	16.62*	15.37 – 17.87
OKEx	8.27*	7.41 – 9.13

The lead-lag times vary slightly by trading platform, but are all contained within a positive value band of 6.51–17.19 seconds, indicating CME leading. All results are statistically significant.

The results of our TSLL analysis support the conclusion of our IS/CS analysis, showing that the CME Market leads each of the ten evaluated spot trading platforms in a statistically significant manner over the duration of the study.

These findings across both types of statistical analysis are, perhaps, unsurprising. Futures markets often lead price discovery when compared to spot markets. As described in papers like Garbade and Silver (1983),[55] Chan (1992),[56] and Fleming et al. (1996),[57] futures benefit from leverage, lower transaction costs, and access to short exposure. In addition, in the bitcoin market, the regulated nature of the CME Market may attract more professional investors than unregulated spot markets. These professional investors may have advantages over retail investors from an available capital, technology, information

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55 Garbade, K. and Silber, W. (1983), Price movements and price discovery in futures and cash markets. The Review of Economics and Statistics 65(2), 289-297.

56 Chan, K. (1992), A further analysis of the lead-lag relationship between the cash market and stock index futures market. The Review of Financial Studies (5)1, 123-152.

57 Fleming et al. (1996), Trading Costs and the relative rates of price discovery in stock, futures, and option markets. Journal of Futures Markets 16(4), 353-387.

flow, and trading speed perspective. Such conditions may be expected to continue into the future, particularly as bitcoin sees continued and expanded adoption as an investable asset among professional and institutional investors.

Examining Lead-Lag Relationships Between the Unregulated Bitcoin Futures Market and the CME Bitcoin Futures Market

After completing its analysis showing that the CME Market leads price discovery compared to the bitcoin spot market, the Sponsor considered whether the CME Market leads price discovery compared to the unregulated bitcoin futures market.

A number of unregulated bitcoin futures trading platforms ("Unregulated Futures Platforms") exist, so the first step in this analysis was to determine which Unregulated Futures Platforms to consider.

The Sponsor gathered data from CoinGecko, a popular crypto data provider, which maintains an extensive list of Unregulated Futures Platforms and their futures contracts.[58] CoinGecko tracks two categories of contracts: perpetual futures and quarterly futures. Perpetual futures are cash-settled futures that do not have an expiration date, while quarterly futures settle on a calendar basis and must be rolled forward to maintain exposure. Aggregating these two categories generated a list of 33 Unregulated Futures Platforms. The Sponsor elected to evaluate the seven largest Unregulated Futures Platforms based on open interest: Binance, BitMEX, Bybit, Deribit, FTX, Huobi, and OKEx. Together, these Unregulated Futures Platforms accounted for approximately 80% of all open interest captured by CoinGecko at the time of the analysis on May 4,

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[58] CoinGecko (https://www.coingecko.com/en/coins/bitcoin#markets). Navigate to the "Perpetuals" (perpetual futures) and "Futures" (predominantly quarterly futures) sub tabs within the "Markets" tab.

2021.

Because some offer both perpetual and quarterly contracts, the Sponsor selected from each Unregulated Futures Platform the contract type and specific contract with the highest level of open interest: perpetual futures for Binance, BitMEX, Bybit, Deribit, and FTX, and quarterly futures for Huobi and OKEx.

The Sponsor used the full period of data available for each Unregulated Futures Platform, through the end of Q1, 2021. The data start month for each Unregulated Futures Platform was:

- Binance: September 2019
- BitMEX: December 2017[59]
- Bybit: October 2019
- Deribit: August 2018
- FTX: July 2019
- Huobi: August 2019
- OKEx: October 2018

As with the CME Market's monthly futures contract, Huobi and OKEx's quarterly futures contracts were rolled one day prior to expiration in order to create a continuous price series.

The table below highlights key statistics for the highest open interest contract on each of the evaluated Unregulated Futures Platforms, plus the CME Market, for the

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59 BitMEX was the only platform that existed and has data available from the inception of the CME bitcoin futures market on December 17, 2017. OKEx claims to have launched bitcoin futures trading as early as June 2013, but historical data for OKEx is not available before October 2018. Binance, Bybit, Deribit, FTX, and Huobi all launched bitcoin futures trading after the inception of the CME bitcoin futures market, between 2018 and 2019.

month of May 2021: Open Interest, Trading Volume, and Required Margin. The CME Market row is highlighted in light blue.

	Open Interest	Trading Volume	Required Margin
Bybit	$1,666,878,515	$7,438,356,443	1%
Binance	$1,575,326,903	$21,718,058,270	<1%
CME	$1,404,125,298	$1,840,129,468	33%
FTX	$1,232,139,553	$4,423,394,792	1%
OKEx	$842,460,775	$2,112,965,793	<1%
Huobi	$680,431,607	$5,823,998,157	<1%
BitMEX	$664,421,615	$2,656,967,907	1%
Deribit	$599,004,598	$1,264,134,910	1%

The contracts differ significantly along each of these tracked metrics. For instance, Bybit perpetual futures have the highest open interest, while Binance perpetual futures have the highest trading volume.

The Sponsor noted the stark difference in required margin between the CME Market and all of the evaluated Unregulated Futures Platforms. The Unregulated Futures Platforms in this study offer clients leverage at ratios ranging from 100-to-1 to 125-to-1, meaning the required margin is 1% or less of the notional value of open contract positions. By comparison, the maximum leverage ratio for the CME bitcoin futures contract is 3-to-1, meaning a 33% required margin ratio.

While traders on a given Unregulated Futures Platform do not always make use of the full amount of potential leverage, industry reports suggest that the level of realized leverage on Unregulated Futures Platforms is high. For instance, a 2019 report from BitMEX found that the average level of realized leverage for BitMEX bitcoin perpetual futures for the year ending April 2019 was approximately 27-to-1, meaning an average

maintained margin of less than 4%.[60]

The high leverage ratios offered by Unregulated Futures Platforms mean that, at any given moment, the amount of capital committed to any one of these unregulated futures contracts is likely significantly lower than the amount of capital committed to the CME bitcoin futures contract. As a hypothetical example, assuming an average margin of 4% (i.e., 25-to-1 leverage), the amount of capital backing the $7.26 billion in aggregate open interest across the seven unregulated futures contracts can be estimated at $363 million. By comparison, assuming a 33% margin (the minimum required), the capital backing the $1.40 billion of open interest on the CME bitcoin futures contract is at least $462 million. In other words, it is possible that the amount of capital committed to the CME bitcoin futures contract is larger than the capital committed to all of the evaluated Unregulated Futures Platform futures contracts, combined.

The Sponsor's analysis noted that it is not clear, looking just at these top-level statistics alone, that the CME Market or any of the Unregulated Futures Platforms is likely to lead price discovery. To make this determination, the Sponsor compared data from the CME Market and each of the Unregulated Futures Platformsusing the same statistical techniques used to evaluate price discovery between the CME Market and spot bitcoin trading platforms.

The table below shows the results of the Sponsor's IS and CS analysis, comparing the CME Market with each of the seven Unregulated Futures Platforms over the duration of the study. Each Unregulated Futures Platform evaluation has its own date range, based

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60 BitMEX Leverage Statistics, April 2019 (https://blog.bitmex.com/bitmex-leverage-statistics-april-2019/).

on the length of data available for such platform.

As in the spot market analysis, IS and CS values above 50% indicate that the CME Market led price discovery against a given Unregulated Futures Platformover the duration of the study period. A * indicates that the results are statistically significant (p-value < 0.05). The confidence interval column shows a 95% confidence interval for the context.

The results show that the CME Market has led price discovery against each of the seven Unregulated Futures Platforms across the duration of the study. The results are statistically significant for all platforms when evaluated from an IS perspective, and for six of seven platforms from a CS perspective.

	CME IS	**Confidence Interval**	**CME CS**	**Confidence Interval**	**Data Range**
Binance	55.30%*	53.64% - 56.96%	54.01%*	51.41% - 56.61%	Sept 2019 - Mar 2021
BitMEX	63.67%*	62.30% - 65.04%	63.33%*	61.68% - 64.99%	Dec 2017 - Mar 2021
Bybit	61.50%*	59.69% - 63.30%	60.26%*	57.75% - 62.77%	Oct 2019 - Mar 2021
Deribit	56.91%*	55.56% - 58.26%	56.20%*	54.23% - 58.17%	Aug 2018 - Mar 2021
FTX	56.73%*	55.13% - 58.32%	58.72%*	56.33% - 61.10%	July 2019 - Mar 2021
Huobi	55.25%*	53.33% - 57.17%	53.85%*	51.36% - 56.33%	Aug 2019 - Mar 2021
OKEx	53.04%*	51.45% - 54.63%	51.22%	49.14% - 53.31%	Oct 2018 - Mar 2021

The Sponsor also compared the CME Market against each Unregulated Futures Platform on a month-by-month basis. The table below shows the percentage of months that the CME Market led IS/CS price discovery against each Unregulated Futures Platform:

	% of Months CME Led IS	% of Months CME Led CS	Data Range
Binance	84%	74%	Sept 2019 - Mar 2021
BitMEX	93%	90%	Dec 2017 - Mar 2021
Bybit	100%	94%	Oct 2019 - Mar 2021
Deribit	88%	78%	Aug 2018 - Mar 2021
FTX	90%	95%	July 2019 - Mar 2021
Huobi	85%	70%	Aug 2019 - Mar 2021
OKEx	73%	60%	Oct 2018 - Mar 2021

These monthly results support the conclusion of the Sponsor's full duration analysis in finding that the CME Market leads each of the seven Unregulated Futures Platforms from an IS and CS perspective.

In addition to its IS/CS analysis, the Sponsor also examined the CME Market and each of the Unregulated Futures Platforms using TSLL analysis. The table below shows the lead-lag time (the amount of lead or lag that results in the highest cross-correlation between two price series) for the CME Market versus each of the seven Unregulated Futures Platforms, calculated daily and averaged across the entire time period applicable to the Unregulated Futures Platform. The table also shows the 95% confidence interval for those results.

A positive value indicates the CME Market leading by that amount of seconds. A negative value would indicate CME Market lagging. The * indicates the result being statistically significant (p-value < 0.05), meaning the lead-lag time for the entire time period lies squarely within the positive (or negative) value territory.

	Lead-Lag Time (seconds)	Confidence Interval (seconds)	Data Range
Binance	3.07*	2.50 - 3.65	Sept 2019 - Mar 2021
BitMEX	7.23*	6.76 - 7.70	Dec 2017 - Mar 2021

Bybit	5.13*	4.56 - 5.70	Oct 2019 - Mar 2021
Deribit	4.98*	4.47 - 5.49	Aug 2018 - Mar 2021
FTX	2.27*	2.08 - 2.46	July 2019 - Mar 2021
Huobi	2.34*	2.21 - 2.47	Aug 2019 - Mar 2021
OKEx	3.47*	2.94 - 4.00	Oct 2018 - Mar 2021

The results show that prices on the CME Market led prices on the Unregulated Futures Platforms by 2-7 seconds in a statistically significant manner. These results are in-line with the results of the IS/CS analysis, and support the finding that the CME Market leads price discovery compared to the unregulated bitcoin futures market.

That these findings demonstrating that the CME Market leads the unregulated bitcoin futures market in price discovery might surprise some market observers, given the higher total notional volumes on the Unregulated Futures Platforms. Besides the possibility that the self-reported trading volumes on Unregulated Futures Platforms could be inflated, the Sponsor theorizes that highly levered retail investors with limited capital on the Unregulated Futures Platforms may be opening and closing positions more frequently, resulting in higher notional volumes, but with lesser impact on price discovery relative to well capitalized, long-term oriented professional investors on the CME Market. In addition, professional investors may have advantages over retail investors from a technology, information flow, and trading speed perspective. Such conditions may be expected to continue into the future, particularly as bitcoin sees continued and expanded adoption as an investable asset among professional and institutional investors.

Conclusion of Winklevoss Standard Prong 1: Reasonable Likelihood

The first prong of the Winklevoss Standard requires demonstrating a reasonable

likelihood that a person attempting to manipulate a bitcoin ETP would also have to trade on the CME Market. In prior disapproval orders, the Commission has stated that demonstrating a lead-lag relationship between prices on the CME Market and the underlying bitcoin spot market is "central" to understanding this reasonable likelihood.

As detailed herein, through extensive statistical analysis and careful consideration of third-party evaluations of these markets, the Sponsor has demonstrated that the CME Market leads the bitcoin spot market and the unregulated bitcoin futures market, such that it is reasonably likely that a person attempting to manipulate the ETP would also have to trade on the CME Market, thus satisfying the first prong of the Winklevoss Standard.

Winklevoss Standard Prong 2: Predominant Influence

The second prong of the Winklevoss Standard requires demonstrating that it is unlikely that trading in the Trust would become the predominant influence on prices in the CME Market. As detailed below, the Sponsor's analysis shows that trading in the Trust is unlikely to become the predominant influence on prices in the CME Market, even when assuming aggressive estimates of first-year flows of $4.7 billion and average daily trading volume of $143 million.[61]

Estimating the Likely First-Year Flows into a Bitcoin ETP

The Sponsor examined extensive data from other ETPs and a well-known, publicly traded bitcoin trust to estimate the likely first-year flows into a newly approved bitcoin ETP.

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61 See Matthew Hougan, Hong Kim, and Satyajeet Pal, Is it likely that a US bitcoin ETP, if approved, will become the predominant influence on prices in the CME bitcoin futures market? February 16, 2021, as amended and supplemented ("Bitwise Prong Two Paper").

First, the Sponsor examined first-year flows into all ETPs currently listed on the market, using data from FactSet.[62] The Sponsor excluded ETPs with negative first-year flows.

Of the more than 2,200 ETPs with positive or flat first-year flows:

- The median ETP attracted $28 million in flows during its first year on the market.
- The ETP with the highest first-year flows in history—the Invesco QQQ Trust (Nasdaq: QQQ)—attracted $5.35 billion in flows.

The table below highlights the ten ETPs with the highest first-year flows in ETP history.

Fund	**Ticker**	**Year-One Flows ($M)**
Invesco QQQ Trust	QQQ	5,351
Communication Services Select Sector SPDR	XLC	5,186
iShares MSCI EAFE ETF	EFA	4,292
JPMorgan BetaBuilders Europe ETF	BBEU	4,187
PIMCO Active Bond ETF	BOND	4,116
JPMorgan BetaBuilders Japan ETF	BBJP	3,755
JPMorgan BetaBuilders Canada ETF	BBCA	3,656
iShares Select Dividend ETF	DVY	3,245
Real Estate Select Sector SPDR Fund	XLRE	3,171
SPDR Gold Shares	GLD	3,010

As the analysis shows, $5.35 billion is the outer limit of historical first-year flows into a bitcoin ETP. There is no precedent for an ETP attracting more than this in its first year on the market. The Sponsor concluded it is unlikely that a bitcoin ETP will experience the highest first-year flows in history, particularly given the relative size of

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62 Data obtained from FactSet on November 30, 2020.

the bitcoin market compared to the markets captured by the ETPs above, which target parts or all of the equity, bond, real estate, and gold markets.[63]

To provide a more detailed comparison, the Sponsor also examined first-year flows into first-to-market single-commodity ETPs. Bitcoin is considered a commodity by the Commodity Futures Trading Commission,[64] and one way to view a potential bitcoin ETP is as a first-to-market single-commodity ETP offering exposure to bitcoin in the same manner that the SPDR Gold Shares (NYSEArca: GLD) was a first-to-market single-commodity ETP offering exposure to gold, and the iShares Silver Trust (NYSEArca: SLV) was a first-to-market single-commodity ETP offering exposure to silver.

The following table shows the first-year flows into every first-to-market single-commodity ETP currently available in the U.S., again using data from FactSet.[65] First-year flows range from $3.01 billion for GLD to negative $1 million for the iPath

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63 At year-end 2020, the total market capitalization of bitcoin was $539 billion, according to blockchain.com. By comparison, the global market capitalization of the equity market was $95 trillion and the outstanding value of the global bond market was $106 trillion in 2019, according to the most recently published SIFMA Capital Markets Fact Book (September 2020), available at https://www.sifma.org/wp-content/uploads/2020/09/US-Fact-Book-2020-SIFMA.pdf; the professionally managed global real estate market was $9.6 trillion in 2019, according to MSCI's Market Size Report on Global Real Estate, available at https://www.msci.com/real-estate/market-size-report; and the total value of above-ground gold was $10 trillion on December 31, 2020, according to the World Gold Council available at https://www.gold.org/goldhub/data/above-ground-stocks.

64 The Commodity Futures Trading Commission has argued successfully in federal courts that digital assets such as bitcoin are commodities. See, e.g., Commodity Futures Trading Commission v McDonnell and CabbageTech, Corp., 18-CV-361 (E.D.N.Y. March 6, 2018) and Commodity Futures Trading Commission v My Big Coin Pay, Inc., 18-cv-10077-RWZ (D. Mass. Sept. 26, 2018).

65 Data obtained from FactSet on November 30, 2020.

Bloomberg Lead Subindex Total Return ETN (NYSEArca: LD).[66]

Commodity	Ticker	Year-One Flows ($M)
Gold	GLD	$3,010
Silver	SLV	$1,730
Crude Oil	USO	$827
Platinum	PPLT	$708
Palladium	PALL	$603
Natural Gas	UNG	$374
Corn	CORN	$115
Coffee	JO	$48
Gasoline	UGA	$28
Sugar	SSG	$12
Soybeans	SOYB	$10
Cotton	BAL	$7
Nickel	JJN	$2
Copper	CPER	$2
Wheat	WEAT	$1
Cocoa	NIB	$1
Aluminum	JJU	$1
Carbon Credits	GRN	$0
Tin	JJT	$0
Lead	LD	-$1

These figures provide additional context on the likely upper bound of potential flows into a bitcoin ETP.

Finally, the Sponsor examined the Grayscale Bitcoin Trust (OTCQX: GBTC), a publicly traded grantor trust that holds bitcoin directly with a third-party custodian. As of

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66 Negative flows occur when a product is seeded with a certain amount of capital but some of that capital is redeemed over time, and there are no offsetting creations.

December 31, 2020, GBTC was the only product that provided investors with readily accessible exposure to bitcoin through traditional brokerage accounts, and has been available to U.S. investors since May 2015.[67] A bitcoin ETP and GBTC will likely compete for investor allocations.

GBTC is different from an ETP in certain ways, including that the structure does not allow for redemptions, that it has a different regulatory status than an ETP, and that shares of GBTC are materially more likely to trade at significant and variable premiums and/or discounts to the net asset value of the trust. GBTC does, however, permit creations, allowing it to accommodate flows to reflect investor demand. As such, it can be a useful data set for analyzing investor demand for exposure to bitcoin through a traditional brokerage window and what impact flows from such demand can have on prices in the CME Market.[68]

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67 See OTC Markets Group Inc., press release, May 5, 2015. OTC Markets Group Welcomes Bitcoin Investments Trust to OTCQX, available at https://www.prnewswire.com/news-releases/otc-markets-group-welcomes-bitcoin-investment-trust-to-otcqx-300077150.html.

68 The Sponsor notes that one difference between the creation/redemption and arbitrage mechanism between GBTC and an ETP is that newly created shares in GBTC are not immediately available to be sold in the secondary market. Instead, after purchasing shares, an investor must hold the shares for 6-months before they are permitted to be traded on the secondary market. This creates a longer holding period for an arbitrageur, as compared to a typical ETP arbitrage trade where an authorized participant may immediately trade newly created shares into the secondary market. For example, to capture arbitrage on GBTC shares trading at a premium, an arbitrageur would need to short sell GBTC shares while buying spot bitcoin, deliver the bitcoin for creation of GBTC shares, and hold those shares for six months until they are released from transfer restriction and can be delivered to the short sellers to close out the trade. But while the holding period of the GBTC share premium arbitrage is at minimum 6 months, the buying in the spot bitcoin market occurs, in this case, right before the creation date, which is the date inflows into GBTC are recorded.

In its most successful year, GBTC attracted a record $4.7 billion in flows in 2020, according to Grayscale Investments.[69] The fund's previous record was $472 million, set in 2019. 2020's record flows occurred during a sustained bull market for bitcoin, as bitcoin's price rose 306% in 2020.[70]

Based on the foregoing assessments, the Sponsor utilized $4.7 billion as its working estimate for first-year flows into a new bitcoin ETP. The Sponsor believed this estimate to be aggressive, as it assumes that a bitcoin ETP will:

- be the third-fastest-growing ETP in history, out of more than 2,200 products with positive year-one flows;
- significantly surpass (by more than 50%) the first-year flows into GLD, which experienced the highest first-year flows in first-to-market single-commodity ETP history; and
- match the highest annual flow in GBTC's history, achieved during a strong bull market, all while the new ETP is forced to compete for market share with GBTC itself.

Evaluating the Potential Influence of ETP Flows on Prices in the CME Market

The Sponsor analyzed whether such flows into a first-to-market bitcoin ETP

In addition, institutional arbitrageurs are not the only cohort that can create shares for GBTC. Accredited investors may also subscribe for GBTC shares either by contributing bitcoin or delivering cash. For cash orders, Genesis Trading Global, Inc., the "authorized participant" of the trust, purchases the bitcoin for the given cash amount by 6 p.m. ET on the day the cash is provided by the subscriber.

69 See Grayscale Investments, Digital Asset Investment Report, Q4 2020 (grayscale.co/insights/grayscale-q4-2020-digital-asset-investment-report/).

70 Bitcoin's price rose from $7,147 on December 31, 2019 to $29,026 on December 31, 2020 according to the Coin Metrics bitcoin reference rate, available at https://coinmetrics.io/reference-rates/.

would cause such ETP to be the predominant influence on prices in the CME Market.

Based on information on the flows into GBTC that are publicly available from multiple sources,[71] the Sponsor analyzed with historical data whether $4.7 billion in flows into a bitcoin investment product in a single year would be likely to cause that product to become the predominant influence on prices in the CME Market.

The Sponsor's statistical analysis examined the relationship of flows into GBTC in 2020 and the changes in the price of bitcoin, using both daily and weekly flows.[72] Daily (or weekly) flows were calculated from Bloomberg data by multiplying the change in outstanding shares of the trust by the net asset value per share of that day (or week). Daily (or weekly) percentage price changes of bitcoin were calculated using the 4:00 p.m. E.T. bitcoin reference rate from Coin Metrics.[73]

The charts below show the results of the Sponsor's analysis. Each dot represents a daily (or weekly) flow into GBTC and the corresponding daily (or weekly) change in the price of bitcoin. As such, there are 253 dots in the first chart representing each trading day, and 52 dots in the second chart representing each week in 2020.

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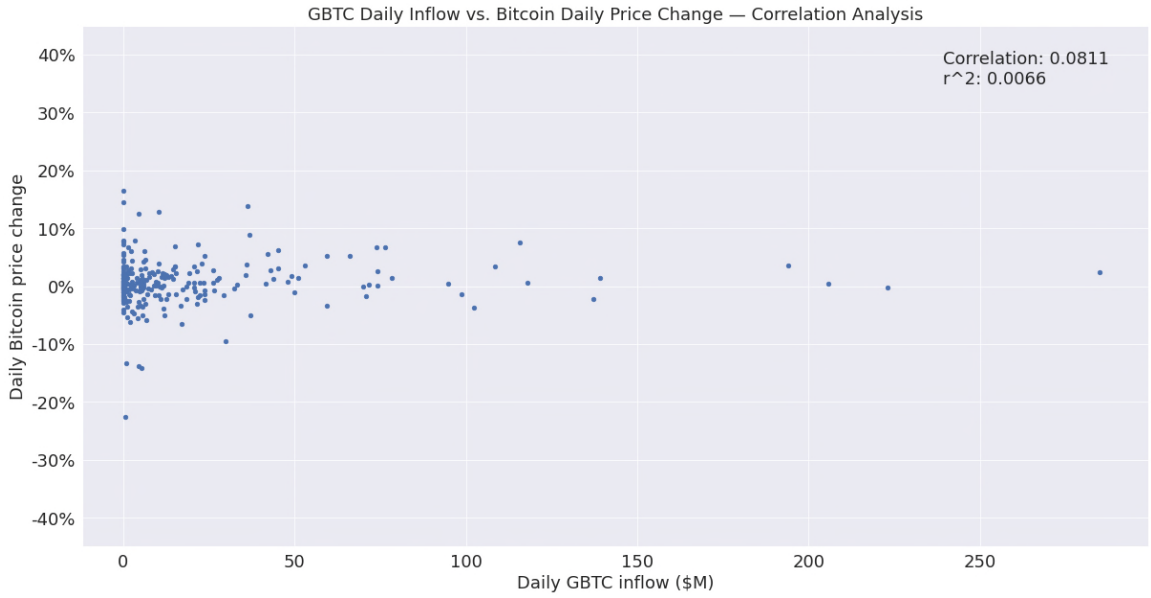
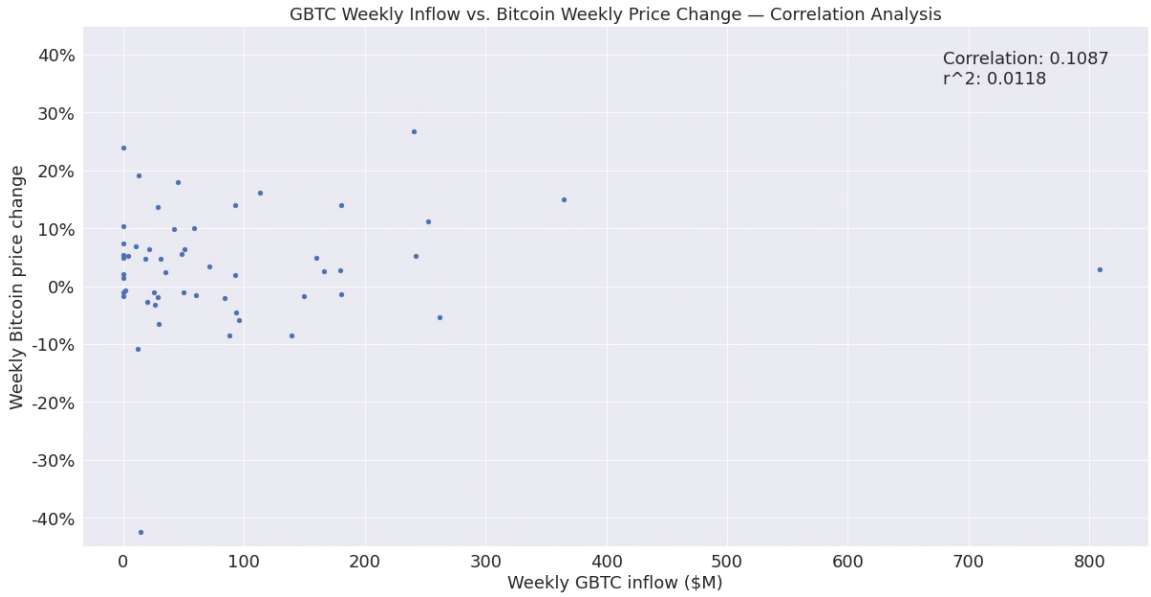
71 Information on GBTC creation of shares is available from the issuer, reports on Form 8-K filed by the issuer on sec.gov, and third party websites such as Bloomberg.

72 The Sponsor has used both single day and weekly flows, acknowledging that the buying activity for an in-kind creation may not necessarily occur in a single day leading up to the creation date. Instead, an investor might build their position over time. Using both daily and weekly flows helps to capture more of this extended possibility.

73 See note70, supra.





The data shows there is no meaningful relationship between daily and weekly flows into GBTC and changes in the price of bitcoin, despite the aggregate flows being $4.7 billion: The correlation for daily results is 0.08 and the correlation for weekly results is 0.11, both of which are low.

The experience of outlier days and weeks with large flows supports this conclusion. For instance, the largest one-day flow occurred on December 22, 2020, when

$285 million flowed into the fund; bitcoin's price moved up 2.3% that day, within the normal daily range for a bitcoin price move.[74]

Similarly, the largest one-week flow occurred for the week ending December 27, 2020, when GBTC attracted approximately $809 million in flows; bitcoin's price settled up just 2.9% that week, again within the normal range for a weekly price move.[75]

Based on this statistical analysis, the Sponsor concluded that it is unlikely that the aggressive estimate of first-year flows into a bitcoin ETP ($4.7 billion) would cause it to become the predominant influence on prices in the CME Market.

Estimating the Likely Trading Volume of a Bitcoin ETP

Beyond the impact of investment flows, the Sponsor considered whether secondary market trading in the Shares would be likely to become the predominant influence on prices in the CME Market. The Sponsor was able to draw on two relevant comparisons to create estimates of the likely trading volume of a bitcoin ETP.

First, the Sponsor considered trading in GBTC, using secondary market data from Bloomberg. Shares of GBTC are publicly quoted on the OTCQX Best Market and are widely available to U.S. investors through traditional brokerage accounts. As such, although GBTC operates under a different regulatory structure than an ETP and has historically traded at significant and variable premiums and discounts to its net asset value, the historical turnover of GBTC provide one estimate of the future turnover of a bitcoin ETP. GBTC's average daily trading volume (ADV) in 2020 was $103 million.

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74 The standard deviation of the daily percentage price change of bitcoin in 2020 using the Coin Metrics bitcoin reference rate was 4.38%.

75 The standard deviation of the weekly percentage price change of bitcoin in 2020 using the Coin Metrics bitcoin reference rate was 10.35%.

On a monthly basis, that figure ranged from $37 million in April 2020 to $368 million December 2020, as reported in the table below.

Examining ADV in isolation offers only a partial picture, however. Trading activity in GBTC is correlated with the product's assets under management (AUM), which is in turn linked to bitcoin's price. The table below shows the "ADV/AUM Ratio" for GBTC for each month in 2020, using the month-end AUM as the denominator. Although the absolute size of the ADV ranges widely across 2020, the ADV/AUM ratio stays fairly consistent, running from 1.10% (April and September) to 2.21% (February). The average ADV/AUM ratio for the year was 1.54%.

Month	**ADV (M)**	**AUM (M)**	**ADV / AUM RATIO**
Jan 2020	$43	$3,191	1.36%
Feb 2020	$66	$2,997	2.21%
Mar 2020	$44	$2,249	1.96%
Apr 2020	$37	$3,313	1.10%
May 2020	$68	$4,034	1.68%
Jun 2020	$52	$3,870	1.33%
Jul 2020	$65	$5,264	1.23%
Aug 2020	$89	$6,018	1.47%
Sep 2020	$57	$5,167	1.10%
Oct 2020	$95	$7,728	1.23%
Nov 2020	$259	$13,060	1.98%
Dec 2020	$368	$20,445	1.80%
Average	***$103***	***$6,445***	***1.54%***

Applying this average ADV/AUM ratio to the $4.7 billion working estimate of first-year flows into a bitcoin ETP, the estimated daily trading volume would be approximately $72 million at the end of the ETP's first year.

A second comparison that may be useful is to examine the case of other first-to-

market commodity ETPs. GLD is the largest such ETP, and therefore trading activity of GLD[76] may provide a useful comparison. Using the same methodology as with GBTC, the Sponsor examined the ADV/AUM ratio of GLD for every month in 2020. The ratio value ranged from 1.65% (September) to 5.93% (March). The average ratio was 3.04%.

Month	**ADV (M)**	**AUM (M)**	**ADV / AUM RATIO**
Jan 2020	$1,206	$46,053	2.62%
Feb 2020	$2,010	$47,348	4.25%
Mar 2020	$2,903	$48,916	5.93%
Apr 2020	$1,828	$57,343	3.19%
May 2020	$1,819	$62,557	2.91%
Jun 2020	$1,606	$67,484	2.38%
Jul 2020	$2,215	$78,789	2.81%
Aug 2020	$3,312	$79,163	4.18%
Sep 2020	$1,272	$76,941	1.65%
Oct 2020	$1,376	$75,889	1.81%
Nov 2020	$1,855	$73,285	2.53%
Dec 2020	$1,369	$71,558	1.91%
Average	***$1,901***	***$65,022***	***3.04%***

Applying GLD's ADV/AUM ratio to the $4.7 billion working estimate of first-year flows into a bitcoin ETP, the estimated daily trading volume would be approximately $143 million. The Sponsor elected to use this estimate of $143 million as its working estimate for average daily trading volume of a new bitcoin ETP at the end of its first year. The Sponsor believes this estimate to be aggressive, as it assumes that a bitcoin ETP will:

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76 See GLD historical market data, available at https://www.spdrgoldshares.com/usa/historical-data/.

- be the third-fastest-growing ETP in history, out of more than 2,200 products with positive year-one flows.
- have an ADV/AUM ratio approximately two times higher than that of GBTC, which also offers exposure to bitcoin through traditional brokerage accounts.

Evaluating the Potential Influence of Secondary Market Trading in ETP Shares on Prices in the CME Market

The CME Market had an average daily trading volume of $392 million in 2020. The lowest month, April 2020, had an average daily trading volume of $176 million, and the highest month, December 2020, had an average daily trading volume of $935 million. The table below shows the ADV of the CME Market each month in 2020.

Month	**CME ADV (M)**
Jan 2020	$408
Feb 2020	$401
Mar 2020	$202
Apr 2020	$176
May 2020	$305
Jun 2020	$223
Jul 2020	$252
Aug 2020	$455
Sep 2020	$397
Oct 2020	$329
Nov 2020	$665
Dec 2020	$935

Given that the average daily trading volume of the CME Market in 2020 was 174% higher at $392 million than the Sponsor's aggressive estimate of a new bitcoin ETP's potential trading volume of $143 million, the Sponsor found that it is unlikely that

trading in a new bitcoin ETP will cause such ETP to become the predominant influence on prices in the CME Market.

Conclusion of Winklevoss Standard Prong 2: Predominant Influence

The second prong of the Winklevoss Standard requires demonstration that it is unlikely that trading in the Trust would become the predominant influence on prices in the CME Market.

As detailed herein, the Sponsor's analysis shows that trading in the Trust is unlikely to become the predominant influence on prices in the CME Market, even when assuming aggressive estimates of first-year flows of $4.7 billion and average daily trading volume of $143 million.

* * *

In conclusion, as the foregoing analysis and data demonstrates, the proposal has met its burden presented by Section 6(b)(5) of the Act[77] and, in particular, the requirement that the rules of a national securities exchange be designed to prevent fraudulent and manipulative acts and practices, by demonstrating that the CME Market (i) is a regulated market; (ii) participates in a surveillance sharing agreement with the Exchange; and (iii) satisfies the Commission's "significant market" definition under the Winklevoss Standard.

Availability of Information Regarding the Shares and Bitcoin

The NAV will be disseminated daily to all market participants at the same time. Quotation and last-sale information regarding the Shares will be disseminated through the facilities of the CTA. The ITV will be calculated every 15 seconds throughout the core

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77 15 U.S.C. 78f(b)(5).

trading session each trading day, and available through online information services.

The Sponsor will cause information about the Shares to be posted to the Trust's website (https://www.bitwiseinvestments.com/): (i) the NAV and NAV per Share for each Exchange trading day, posted at end of day; (ii) the daily holdings of the Trust, before 9:30 a.m. E.T. on each Exchange trading day; (iii) the Trust's effective prospectus, in a form available for download; and (iv) the Shares' ticker and CUSIP information, along with additional quantitative information updated on a daily basis for the Trust. For example, the Trust's website will include (i) the prior business day's trading volume, the prior business day's reported NAV and closing price, and a calculation of the premium and discount of the closing price or mid-point of the bid/ask spread at the time of NAV calculation ("Bid/Ask Price") against the NAV; and (ii) data in chart format displaying the frequency distribution of discounts and premiums of the daily closing price or Bid/Ask Price against the NAV, within appropriate ranges, for at least each of the four previous calendar quarters. The Trust's website will be publicly available prior to the public offering of Shares and accessible at no charge.

Investors may obtain on a 24-hour basis bitcoin pricing information based on the CME US Reference Rate, CME UK Reference Rate and CME Bitcoin Real Time Price, bitcoin spot market prices and bitcoin futures price from various financial information service providers. Current bitcoin spot market prices are also generally available with bid/ask spreads from bitcoin trading platforms, including the Constituent Platforms of the CME US Reference Rate.

Trading Halts

With respect to trading halts, the Exchange may consider all relevant factors in

exercising its discretion to halt or suspend trading in the Shares of the Trust.[78] Trading in Shares of the Trust will be halted if the circuit breaker parameters in NYSE Arca Rule 7.12-E have been reached. Trading also may be halted because of market conditions or for reasons that, in the view of the Exchange, make trading in the Shares inadvisable.

The Exchange may halt trading during the day in which an interruption to the dissemination of the ITV occurs.[79] If the interruption to the dissemination of the ITV persists past the trading day in which it occurred, the Exchange will halt trading no later than the beginning of the trading day following the interruption. In addition, if the Exchange becomes aware that the NAV with respect to the Shares is not disseminated to all market participants at the same time, it will halt trading in the Shares until such time as the NAV is available to all market participants. The Exchange may also halt trading if the value of the underlying commodity is no longer calculated or available on at least a 15-second delayed basis from a source unaffiliated with the Sponsor, Trust, Bitcoin Custodian or the Exchange or if the Exchange stops providing a hyperlink on its Web site to any such unaffiliated commodity value.

Trading Rules

The Exchange deems the Shares to be equity securities, thus rendering trading in the Shares subject to the Exchange's existing rules governing the trading of equity securities. Shares will trade on the NYSE Arca Marketplace from 4 a.m. to 8 p.m. E.T. in accordance with NYSE Arca Rule 7.34-E (Early, Core, and Late Trading Sessions). The Exchange has appropriate rules to facilitate transactions in the Shares during all trading

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78 See NYSE Arca Rule 7.12-E.

79 A limit up/limit down condition in the futures market would not be considered an interruption requiring the Trust to be halted.

sessions. As provided in NYSE Arca Rule 7.6-E, the minimum price variation ("MPV") for quoting and entry of orders in equity securities traded on the NYSE Arca Marketplace is $0.01, with the exception of securities that are priced less than $1.00 for which the MPV for order entry is $0.0001.

The Shares will conform to the initial and continued listing criteria under NYSE Arca Rule 8.201-E. The trading of the Shares will be subject to NYSE Arca Rule 8.201-E(g), which sets forth certain restrictions on Equity Trading Permit ("ETP") Holders acting as registered Market Makers in Commodity-Based Trust Shares to facilitate surveillance.[80] The Exchange represents that, for initial and continued listing, the Trust will be in compliance with Rule 10A-3 under the Act,[81] as provided by NYSE Arca Rule 5.3-E. A minimum of 100,000 Shares of the Trust will be outstanding at the commencement of trading on the Exchange.

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80 Under NYSE Arca Rule 8.201-E(g), an ETP Holder acting as a registered Market Maker in the Shares is required to provide the Exchange with information relating to its trading in the underlying commodity, related futures or options on futures, or any other related derivatives. Commentary .04 of NYSE Arca Rule 11.3-E requires an ETP Holder acting as a registered Market Maker, and its affiliates, in the Shares to establish, maintain and enforce written policies and procedures reasonably designed to prevent the misuse of any material nonpublic information with respect to such products, any components of the related products, any physical asset or commodity underlying the product, applicable currencies, underlying indexes, related futures or options on futures, and any related derivative instruments (including the Shares).

As a general matter, the Exchange has regulatory jurisdiction over its ETP Holders and their associated persons, which include any person or entity controlling an ETP Holder. To the extent the Exchange may be found to lack jurisdiction over a subsidiary or affiliate of an ETP Holder that does business only in commodities or futures contracts , the Exchange could obtain information regarding the activities of such subsidiary or affiliate through surveillance sharing agreements with regulatory organizations of which such subsidiary or affiliate is a member.

81 17 CFR 240.10A-3.

Surveillance

The Exchange represents that trading in the Shares of the Trust will be subject to the existing trading surveillances administered by the Exchange, as well as cross-market surveillances administered by FINRA on behalf of the Exchange, which are designed to detect violations of Exchange rules and applicable federal securities laws.[82] The Exchange represents that these procedures are adequate to properly monitor Exchange trading of the Shares in all trading sessions and to deter and detect violations of Exchange rules and federal securities laws applicable to trading on the Exchange.

The Exchange further represents that it may obtain information regarding trading in the Shares and the CME Market from the CME and other markets and other entities that are members of the ISG or with which the Exchange has in place a comprehensive surveillance sharing agreement.[83] The Exchange or FINRA, on behalf of the Exchange, or both, will communicate as needed regarding trading in the Shares and the CME Market with the CME and other markets and entities that are members of the ISG, and the Exchange or FINRA, on behalf of the Exchange, or both, may obtain trading information regarding trading in the Shares, the CME Market and the underlying commodity, as applicable, from such markets and other entities.

Also, pursuant to NYSE Arca Rule 8.201-E(g), the Exchange is able to obtain information regarding trading in the Shares, bitcoin futures and the underlying bitcoin

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82 FINRA conducts cross-market surveillances on behalf of the Exchange pursuant to a regulatory services agreement. The Exchange is responsible for FINRA's performance under this regulatory services agreement.

83 For a list of the current members of ISG, see https://isgportal.org/. The Exchange notes that not all components of the Trust may trade on markets that are members of ISG or with which the Exchange has in place a comprehensive surveillance sharing agreement.

through ETP Holders acting as registered Market Makers, in connection with such ETP Holders' proprietary or customer trades through ETP Holders which they effect on any relevant market.

In addition, the Exchange has a general policy prohibiting the improper distribution of material, non-public information by its employees.

All statements and representations made in this filing regarding (i) the description of the index, portfolio or referenced asset, (ii) limitations on index or portfolio holdings or reference assets, or (iii) the applicability of Exchange listing rules specified in this rule filing will constitute continued listing requirements for listing the Shares on the Exchange.

The Sponsor has represented to the Exchange that it will advise the Exchange of any failure by the Trust to comply with the continued listing requirements, and, pursuant to its obligations under Section 19(g)(1) of the Act, the Exchange will monitor for compliance with the continued listing requirements. If the Trust is not in compliance with the applicable listing requirements, the Exchange will commence delisting procedures under NYSE Arca Rule 9.2-E(a).

2. Statutory Basis

The basis under the Act for this proposed rule change is the requirement under Section 6(b)(5)[84] that an exchange have rules that are designed to prevent fraudulent and manipulative acts and practices, to promote just and equitable principles of trade, to remove impediments to, and perfect the mechanism of a free and open market and, in general, to protect investors and the public interest.

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84 15 U.S.C. 78f(b)(5).

The Exchange believes that the proposed rule change is designed to prevent fraudulent and manipulative acts and practices and to protect investors and the public interest in that the Shares will be listed and traded on the Exchange pursuant to the initial and continued listing criteria in NYSE Arca Rule 8.201-E. Further, the Exchange has demonstrated that the proposed rule change satisfies the Winklevoss Standard with respect to the CME Market.

As discussed above, both existing academic literature and the Sponsor's own studies show that the CME Market leads price discovery relative to the bitcoin spot market. As a result, and given that the Sponsor has demonstrated that it is unlikely that trading in the Shares will become the predominant influence upon prices in the CME Market, the CME Market represents a regulated market of significant size, and that there is a reasonable likelihood that a person attempting to manipulate the Shares would also have to trade on that market to successfully manipulate the Shares.[85]

The Exchange has in place surveillance procedures that are adequate to properly monitor trading in the Shares and the CME Market in all trading sessions and to deter and detect attempted manipulation of the Shares or other violations of Exchange rules and applicable federal securities laws. The Exchange or FINRA, on behalf of the Exchange, or both, will communicate as needed regarding trading in the Shares and bitcoin futures with the CME and other markets and other entities that are members of the ISG, and the Exchange or FINRA, on behalf of the Exchange, or both, may obtain trading information regarding trading in the Shares from such markets and other entities. In addition, the Exchange may obtain information regarding trading in the Shares from markets and other

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85 See notes 222 and 23, supra, and accompanying text.

entities that are members of ISG or with which the Exchange has in place a comprehensive surveillance sharing agreement. The Exchange is also able to obtain information regarding trading in the Shares and bitcoin futures or the underlying bitcoin through ETP Holders, in connection with such ETP Holders' proprietary or customer trades which they effect through ETP Holders on any relevant market.

Quotation and last-sale information regarding the Shares will be disseminated through the facilities of the CTA. The Trust's website will also include a form of the prospectus for the Trust that may be downloaded. The website will include the Shares' ticker and CUSIP information, along with additional quantitative information updated on a daily basis for the Trust. The Trust's website will include (i) daily trading volume, the prior business day's reported NAV and closing price, and a calculation of the premium and discount of the closing price or mid-point of the Bid/Ask Price against the NAV; and (ii) data in chart format displaying the frequency distribution of discounts and premiums of the daily closing price or Bid/Ask Price against the NAV, within appropriate ranges, for at least each of the four previous calendar quarters. The Trust's website will be publicly available prior to the public offering of Shares and accessible at no charge.

Trading in Shares of the Trust will be halted if the circuit breaker parameters in NYSE Arca Rule 7.12-E have been reached or because of market conditions or for reasons that, in the view of the Exchange, make trading in the Shares inadvisable.

The proposed rule change is designed to perfect the mechanism of a free and open market and, in general, to protect investors and the public interest in that it will facilitate the listing and trading of a new type of exchange-traded product based on the price of bitcoin that will enhance competition among market participants, to the benefit of

investors and the marketplace. As noted above, the Exchange has in place surveillance procedures that are adequate to properly monitor trading in the Shares in all trading sessions and to deter and detect violations of Exchange rules and applicable federal securities laws.

B. Self-Regulatory Organization's Statement on Burden on Competition

The Exchange does not believe that the proposed rule change will impose any burden on competition that is not necessary or appropriate in furtherance of the purpose of the Act. The Exchange notes that the proposed rule change will facilitate the listing and trading of a new type of Commodity-Based Trust Share based on the price of bitcoin that will enhance competition among market participants, to the benefit of investors and the marketplace.

C. Self-Regulatory Organization's Statement on Comments on the Proposed Rule Change Received from Members, Participants, or Others

No written comments were solicited or received with respect to the proposed rule change.

III. Date of Effectiveness of the Proposed Rule Change and Timing for Commission Action

Within 45 days of the date of publication of this notice in the Federal Register or up to 90 days (i) as the Commission may designate if it finds such longer period to be appropriate and publishes its reasons for so finding or (ii) as to which the self-regulatory organization consents, the Commission will:

(A) by order approve or disapprove the proposed rule change, or

(B) institute proceedings to determine whether the proposed rule change should be disapproved.

IV. Solicitation of Comments

Interested persons are invited to submit written data, views, and arguments concerning the foregoing, including whether the proposed rule change is consistent with the Act. Comments may be submitted by any of the following methods:

Electronic comments:

- Use the Commission's Internet comment form (http://www.sec.gov/rules/sro.shtml); or
- Send an e-mail to rule-comments@sec.gov. Please include File Number SR-NYSEARCA-2021-89 on the subject line.

Paper comments:

- Send paper comments in triplicate to: Secretary, Securities and Exchange Commission, 100 F Street, NE, Washington, DC 20549-1090.

All submissions should refer to File Number SR-NYSEARCA-2021-89. This file number should be included on the subject line if e-mail is used. To help the Commission process and review your comments more efficiently, please use only one method. The Commission will post all comments on the Commission's Internet website (http://www.sec.gov/rules/sro.shtml). Copies of the submission, all subsequent amendments, all written statements with respect to the proposed rule change that are filed with the Commission, and all written communications relating to the proposed rule change between the Commission and any person, other than those that may be withheld from the public in accordance with the provisions of 5 U.S.C. 552, will be available for website viewing and printing in the Commission's Public Reference Room, 100 F Street, NE, Washington, DC 20549 on official business days between the hours of 10:00 a.m.

and 3:00 p.m. Copies of the filing also will be available for inspection and copying at the principal office of the Exchange. All comments received will be posted without change. Persons submitting comments are cautioned that we do not redact or edit personal identifying information from comment submissions. You should submit only information that you wish to make available publicly. All submissions should refer to File Number SR-NYSEARCA-2021-89 and should be submitted on or before [insert date 21 days from publication in the Federal Register].

For the Commission, by the Division of Trading and Markets, pursuant to delegated authority.[86]

Eduardo A. Aleman
Deputy Secretary

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86 17 CFR 200.30-3(a)(12).

EXHIBIT 3A

Price Discovery In The Modern Bitcoin Market: Examining Lead-Lag Relationships Between The Bitcoin Spot And Bitcoin Futures Market

By Matthew Hougan, Hong Kim, and Satyajeet Pal

Bitwise Asset Management

June 11, 2021

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I. Introduction

In 2008, the online posting of a technical white paper—*Bitcoin: A Peer-to-Peer Cash Electronic Cash System*[1]—envisioned a new way to store and transfer value on the internet. In the ensuing years, bitcoin has grown from a niche asset embraced by retail investors into an increasingly mainstream allocation held by a wide variety of market participants, from individual investors to financial advisors, hedge funds, corporations, institutions, endowments, insurance companies, and more. As of September 30, 2020, the end of this study, bitcoin was valued at $200 billion.[2]

As the market has grown, so too has the trading ecosystem that allows for the efficient transfer of bitcoin from one market participant to another. This ecosystem today includes both large spot trading platforms (e.g., Coinbase[3]) and a large, regulated futures market run by the CME Group.[4]

This paper builds on a growing library of academic and practitioner research that aims to determine whether price discovery in the bitcoin market primarily takes place on spot trading platforms or on the regulated CME bitcoin futures market. This paper extends the existing literature in four primary ways:

1. **Time Period:** This paper uses available trade data on the CME bitcoin futures market, from its inception in December 2017 through the end of the study on September 30, 2020.

2. **Academic Survey:** This paper includes a detailed survey of existing academic and practitioner research, examining papers that have evaluated where price discovery occurs between spot trading platforms and the regulated bitcoin futures market.

3. **Diversity of Statistical Approaches:** This paper takes a broad approach to its analysis, using two distinct and well-established statistical methods to evaluate the lead-lag relationship between the spot and futures markets.

4. **Data Quality and Replicability:** This paper uses professionally developed data feeds in its analysis, as well as commonly available statistical software tools, so that the study can be replicated by other researchers.

Using this multifaceted and replicable approach, the paper finds that the CME bitcoin futures

[1] https://bitcoin.org/bitcoin.pdf
[2] Bitcoin's market cap as of September 30, 2020 was $200.75B. Source: Blockchain.com.
[3] Q3 2020 ADV for Coinbase was $194M. Source: Coin Metrics.
[4] Q3 2020 ADV of the CME bitcoin futures market was $365M. Source: CME Group.

market leads the bitcoin spot market in a consistent and statistically significant manner.

II. Data Sourcing

Bitcoin trading platforms exist in multiple countries and operate under a variety of regulatory regimes. There are generally no requirements for these platforms to provide data on their trading activity in a uniform fashion to a centralized database. As a result, there is no equivalent to the Consolidated Tape System in the U.S., which offers a single source of universally agreed-upon trading data for publicly traded equities in the U.S.

Over the years, however, a variety of private data providers have emerged that consolidate trading data from large numbers of bitcoin trading platforms. In preparing to evaluate price discovery in the bitcoin markets, we engaged in a detailed survey of these data providers in May 2020, evaluating them on metrics including data quality, trading platform coverage, cost, service quality, and other corporate factors. The goal of this survey was to determine which provider or set of providers could supply the highest quality data.

We began by cataloging bitcoin data providers commonly referenced in the industry. We then supplemented this list by conducting broad web searches to identify additional bitcoin data providers and by consulting a third-party survey titled, “The State of the Digital Asset Data and Infrastructure,” published by The Block on May 14, 2020.[5]

Aggregating these steps resulted in a total of 29 firms, 14 of which offered bitcoin tick data, the specific type of data needed to conduct lead-lag analysis. We evaluated these 14 firms on four separate criteria:

- **Data coverag**e: All else equal, more trading platforms are better than fewer.
- **Data quality**: Data gathered by third-party providers should match the actual activity that takes place on each trading platform, with as few errors as possible.
- **Cost**: The cost of licensing the data from a given provider should be reasonable.
- **Corporate factors**: Available facts should give confidence that the provider in question will continue to operate in a robust manner over a meaningful period of time.

Data quality was weighted heavily in the analysis, as it has a direct impact on the output of price discovery research. Still, the other three factors were important as well.

Based on this analysis, we elected to use Coin Metrics as the lead data provider for our analysis.

[5]https://www.tbstat.com/wp/uploads/2020/05/The-State-of-the-Digital-Asset-Data-and-Infrastructure-Landscape-1.pdf

At the time, Coin Metrics offered coverage of 26 exchanges, and had exceptionally high data quality. For instance, in one portion of our analysis, we downloaded the full record of BTC/USD trades (2,523,481 trades) directly from Bitfinex, a spot bitcoin trading platform, for the month of March 2020. We compared these trades with data from participating data providers, looking for three types of errors: duplicated trades, erroneous trades, and missing trades. Coin Metrics had zero data errors, while its competitors had between two and 4,929 errors. We repeated this analysis using trades at Coinbase and LBank, two additional bitcoin trading platforms, and found similar results.

To supplement Coin Metrics' data, we evaluated data providers that covered a large number (>100) of crypto trading platforms. Of these providers, CoinAPI scored the best on our four factors, including scoring well on data quality. We elected to use CoinAPI data to supplement Coin Metrics data where necessary to conduct our analysis.

Using Coin Metrics and CoinAPI data, we focused our analysis on 10 bitcoin trading platforms: the five trading platforms that contribute to the price used to settle the CME CF Bitcoin Reference Rate[6] (Bitstamp, Coinbase, Gemini, itBit, and Kraken), and five additional trading platforms with large reported trading volumes that do not contribute to the CME CF Bitcoin Reference Rate (Binance, Bitfinex, Huobi, LBank, and OKEx).

Data on CME bitcoin futures was taken directly from the CME Group.

[6] The price used to settle bitcoin futures contracts on the CME. https://www.cmegroup.com/trading/cryptocurrency-indices/cf-bitcoin-reference-rate.html

III. Analytical Framework: Two Approaches To Evaluating Price Discovery And Lead-Lag Relationships

We began this analysis by reviewing relevant academic and practitioner papers. This included papers broadly related to the topic of price discovery and lead-lag analysis in financial markets, and papers that specifically evaluated these concepts vis-à-vis the bitcoin spot market and the regulated bitcoin futures market.

This survey revealed two major categories of price discovery analysis in the general financial market literature:

> **i) Information Share (IS)/Component Share (CS) Price Discovery Analysis:** This type of analysis is based on the principle that there is a common "efficient" price for any asset being traded on multiple platforms. It allows you to construct a model of the relationship between different platforms by comparing their price series against this common efficient price, and testing which price series is faster to incorporate new information. Markets that are faster to incorporate new information are considered to have a "higher share" of price discovery; and
>
> **ii) Time-Shift Lead-Lag Analysis (TSLL):** TSLL is a more intuitive approach to evaluating lead-lag relationships between markets. It involves taking two time series of price data and offsetting (or "shifting") them against each other to determine what offset, or "lag," produces the highest cross-correlation between the two series.

Both IS/CS price discovery analysis and TSLL have an extensive history in the financial literature, and each comes with its own strengths and weaknesses.

We evaluate each approach separately in this paper and discuss the holistic result in our conclusion.

IV. Information Share (IS) And Component Share (CS) Price Discovery Analysis

Information share (IS) and component share (CS) are two variants of a core analytical approach to price discovery research that traces its roots back to the 1990s. It is sometimes referred to in the literature as "common efficient price"-based analysis, "fundamental price"-based analysis, or simply "price discovery" analysis.

Price discovery analysis is based on the idea that, in a perfectly efficient market, new information should be reflected simultaneously in the price of an asset as it trades on different platforms. In practice, however, this is not the case; some platforms move before others. In addition, some market moves are simply noise that do not reflect a change in the fundamental price at all. Price discovery analysis attempts to measure the speed and accuracy with which each platform incorporates new information into its price. Platforms that are faster to incorporate new information while being better at avoiding noise are considered to have a "higher share" of price discovery.

Specific approaches to this type of price discovery analysis have evolved over time.

A. Academic Overview

In 1995, Hasbrouck[7] proposed the information share (IS) metric, describing his new metric as measuring "'who moves first' in the process of price adjustment." He used it to compare price discovery for equities on the New York Stock Exchange with those on regional stock exchanges. Hasbrouck's work built on early advances of Garbade and Silber (1983),[8] and is considered a foundational paper in price discovery research.

In the same year, Gonzalo and Granger (1995)[9] discussed a method of modeling a common time series by composing each individual series based on its "component weight," or contribution to the common price. Gonzalo and Granger's work was extended by many others, including Booth, So, and Tse (1999),[10] Chu, Hsieh, and Tse (1999),[11] and Harris, McInish, and Wood (2002).[12] It

[7] Hasbrouck, J. (1995). One security, many markets: Determining the contributions to price discovery. The Journal of Finance, 50(4), 1175-1199.
[8] Garbade, K.D., and Silber, W.L. (1983). Price movements and price discovery in futures and cash markets, Review of Economics and Statistics 65(2), 289-297.
[9] Gonzalo, J., and Granger, C. (1995). Estimation of common long-memory components in cointegrated systems. Journal of Business & Economic Statistics, 13(1), 27-35.
[10] Booth G., So R., Tse Y. (1999). Price discovery in the German equity index derivatives markets. Journal of Futures Markets, 19(6), 619-643.
[11] Chu QC, Hsieh WG, Tse Y (1999). Price discovery on the S&P 500 index markets: An analysis of spot index, index futures and SPDRs. International Review of Financial Analysis, 8(1), 21-34.
[12] Harris F., McInish T., Wood R. (2002). Security price adjustment across exchanges: An investigation of common factor components for Dow stocks. Journal of Financial Markets, 5(3), 277-308.

was labeled with the name Component Share (CS) by Yan and Zivot (2010).[13]

It is fairly standard in academic analyses of price discovery to present both IS and CS statistics, since they have slightly different statistical characteristics. We have followed that standard in our own analysis.

Importantly, as the name suggests, IS and CS are presented as "shares" in the literature. When comparing two markets, the IS (CS) assigned to the two markets must sum to 100%. A market is considered to lead price discovery if it has a majority share (>50%) of IS (CS).

Despite the paired nature of IS (CS) values, the convention in the literature is to present only one value in the results tables, leaving the other implied. For instance, a paper examining price discovery between Market A and Market B would only report the IS (CS) share of Market A.

We have followed that convention, only reporting the IS (CS) value of the CME bitcoin futures market, as it is compared to each spot bitcoin trading platform. Therefore, in this document, an IS (CS) value above 50% indicates that the CME bitcoin futures market leads price discovery compared with the bitcoin spot trading platform in question.

B. Bitcoin Markets Literature Review

We conducted a broad literature survey and identified 10 academic and practitioner studies that use IS and/or CS to compare the bitcoin spot market with the CME bitcoin futures market. These papers and core findings are summarized in the table below (a single long horizontal table has been divided here into two parts).

#	Title	Year	Authors
1	Bitcoin futures—What use are they?	2018	Corbet, Lucey, et al.
2	Price discovery in bitcoin spot or futures?	2019	Baur and Dimpfl
3	An analysis of price discovery between bitcoin futures and spot markets	2019	Kapar and Olmo
4	Price discovery, high-frequency trading and jumps in bitcoin markets	2019	Alexander and Heck
5	What role do futures markets play in bitcoin pricing? Causality, cointegration and price discovery from a time-varying perspective	2019	Hu, Hou, and Oxley
6	The development of bitcoin futures: Exploring the interactions between cryptocurrency derivatives	2019	Akyildirim, Corbet, et al.
7	Price discovery in bitcoin futures	2020	Fassas, Papadamou, and Koulis

[13] Yan, B., and Zivot, E. (2010). A structural analysis of price discovery measures. Journal of Financial Markets, 13(1) 1-19.

8	The determinants of price discovery on bitcoin markets	2020	Entrop, Frijns, and Seruset
9	Bitcoin spot and futures market microstructure	2020	Aleti and Mizrach
10	Efficient price discovery in the bitcoin markets	2020	Chang, Herrmann, and Cai

#	Authors	CME IS	CME CS	Intervals	Time Period	Result
1	Corbet, Lucey, et al.	15%	18%	1 min	--	Spot leads
2	Baur and Dimpfl	14%	14%	15 min	12/18/2017 - 10/18/2018	Spot leads
3	Kapar and Olmo	89%	--	1 day	12/18/2017 - 05/16/2018	Futures lead
4	Alexander and Heck	66%	73%	30 min	12/18/2017 - 06/30/2019	Futures lead
5	Hu, Hou, and Oxley	55%	--	1 day	12/18/2017 - 06/16/2019	Futures lead
6	Akyildirim, Corbet, et al.	91-97%	67-87%	1/5/10/15/30/60 min	12/18/2017 - 02/26/2018	Futures lead
7	Fassas, Papadamou, and Koulis	97%	77%	1 hour	01/01/2018 - 12/31/2018	Futures lead
8	Entrop, Frijns, and Seruset	50%	53%	1 min	12/18/2017 - 03/31/2019	Mixed
9	Aleti and Mizrach	53-55%	68-91%	5 min	01/02/2019 - 02/28/2019	Futures lead
10	Chang, Herrmann, and Cai	--	63%	1 min	07/01/2019 - 12/31/2019	Futures lead

As the table indicates, a majority of papers support the notion that the CME bitcoin futures market leads price discovery using IS and/or CS when compared to the bitcoin spot market.

Because the methodologies and findings of each paper are nuanced, it is worth examining each paper in detail.

We begin with papers aligned with the majority opinion that the CME bitcoin futures market leads the bitcoin spot market:

- Kapar and Olmo (2019)[14] was the first paper to assert that, contrary to the two studies that came before it (Corbet et al. (2018)[15] and Baur and Dimpfl (2019)[16]), the data "clearly reflect the leadership of the Bitcoin futures markets with respect to the spot market." The paper attributed 89% of IS to the futures market.

  Kapar and Olmo (2019) relies on daily price data, which means the study may not capture intraday information flow. Still, long-run relationships are relevant in holistically describing the relative strength one market has compared with another.

  The authors illustrated the importance of long-run relationships, saying, "when the market is in contango we can expect increases in the spot price in the next period. In contrast, when the market is in backwardation, the VECM suggests a fall in spot prices to correct departures from equilibrium." In other words, the authors found that if there is a gap between the spot and futures price on a given day, the spot price is more likely to correct toward the futures price than vice versa.

- Alexander and Heck (2019)[17] similarly found that there was "strong evidence that both CME and CBOE futures have played the leading role in price discovery." Unlike Kapar and Olmo (2019), Alexander and Heck (2019) used intraday data with a 30-minute timing interval. Their analysis ran from December 18, 2017 to June 30, 2019, the longest time period among the 10 studies we discovered. It showed that the CME bitcoin futures market led the bitcoin spot market with 66% of IS and 73% of CS during that time.

  Interestingly, the authors noted strong price leadership from CME futures during Q2 2019, the last quarter they studied. In fact, Q2 2019 boosted the overall IS from the study from 57% to 66%, and CS from 50% to 73%. This increase in the CME's contribution to price discovery aligned with significant growth in volume on the CME bitcoin futures market after Q1 2019.[18]

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[14] Kapar, B., and Olmo, J. (2019) An analysis of price discovery between Bitcoin futures and spot markets. Economics Letters (174), 62-64.
[15] Corbet, S., Lucey, B., Peat, M., and Vigne, S. (2018) Bitcoin futures—What use are they? Economics Letters (172), 23-27.
[16] Baur, D.G., and Dimpfl, T. (2019) Price discovery in bitcoin spot or futures? Journal of Futures Markets (39)7, 803-817.
[17] Alexander, C., and Heck, D. (2019) Price Discovery, High-Frequency Trading and Jumps in Bitcoin Markets. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3383147.
[18] The monthly ADV in the CME Bitcoin Futures Market grew from $60 million in March 2019 to $230 million in April 2019, according to data from the CME Group. In Q3 2020, the CME Bitcoin Futures market had a $365 million ADV.

Of note, Alexander and Heck published a second paper, in 2020, titled "Price discovery in bitcoin: The impact of unregulated markets"[19] where the authors highlight the role unregulated futures and perpetual swaps from trading platforms such as Bitmex, Huobi, and OKEx play in the bitcoin market. The analysis involves a complex, multidimensional approach to price discovery analysis conducted across eight different markets and four different exposure types (unregulated futures, regulated futures, perpetual swaps, and spot markets), each with different levels of microstructure friction and data integrity. These complications make it difficult to draw a direct comparison of this paper's results with the 10 studies included in the table above.

The direct question around whether the CME bitcoin futures market leads or lags price discovery compared to unregulated bitcoin futures trading platforms is explored in detail in Appendix A.

- Hu et al. (2020)[20] added to the literature, saying, "What we contribute to this literature here, especially compared to Alexander & Heck (2019), is that we consider price discovery in the Bitcoin futures markets that allow for time-varying approaches," noting that cointegrating relationships can be interrogated more comprehensively using time-varying approaches.

  The authors conclude that, "Bitcoin futures markets dominate the price discovery process using a time-varying version of an information share measure of both the IS and GIS types." This finding provides additional clarity around the time-dependency of other price discovery analytical results.

- Akyildirim, Corbet, et al. (2019)[21] conducted its analysis in 5-, 10-, 15-, 30-, and 60-min price data intervals to reach a range of IS and CS outcomes in order to test robustness across different data time intervals. The finding that the CME bitcoin futures market led the bitcoin spot market was consistent across all studied intervals.

- Fassas et al. (2020)[22] added another record to the body of literature, finding that CME futures lead the bitcoin spot market, saying, "Our study confirms [the] Akyildirim et al. (2019), Alexander et al. (2019) and Kapar and Olmo (2019) conclusion that bitcoin futures markets, while in their relative youth, have portrayed evidence of price discovery

[19] Alexander, C., and Heck, D. (2020). Price Discovery in Bitcoin: The Impact of Unregulated Markets. Journal of Financial Stability (50), Article Number 100776.
[20] Hu et al. (2020) What role do futures markets play in bitcoin pricing? Causality, cointegration and price discovery from a time-varying perspective. International Review of Financial Analysis (72).
[21] Akyildirim, Corbet, et al. (2020). The development of bitcoin futures: Exploring the interactions between cryptocurrency derivatives. Finance Research Letters (34).
[22] Fassas et al. (2020) Price discovery in bitcoin futures. Research in International Business and Finance (52).

leadership compared to the spot market." Fassas et al. (2020) arrives at this conclusion after applying price discovery measures to the entire year of 2018 with hourly price data.

- Aleti and Mizrach (2020)[23] explore the market microstructure of four spot trading platforms (Bitstamp, Coinbase, Kraken, and itBit) and the CME bitcoin futures market over a relatively narrow two-month time period (January 2, 2019 to February 28, 2019). The paper reports separate CME IS values for each of the four spot trading platforms, ranging from 53% versus itBit to 55% versus Bitstamp, and four CME CS values ranging from 68% versus itBit to 91% versus Kraken. All of these tests find that the CME futures led price discovery against each of the spot trading platforms.

- Chang et al. (2020)[24] explored a more recent time period (the "second half of 2019") and found that CME futures led the spot market in price discovery with a CS of 63%.

Of course, we should address the three studies where the authors noted that the spot market led the CME futures market or had mixed results:

- Corbet et al. (2018) is the earliest study examining whether the futures or spot market led in the bitcoin marketplace. It reached the conclusion that the spot market led, with IS and CS values assigned to the futures market of just 15% and 18%, respectively. The time period of the price discovery analysis is not clear from the paper, and it is possible that, being the earliest paper, the period was very short. Akyildirim, Corbet, et al. (2019), a study that shares the same co-author (Corbet) but examines different data sets, arrived at the opposite conclusion, as noted above, determining that the futures market had the dominant share of price discovery. Discussing the difference between the two papers, Akyildirim, Corbet, et al. (2019) notes that Corbet et al. (2018) was based on a shorter time period, and for that reason, could have found a relationship that has since reversed.[25]

- Baur and Dimpfl (2019) is the other study that found the bitcoin spot markets led the bitcoin futures market. This paper, however, has an important methodological flaw that led the the CME futures contribution to appear artificially low: The authors conducted their price discovery analysis on a per-lifetime-of-each-contract basis, rather than a standard rolling-contract basis.

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[23] Aleti, S., and Mizrach, B. (2021) Bitcoin spot and futures market microstructure. Journal of Futures Markets (41)2, 194-225.

[24] Chang et al. (2020) Efficient price discovery in the bitcoin markets. Wilshire Phoenix.

[25] Akyildirim, Corbet, et al. (2019) notes that "in contrast to results based on a shorter period as in Corbet et al. (2018a), it appears that as the new cryptocurrency futures markets developed, they presented substantial leadership in price discovery over spot Bitcoin markets." The view is repeated in the conclusion, which says, "while earlier research found that information flows and price discovery were transmitted from spot to futures markets, this research verifies that this relationship has since reversed, most likely explained by the influx of institutional and sophisticated investors."

Alexander and Heck (2019) explore this issue extensively, going as far as running a similar per-lifetime-of-each-contract analysis to observe how much lower the futures market contribution can appear, and concluded that, “This apparently leading role of the spot market is not surprising since, during the first few months after the introduction of a contract, there is always another contract with a nearer maturity where almost all trading activity occurs. So any finding that the spot market dominates the price discovery process is merely an artefact of very low trading volumes when the contract is first issued.”

Baur and Dimpfl (2019) acknowledge this issue in their own paper, and run a rolling-futures model of the same analysis for contracts traded on the Cboe, using a fairly standard methodology where the studied contract is rolled over one day prior to maturity. This led to a significantly higher share of price discovery for the Cboe contract, albeit one that still did not dominate the bitcoin spot market. Unfortunately, the authors were not able to do the same analysis for CME futures, noting that the continuous price data approach was “only feasible for the CBOE futures as there are short gaps in our CME data.”

It is not clear why such data gaps existed, as CME data is readily available. Additionally, it is not appropriate to assume that, if the authors had studied a rolling-futures version of the CME analysis, the result would also have aligned with the findings of the rolling-futures version of the Cboe analysis. There were fewer CME bitcoin futures contracts in the data set than in the Cboe data set (four versus seven), and each of the CME contracts had a longer lifetime (or “Sample Period,” as shown in Table 1 of the paper), likely leading to a stronger bias from this methodological flaw.

Therefore, this paper does not actually address the question at hand: whether the CME bitcoin futures market (as a whole) leads price discovery versus the bitcoin spot market.

- Entrop et al. (2020)[26] arrives at a mixed result. In aggregate, the paper finds that the CME leads, noting that the futures exchange has an average IS value of 50% and average CS value of 53%. The paper also finds that the CME led price discovery in a majority of months studied, noting, “We find that, on average, the futures market leads the price formation process in 9 (contract) months, while the spot market is the leader in the remaining (6) months.”

  The paper, however, does note that the spot market led the CME market in a statistically significant way in the last two months of the study (February and March 2019), and in

[26] Entrop, O., Frijns B., Seruset, M. (2020) The determinants of price discovery on bitcoin markets, The Journal of Futures Markets, (40)5, 816-837.

nonsignificant ways in select other months. These findings led the authors to the claim that “the leading market has changed.”

It is worth noting that Aleti et al. (2020) and Alexander and Heck (2019) explored price discovery in overlapping time periods and reached a different conclusion.

In summary, the majority of academic and practitioner papers support the view that the CME bitcoin futures market leads price discovery as compared with the bitcoin spot market. Of the 10 papers available in the literature, seven clearly find that the CME leads, and an eighth (Entrop et al. (2020)) has aggregate results in favor of CME leading. Of the two papers that conclude that the spot market leads, one was an early paper that potentially studied a very limited time period (Corbet et al. (2018)) and the other (Baur and Dimpfl (2019)) has an important methodological flaw that limits its applicability to the question at hand.

C. Analytical Methodology

We looked to extend and expand upon the academic literature by conducting a broad analysis of IS/CS price discovery between the CME bitcoin futures market and 10 bitcoin spot trading platforms, including all five trading platforms that contribute prices to the CME CF Bitcoin Reference Rate and five additional trading platforms with significant reported trading volume.

These 10 spot trading platforms were:

- Binance
- Bitfinex
- Bitstamp
- Coinbase
- Gemini
- Huobi
- itBit
- Kraken
- LBank
- OKEx

We used available trade data, from the inception of the CME bitcoin futures contract on December 18, 2017 through the end of the study on September 30, 2020. Data on spot trading

platforms was downloaded from Coin Metrics and CoinAPI.[27] Data on CME bitcoin futures was acquired directly from the CME Group.

We ran our IS/CS analysis using "pdshare,"[28] a publicly available software package written in the programming language R, that includes an implementation of IS and CS based on Hasbrouck (1995) and Gonzalo and Granger (1995). We chose to use a publicly available software package to increase the replicability of our research.

We took the following steps to run our analysis:

- Remove trades during non-CME trading hours. This includes removing holidays and weekends.
- For each pair of spot trading platform and CME bitcoin futures, align the price series into 1-second intervals where both platforms have a trade, taking the last traded price of the interval.
- Run pdshare's IS/CS analysis on each pair of price series, outputting an IS and CS value for each spot platform/futures pair for each day (i.e., the CME bitcoin futures market's percentage share of IS or CS versus the given spot trading platform for each day).
- Average the daily IS/CS values across the time periods, while running statistical significance tests with a 95% confidence interval.

D. Results

The results of our analysis align with the majority of academic and practitioner research in finding that the CME bitcoin futures market leads all evaluated bitcoin spot trading platforms over the duration of the study. These results are statistically significant for all 10 trading platforms when evaluated from both an IS and a CS perspective.

Here, we present the results in both full time period and monthly formats. The full time period results are commonly how results are presented in academic literature. However, shorter time periods such as the monthly results may be more appropriate given the potential for time variation in the cryptomarket.

Full Period Analysis

The table below shows the IS and CS for the CME versus each of the 10 spot trading platforms

[27] Coin Metrics data was used as the primary data source for all 10 spot trading platforms. CoinAPI data was used only to extend the time period back to December 18, 2017 for four trading platforms (Gemini, Huobi, itBit, and OKEx) that Coin Metrics did not have full time period coverage for.

[28] https://rdrr.io/rforge/ifrogs/man/pdshare.html. More details about the implementation including validation of accuracy can be found here: https://rdrr.io/rforge/ifrogs/f/inst/doc/pdshare.pdf.

averaged across the entire time period of this study (December 18, 2017 to September 30, 2020), along with a 95% confidence interval for those results. The * indicates that the results are statistically significant (p-value < 0.05). Note that all of the IS and CS values and their confidence intervals are above the 50% mark, indicating that CME led all of the 10 spot trading platforms across this time period.

	CME IS	**Confidence Interval**	**CME CS**	**Confidence Interval**
Binance	58.32%*	56.78% - 59.86%	57.38%*	55.45% - 59.32%
Bitfinex	65.75%*	64.22% - 67.29%	65.08%*	63.28% - 66.89%
Bitstamp	64.10%*	62.74% - 65.47%	68.03%*	66.21% - 69.86%
Coinbase	60.60%*	59.20% - 62.00%	60.88%*	58.99% - 62.77%
Gemini	56.44%*	55.03% - 57.84%	56.73%*	54.73% - 58.72%
Huobi	60.91%*	59.34% - 62.49%	58.97%*	56.96% - 60.98%
itBit	53.33%*	51.91% - 54.75%	52.97%*	50.93% - 55.00%
Kraken	63.17%*	61.58% - 64.76%	63.24%*	61.29% - 65.19%
LBank	66.03%*	63.95% - 68.11%	63.51%*	61.34% - 65.68%
OKEx	56.19%*	54.74% - 57.64%	53.60%*	51.73% - 55.47%

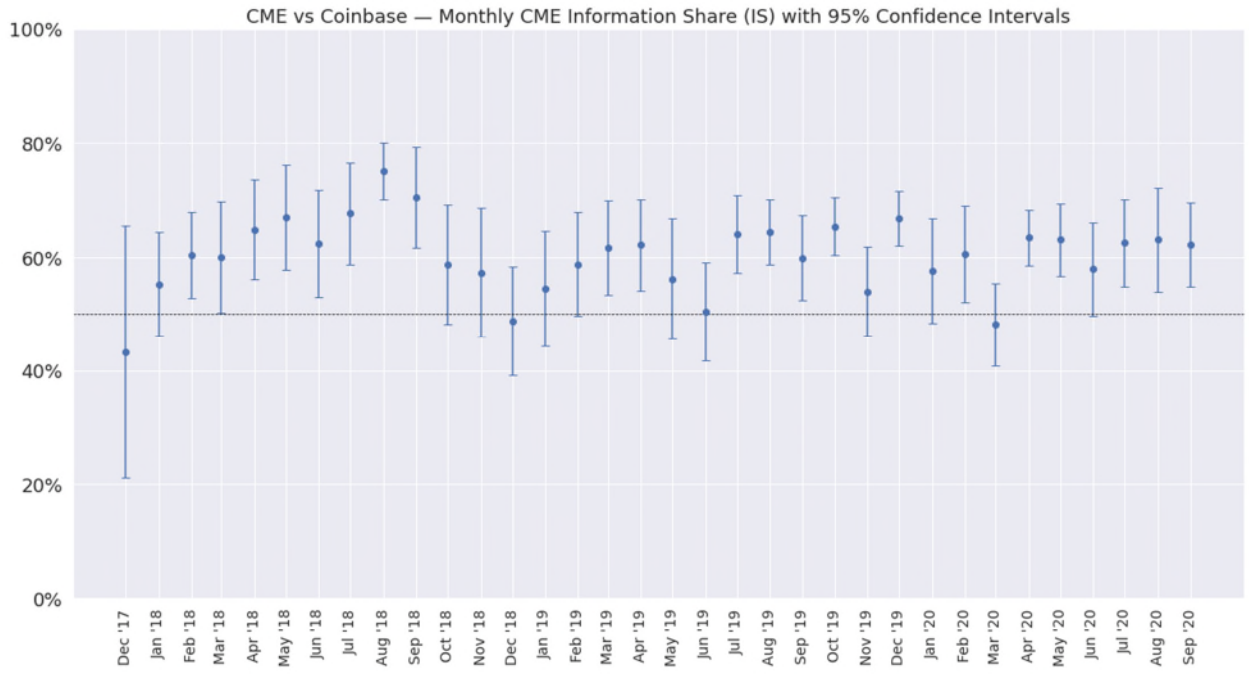
Monthly Period Analysis

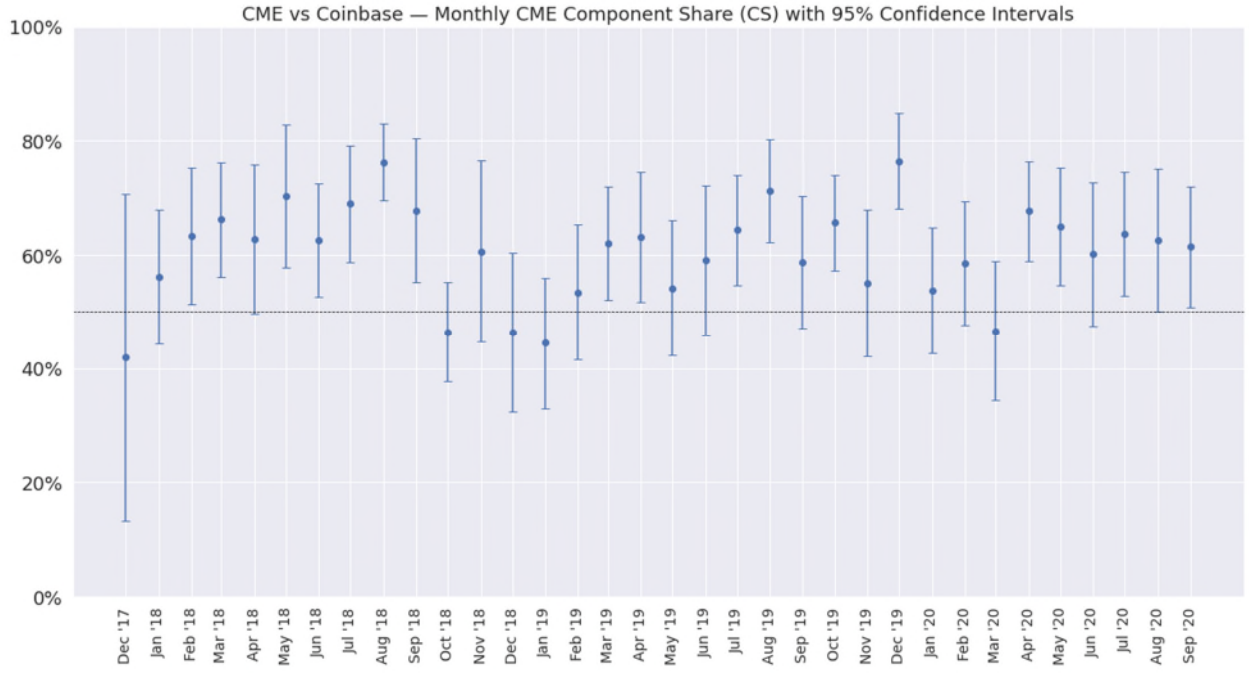
To provide additional context to this finding, we also examined each market on a calendar-month-by-calendar-month basis, as discussed. This calendar-month-segmented approach allows us to evaluate the potential for time variation in price discovery leadership between the CME bitcoin futures market and the bitcoin spot market over shorter periods.

The charts below present this month-by-month data in a graphical format for the CME-Coinbase pair, as one example of the output of this analysis. For each month, the large dot represents the midpoint finding of the analysis (averaged across the findings for each day of the month), or what the literature would generally refer to as the CME's IS or CS value for a given time period (in this case, a month). The confidence bars capture the values contained within a 95% confidence interval.

The results show that the CME has led price discovery versus Coinbase in 31 of 34 months studied (91% of all months) from an IS perspective, and in 29 of 34 months studied (85% of all

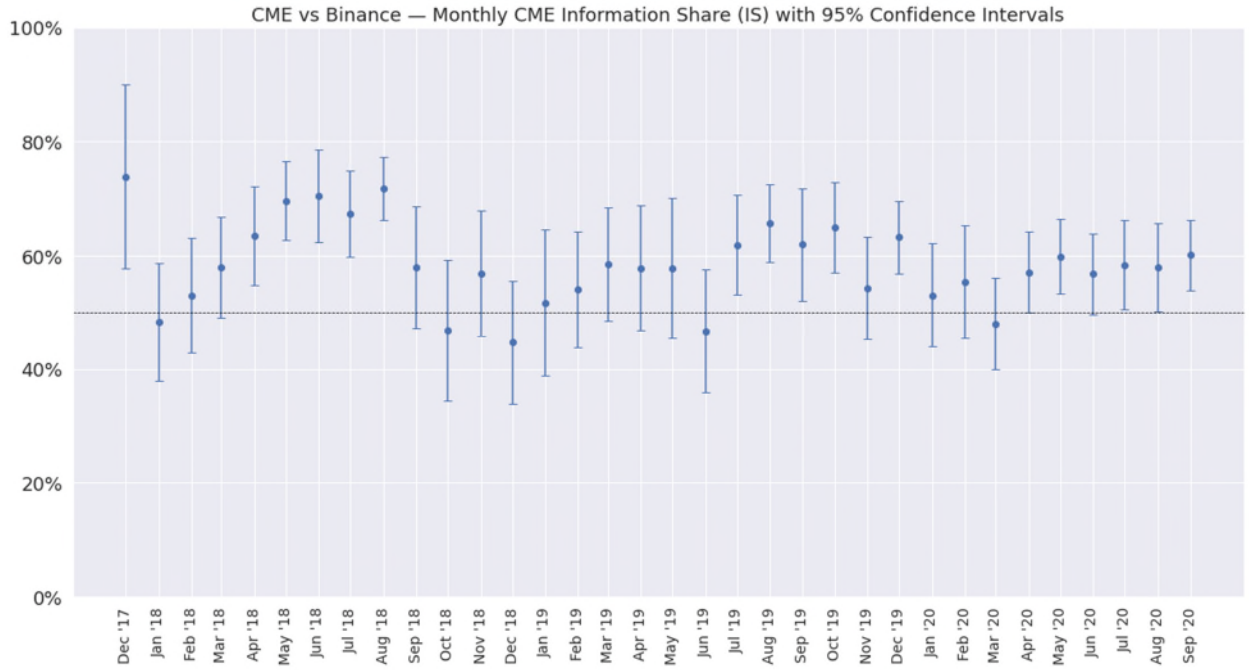
months) from a CS perspective. The wider confidence intervals versus the full-duration analysis is a matter of statistical power: Monthly analysis incorporates significantly fewer data points than longer periods, and therefore has lower levels of statistical strength. It is worth noting that the month of December 2017 only has nine trading days worth of data, since the CME bitcoin futures market launched on December 18, 2017.

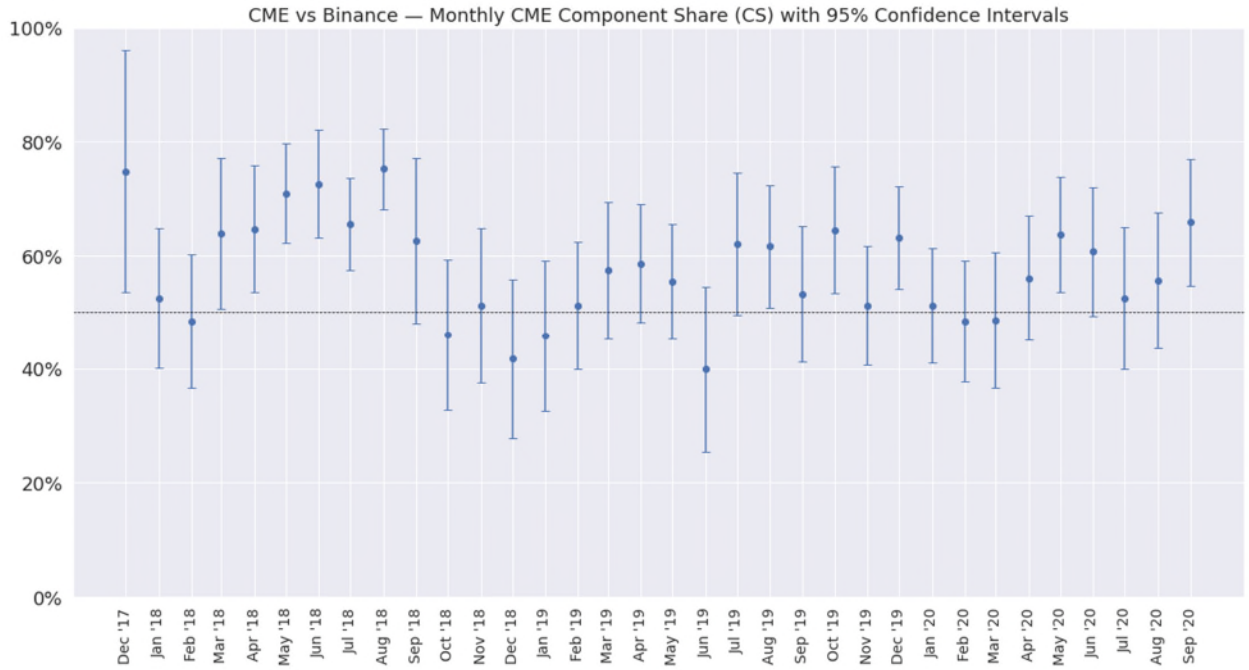




As one would expect, each trading platform generates a slightly different profile and has slightly

different results. For instance, the CME versus Binance pair shows that CME led price discovery in 29 of 34 months studied (85% of all months) from an IS perspective, and 27 of 34 months studied (79% of all months) from a CS perspective.





The table below displays the percentage of months that the CME has led price discovery versus each of the 10 evaluated spot trading platforms since the launch of the CME bitcoin futures

contract in December 2017. The exact numbers vary by exchange, but on average, CME has led spot trading platforms from an IS perspective in 90% of evaluated months, and from a CS perspective in 81% of evaluated months. Month-by-month IS and CS charts are available for each of the 10 trading platforms versus the CME in Appendix B.

	% of Months CME Led IS	% of Months CME Led CS
Binance	85%	79%
Bitfinex	94%	91%
Bitstamp	94%	91%
Coinbase	91%	85%
Gemini	82%	76%
Huobi	94%	84%
itBit	79%	62%
Kraken	94%	91%
LBank	90%	80%
OKEX	85%	65%
Average	**89%**	**80%**

Taken together, these findings support the notion that the CME leads price discovery compared with the bitcoin spot market, and that leadership is generally persistent across the full time period.

V. Time-Shift Lead-Lag Analysis

The other popular academic approach to investigating market leadership is time-shift lead-lag analysis (TSLL). Time-shift lead-lag analysis is an attempt to find the direction and length of the lead-lag relationship between two price series that maximizes the predictive strength of one price series against another.

The analysis is performed by shifting one price series forward or backward in time relative to another series and calculating the cross-correlation between the two series. This shifting is repeated for many different lag periods to see which amount of lag of one price series results in the highest cross-correlation between the two price series. The amount of lead or lag that results in the highest cross-correlation is referred to as "lead-lag time" in the literature.

A. Academic Overview

The literature on how to conduct lead-lag analysis has evolved over time. Initially, cross-correlations were calculated based on time series with price observations made at specific intervals. This is called the "synchronous" approach. Later, a "non-synchronous" approach was developed. The non-synchronous approach does not use fixed sampling intervals; rather, it uses all tick-by-tick price observations from each time series without matching up intervals in a time-rigid fashion.

Early research using time-shift lead-lag analysis, such as de Jong and Nijman (1997),[29] described the synchronous approach, using fixed sampling intervals (such as one price every 10 minutes). The paper was one of the first to extensively explore lead-lag relationships between financial markets by calculating synchronous cross-correlations on leads and lags of different time series. It focused on the relationship between the S&P 500 Index and S&P 500 futures. The paper determined that, at all chosen intervals (10 minutes, 5 minutes, and 1 minute), futures returns led index returns.

The non-synchronous approach was proposed in Hayashi and Yoshida (2005)[30] to address concerns that "the choice of regular interval size and data interpolation scheme (in the synchronous approach) may lead to unreliable estimation … and bias… ." Hayashi-Yoshida has become the dominant (but not exclusive) paradigm for conducting this type of analysis.

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[29] de Jong, F., and Nijman, T. (1997) High frequency analysis of lead-lag relationships between financial markets. Journal of Empirical Finance (4)2-3, 259-277.

[30] Hayashi, T., and Yoshida, N. (2005) On covariance estimation of non-synchronously observed diffusion processes. Bernoulli 11(2), 359-379.

Hoffmann, Rosenbaum, and Yoshida (2013)[31] extended the Hayashi-Yoshida cross-correlation function by describing how to apply it to leads and lags of one time series against another to determine the lead-lag time between the two time series.

Alsayed and McGroarty (2014)[32] applied the Hayashi-Yoshida cross-correlation function to identify lead-lag relationships between S&P 500, FTSE 100, and DAX futures contracts. They also confirmed that the non-synchronous approach was more robust in avoiding data errors compared with the synchronous approach.

B. Bitcoin Markets Literature Review

Schei (2019)[33] applied the Hayashi-Yoshida cross-correlation function to determine the lead-lag relationship between various spot trading platforms. Schei looked at trades on Binance, Bitfinex, Bitstamp, Coinbase, HitBTC, Poloniex, and Kraken during 2018. He found that low-volume exchanges (Poloniex and Kraken) tended to lag higher-volume exchanges (Bitfinex, Binance, Bitstamp, and Coinbase). Schei also found that similar volume exchanges showed weaker lead-lag relationships, such as between Bitstamp and Bitfinex.

Schei did not evaluate the lead-lag relationship between the bitcoin spot and bitcoin futures markets. In fact, while the TSLL technique has been used to compare spot and futures relationships in multiple asset classes, as discussed above, this study is the first to apply this technique to the bitcoin spot and bitcoin futures markets.

C. Analytical Methodology

We analyzed the TSLL relationship between the CME bitcoin futures market and the same 10 bitcoin spot trading platforms we evaluated using IS/CS price discovery analysis, including all five trading platforms that contribute prices to the CME CF Bitcoin Reference Rate and five additional trading platforms with significant reported trading volume.

We used available trade data from the inception of the CME bitcoin futures contract on December 18, 2017 through the end of the study on September 30, 2020. Data on spot trading

[31] Hoffmann, M., Rosenbaum, M., Yoshida, N. (2013) Estimation of the lead-lag parameter from non-synchronous data. Bernoulli, 19(2), 426-461.
[32] Alsayed, H., and McGroarty, F. (2014) Ultra-high-frequency algorithmic arbitrage across international index futures. Journal of Forecasting, 33(6), 391-408.
[33] Schei, B. (2019) High frequency lead-lag relationships in the bitcoin market (unpublished master's thesis). Copenhagen Business School, Copenhagen, Denmark.

platforms were downloaded from Coin Metrics and CoinAPI.[34] Data on CME bitcoin futures was acquired directly from the CME Group.

We ran our TSLL analysis using "lead-lag,"[35] a publicly available open source implementation of TSLL written in the programming language Python based on Hoffmann, Rosenbaum, and Yoshida (2013).

We took the following steps to run our analysis:

- Remove trades during non-CME trading days. This includes removing holidays and weekends.
- Remove zero-return trades (trades with the same price as the previous trade) from the price series, consistent with the procedure used by Huth and Abergel (2014)[36] and Alysayed and McGroarty (2014).
- For each pair of spot trading platform and CME bitcoin futures, run TSLL analysis for each day, shifting the lag time from -60 seconds to +60 seconds in 0.2 second increments. Find the lead-lag time (LLT) that produces the highest cross-correlation.
- Average the daily lead-lag time across the full time period, while running statistical significance tests with a 95% confidence interval.

D. Results

The results of our TSLL analysis align with the results of our IS/CS analysis and demonstrate that the CME bitcoin futures market leads all evaluated spot trading platforms over the duration of the study.

Here, again, we present the results in both full time period and monthly formats. The full time period results are commonly how results are presented in academic literature. However, shorter time periods such as the monthly results may be more appropriate given the potential for time variation in the cryptomarket.

Full Period Analysis

The table below shows the lead-lag time (the amount of lead or lag that results in the highest cross-correlation between two price series) for the CME versus each of the 10 spot trading

[34] Coin Metrics data was used primarily for all 10 spot trading platforms. CoinAPI data was used only to extend the time period back to December 18, 2017 for four trading platforms (Gemini, Huobi, itBit, and OKEx) that Coin Metrics did not have full time period coverage for.
[35] https://github.com/philipperemy/lead-lag.
[36] Huth, N., and Abergel, F. (2014) High frequency lead/lag relationships: Empirical facts. Journal of Empirical Finance (26), 41-58.

platforms, calculated daily, and averaged across the entire time period of this study (December 18, 2017 to September 30, 2020). It also shows the 95% confidence interval for those results. A positive value indicates the CME leading by that amount of seconds. A negative value would indicate CME lagging. The * indicates the result being statistically significant (p-value < 0.05), meaning the lead-lag time for the entire time period lies squarely within the positive (or negative) value territory.

	Lead-Lag Time (seconds)	**Confidence Interval (seconds)**
Binance	7.28*	6.53 - 8.03
Bitfinex	9.03*	8.33 - 9.73
Bitstamp	6.52*	5.96 - 7.08
Coinbase	8.42*	7.65 - 9.18
Gemini	6.51*	5.91 - 7.11
Huobi	7.57*	6.96 - 8.18
itBit	8.63*	7.89 - 9.37
Kraken	17.19*	16.00 - 18.38
LBank	16.62*	15.37 - 17.87
OKEx	8.27*	7.41 - 9.13

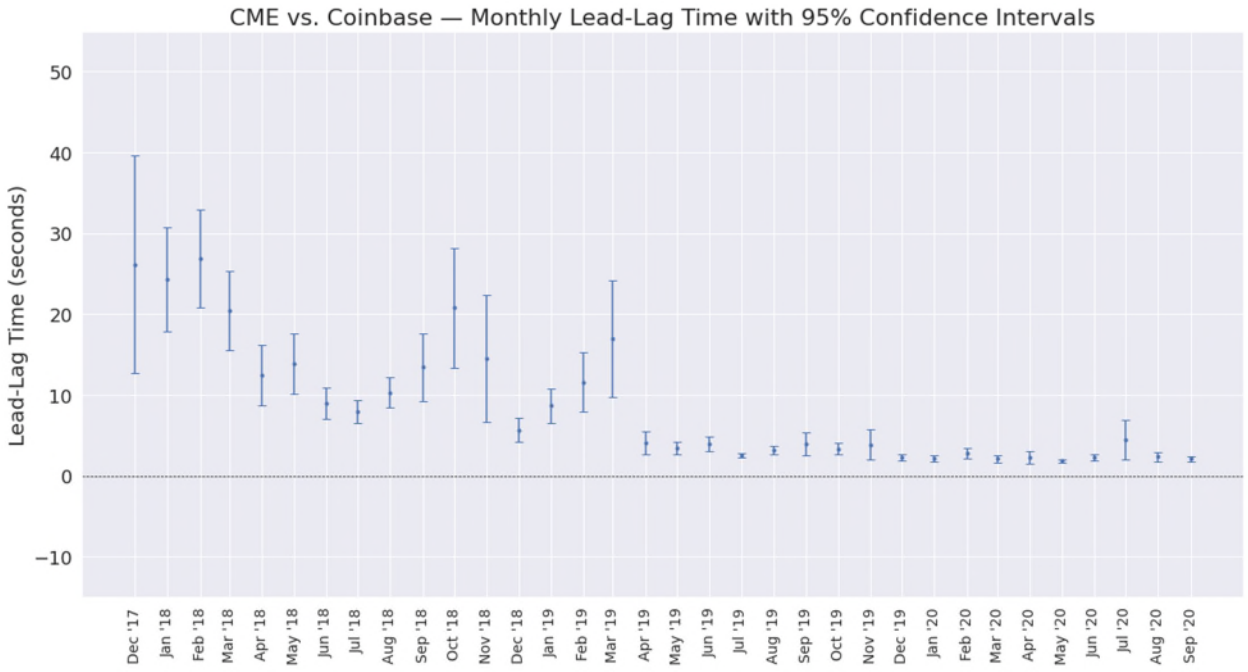
The lead-lag times vary slightly by platform, but are all contained within a positive value band of 6.51 - 17.19 seconds, indicating CME leading. All results are statistically significant.

Monthly Period Analysis

To provide additional context to this finding, we also examined each market on a calendar-month-by-calendar-month basis, as we did with our IS/CS analysis. This calendar-month-segmented approach allows us to evaluate the potential for time variation in price leadership between the CME bitcoin futures market and the bitcoin spot market over shorter periods, using the TSLL approach.

The chart below presents this month-by-month data in a graphical format for the CME-Coinbase pair, as one example of the output of this analysis. For each month, the dot represents the midpoint finding of the analysis (averaged across the findings for each day of the month), or what literature would generally refer to as the lead-lag time value for a given time period. The confidence bars capture the values contained within a 95% confidence interval.

The results show that the CME led Coinbase from a TSLL perspective in all 34 of the 34 months studied (100% of all months). Additionally, the results were statistically significant for all 34 of 34 months studied (100% of all months).

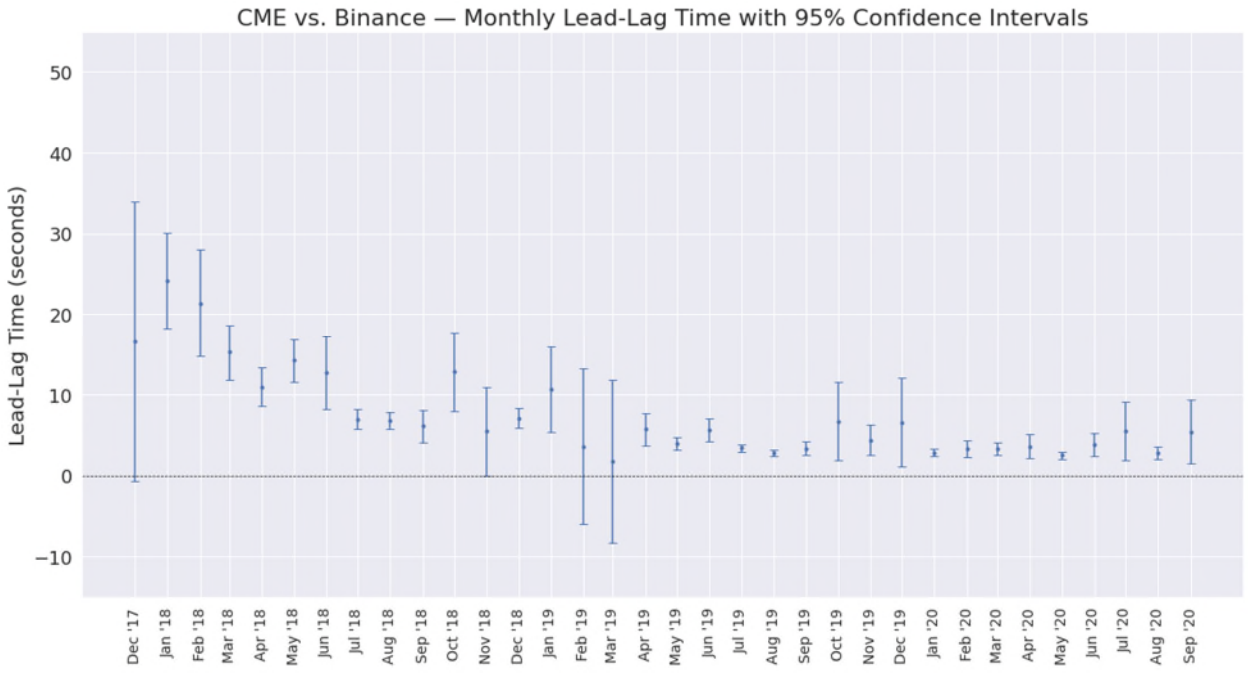


The chart displays a notable pattern, which is repeated in other trading platform pairs: The CME's "lead" versus Coinbase starts out long, with wide confidence bands, and then tightens over time and becomes more consistent.

For instance, the average monthly lead-lag time for CME versus Coinbase from December 2017 through March 2019 is 15.18 seconds, and the confidence interval span is from 2.84 seconds to 26.87 seconds. By comparison, from April 2019 through September 2020, the average monthly lead-lag time is 2.94 seconds, and the confidence interval span is from 0.27 seconds to 4.85 seconds.

As one would expect, each trading platform generates a slightly different profile and has slightly different results. For instance, the CME versus Binance pair also shows the CME has led price discovery in all 34 of 34 months studied (100% of all months), but with different exact lead times. The result is statistically significant in 30 of 34 months studied (88% of all months).

The results show the same general trend as the CME versus Coinbase pair, although in a more muted fashion: starting wide, with the relationship tightening and becoming more consistent over time.



Month-by-month TSLL analysis results for the remaining eight evaluated spot trading platforms are available in Appendix C. They share Coinbase's and Binance's results in that the CME leads consistently across an overwhelming majority of months.

Taken together, the results of our TSLL analysis support the conclusion of our IS/CS analysis, showing that the CME bitcoin futures market leads each of the 10 evaluated spot trading platforms in a statistically significant manner over the duration of the study.

VI. Conclusion

This study extends and improves upon prior literature by conducting a detailed survey and analysis of academic and practitioner papers in the space, running a validation of the data feeds, incorporating a longer period of time, and using multiple statistical techniques to evaluate the relationship between the CME bitcoin futures market and the bitcoin spot market.

The results show that the CME bitcoin futures market leads the bitcoin spot market in a significant fashion:

1. **Academic and Practitioner Literature**: The majority of academic and practitioner studies conclude that the CME bitcoin futures market leads the bitcoin spot market.

2. **IS/CS Price Discovery Analysis**: The CME bitcoin futures market has the dominant share of price discovery when compared with each of the 10 evaluated bitcoin spot trading platforms using both information share (IS) and component share (CS).

3. **TSLL Analysis**: The CME bitcoin futures market has led each of the 10 evaluated bitcoin spot trading platforms using time-shift lead-lag analysis over the duration of the study.

We therefore conclude that the CME bitcoin futures market is the dominant source of price discovery when compared with the bitcoin spot market, and that prices on the CME bitcoin futures market lead prices on bitcoin spot markets.

These findings are, perhaps, unsurprising. Futures markets often lead price discovery when compared to spot markets. As described in papers like Garbade and Silver (1983),[37] Chan (1992),[38] and Fleming et al. (1996),[39] futures benefit from leverage, lower transaction costs, and access to short exposure. In addition, in the bitcoin market, the regulated nature of the CME bitcoin futures market may attract more professional investors than unregulated spot markets. These professional investors may have advantages over retail investors from an available capital, technology, information flow, and trading speed perspective. Such conditions may be expected to continue into the future, particularly as we see continued and expanded adoption of bitcoin as an investable asset by professional and institutional investors.

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[37] Garbade, K. and Silber, W. (1983). Price movements and price discovery in futures and cash markets. The Review of Economics and Statistics 65(2), 289-297.
[38] Chan, K. (1992). A further analysis of the lead-lag relationship between the cash market and stock index futures market. The Review of Financial Studies (5)1, 123-152.
[39] Fleming et al. (1996). Trading costs and the relative rates of price discovery in stock, futures, and option markets. Journal of Futures Markets 16(4), 353-387.

Appendix A. Examining Lead-Lag Relationships Between The Unregulated Bitcoin Futures Trading Platforms And The CME Bitcoin Futures Market

Introduction

Investors and traders have multiple ways of accessing the bitcoin market, including spot trading platforms like Coinbase, regulated futures markets like the CME bitcoin futures market, and unregulated futures trading platforms like BitMEX.

In the main body of this paper, we demonstrated that the regulated CME bitcoin futures market leads price discovery compared to the largest bitcoin spot trading platforms. In this Appendix, we turn our attention to unregulated bitcoin futures trading platforms, and determine where price discovery occurs between those platforms and the CME.

Getting Started: The Selection of Unregulated Futures Trading Platforms And Contracts For Analysis

The goal of our analysis was to determine whether price discovery on the CME bitcoin futures market leads or lags relative to unregulated bitcoin futures trading platforms. We began our analysis by gathering general market data on unregulated futures trading platforms from CoinGecko, a popular crypto data provider that maintains an extensive list of unregulated bitcoin futures trading platforms and their futures contracts[40].

The site tracks two categories of contracts: perpetual futures and quarterly futures. Perpetual futures are cash-settled futures that do not have an expiration date, while quarterly futures settle on a calendar basis and must be rolled forward to maintain exposure. Aggregating these two categories generated a list of 33 unregulated bitcoin futures trading platforms. We elected to evaluate the seven largest markets, which accounted for approximately 80% of all open interest and included the most recognized names in the unregulated bitcoin futures market: Binance, BitMEX, Bybit, Deribit, FTX, Huobi, and OKEx.[41]

Because some platforms offer both perpetual and quarterly contracts, on each platform, we selected the contract type with the highest level of open interest: Perpetuals for Binance, BitMEX, Bybit, Deribit, and FTX, and quarterlies for Huobi and OKEx.

We pulled data on these contracts from CoinMetrics and CoinAPI, the same data providers used

[40] https://www.coingecko.com/en/coins/bitcoin#markets. Navigate to the “Perpetuals” (perpetual futures) and “Futures” (predominantly quarterly futures) sub tabs within the “Markets” tab.
[41] Data as of May 4, 2021.

in our spot market analysis. Data on the CME bitcoin futures contract was pulled directly from the CME.

We used the full period of data available for each unregulated trading platform. The data start month for each trading platform was:

- Binance: September 2019
- BitMEX: December 2017[42]
- Bybit: October 2019
- Deribit: August 2018
- FTX: July 2019
- Huobi: August 2019
- OKEx: October 2018

The study ran through the end of Q1 2021.

For both CME's monthly contract and the Huobi and OKEx's quarterly contracts, we followed the same technique used in our spot market analysis to create a continuous price series for analysis, rolling contracts one day prior to expiration.

Important Context Regarding The Unregulated Bitcoin Futures Trading Platforms

Unregulated bitcoin futures trading platforms may be less familiar to casual market observers than either the spot bitcoin trading platforms or the regulated CME bitcoin futures market. It may be helpful, therefore, to provide context on the relative size, volume, and functioning of these markets before we proceed to our statistical analysis.

The table below highlights three key statistics for the highest open interest contract on each of the evaluated trading platforms for the month of May 2021: Open Interest, Trading Volume, and Required Margin. The CME row is highlighted in light blue.

	Open Interest	Trading Volume	Required Margin
Bybit	$1,666,878,515	$7,438,356,443	1%
Binance	$1,575,326,903	$21,718,058,270	<1%
CME	$1,404,125,298	$1,840,129,468	33%

[42] BitMEX was the only platform that existed and has data available from the inception of the CME bitcoin futures market on December 17, 2017. OKEx claims to have launched bitcoin futures trading as early as June 2013, but historical data for OKEx is not available before October 2018. Binance, Bybit, Deribit, FTX, and Huobi all launched bitcoin futures trading after the inception of the CME bitcoin futures market, between 2018 and 2019.

FTX	$1,232,139,553	$4,423,394,792	1%
OKEx	$842,460,775	$2,112,965,793	<1%
Huobi	$680,431,607	$5,823,998,157	<1%
BitMEX	$664,421,615	$2,656,967,907	1%
Deribit	$599,004,598	$1,264,134,910	1%

Three factors jump out from the table:

1. **Open Interest:** Open interest reflects the notional value of outstanding contracts and is a common way to judge the size of a futures market. In this table, open interest at the end of each trading day was averaged across the month of May 2021.The largest contract (Bybit's perpetuals) had $1.67 billion in average open interest in May, while the smallest contract (Deribit's perpetuals) had $600 million. The CME contract ranked third in this list, with $1.40 billion in average open interest.

2. **Trading Volume:** Trading volume reflects the notional value traded in a given contract on each trading day averaged across the month of May 2021. The dispersion of trading volume statistics here is much wider than the dispersion of open interest: The most traded contract (Binance's perpetuals) reported $21.72 billion in average daily trading volume in May, while the least traded contract (Deribit' perpetuals) reported $1.26 billion. The CME contract ranked seventh by trading volume, at $1.84 billion.[43]

3. **Required Margin:** The required margin statistic highlights the major difference in potential leverage between the regulated CME market and the unregulated bitcoin futures trading platforms. The evaluated unregulated bitcoin futures trading platforms offer clients leverage at ratios ranging from 100-to-1 to 125-to-1[44], meaning required margin is 1% or less of the notional value of open contract positions. By comparison, the maximum leverage ratio on the CME bitcoin futures market is 3-to-1, meaning a 33% required margin ratio.[45]

The last point is of particular interest. While traders on a given platform do not always make use of the full amount of potential leverage, industry reports suggest that the level of realized leverage on unregulated futures trading platforms is high. For instance, a 2019 report from

[43] Note that both trading volume and open interest statistics are self-reported. While most observers have a high degree of confidence in the data reported by regulated exchanges like the CME, the same cannot be said for market statistics self-reported by unregulated futures trading platforms.
[44] As of May 31, 2021, BitMEX, Bybit, Deribit offered 100-to-1 leverage, FTX offered 101-to-1 leverage, and Binance, Huobi and OKEx offered 125-to-1 leverage, according to each trading platform's website.
[45] https://www.cmegroup.com/trading/equity-index/us-index/bitcoin.html.

BitMEX found that the average level of realized leverage on that platform for the year ending April 2019 was approximately 27-to-1, meaning an average maintained margin of less than 4%.[46]

The high leverage ratios offered by unregulated bitcoin futures trading platforms mean that, at any given moment, the amount of capital committed to any one of these unregulated futures contracts is likely significantly lower than the amount of capital committed to the CME bitcoin futures contract.

As a hypothetical example, assuming an average margin of 4% (i.e., 25-to-1 leverage), the amount of capital backing the $7.26 billion in aggregate open interest across the seven unregulated futures contracts can be estimated at $363 million. By comparison, assuming a 33% margin (the minimum required), the capital backing the $1.40 billion of open interest on the CME bitcoin futures contract is at least $462 million. In other words, it is very possible that the amount of capital committed to the CME bitcoin futures contract is larger than the capital committed to all of the evaluated unregulated futures contracts, combined.

It is also worth noting that all evaluated unregulated bitcoin futures contracts have a higher ratio of trading volume to open interest than the CME bitcoin futures contract. This difference could be indicative of different styles of trading: highly levered short-term trades with frequent opening and closing of positions versus less levered longer-term trades with lower turnover.

The question of which style of trading and/or which features of a market are more important for price leadership is interesting. In the following section, we examine whether the CME bitcoin futures market or the unregulated bitcoin futures trading platforms leads price discovery using established statistical techniques..

Methodology and Results

To determine whether the CME bitcoin futures market leads or lags price discovery compared to unregulated bitcoin futures trading platforms, we applied the same statistical tests that we did when comparing the CME to bitcoin spot trading platforms: Information Share/Component Share analysis (IS/CS) and Time-Shift Lead-Lag analysis (TSLL).

IS/CS Analysis

The table below shows the results of our IS and CS analysis comparing the CME with each of the seven unregulated bitcoin futures trading platforms over the duration of our study. Each unregulated futures trading platform evaluation has its own date range, based on the length of data available for each trading platform.

[46] https://blog.bitmex.com/bitmex-leverage-statistics-april-2019/

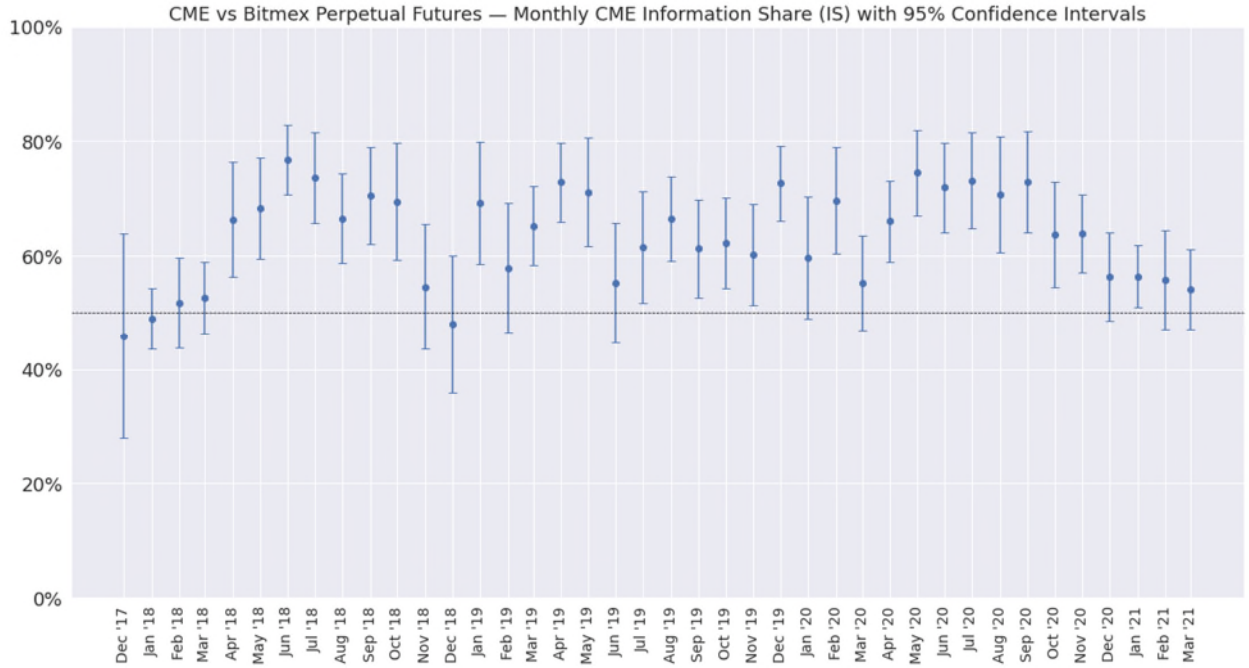
IS and CS values above 50% indicate that the CME led price discovery against a given unregulated futures trading platform over the duration of the study period. A * indicates that the results are statistically significant (p-value < 0.05). We have also included a 95% confidence interval for the results to provide further context.

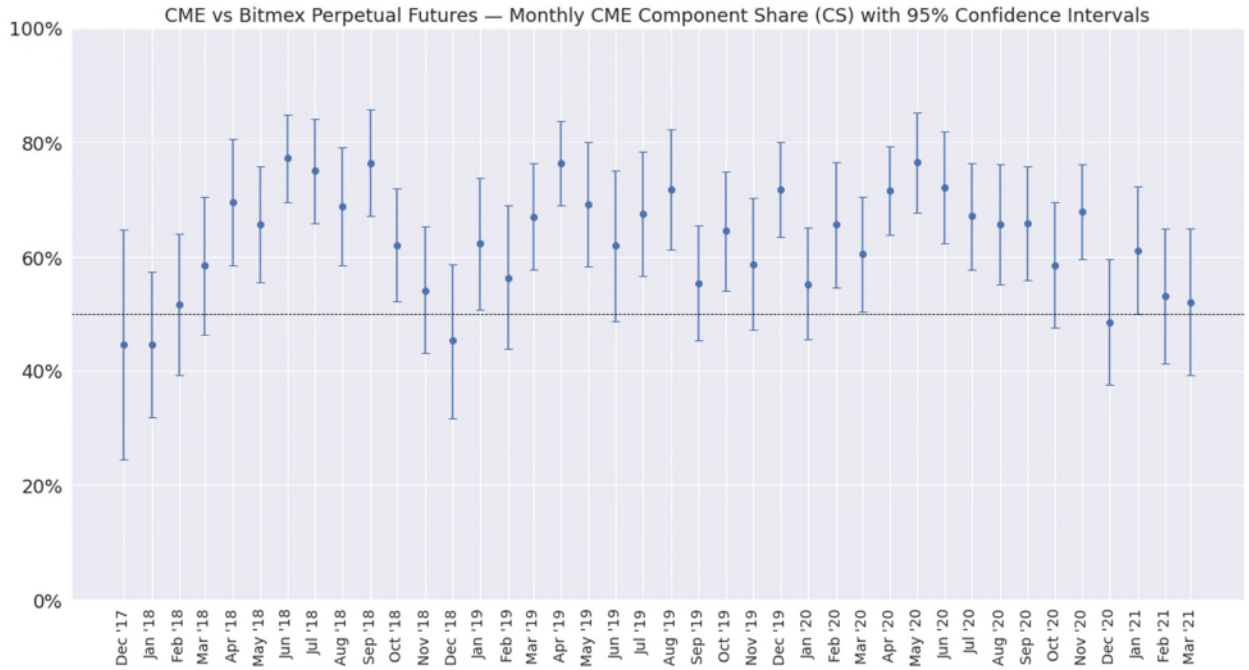
The results show that the CME has led price discovery against each of the seven unregulated trading platforms across the duration of the study. The results are statistically significant for all platforms when evaluated from an IS perspective, and for six of seven platforms from a CS perspective.

	CME IS	**Confidence Interval**	**CME CS**	**Confidence Interval**	**Data Range**
Binance	55.30%*	53.64% - 56.96%	54.01%*	51.41% - 56.61%	Sept 2019 - Mar 2021
BitMEX	63.67%*	62.30% - 65.04%	63.33%*	61.68% - 64.99%	Dec 2017 - Mar 2021
Bybit	61.50%*	59.69% - 63.30%	60.26%*	57.75% - 62.77%	Oct 2019 - Mar 2021
Deribit	56.91%*	55.56% - 58.26%	56.20%*	54.23% - 58.17%	Aug 2018 - Mar 2021
FTX	56.73%*	55.13% - 58.32%	58.72%*	56.33% - 61.10%	July 2019 - Mar 2021
Huobi	55.25%*	53.33% - 57.17%	53.85%*	51.36% - 56.33%	Aug 2019 - Mar 2021
OKEx	53.04%*	51.45% - 54.63%	51.22%	49.14% - 53.31%	Oct 2018 - Mar 2021

To add greater context to this full duration analysis, we also examined the results for each unregulated futures trading platform on a month-by-month basis. The chart below showcases those findings for the CME-BitMEX pair, as the longest data range example; the IS/CS results for all other unregulated futures trading platforms are available at the end of Appendix B.

For each month, the dot represents the midpoint finding averaged across the findings for each day of the month, or what the literature would generally refer to as the CME's IS or CS value for the given month. Dots that appear above the black horizontal line at the 50% mark show that the CME led price discovery for that month, while dots below the 50% mark show that BitMEX led. Confidence bars capture a 95% confidence interval.





The results show that the CME led price discovery versus BitMEX in 37 of 40 months studied (93% of all months) from an IS perspective, and 36 or 40 months (90%) from a CS perspective. The results are statistically significant in a majority of months.

The wider confidence intervals versus the full duration analysis is a matter of statistical power: Monthly analysis incorporates significantly fewer data points than the full study period, and therefore has lower levels of statistical strength.

Other trading platform pairs show similar results. The table below shows the percentage of months that the CME led IS/CS price discovery against each trading platform:

	% of Months CME Led IS	% of Months CME Led CS	Data Range
Binance	84%	74%	Sept 2019 - Mar 2021
BitMEX	93%	90%	Dec 2017 - Mar 2021
Bybit	100%	94%	Oct 2019 - Mar 2021
Deribit	88%	78%	Aug 2018 - Mar 2021
FTX	90%	95%	July 2019 - Mar 2021
Huobi	85%	70%	Aug 2019 - Mar 2021
OKEx	73%	60%	Oct 2018 - Mar 2021

These monthly results support the conclusion of our full duration analysis in finding that the CME bitcoin futures market leads each of the seven unregulated bitcoin futures trading platforms from an IS and CS perspective.

TSLL Analysis

In addition to our IS/CS analysis, we also examined the CME bitcoin futures market versus the unregulated bitcoin futures trading platforms using Time-Shift Lead-Lag (TSLL) analysis. TSLL analysis is a more intuitive approach to analyzing price discovery, using cross-correlation measures to determine which of two price series “leads” the other from a time-ordered perspective: i.e., are the prices on one platform ahead or behind prices on the other platform more frequently.

The results of our TSLL analysis align with the results of our IS/CS analysis in finding that the CME bitcoin futures market leads all evaluated unregulated bitcoin futures trading platforms over the duration of the study. The results are statistically significant for all seven evaluated trading platforms.

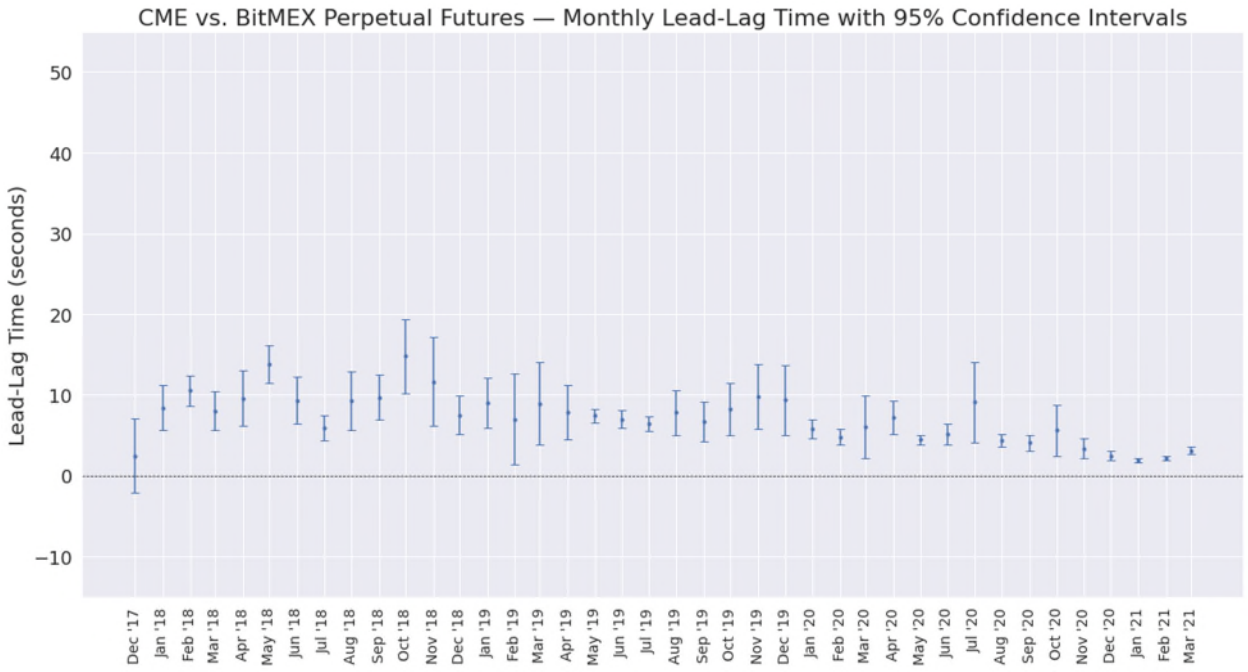
The table below shows the lead-lag time (the amount of lead or lag that results in the highest cross-correlation between two price series) for the CME versus each of the seven unregulated bitcoin futures trading platforms, calculated daily and averaged across the entire time period. The table also shows the 95% confidence interval for those results.

A positive value indicates the CME leading by that amount of seconds. A negative value would indicate CME lagging. The * indicates the result being statistically significant (p-value < 0.05), meaning the lead-lag time for the entire time period lies squarely within the positive (or negative) value territory.

	Lead-Lag Time (seconds)	**Confidence Interval (seconds)**	**Data Range**
Binance	3.07*	2.50 - 3.65	Sept 2019 - Mar 2021
BitMEX	7.23*	6.76 - 7.70	Dec 2017 - Mar 2021
Bybit	5.13*	4.56 - 5.70	Oct 2019 - Mar 2021
Deribit	4.98*	4.47 - 5.49	Aug 2018 - Mar 2021
FTX	2.27*	2.08 - 2.46	July 2019 - Mar 2021
Huobi	2.34*	2.21 - 2.47	Aug 2019 - Mar 2021
OKEx	3.47*	2.94 - 4.00	Oct 2018 - Mar 2021

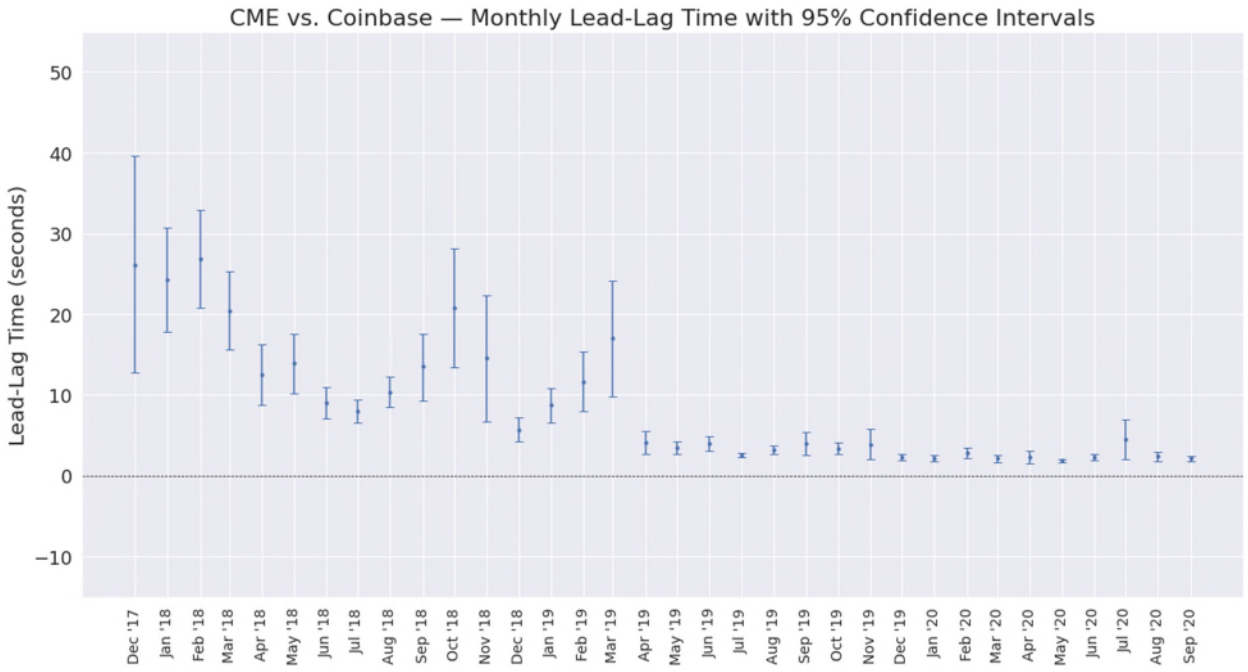
The results show that prices on the CME generally led prices on unregulated bitcoin futures trading platforms by 2-7 seconds.

To add context, we also evaluated each platform on a month-by-month basis, as we did with IS/CS. The chart below shows the results for the CME-BitMEX pair, as the longest data range example; the TSLL results for all other unregulated futures trading platforms are available at the end of Appendix C.



The results show that the CME led BitMEX from a TSLL perspective in all 40 of 40 months studied (100% of all months). The results were statistically significant for 39 of 40 months studied (98% of all months).

The lead-lag relationship between the CME and BitMEX does not follow the pattern seen in TSLL charts between the CME and spot platforms where the CME leads by a large number of seconds in the early part of the study, with that lead time shortening substantially after Q1 2019. You can see that pattern, for instance, in the chart below comparing the CME and Coinbase.



The CME-BitMEX chart does not follow this pattern. This may be related to the prolonged bear market that occurred during the early period of our study, ending in Q1 2019. After all, spot trading platforms like Coinbase and futures trading platforms like BitMEX differ in the types of exposure they provide: Spot trading platforms primarily facilitate long exposure, while futures trading platforms allow traders to go both long and short. This difference could be the reason why BitMEX diverged and lagged from the CME less compared to spot trading platforms such as Coinbase during the prolonged bear market.

Regardless, however, in both CME-BitMEX and CME-Coinbase, the CME bitcoin futures market consistently leads price discovery throughout the study period, and does so in a statistically significant manner.

Conclusion

In this appendix, we used established statistical techniques also used in the main body of the paper to determine where price discovery occurs between seven unregulated bitcoin futures trading platforms and the regulated CME bitcoin futures market. The results demonstrate that the CME has led each of the seven unregulated futures trading platforms over the duration of our study, and has done so in most instances in a statistically significant manner.

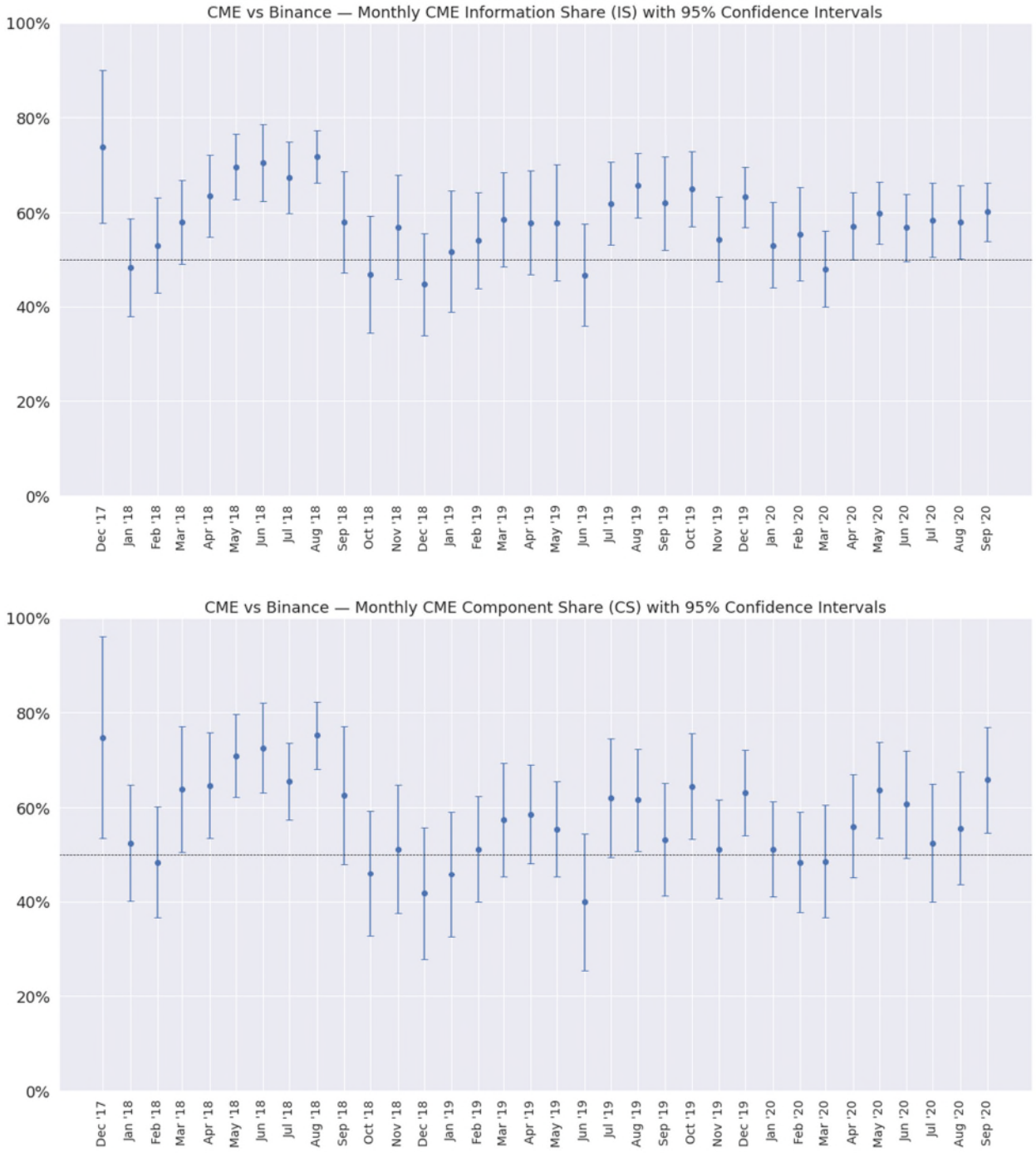
These results may surprise some observers given the high notional trading volume statistics reported by unregulated entities. These volume statistics, however, must be understood in the context of other important measures of market size, including open interest and capital-at-risk. Viewed from these perspectives, unregulated bitcoin futures markets appear similar or smaller

than the regulated CME bitcoin futures market.

The question this study answered is an interesting one: Whether highly leveraged, unregulated platforms dominated by day-traders can lead price discovery against a regulated platform with long-term oriented investors and more capital-at-risk. In this instance, the data lands in favor of the regulated market.

Appendix B: List Of IS/CS Price Discovery Analysis Monthly Results

CME vs. Binance (Chart)

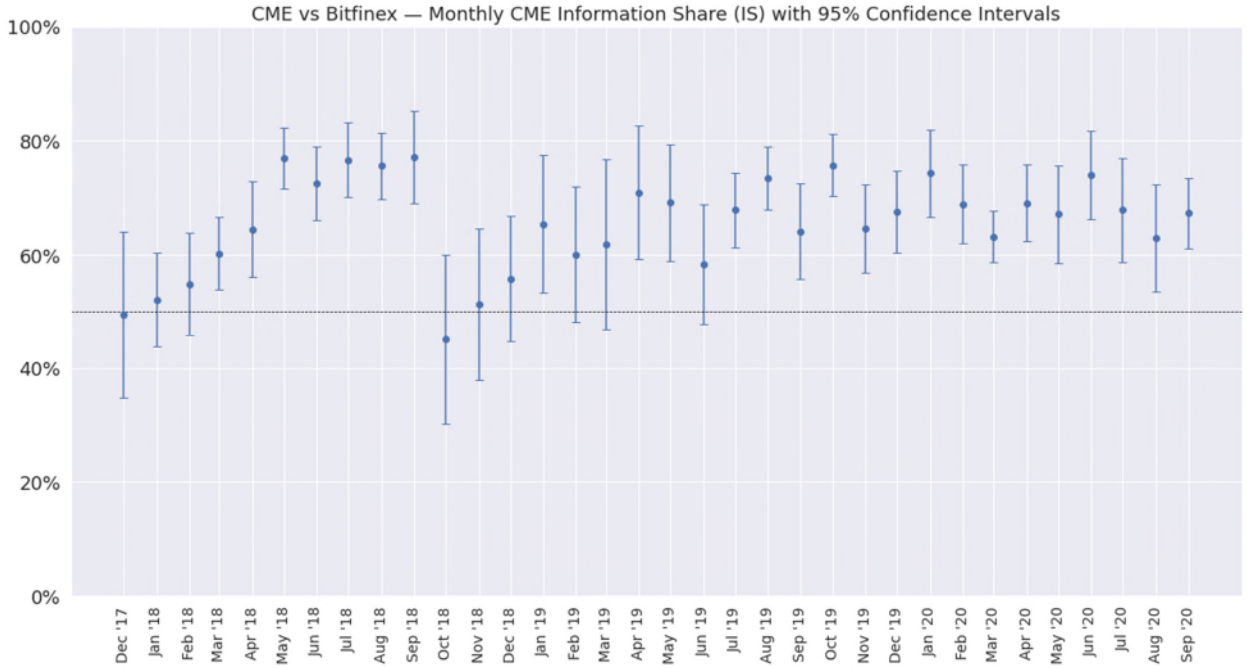


CME vs. Binance (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Dec '17	73.88%*	57.83% - 89.92%	74.77%*	53.55% - 95.98%
Jan '18	48.38%	37.98% - 58.78%	52.54%	40.20% - 64.87%
Feb '18	53.00%	42.85% - 63.15%	48.38%	36.61% - 60.16%
Mar '18	58.03%	49.23% - 66.83%	63.90%*	50.70% - 77.09%
Apr '18	63.50%*	54.80% - 72.19%	64.66%*	53.48% - 75.83%
May '18	69.62%*	62.67% - 76.56%	70.95%*	62.13% - 79.76%
Jun '18	70.50%*	62.43% - 78.56%	72.58%*	63.06% - 82.10%
Jul '18	67.42%*	59.90% - 74.94%	65.54%*	57.43% - 73.64%
Aug '18	71.78%*	66.23% - 77.33%	75.22%*	68.13% - 82.31%
Sep '18	57.98%	47.31% - 68.64%	62.61%	48.13% - 77.09%
Oct '18	46.86%	34.51% - 59.20%	45.99%	32.76% - 59.22%
Nov '18	56.87%	45.85% - 67.88%	51.20%	37.57% - 64.83%
Dec '18	44.76%	33.85% - 55.68%	41.87%	27.89% - 55.85%
Jan '19	51.76%	38.93% - 64.60%	45.85%	32.54% - 59.16%
Feb '19	54.06%	43.89% - 64.22%	51.20%	40.02% - 62.37%
Mar '19	58.55%	48.62% - 68.48%	57.34%	45.26% - 69.42%
Apr '19	57.86%	46.88% - 68.84%	58.56%	48.18% - 68.94%
May '19	57.84%	45.51% - 70.18%	55.37%	45.25% - 65.49%
Jun '19	46.78%	35.95% - 57.62%	39.94%	25.34% - 54.55%
Jul '19	61.92%*	53.21% - 70.62%	62.06%	49.53% - 74.60%
Aug '19	65.71%*	58.85% - 72.57%	61.61%*	50.82% - 72.39%
Sep '19	61.95%*	52.07% - 71.82%	53.23%	41.30% - 65.17%
Oct '19	64.98%*	57.10% - 72.86%	64.49%*	53.32% - 75.66%
Nov '19	54.33%	45.37% - 63.29%	51.09%	40.60% - 61.57%
Dec '19	63.24%*	56.91% - 69.57%	63.09%*	54.13% - 72.06%
Jan '20	53.07%	44.00% - 62.13%	51.12%	41.00% - 61.24%
Feb '20	55.37%	45.41% - 65.33%	48.39%	37.76% - 59.02%
Mar '20	48.10%	39.99% - 56.21%	48.61%	36.71% - 60.50%
Apr '20	57.08%*	50.01% - 64.15%	56.04%	45.03% - 67.05%
May '20	59.90%*	53.37% - 66.42%	63.65%*	53.58% - 73.73%
Jun '20	56.85%	49.76% - 63.93%	60.70%	49.37% - 72.02%
Jul '20	58.40%*	50.55% - 66.24%	52.52%	39.98% - 65.06%
Aug '20	57.97%*	50.19% - 65.76%	55.63%	43.66% - 67.60%
Sep '20	60.11%*	54.02% - 66.19%	65.87%*	54.73% - 77.02%

2017-12-18 - 2020-09-30	58.32%*	56.78% - 59.86%	57.38%*	55.45% - 59.32%

CME vs. Bitfinex (Chart)


CME vs Bitfinex — Monthly CME Information Share (IS) with 95% Confidence Intervals
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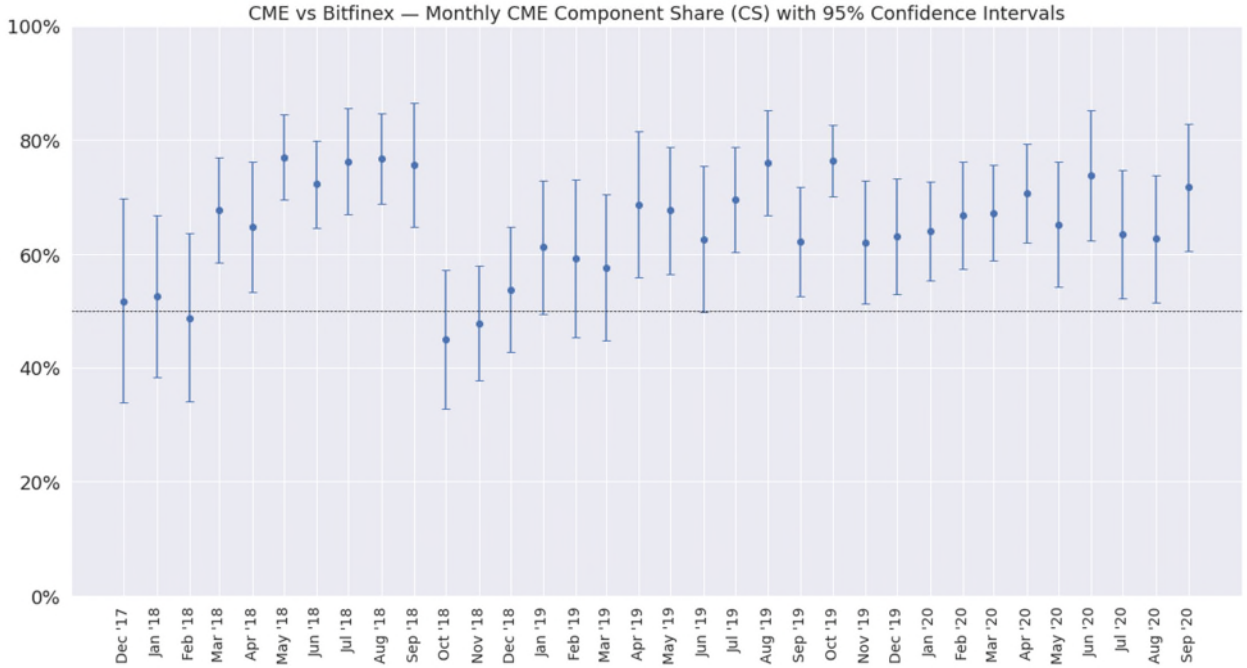
CME vs Bitfinex — Monthly CME Component Share (CS) with 95% Confidence Intervals
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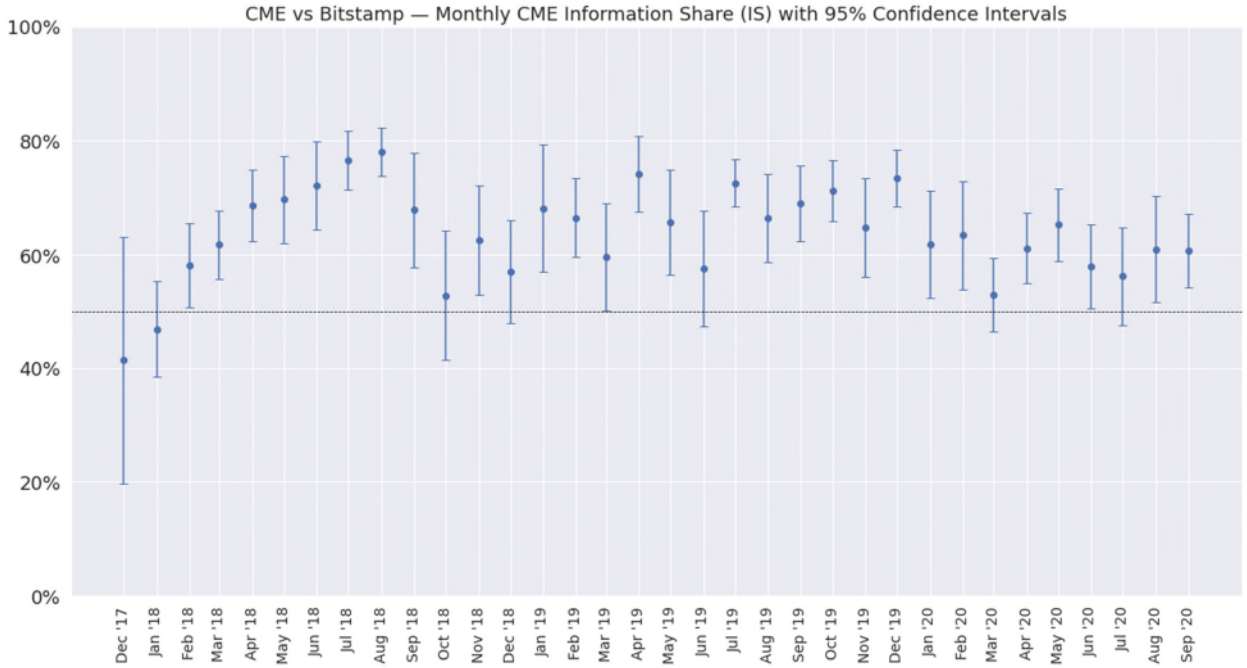
CME vs. Bitfinex (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Dec '17	49.44%	34.75% - 64.13%	51.78%	33.83% - 69.73%
Jan '18	52.12%	43.86% - 60.37%	52.57%	38.27% - 66.87%
Feb '18	54.82%	45.82% - 63.82%	48.82%	34.04% - 63.60%
Mar '18	60.22%*	53.88% - 66.56%	67.73%*	58.60% - 76.87%
Apr '18	64.47%*	56.08% - 72.85%	64.84%*	53.46% - 76.21%
May '18	76.94%*	71.66% - 82.22%	76.97%*	69.55% - 84.40%
Jun '18	72.50%*	66.05% - 78.95%	72.27%*	64.66% - 79.89%
Jul '18	76.62%*	70.09% - 83.15%	76.26%*	66.99% - 85.53%
Aug '18	75.55%*	69.77% - 81.32%	76.74%*	68.91% - 84.56%
Sep '18	77.13%*	68.98% - 85.29%	75.63%*	64.73% - 86.54%
Oct '18	45.08%	30.12% - 60.03%	44.99%	32.76% - 57.23%
Nov '18	51.30%	38.00% - 64.60%	47.82%	37.65% - 57.99%
Dec '18	55.81%	44.77% - 66.84%	53.80%	42.80% - 64.81%
Jan '19	65.40%*	53.33% - 77.46%	61.22%	49.55% - 72.88%
Feb '19	60.07%	48.18% - 71.96%	59.19%	45.37% - 73.01%
Mar '19	61.84%	46.94% - 76.75%	57.56%	44.71% - 70.40%
Apr '19	70.92%*	59.27% - 82.56%	68.74%*	55.88% - 81.60%
May '19	69.17%*	58.93% - 79.40%	67.67%*	56.57% - 78.78%
Jun '19	58.38%	47.95% - 68.81%	62.62%	49.82% - 75.42%
Jul '19	67.83%*	61.32% - 74.33%	69.52%*	60.28% - 78.76%
Aug '19	73.42%*	67.87% - 78.97%	75.99%*	66.84% - 85.14%
Sep '19	64.12%*	55.73% - 72.52%	62.21%*	52.69% - 71.73%
Oct '19	75.64%*	70.21% - 81.07%	76.37%*	70.08% - 82.66%
Nov '19	64.53%*	56.82% - 72.25%	62.11%*	51.43% - 72.80%
Dec '19	67.56%*	60.44% - 74.68%	63.12%*	52.96% - 73.27%
Jan '20	74.29%*	66.65% - 81.93%	64.12%*	55.48% - 72.76%
Feb '20	68.90%*	62.02% - 75.77%	66.73%*	57.34% - 76.12%
Mar '20	63.19%*	58.64% - 67.75%	67.27%*	58.92% - 75.62%
Apr '20	69.09%*	62.34% - 75.83%	70.71%*	62.11% - 79.31%
May '20	67.11%*	58.52% - 75.71%	65.24%*	54.36% - 76.12%
Jun '20	73.99%*	66.21% - 81.78%	73.83%*	62.44% - 85.22%
Jul '20	67.84%*	58.73% - 76.95%	63.50%*	52.24% - 74.77%
Aug '20	62.91%*	53.48% - 72.34%	62.67%*	51.49% - 73.86%
Sep '20	67.29%*	61.10% - 73.48%	71.74%*	60.62% - 82.87%
2017-12-18 - 2020-09-30	65.75%*	64.22% - 67.29%	65.08%*	63.28% - 66.89%

CME vs. Bitstamp (Chart)


CME vs Bitstamp — Monthly CME Information Share (IS) with 95% Confidence Intervals
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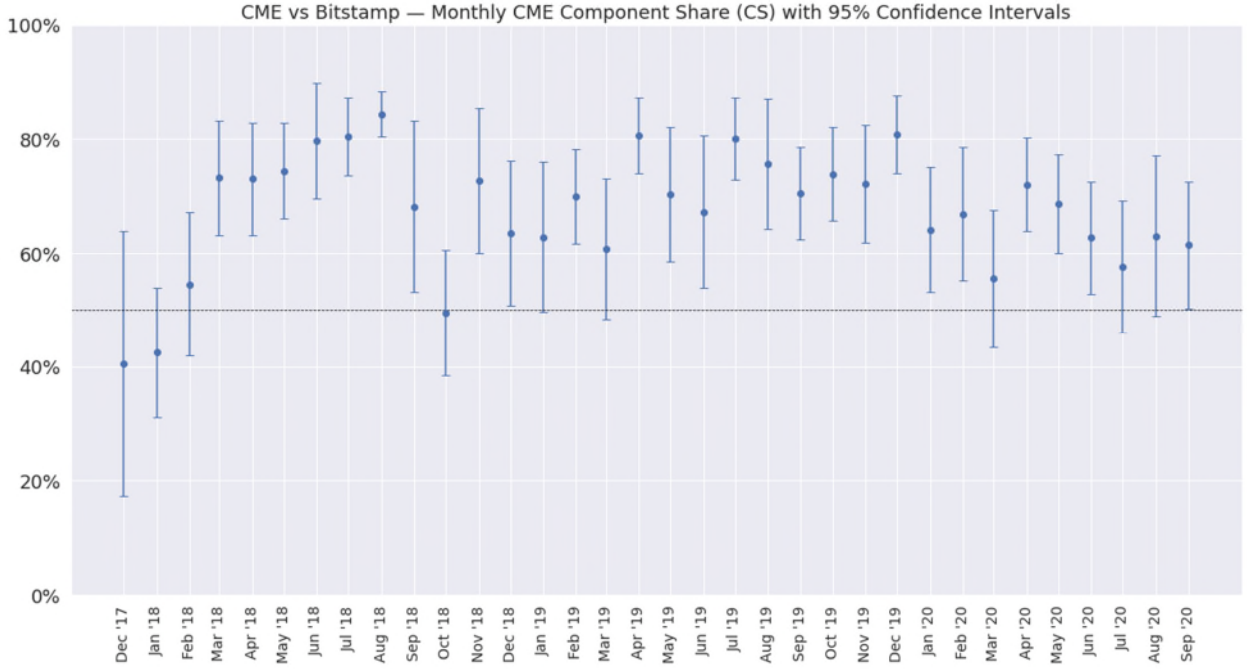
CME vs Bitstamp — Monthly CME Component Share (CS) with 95% Confidence Intervals
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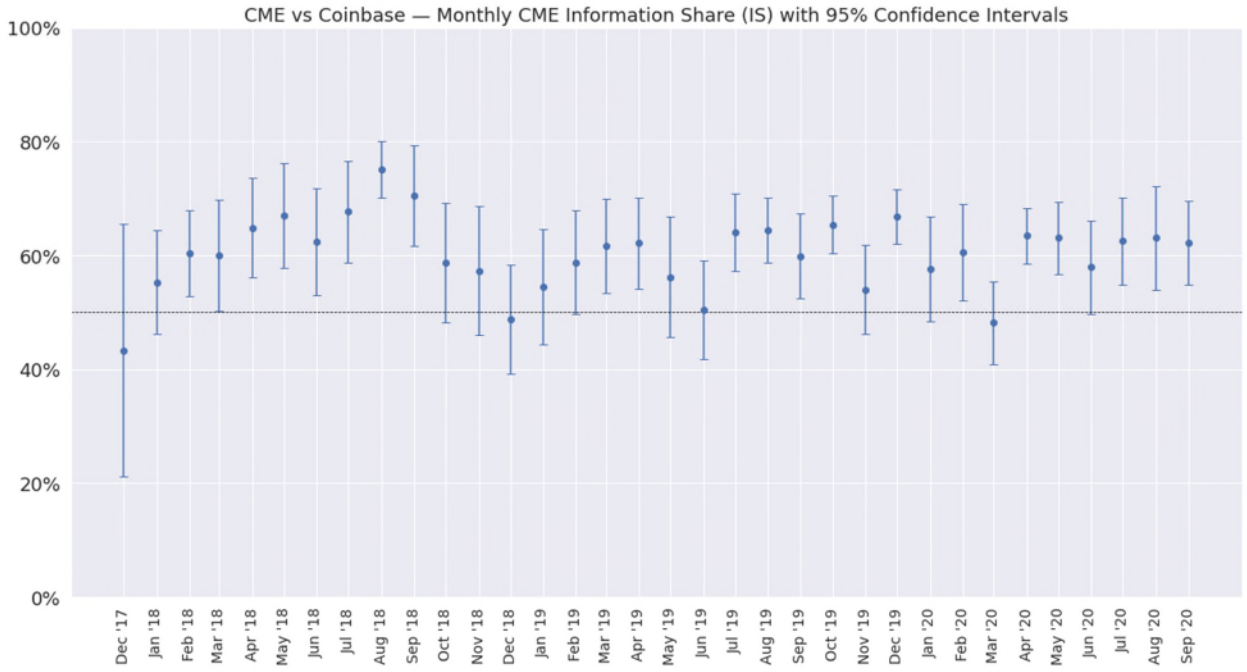
CME vs. Bitstamp (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Dec '17	41.39%	19.72% - 63.05%	40.57%	17.33% - 63.82%
Jan '18	46.93%	38.42% - 55.43%	42.49%	31.06% - 53.91%
Feb '18	58.16%*	50.73% - 65.60%	54.52%	41.89% - 67.15%
Mar '18	61.80%*	55.78% - 67.81%	73.16%*	63.14% - 83.17%
Apr '18	68.67%*	62.45% - 74.90%	72.98%*	63.09% - 82.87%
May '18	69.66%*	61.96% - 77.36%	74.39%*	66.05% - 82.74%
Jun '18	72.13%*	64.37% - 79.89%	79.61%*	69.49% - 89.73%
Jul '18	76.50%*	71.35% - 81.65%	80.49%*	73.68% - 87.30%
Aug '18	78.01%*	73.85% - 82.18%	84.35%*	80.37% - 88.34%
Sep '18	67.85%*	57.83% - 77.86%	68.18%*	53.24% - 83.13%
Oct '18	52.84%	41.36% - 64.31%	49.48%	38.42% - 60.54%
Nov '18	62.57%*	52.92% - 72.22%	72.67%*	59.92% - 85.41%
Dec '18	57.05%	48.06% - 66.05%	63.52%*	50.88% - 76.16%
Jan '19	68.15%*	57.05% - 79.25%	62.81%	49.61% - 76.02%
Feb '19	66.53%*	59.58% - 73.48%	69.92%*	61.58% - 78.27%
Mar '19	59.56%*	50.18% - 68.93%	60.71%	48.40% - 73.02%
Apr '19	74.16%*	67.58% - 80.74%	80.55%*	73.93% - 87.17%
May '19	65.72%*	56.56% - 74.88%	70.38%*	58.61% - 82.14%
Jun '19	57.60%	47.54% - 67.66%	67.27%*	53.86% - 80.67%
Jul '19	72.58%*	68.42% - 76.75%	80.08%*	72.91% - 87.24%
Aug '19	66.48%*	58.78% - 74.17%	75.64%*	64.20% - 87.08%
Sep '19	68.96%*	62.35% - 75.57%	70.45%*	62.31% - 78.60%
Oct '19	71.24%*	65.87% - 76.60%	73.86%*	65.66% - 82.06%
Nov '19	64.77%*	56.12% - 73.43%	72.17%*	61.82% - 82.53%
Dec '19	73.52%*	68.55% - 78.48%	80.80%*	74.03% - 87.57%
Jan '20	61.80%*	52.42% - 71.17%	64.13%*	53.11% - 75.16%
Feb '20	63.47%*	53.98% - 72.96%	66.85%*	55.15% - 78.56%
Mar '20	53.01%	46.55% - 59.47%	55.52%	43.41% - 67.63%
Apr '20	61.12%*	54.97% - 67.28%	72.05%*	63.85% - 80.25%
May '20	65.27%*	58.99% - 71.56%	68.66%*	60.07% - 77.25%
Jun '20	58.02%*	50.65% - 65.40%	62.67%*	52.80% - 72.54%
Jul '20	56.27%	47.74% - 64.81%	57.57%	45.94% - 69.20%
Aug '20	60.97%*	51.70% - 70.25%	63.01%	48.90% - 77.12%
Sep '20	60.74%*	54.37% - 67.11%	61.44%*	50.30% - 72.57%

2017-12-18 - 2020-09-30	64.10%*	62.74% - 65.47%	68.03%*	66.21% - 69.86%

CME vs. Coinbase (Chart)


CME vs Coinbase — Monthly CME Information Share (IS) with 95% Confidence Intervals
100%
80%
60%
40%
20%
0%
Dec '17
Jan '18
Feb '18
Mar '18
Apr '18
May '18
Jun '18
Jul '18
Aug '18
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Oct '18
Nov '18
Dec '18
Jan '19
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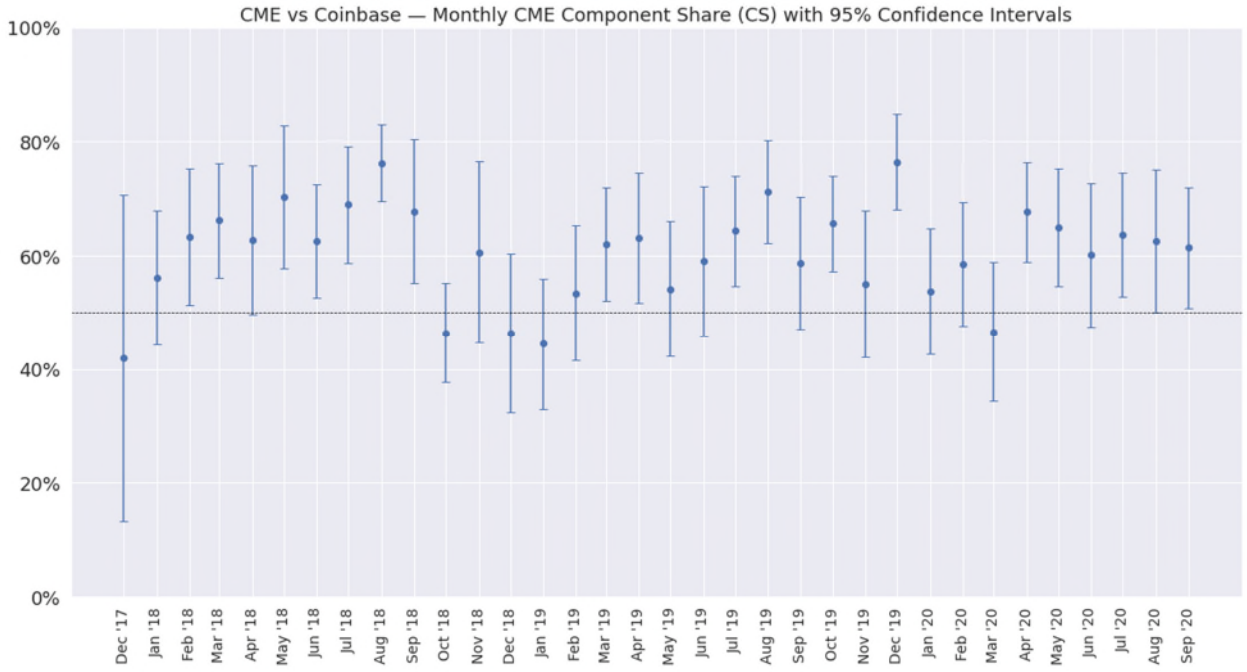
Jul '20
Aug '20
Sep '20


CME vs Coinbase — Monthly CME Component Share (CS) with 95% Confidence Intervals
100%
80%
60%
40%
20%
0%
Dec '17
Jan '18
Feb '18
Mar '18
Apr '18
May '18
Jun '18
Jul '18
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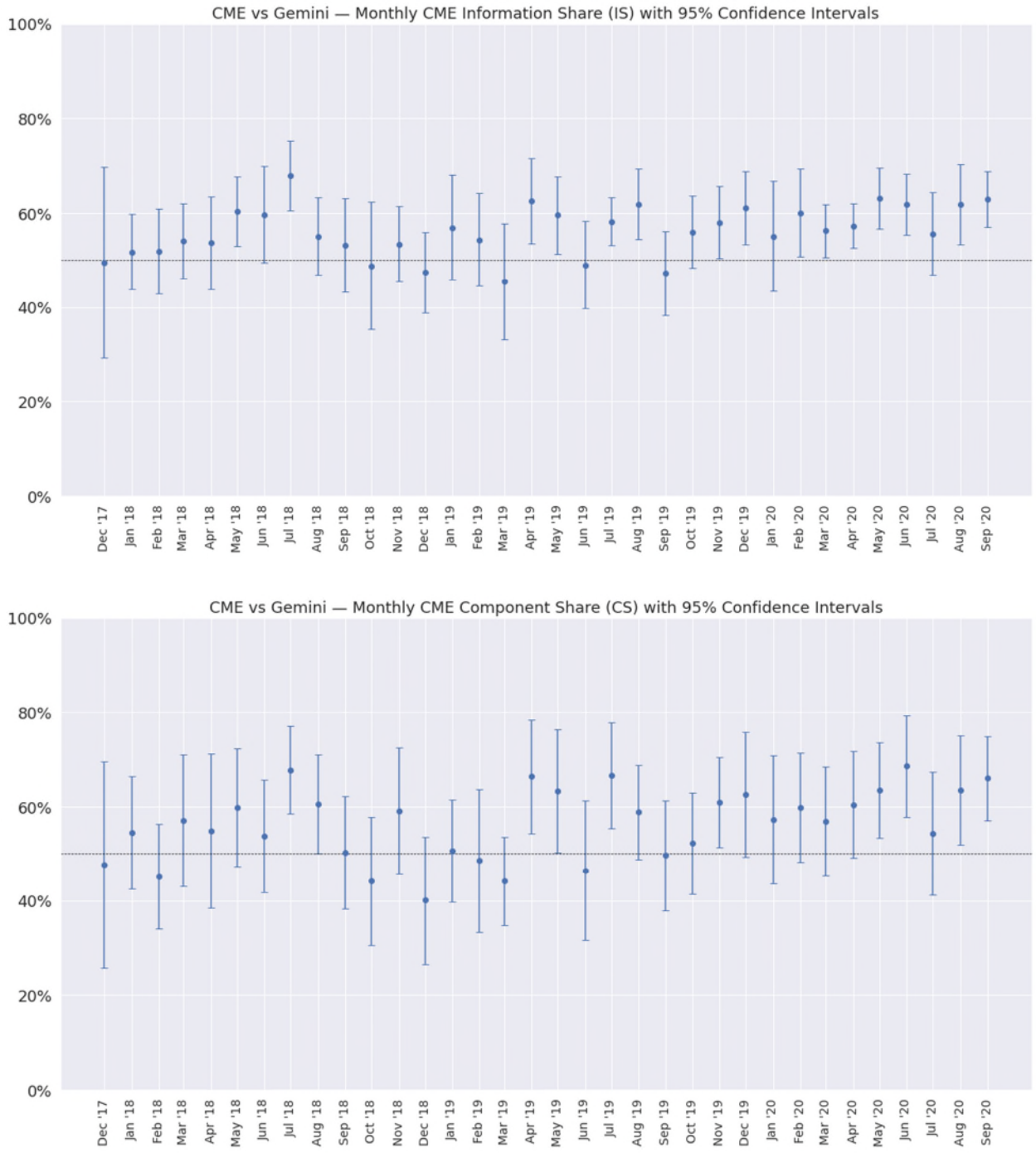
Jul '20
Aug '20
Sep '20

CME vs. Coinbase (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Dec '17	43.35%	21.24% - 65.47%	42.04%	13.35% - 70.73%
Jan '18	55.27%	46.14% - 64.40%	56.14%	44.35% - 67.94%
Feb '18	60.41%*	52.87% - 67.95%	63.39%*	51.42% - 75.36%
Mar '18	60.01%*	50.30% - 69.72%	66.22%*	56.22% - 76.22%
Apr '18	64.85%*	56.14% - 73.57%	62.74%	49.71% - 75.77%
May '18	66.99%*	57.75% - 76.22%	70.27%*	57.75% - 82.79%
Jun '18	62.44%*	53.09% - 71.80%	62.58%*	52.60% - 72.56%
Jul '18	67.66%*	58.67% - 76.64%	68.96%*	58.77% - 79.14%
Aug '18	75.08%*	70.12% - 80.04%	76.25%*	69.57% - 82.93%
Sep '18	70.47%*	61.62% - 79.32%	67.79%*	55.18% - 80.40%
Oct '18	58.67%	48.22% - 69.13%	46.47%	37.75% - 55.18%
Nov '18	57.32%	45.93% - 68.70%	60.57%	44.65% - 76.49%
Dec '18	48.71%	39.14% - 58.28%	46.33%	32.35% - 60.30%
Jan '19	54.51%	44.37% - 64.65%	44.48%	32.99% - 55.97%
Feb '19	58.78%	49.75% - 67.82%	53.44%	41.60% - 65.28%
Mar '19	61.65%*	53.36% - 69.93%	62.09%*	52.16% - 72.02%
Apr '19	62.15%*	54.11% - 70.20%	63.08%*	51.70% - 74.46%
May '19	56.17%	45.58% - 66.76%	54.16%	42.30% - 66.02%
Jun '19	50.37%	41.74% - 58.99%	59.07%	45.93% - 72.20%
Jul '19	64.11%*	57.28% - 70.93%	64.35%*	54.72% - 73.98%
Aug '19	64.46%*	58.71% - 70.20%	71.30%*	62.28% - 80.31%
Sep '19	59.90%*	52.40% - 67.39%	58.73%	47.13% - 70.32%
Oct '19	65.40%*	60.40% - 70.41%	65.62%*	57.33% - 73.90%
Nov '19	53.97%	46.13% - 61.81%	55.05%	42.19% - 67.92%
Dec '19	66.79%*	61.94% - 71.63%	76.40%*	68.06% - 84.75%
Jan '20	57.65%	48.46% - 66.85%	53.68%	42.62% - 64.74%
Feb '20	60.62%*	52.16% - 69.08%	58.53%	47.69% - 69.37%
Mar '20	48.14%	40.83% - 55.45%	46.63%	34.36% - 58.90%
Apr '20	63.43%*	58.53% - 68.32%	67.69%*	58.99% - 76.39%
May '20	63.06%*	56.76% - 69.35%	65.05%*	54.74% - 75.35%
Jun '20	57.92%	49.73% - 66.11%	60.11%	47.53% - 72.70%
Jul '20	62.50%*	54.88% - 70.12%	63.65%*	52.76% - 74.53%
Aug '20	63.04%*	53.97% - 72.12%	62.53%*	50.01% - 75.05%
Sep '20	62.16%*	54.77% - 69.54%	61.43%*	50.84% - 72.01%

2017-12-18 - 2020-09-30	60.60%*	59.20% - 62.00%	60.88%*	58.99% - 62.77%

CME vs. Gemini (Chart)

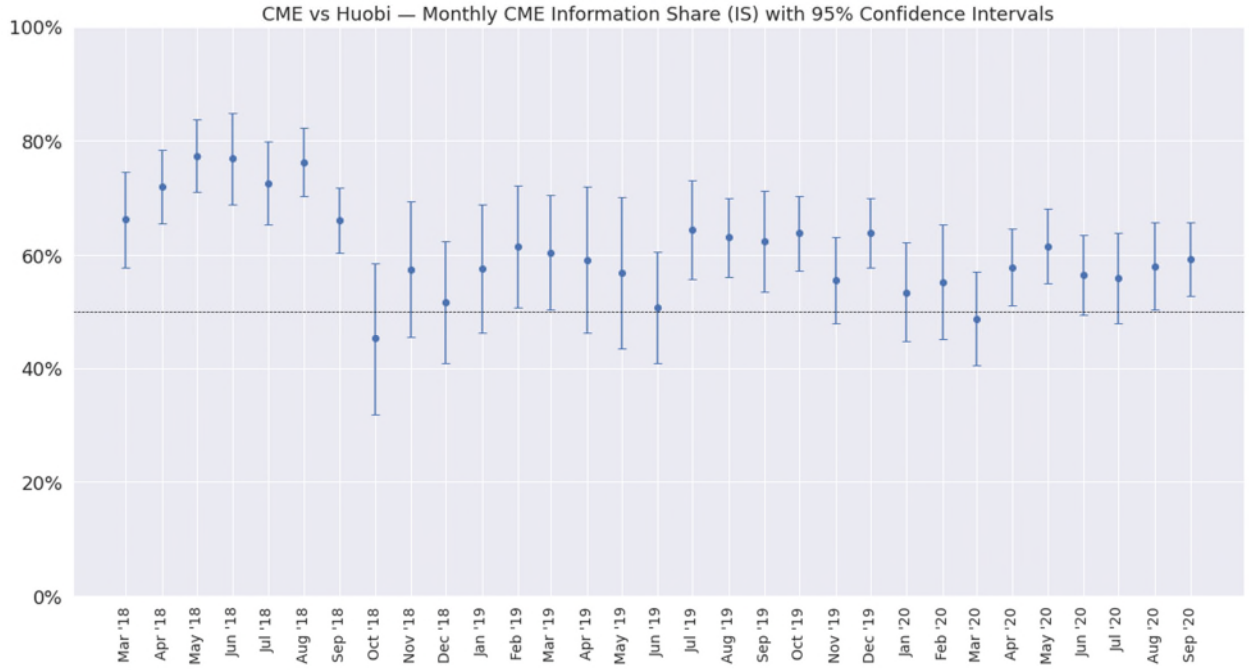


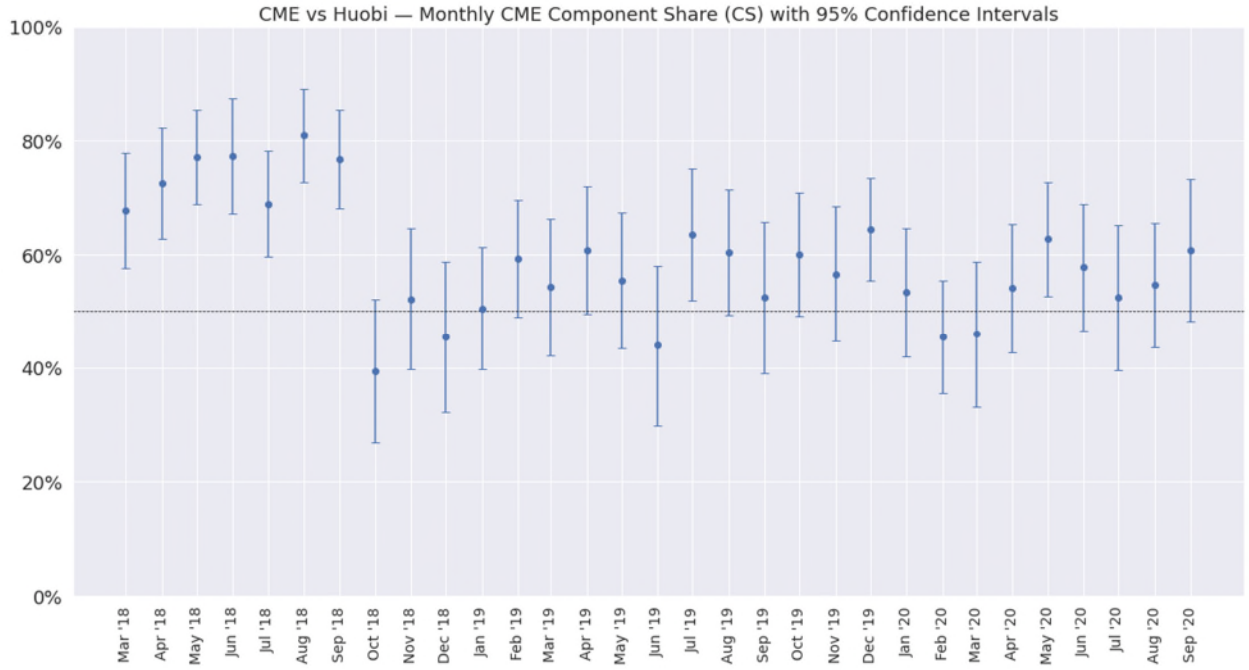
CME vs. Gemini (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Dec '17	49.51%	29.28% - 69.74%	47.63%	25.70% - 69.57%
Jan '18	51.75%	43.74% - 59.77%	54.46%	42.45% - 66.48%
Feb '18	51.88%	42.91% - 60.85%	45.18%	34.04% - 56.32%
Mar '18	54.11%	46.21% - 62.00%	57.06%	43.00% - 71.12%
Apr '18	53.69%	43.81% - 63.58%	54.81%	38.40% - 71.21%
May '18	60.37%*	52.95% - 67.80%	59.83%	47.29% - 72.36%
Jun '18	59.72%	49.55% - 69.88%	53.73%	41.81% - 65.65%
Jul '18	67.94%*	60.52% - 75.36%	67.80%*	58.52% - 77.09%
Aug '18	55.11%	47.00% - 63.22%	60.59%*	50.15% - 71.03%
Sep '18	53.18%	43.22% - 63.14%	50.22%	38.31% - 62.12%
Oct '18	48.84%	35.30% - 62.38%	44.20%	30.61% - 57.79%
Nov '18	53.41%	45.40% - 61.41%	59.07%	45.66% - 72.47%
Dec '18	47.44%	38.87% - 56.01%	40.08%	26.60% - 53.56%
Jan '19	56.96%	45.88% - 68.03%	50.63%	39.72% - 61.53%
Feb '19	54.32%	44.47% - 64.17%	48.56%	33.36% - 63.76%
Mar '19	45.40%	33.10% - 57.70%	44.14%	34.80% - 53.48%
Apr '19	62.51%*	53.49% - 71.53%	66.39%*	54.39% - 78.39%
May '19	59.55%*	51.42% - 67.69%	63.26%*	50.18% - 76.34%
Jun '19	48.97%	39.68% - 58.26%	46.42%	31.63% - 61.21%
Jul '19	58.24%*	53.20% - 63.29%	66.62%*	55.34% - 77.89%
Aug '19	61.93%*	54.42% - 69.44%	58.82%	48.75% - 68.90%
Sep '19	47.24%	38.36% - 56.13%	49.61%	38.02% - 61.21%
Oct '19	56.04%	48.47% - 63.61%	52.20%	41.40% - 63.00%
Nov '19	58.03%*	50.36% - 65.70%	60.91%*	51.42% - 70.40%
Dec '19	61.10%*	53.37% - 68.82%	62.63%	49.35% - 75.91%
Jan '20	55.08%	43.44% - 66.72%	57.20%	43.57% - 70.83%
Feb '20	60.05%*	50.81% - 69.29%	59.75%	48.15% - 71.36%
Mar '20	56.31%*	50.71% - 61.90%	56.89%	45.27% - 68.51%
Apr '20	57.31%*	52.65% - 61.97%	60.43%	49.07% - 71.79%
May '20	63.18%*	56.71% - 69.65%	63.51%*	53.45% - 73.57%
Jun '20	61.83%*	55.42% - 68.23%	68.58%*	57.76% - 79.39%
Jul '20	55.66%	46.90% - 64.43%	54.34%	41.31% - 67.37%
Aug '20	61.81%*	53.40% - 70.22%	63.45%*	51.87% - 75.03%
Sep '20	62.98%*	57.07% - 68.88%	66.02%*	57.08% - 74.96%

2017-12-18 - 2020-09-30	56.44%*	55.03% - 57.84%	56.73%*	54.73% - 58.72%

CME vs. Huobi (Chart)



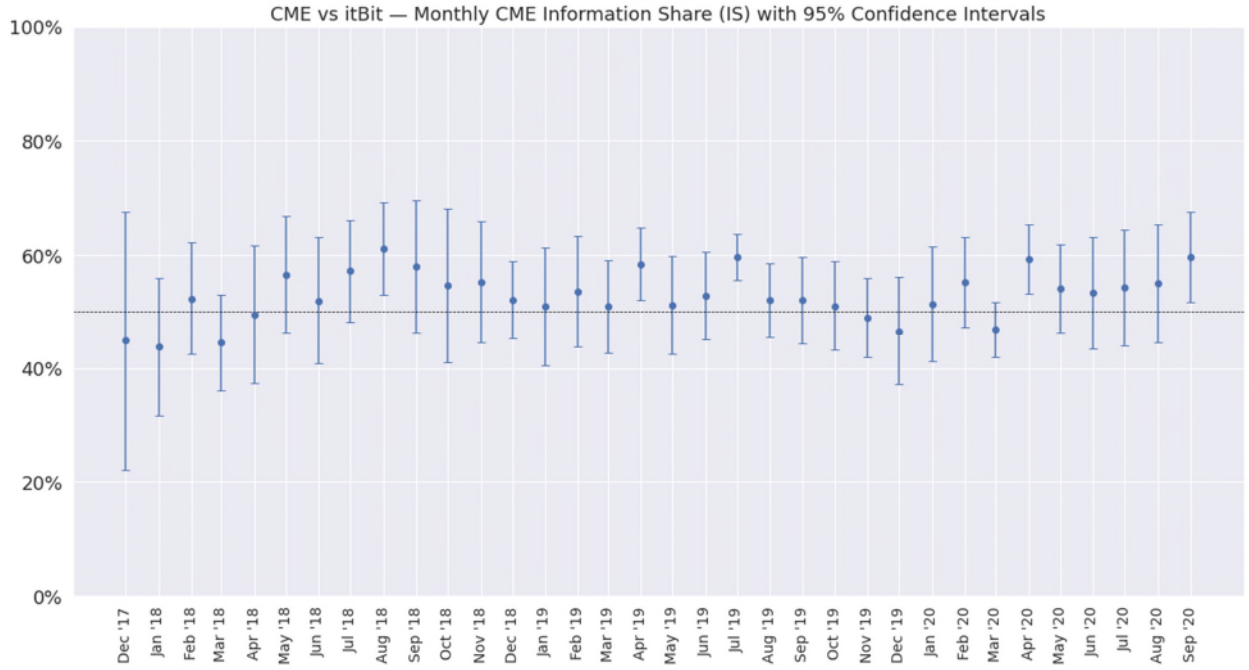


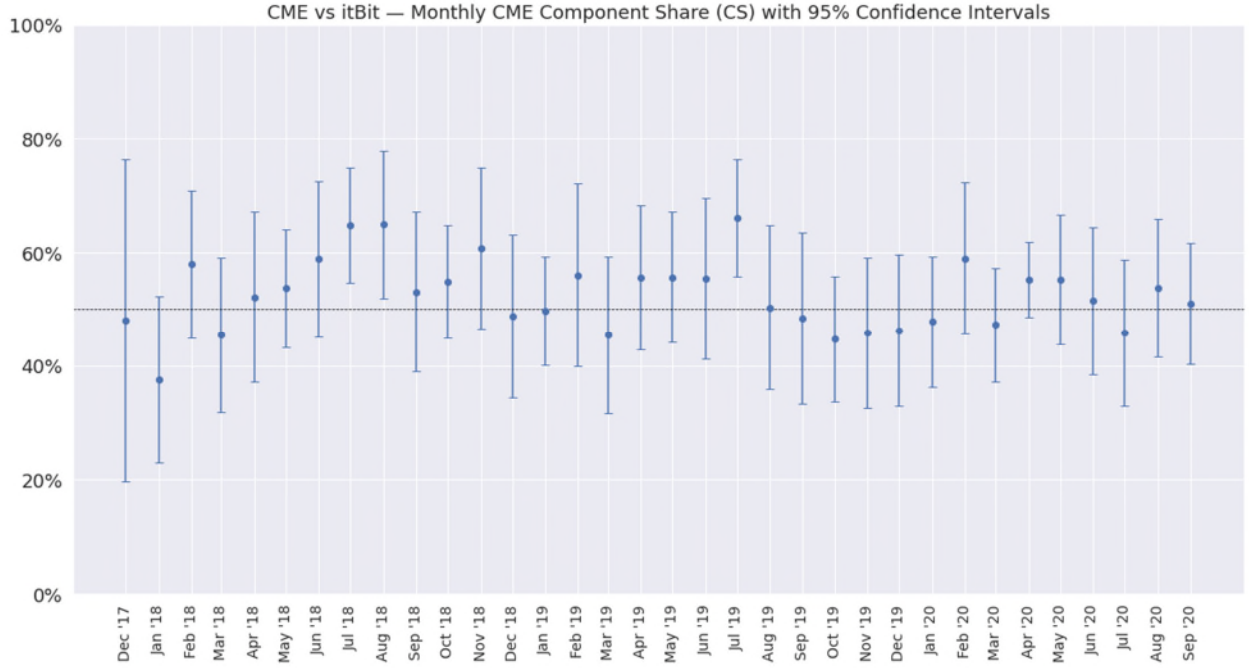
CME vs. Huobi (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Mar '18	66.17%*	57.72% - 74.62%	67.72%*	57.64% - 77.79%
Apr '18	71.96%*	65.56% - 78.37%	72.53%*	62.80% - 82.25%
May '18	77.35%*	71.04% - 83.66%	77.14%*	68.84% - 85.45%
Jun '18	76.84%*	68.75% - 84.92%	77.30%*	67.23% - 87.37%
Jul '18	72.59%*	65.28% - 79.90%	68.88%*	59.58% - 78.18%
Aug '18	76.21%*	70.24% - 82.19%	80.93%*	72.70% - 89.15%
Sep '18	66.04%*	60.30% - 71.78%	76.70%*	68.07% - 85.33%
Oct '18	45.26%	31.92% - 58.59%	39.42%	26.82% - 52.01%
Nov '18	57.49%	45.51% - 69.46%	52.16%	39.80% - 64.52%
Dec '18	51.64%	40.90% - 62.38%	45.47%	32.15% - 58.79%
Jan '19	57.58%	46.33% - 68.84%	50.48%	39.74% - 61.23%
Feb '19	61.48%*	50.84% - 72.12%	59.33%	49.04% - 69.61%
Mar '19	60.41%*	50.36% - 70.45%	54.27%	42.20% - 66.33%
Apr '19	59.15%	46.41% - 71.89%	60.74%	49.54% - 71.94%
May '19	56.79%	43.38% - 70.20%	55.45%	43.49% - 67.40%
Jun '19	50.71%	40.85% - 60.57%	43.93%	29.91% - 57.95%
Jul '19	64.42%*	55.80% - 73.04%	63.51%*	51.96% - 75.05%
Aug '19	63.04%*	56.18% - 69.91%	60.41%	49.40% - 71.41%
Sep '19	62.43%*	53.62% - 71.24%	52.40%	39.04% - 65.77%
Oct '19	63.86%*	57.33% - 70.40%	60.04%	49.19% - 70.88%
Nov '19	55.56%	47.98% - 63.14%	56.59%	44.66% - 68.51%
Dec '19	63.88%*	57.76% - 70.00%	64.41%*	55.42% - 73.40%
Jan '20	53.46%	44.72% - 62.21%	53.35%	42.05% - 64.65%
Feb '20	55.27%	45.18% - 65.36%	45.44%	35.54% - 55.35%
Mar '20	48.81%	40.58% - 57.04%	45.94%	33.22% - 58.66%
Apr '20	57.88%*	51.21% - 64.55%	54.09%	42.78% - 65.39%
May '20	61.55%*	55.05% - 68.05%	62.69%*	52.65% - 72.73%
Jun '20	56.51%	49.45% - 63.57%	57.71%	46.60% - 68.82%
Jul '20	55.99%	48.12% - 63.87%	52.40%	39.67% - 65.14%
Aug '20	58.05%*	50.43% - 65.68%	54.64%	43.71% - 65.57%
Sep '20	59.24%*	52.83% - 65.65%	60.74%	48.22% - 73.25%

2018-03-01 - 2020-09-30	60.91%*	59.34% - 62.49%	58.97%*	56.96% - 60.98%

CME vs. itBit (Chart)



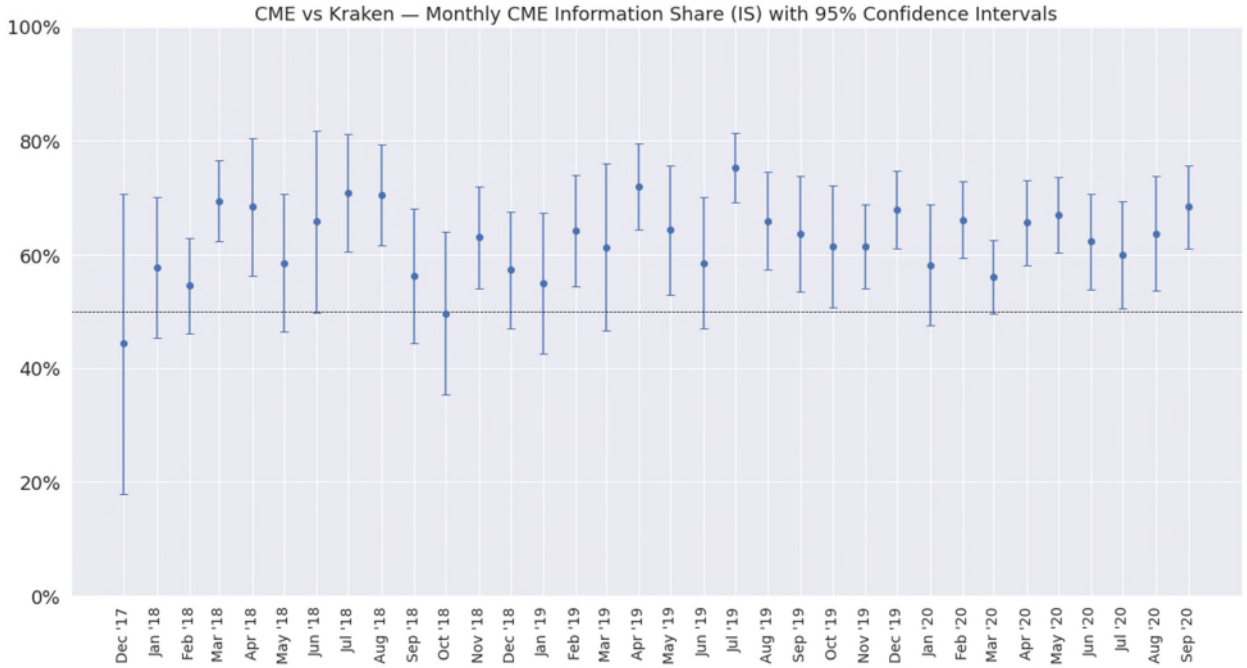


CME vs. itBit (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Dec '17	44.83%	22.06% - 67.60%	48.07%	19.80% - 76.34%
Jan '18	43.81%	31.60% - 56.02%	37.59%	22.97% - 52.22%
Feb '18	52.34%	42.47% - 62.22%	57.90%	44.94% - 70.86%
Mar '18	44.58%	36.07% - 53.09%	45.48%	31.89% - 59.08%
Apr '18	49.45%	37.29% - 61.61%	52.17%	37.12% - 67.22%
May '18	56.59%	46.39% - 66.80%	53.66%	43.23% - 64.09%
Jun '18	51.92%	40.81% - 63.04%	58.86%	45.12% - 72.59%
Jul '18	57.16%	48.30% - 66.02%	64.78%*	54.73% - 74.83%
Aug '18	61.13%*	53.03% - 69.23%	64.89%*	51.88% - 77.90%
Sep '18	57.99%	46.37% - 69.61%	53.08%	38.97% - 67.18%
Oct '18	54.59%	41.03% - 68.14%	54.88%	45.00% - 64.77%
Nov '18	55.19%	44.54% - 65.85%	60.70%	46.54% - 74.86%
Dec '18	52.04%	45.22% - 58.87%	48.78%	34.43% - 63.14%
Jan '19	50.93%	40.54% - 61.33%	49.66%	40.13% - 59.20%
Feb '19	53.53%	43.74% - 63.33%	56.04%	39.96% - 72.12%
Mar '19	50.92%	42.78% - 59.07%	45.50%	31.74% - 59.26%
Apr '19	58.38%*	52.03% - 64.73%	55.63%	42.95% - 68.31%
May '19	51.24%	42.61% - 59.87%	55.63%	44.13% - 67.13%
Jun '19	52.85%	45.08% - 60.63%	55.33%	41.16% - 69.51%
Jul '19	59.71%*	55.68% - 63.75%	65.99%*	55.69% - 76.30%
Aug '19	52.06%	45.52% - 58.61%	50.34%	35.83% - 64.84%
Sep '19	52.01%	44.32% - 59.70%	48.43%	33.34% - 63.52%
Oct '19	51.03%	43.23% - 58.83%	44.71%	33.67% - 55.75%
Nov '19	48.99%	42.06% - 55.92%	45.81%	32.52% - 59.10%
Dec '19	46.61%	37.11% - 56.11%	46.30%	33.02% - 59.58%
Jan '20	51.36%	41.28% - 61.43%	47.78%	36.24% - 59.32%
Feb '20	55.26%	47.32% - 63.19%	58.97%	45.57% - 72.37%
Mar '20	46.90%	42.00% - 51.80%	47.23%	37.19% - 57.26%
Apr '20	59.25%*	53.21% - 65.28%	55.19%	48.55% - 61.83%
May '20	54.13%	46.39% - 61.87%	55.21%	43.82% - 66.61%
Jun '20	53.33%	43.51% - 63.15%	51.48%	38.54% - 64.43%
Jul '20	54.25%	44.08% - 64.43%	45.87%	32.97% - 58.78%
Aug '20	55.00%	44.64% - 65.36%	53.75%	41.54% - 65.97%
Sep '20	59.68%*	51.79% - 67.56%	50.98%	40.36% - 61.59%

2017-12-18 - 2020-09-30	53.33%*	51.91% - 54.75%	52.97%*	50.93% - 55.00%

CME vs. Kraken (Chart)


CME vs Kraken — Monthly CME Information Share (IS) with 95% Confidence Intervals
100%
80%
60%
40%
20%
0%
Dec '17
Jan '18
Feb '18
Mar '18
Apr '18
May '18
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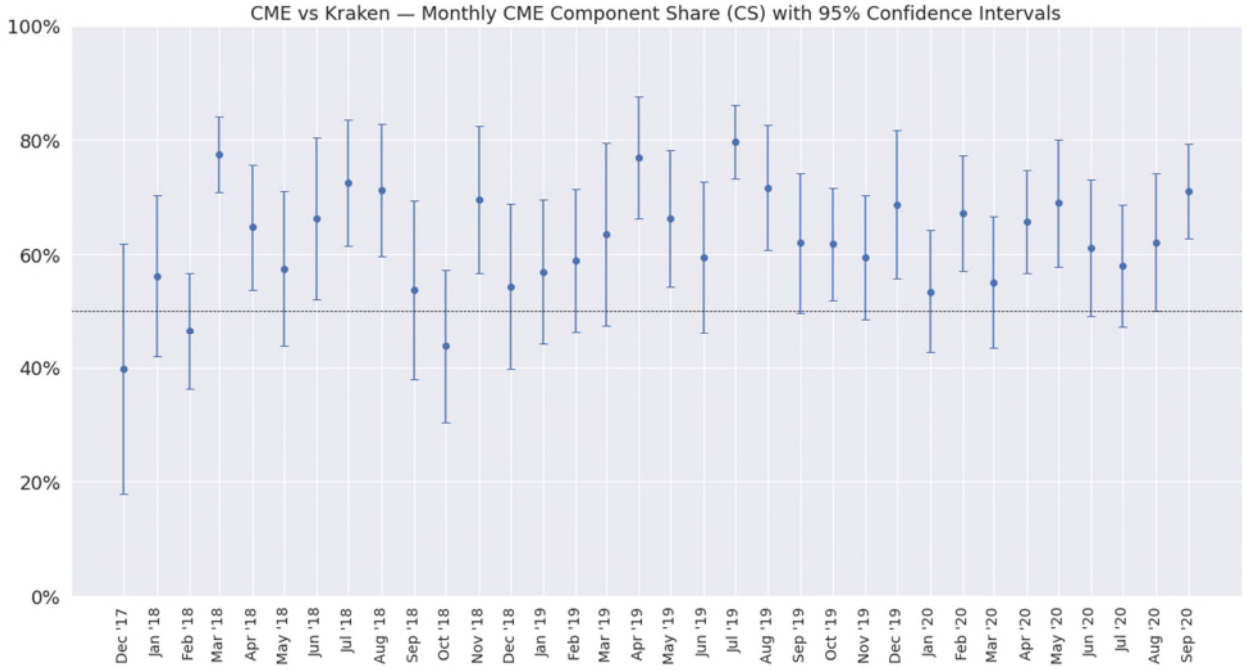
CME vs Kraken — Monthly CME Component Share (CS) with 95% Confidence Intervals
100%
80%
60%
40%
20%
0%
Dec '17
Jan '18
Feb '18
Mar '18
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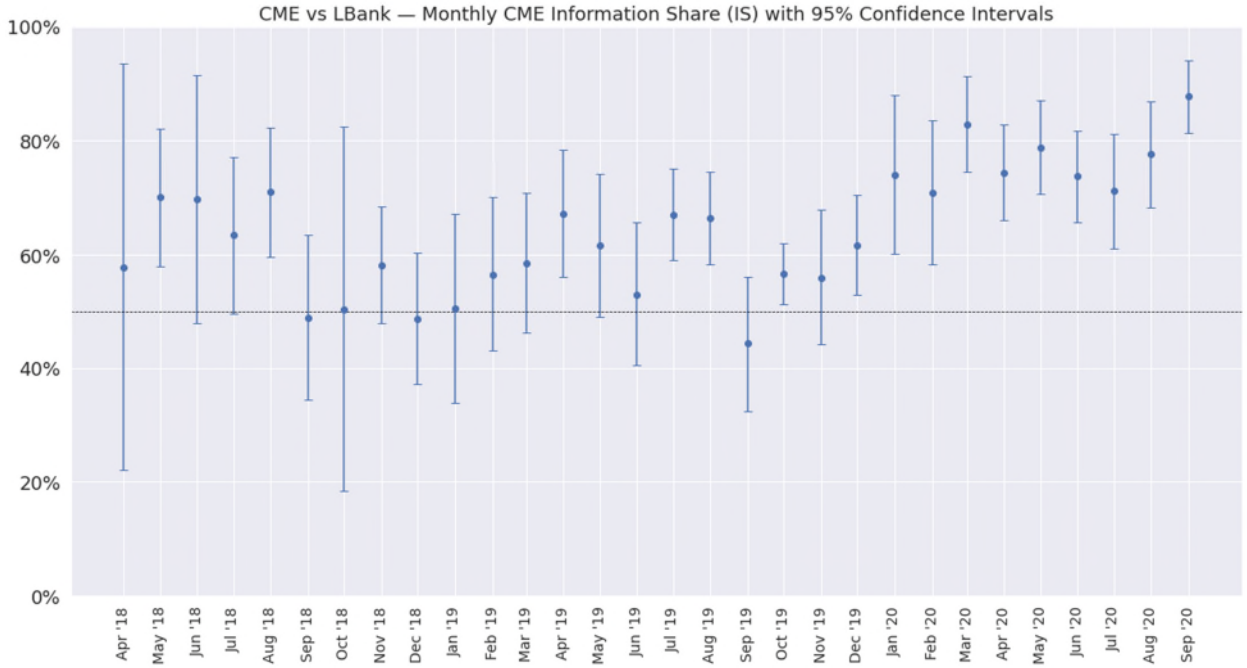
Jun '20
Jul '20
Aug '20
Sep '20

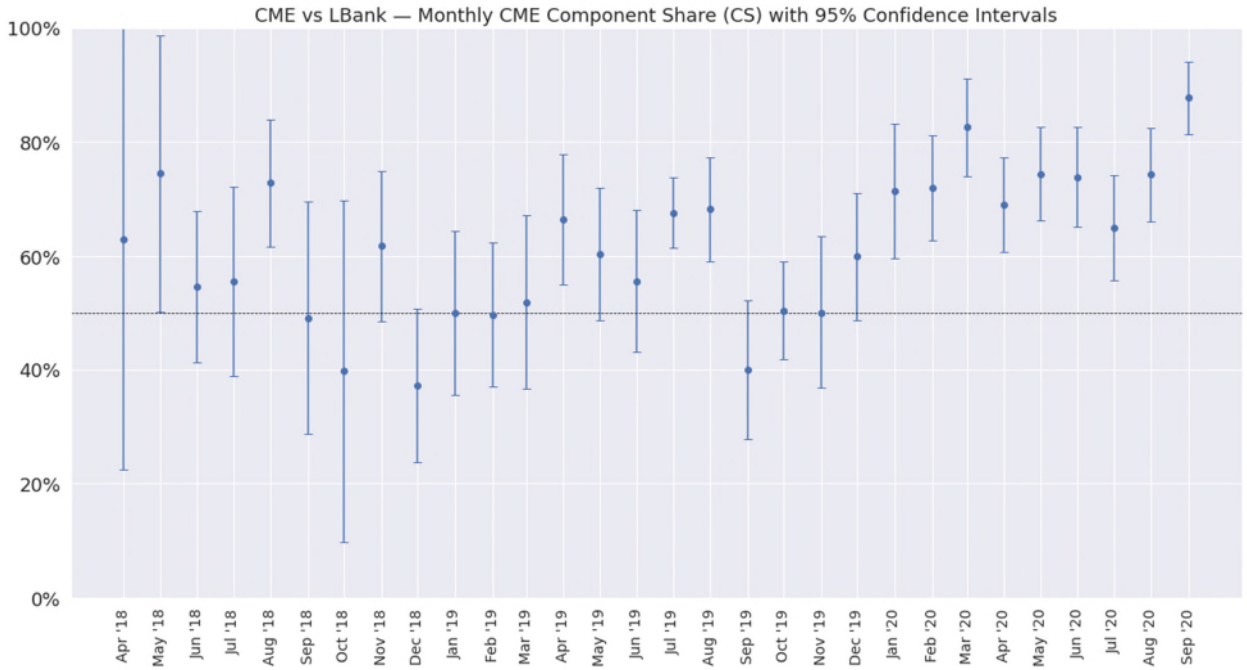
CME vs. Kraken (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Dec '17	44.29%	17.93% - 70.64%	39.83%	17.90% - 61.75%
Jan '18	57.74%	45.33% - 70.15%	56.19%	42.04% - 70.33%
Feb '18	54.59%	46.24% - 62.95%	46.51%	36.25% - 56.77%
Mar '18	69.46%*	62.36% - 76.55%	77.45%*	70.81% - 84.10%
Apr '18	68.42%*	56.37% - 80.46%	64.73%*	53.81% - 75.66%
May '18	58.56%	46.50% - 70.63%	57.41%	43.86% - 70.96%
Jun '18	65.83%	49.91% - 81.75%	66.25%*	52.04% - 80.45%
Jul '18	70.81%*	60.49% - 81.13%	72.48%*	61.41% - 83.54%
Aug '18	70.52%*	61.70% - 79.33%	71.16%*	59.58% - 82.74%
Sep '18	56.26%	44.40% - 68.11%	53.70%	37.96% - 69.45%
Oct '18	49.77%	35.44% - 64.10%	43.74%	30.31% - 57.17%
Nov '18	63.05%*	54.18% - 71.92%	69.62%*	56.76% - 82.49%
Dec '18	57.40%	47.22% - 67.58%	54.29%	39.79% - 68.79%
Jan '19	54.97%	42.53% - 67.41%	56.85%	44.14% - 69.56%
Feb '19	64.26%*	54.50% - 74.02%	58.89%	46.36% - 71.43%
Mar '19	61.37%	46.73% - 76.01%	63.48%	47.54% - 79.42%
Apr '19	72.02%*	64.46% - 79.58%	76.92%*	66.26% - 87.58%
May '19	64.33%*	52.94% - 75.71%	66.35%*	54.39% - 78.31%
Jun '19	58.56%	47.04% - 70.08%	59.46%	46.19% - 72.73%
Jul '19	75.22%*	69.12% - 81.33%	79.66%*	73.23% - 86.09%
Aug '19	65.97%*	57.49% - 74.45%	71.62%*	60.68% - 82.55%
Sep '19	63.67%*	53.47% - 73.87%	61.96%	49.68% - 74.24%
Oct '19	61.50%*	50.89% - 72.11%	61.77%*	51.98% - 71.56%
Nov '19	61.42%*	54.11% - 68.74%	59.48%	48.67% - 70.28%
Dec '19	67.95%*	61.17% - 74.73%	68.73%*	55.70% - 81.75%
Jan '20	58.23%	47.69% - 68.77%	53.39%	42.64% - 64.15%
Feb '20	66.15%*	59.41% - 72.89%	67.20%*	57.02% - 77.37%
Mar '20	56.18%	49.78% - 62.58%	55.11%	43.52% - 66.69%
Apr '20	65.64%*	58.14% - 73.14%	65.72%*	56.76% - 74.69%
May '20	67.04%*	60.40% - 73.67%	68.96%*	57.88% - 80.04%
Jun '20	62.35%*	53.94% - 70.75%	61.04%	49.11% - 72.98%
Jul '20	60.01%*	50.64% - 69.39%	57.99%	47.34% - 68.65%
Aug '20	63.71%*	53.69% - 73.73%	62.07%*	50.01% - 74.12%
Sep '20	68.42%*	61.13% - 75.71%	71.02%*	62.68% - 79.37%

2017-12-18 - 2020-09-30	63.17%*	61.58% - 64.76%	63.24%*	61.29% - 65.19%

CME vs. LBank (Chart)


CME vs LBank — Monthly CME Information Share (IS) with 95% Confidence Intervals
100%
80%
60%
40%
20%
0%
Apr '18
May '18
Jun '18
Jul '18
Aug '18
Sep '18
Oct '18
Nov '18
Dec '18
Jan '19
Feb '19
Mar '19
Apr '19
May '19
Jun '19
Jul '19
Aug '19
Sep '19
Oct '19
Nov '19
Dec '19
Jan '20
Feb '20
Mar '20
Apr '20
May '20
Jun '20
Jul '20
Aug '20
Sep '20

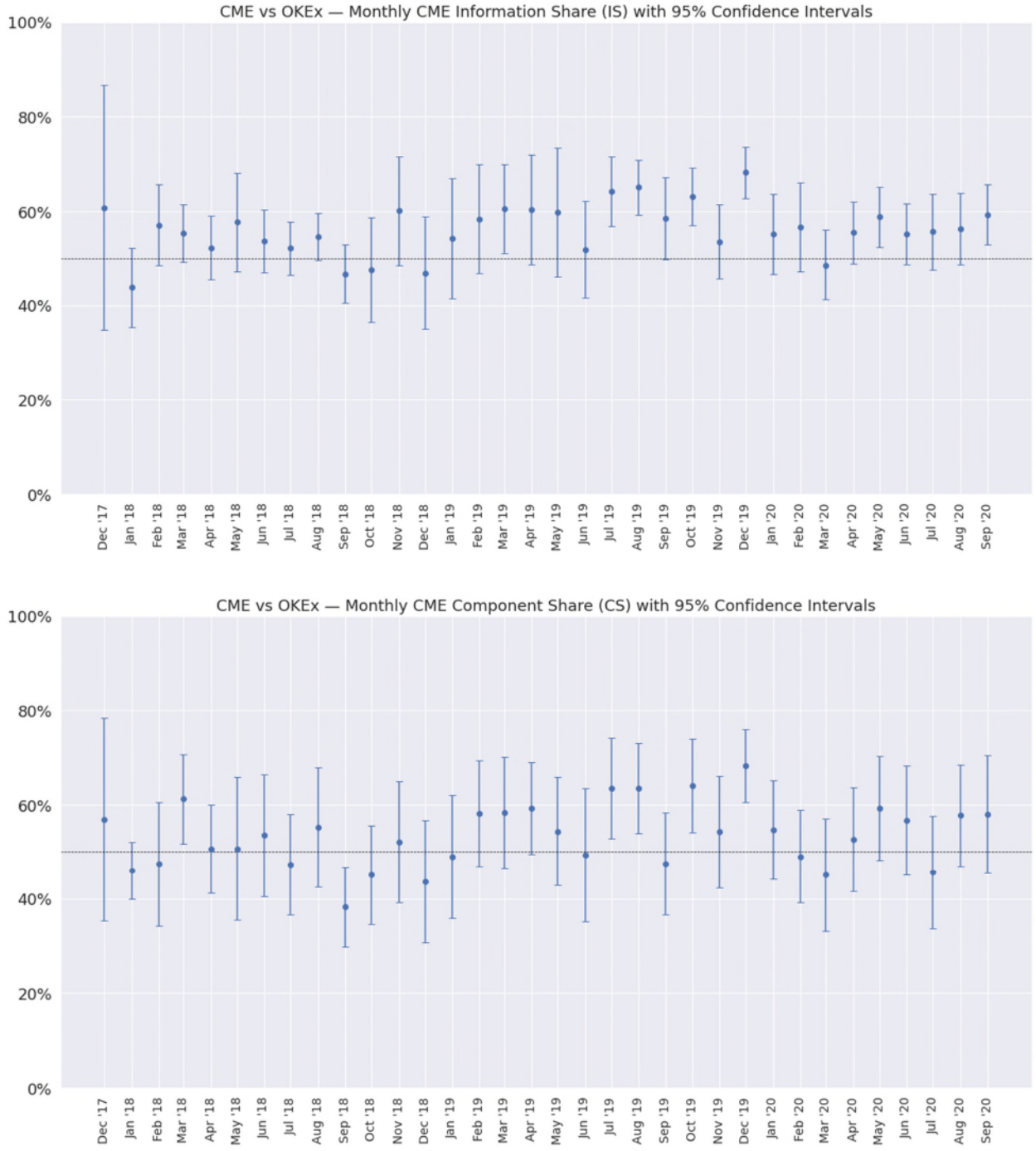

CME vs LBank — Monthly CME Component Share (CS) with 95% Confidence Intervals
100%
80%
60%
40%
20%
0%
Apr '18
May '18
Jun '18
Jul '18
Aug '18
Sep '18
Oct '18
Nov '18
Dec '18
Jan '19
Feb '19
Mar '19
Apr '19
May '19
Jun '19
Jul '19
Aug '19
Sep '19
Oct '19
Nov '19
Dec '19
Jan '20
Feb '20
Mar '20
Apr '20
May '20
Jun '20
Jul '20
Aug '20
Sep '20

CME vs. LBank (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Apr '18	57.83%	22.09% - 93.57%	63.03%	22.42% - 100.00%
May '18	70.04%*	58.06% - 82.02%	74.46%*	50.33% - 98.60%
Jun '18	69.76%	48.11% - 91.41%	54.64%	41.29% - 67.99%
Jul '18	63.43%	49.76% - 77.10%	55.50%	38.86% - 72.14%
Aug '18	71.01%*	59.68% - 82.33%	72.84%*	61.74% - 83.95%
Sep '18	49.00%	34.44% - 63.55%	49.12%	28.68% - 69.56%
Oct '18	50.51%	18.48% - 82.54%	39.74%	9.72% - 69.76%
Nov '18	58.21%	47.99% - 68.42%	61.78%	48.66% - 74.90%
Dec '18	48.84%	37.23% - 60.45%	37.26%	23.74% - 50.78%
Jan '19	50.57%	33.95% - 67.20%	49.99%	35.49% - 64.49%
Feb '19	56.52%	43.00% - 70.04%	49.73%	36.98% - 62.48%
Mar '19	58.61%	46.43% - 70.78%	51.95%	36.68% - 67.22%
Apr '19	67.27%*	56.20% - 78.34%	66.46%*	55.12% - 77.80%
May '19	61.60%	49.10% - 74.11%	60.30%	48.73% - 71.87%
Jun '19	53.08%	40.44% - 65.72%	55.55%	43.09% - 68.01%
Jul '19	67.06%*	59.02% - 75.10%	67.61%*	61.44% - 73.79%
Aug '19	66.47%*	58.37% - 74.58%	68.23%*	59.07% - 77.39%
Sep '19	44.33%	32.48% - 56.17%	40.01%	27.73% - 52.29%
Oct '19	56.64%*	51.27% - 62.01%	50.37%	41.71% - 59.02%
Nov '19	56.03%	44.12% - 67.94%	50.12%	36.81% - 63.43%
Dec '19	61.73%*	53.00% - 70.46%	59.91%	48.80% - 71.03%
Jan '20	74.07%*	60.21% - 87.93%	71.33%*	59.55% - 83.11%
Feb '20	70.92%*	58.33% - 83.51%	71.94%*	62.78% - 81.11%
Mar '20	82.90%*	74.52% - 91.28%	82.54%*	73.99% - 91.10%
Apr '20	74.42%*	66.11% - 82.72%	69.07%*	60.79% - 77.34%
May '20	78.85%*	70.62% - 87.09%	74.41%*	66.23% - 82.59%
Jun '20	73.73%*	65.78% - 81.69%	73.88%*	65.10% - 82.66%
Jul '20	71.17%*	61.18% - 81.15%	64.98%*	55.75% - 74.22%
Aug '20	77.58%*	68.24% - 86.92%	74.31%*	66.15% - 82.47%
Sep '20	87.70%*	81.30% - 94.10%	87.71%*	81.36% - 94.06%

2018-04-05 - 2020-09-30	66.03%*	63.95% - 68.11%	63.51%*	61.34% - 65.68%

CME vs. OKEx (Chart)

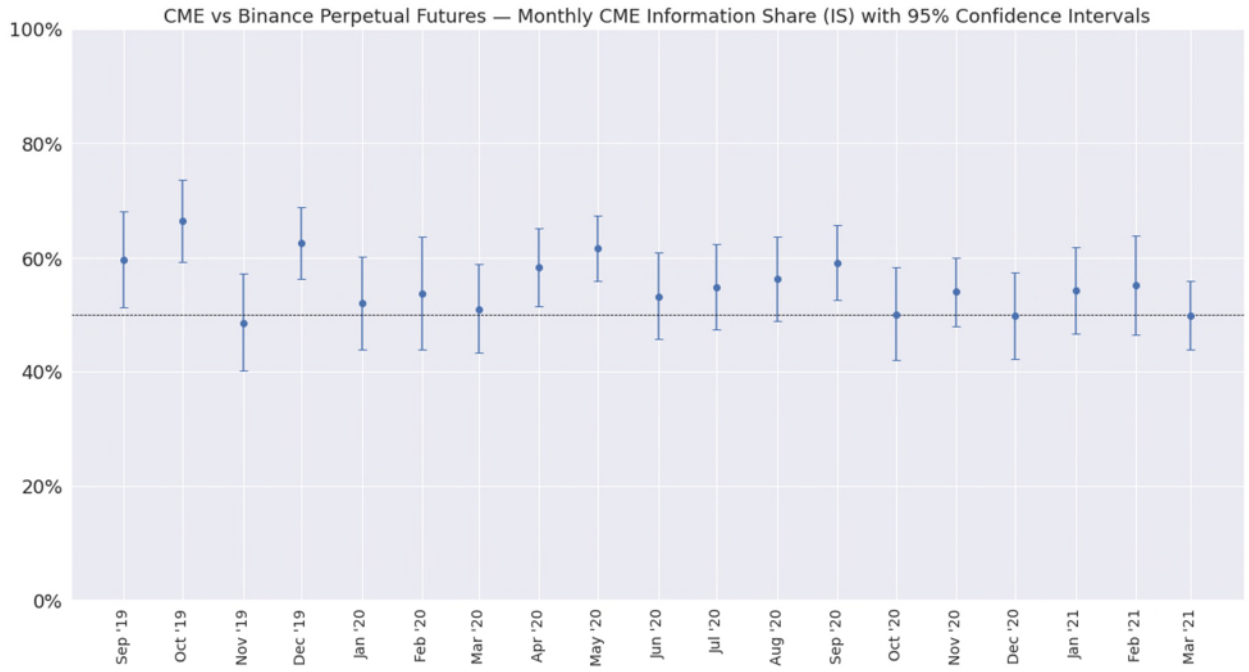


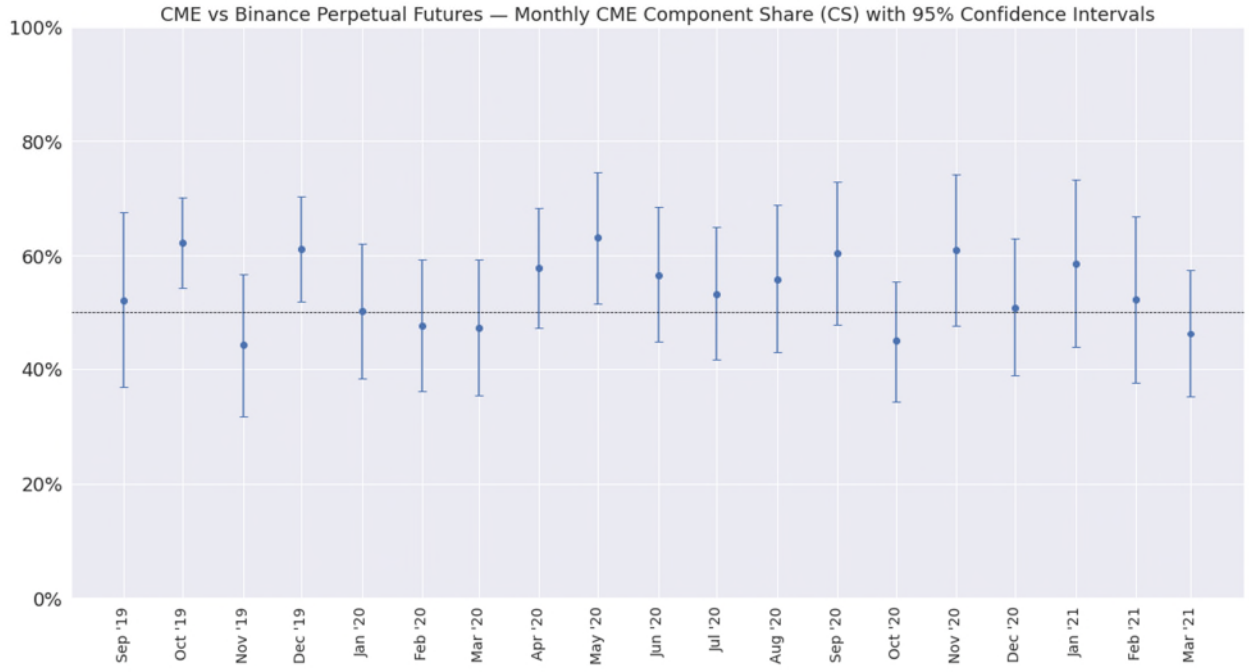
CME vs. OKEx (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Dec '17	60.69%	34.76% - 86.62%	56.88%	35.39% - 78.37%
Jan '18	43.77%	35.33% - 52.21%	46.03%	39.93% - 52.12%
Feb '18	57.14%	48.66% - 65.62%	47.43%	34.29% - 60.57%
Mar '18	55.36%	49.34% - 61.39%	61.20%*	51.79% - 70.61%
Apr '18	52.26%	45.49% - 59.03%	50.68%	41.26% - 60.09%
May '18	57.72%	47.34% - 68.10%	50.67%	35.46% - 65.88%
Jun '18	53.80%	47.17% - 60.43%	53.50%	40.47% - 66.53%
Jul '18	52.19%	46.60% - 57.79%	47.32%	36.68% - 57.96%
Aug '18	54.66%	49.63% - 59.70%	55.22%	42.45% - 67.99%
Sep '18	46.76%	40.42% - 53.10%	38.31%*	29.91% - 46.71%
Oct '18	47.59%	36.46% - 58.72%	45.09%	34.53% - 55.64%
Nov '18	60.12%	48.61% - 71.62%	52.16%	39.30% - 65.03%
Dec '18	46.87%	34.90% - 58.85%	43.68%	30.70% - 56.65%
Jan '19	54.28%	41.49% - 67.08%	48.89%	35.83% - 61.95%
Feb '19	58.41%	46.93% - 69.89%	58.17%	46.94% - 69.39%
Mar '19	60.57%*	51.12% - 70.02%	58.34%	46.55% - 70.14%
Apr '19	60.41%	48.80% - 72.03%	59.27%	49.52% - 69.01%
May '19	59.84%	46.25% - 73.42%	54.39%	42.96% - 65.81%
Jun '19	51.93%	41.59% - 62.27%	49.34%	35.19% - 63.49%
Jul '19	64.22%*	56.85% - 71.60%	63.56%*	52.90% - 74.22%
Aug '19	65.14%*	59.34% - 70.94%	63.51%*	53.90% - 73.13%
Sep '19	58.56%	49.90% - 67.22%	47.42%	36.56% - 58.28%
Oct '19	63.16%*	57.12% - 69.19%	64.07%*	54.10% - 74.03%
Nov '19	53.53%	45.58% - 61.49%	54.27%	42.43% - 66.10%
Dec '19	68.21%*	62.71% - 73.70%	68.32%*	60.55% - 76.10%
Jan '20	55.30%	46.83% - 63.77%	54.66%	44.15% - 65.18%
Feb '20	56.71%	47.34% - 66.07%	49.04%	39.17% - 58.90%
Mar '20	48.68%	41.20% - 56.16%	45.06%	33.15% - 56.97%
Apr '20	55.51%	48.97% - 62.05%	52.67%	41.67% - 63.67%
May '20	58.81%*	52.46% - 65.16%	59.26%	48.18% - 70.34%
Jun '20	55.22%	48.78% - 61.67%	56.69%	45.17% - 68.21%
Jul '20	55.70%	47.74% - 63.66%	45.71%	33.76% - 57.66%
Aug '20	56.31%	48.85% - 63.78%	57.72%	46.96% - 68.47%
Sep '20	59.35%*	53.03% - 65.68%	58.01%	45.53% - 70.49%

2017-12-18 - 2020-09-30	56.19%*	54.74% - 57.64%	53.60%*	51.73% - 55.47%

CME vs. Binance Perpetual Futures (Chart)



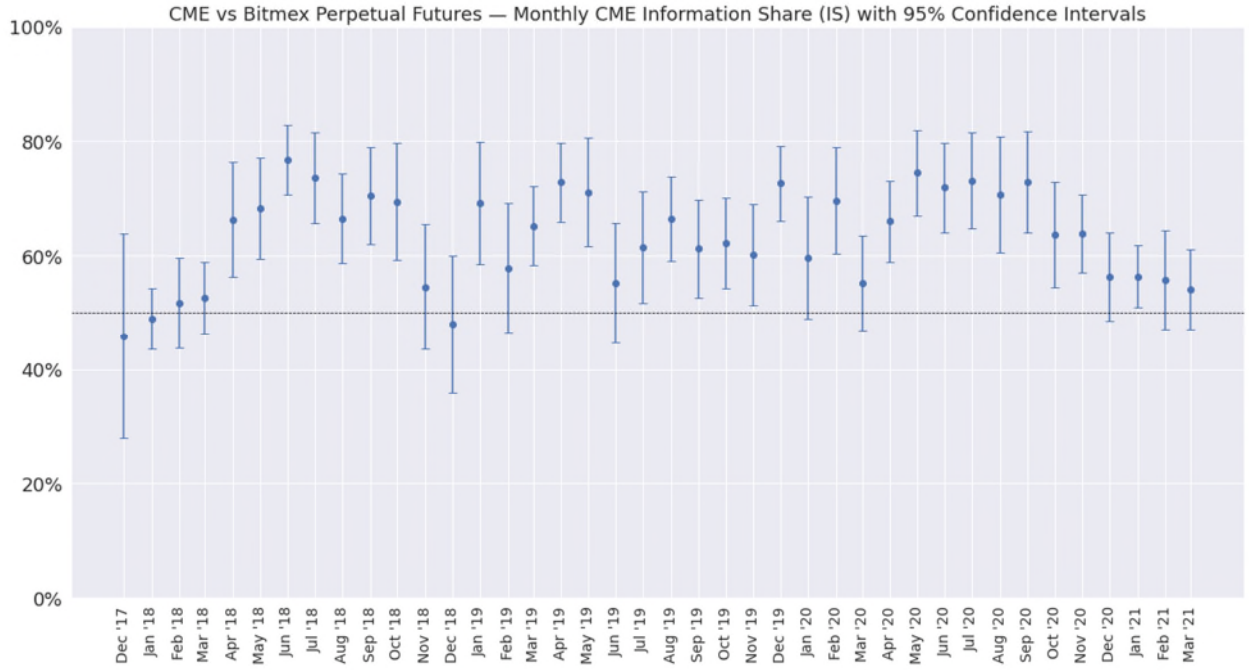


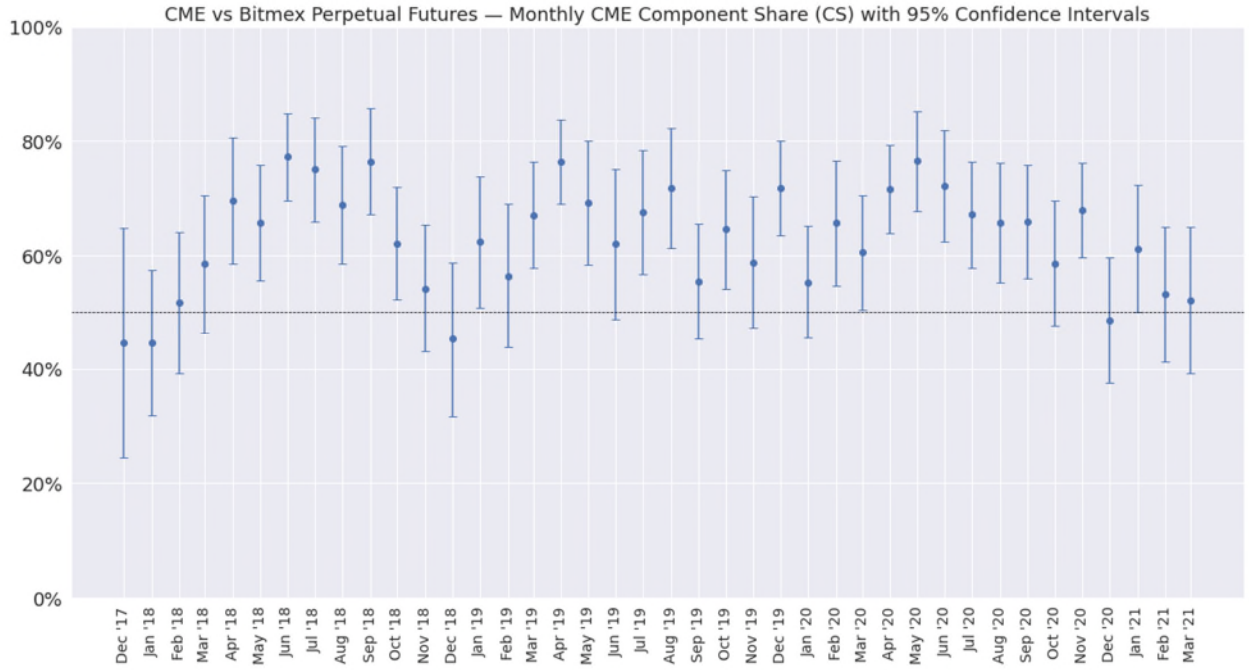
CME vs. Binance Perpetual Futures (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Sep '19	59.69%*	51.29% - 68.09%	52.15%	36.80% - 67.50%
Oct '19	66.52%*	59.33% - 73.71%	62.19%*	54.26% - 70.12%
Nov '19	48.70%	40.17% - 57.22%	44.21%	31.75% - 56.67%
Dec '19	62.65%*	56.37% - 68.92%	61.10%*	51.93% - 70.27%
Jan '20	52.08%	43.89% - 60.27%	50.20%	38.35% - 62.04%
Feb '20	53.77%	43.78% - 63.75%	47.68%	36.04% - 59.33%
Mar '20	51.04%	43.22% - 58.86%	47.39%	35.41% - 59.36%
Apr '20	58.35%*	51.60% - 65.10%	57.84%	47.31% - 68.37%
May '20	61.66%*	55.89% - 67.44%	63.14%*	51.65% - 74.63%
Jun '20	53.27%	45.65% - 60.89%	56.58%	44.72% - 68.43%
Jul '20	54.90%	47.42% - 62.37%	53.31%	41.57% - 65.04%
Aug '20	56.36%	48.93% - 63.78%	55.83%	42.84% - 68.82%
Sep '20	59.16%*	52.59% - 65.72%	60.41%	47.88% - 72.95%
Oct '20	50.16%	41.92% - 58.40%	44.90%	34.35% - 55.45%
Nov '20	54.06%	48.06% - 60.07%	61.01%	47.79% - 74.23%
Dec '20	49.87%	42.23% - 57.52%	50.91%	38.93% - 62.89%
Jan '21	54.31%	46.75% - 61.87%	58.55%	43.82% - 73.29%
Feb '21	55.25%	46.67% - 63.82%	52.30%	37.67% - 66.92%
Mar '21	49.93%	43.86% - 56.00%	46.30%	35.12% - 57.48%

2019-09-10 - 2021-03-31	55.30%*	53.64% - 56.96%	54.01%*	51.41% - 56.61%

CME vs. BitMEX Perpetual Futures (Chart)





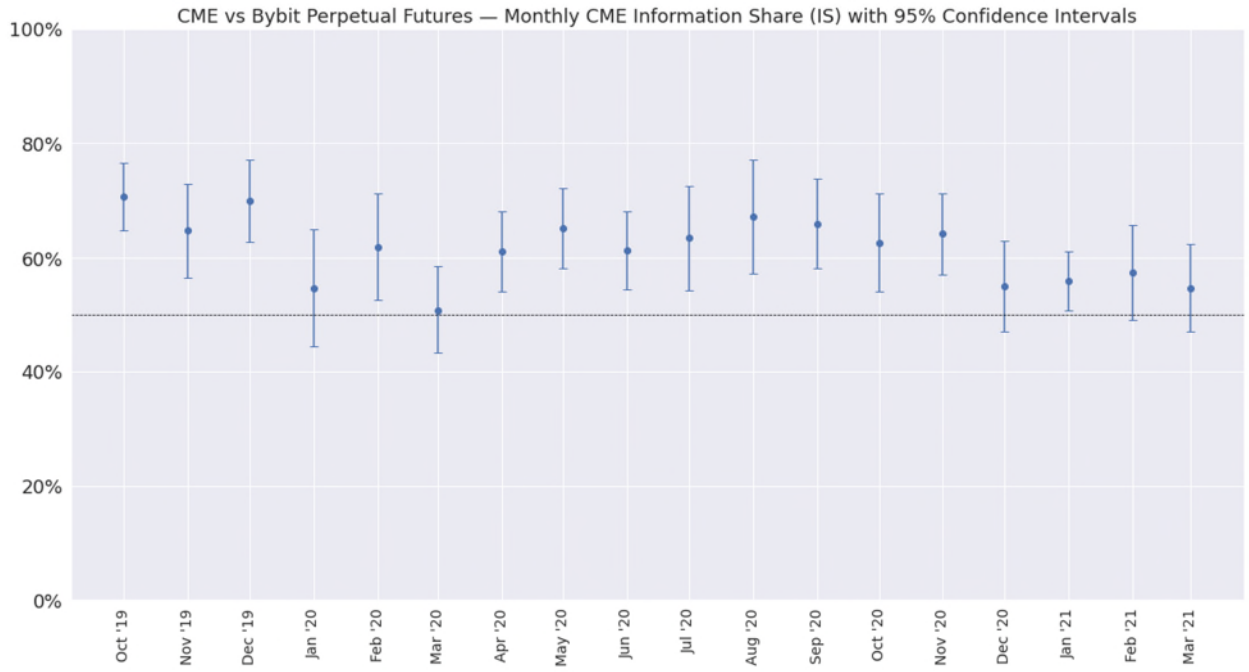
CME vs. BitMEX Perpetual Futures (Table)

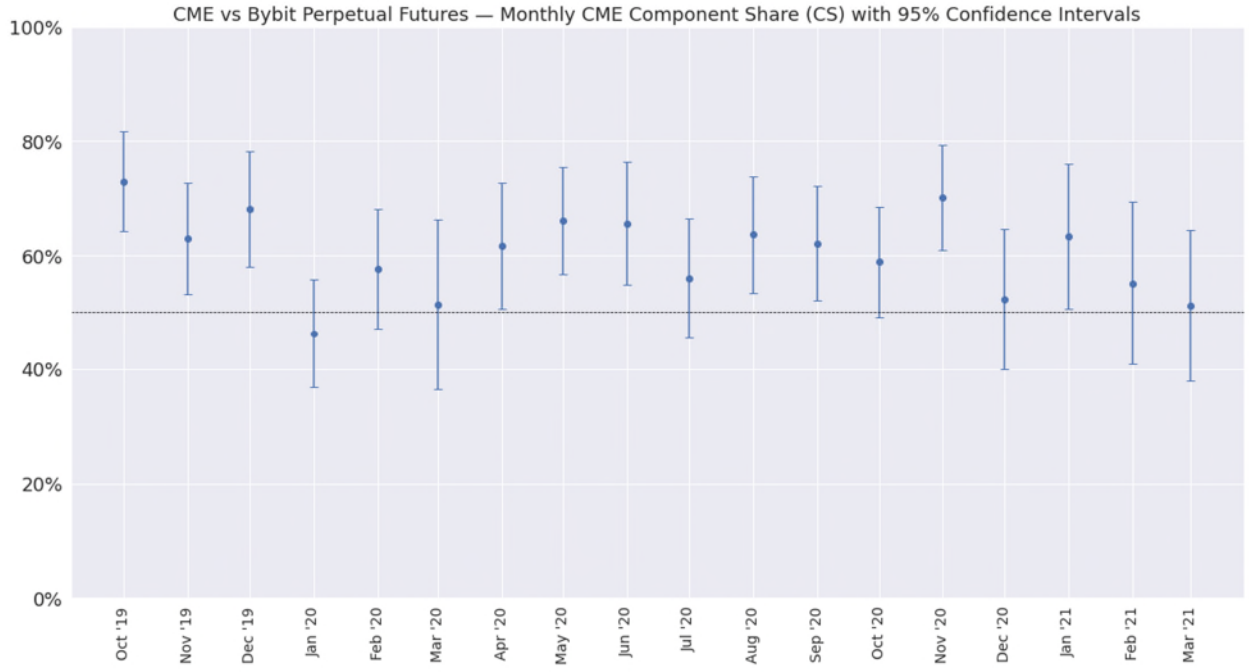
Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Dec '17	45.88%	27.96% - 63.80%	44.61%	24.45% - 64.78%
Jan '18	48.95%	43.55% - 54.36%	44.64%	31.83% - 57.45%
Feb '18	51.78%	43.83% - 59.73%	51.66%	39.22% - 64.10%
Mar '18	52.66%	46.35% - 58.98%	58.47%	46.45% - 70.49%
Apr '18	66.32%*	56.29% - 76.36%	69.58%*	58.62% - 80.53%
May '18	68.32%*	59.52% - 77.11%	65.62%*	55.51% - 75.73%
Jun '18	76.72%*	70.58% - 82.86%	77.21%*	69.63% - 84.78%
Jul '18	73.58%*	65.67% - 81.49%	75.07%*	65.96% - 84.18%
Aug '18	66.49%*	58.69% - 74.29%	68.85%*	58.52% - 79.18%
Sep '18	70.49%*	62.11% - 78.87%	76.45%*	67.23% - 85.68%
Oct '18	69.40%*	59.19% - 79.62%	62.08%*	52.24% - 71.93%
Nov '18	54.57%	43.56% - 65.57%	54.17%	43.07% - 65.27%
Dec '18	48.00%	35.93% - 60.07%	45.20%	31.61% - 58.78%
Jan '19	69.22%*	58.49% - 79.94%	62.34%*	50.82% - 73.87%
Feb '19	57.87%	46.60% - 69.14%	56.39%	43.86% - 68.93%
Mar '19	65.19%*	58.27% - 72.11%	67.07%*	57.81% - 76.33%
Apr '19	72.84%*	65.93% - 79.74%	76.40%*	69.10% - 83.70%
May '19	71.09%*	61.61% - 80.57%	69.16%*	58.36% - 79.97%
Jun '19	55.28%	44.79% - 65.76%	61.96%	48.76% - 75.15%
Jul '19	61.46%*	51.65% - 71.28%	67.54%*	56.67% - 78.41%
Aug '19	66.44%*	58.99% - 73.88%	71.76%*	61.26% - 82.27%
Sep '19	61.21%*	52.70% - 69.71%	55.46%	45.35% - 65.58%
Oct '19	62.23%*	54.30% - 70.17%	64.54%*	54.09% - 74.99%
Nov '19	60.16%*	51.35% - 68.97%	58.79%	47.33% - 70.25%
Dec '19	72.62%*	66.11% - 79.12%	71.78%*	63.58% - 79.98%
Jan '20	59.64%	49.03% - 70.26%	55.30%	45.47% - 65.13%
Feb '20	69.59%*	60.29% - 78.89%	65.69%*	54.74% - 76.64%
Mar '20	55.27%	46.95% - 63.58%	60.46%*	50.38% - 70.55%
Apr '20	66.04%*	58.99% - 73.09%	71.67%*	63.94% - 79.40%
May '20	74.48%*	67.01% - 81.95%	76.47%*	67.80% - 85.13%
Jun '20	71.90%*	64.07% - 79.73%	72.17%*	62.42% - 81.91%
Jul '20	73.12%*	64.76% - 81.49%	67.16%*	57.87% - 76.45%
Aug '20	70.67%*	60.63% - 80.71%	65.75%*	55.27% - 76.23%
Sep '20	72.84%*	64.03% - 81.66%	65.98%*	56.05% - 75.91%
Oct '20	63.65%*	54.47% - 72.82%	58.57%	47.59% - 69.55%
Nov '20	63.87%*	57.02% - 70.71%	67.95%*	59.63% - 76.27%
Dec '20	56.34%	48.56% - 64.13%	48.65%	37.59% - 59.71%
Jan '21	56.40%*	50.96% - 61.85%	61.18%*	50.01% - 72.36%
Feb '21	55.76%	47.12% - 64.39%	53.13%	41.24% - 65.01%

Mar '21	54.11%	47.04% - 61.18%	52.08%	39.13% - 65.03%

2017-12-18 - 2021-03-31	63.67%*	62.30% - 65.04%	63.33%*	61.68% - 64.99%

CME vs. Bybit Perpetual Futures (Chart)



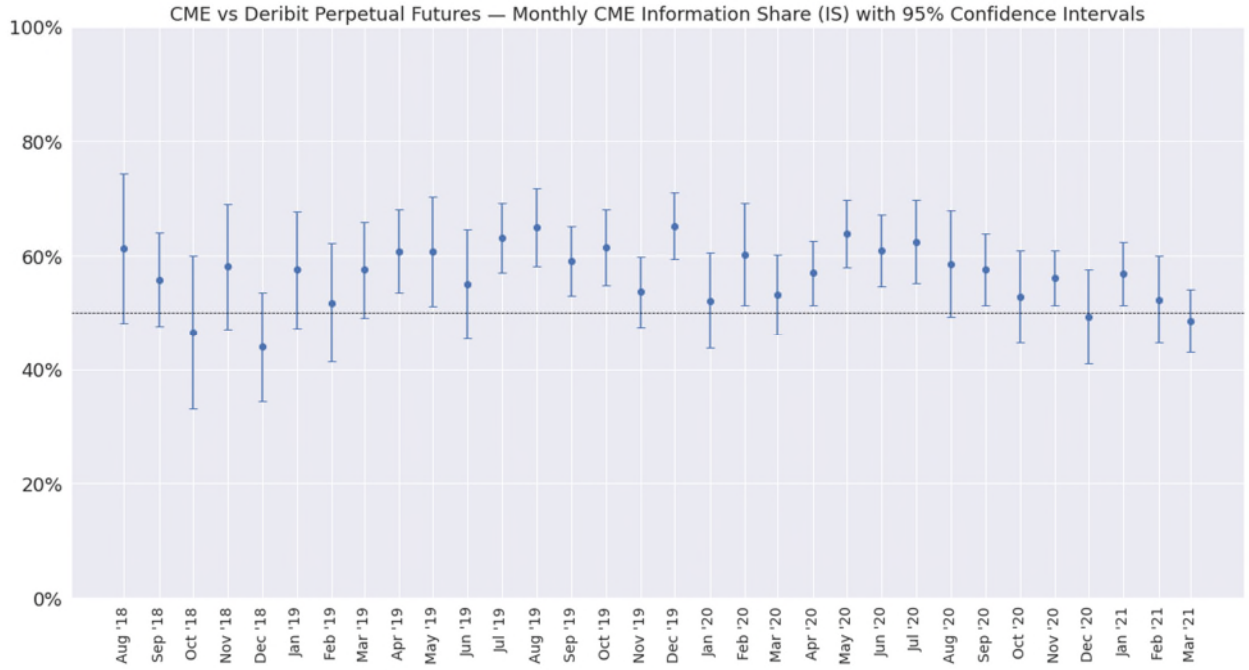


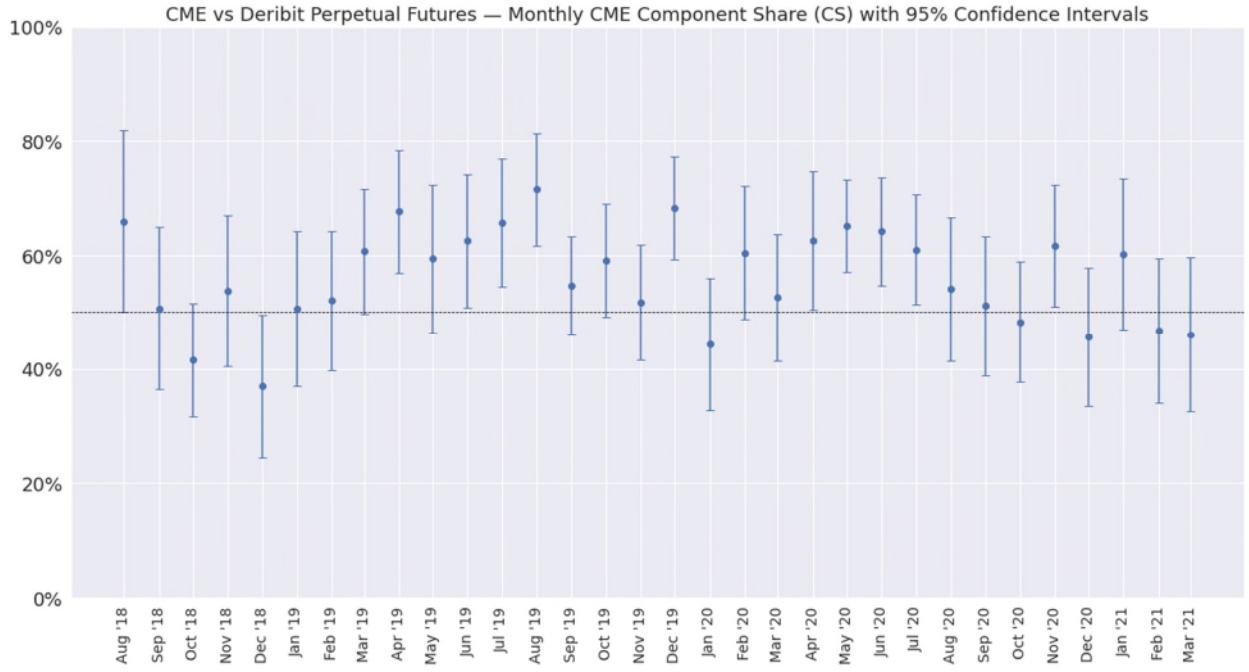
CME vs. Bybit Perpetual Futures (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Oct '19	70.72%*	64.78% - 76.66%	72.99%*	64.26% - 81.72%
Nov '19	64.73%*	56.52% - 72.94%	62.95%*	53.13% - 72.76%
Dec '19	70.03%*	62.83% - 77.22%	68.10%*	57.96% - 78.24%
Jan '20	54.68%	44.39% - 64.96%	46.28%	36.83% - 55.72%
Feb '20	61.92%*	52.64% - 71.21%	57.58%	47.07% - 68.09%
Mar '20	50.85%	43.24% - 58.47%	51.33%	36.43% - 66.24%
Apr '20	61.13%*	54.12% - 68.14%	61.64%*	50.60% - 72.68%
May '20	65.19%*	58.17% - 72.21%	66.06%*	56.64% - 75.49%
Jun '20	61.27%*	54.50% - 68.04%	65.61%*	54.84% - 76.38%
Jul '20	63.47%*	54.41% - 72.53%	56.03%	45.53% - 66.53%
Aug '20	67.12%*	57.19% - 77.05%	63.64%*	53.48% - 73.80%
Sep '20	65.97%*	58.19% - 73.75%	62.13%*	52.11% - 72.15%
Oct '20	62.63%*	54.10% - 71.16%	58.88%	49.20% - 68.56%
Nov '20	64.19%*	57.07% - 71.30%	70.14%*	61.02% - 79.26%
Dec '20	55.07%	47.23% - 62.91%	52.37%	40.03% - 64.70%
Jan '21	55.96%*	50.75% - 61.16%	63.33%*	50.61% - 76.04%
Feb '21	57.39%	49.14% - 65.64%	55.12%	40.84% - 69.39%
Mar '21	54.77%	47.19% - 62.35%	51.20%	38.01% - 64.39%

2019-10-01 - 2021-03-31	61.50%*	59.69% - 63.30%	60.26%*	57.75% - 62.77%

CME vs. Deribit Perpetual Futures (Chart)



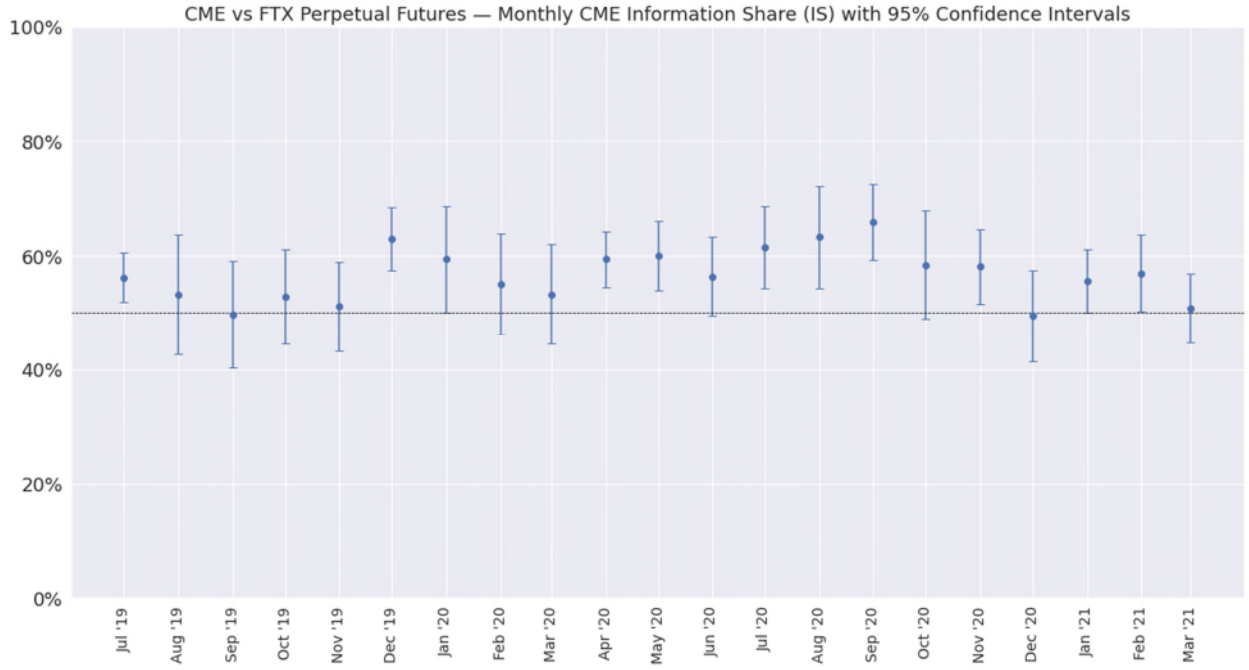


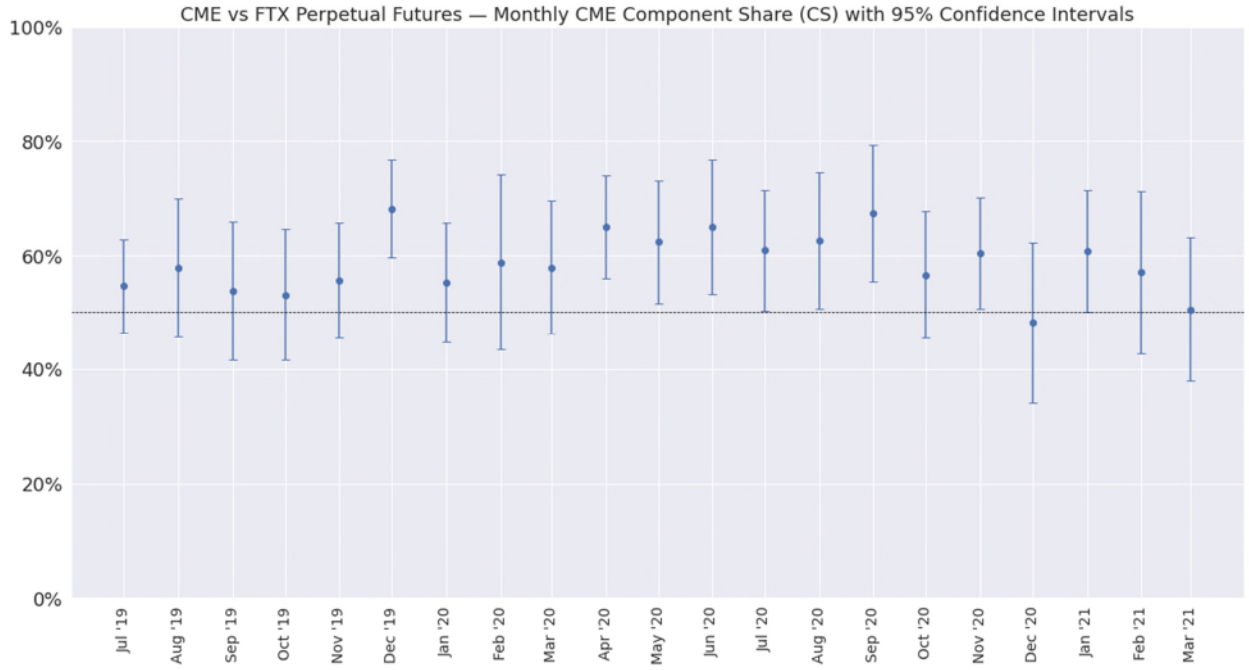
CME vs. Deribit Perpetual Futures (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Aug '18	61.28%	48.19% - 74.38%	65.98%*	50.08% - 81.87%
Sep '18	55.84%	47.69% - 63.99%	50.64%	36.37% - 64.91%
Oct '18	46.58%	33.08% - 60.08%	41.62%	31.66% - 51.59%
Nov '18	58.09%	47.16% - 69.02%	53.79%	40.59% - 66.99%
Dec '18	43.94%	34.39% - 53.50%	37.03%*	24.45% - 49.61%
Jan '19	57.53%	47.24% - 67.82%	50.61%	37.06% - 64.17%
Feb '19	51.80%	41.34% - 62.26%	52.01%	39.76% - 64.27%
Mar '19	57.55%	49.20% - 65.89%	60.70%	49.79% - 71.61%
Apr '19	60.77%*	53.51% - 68.04%	67.66%*	56.92% - 78.39%
May '19	60.67%*	51.10% - 70.24%	59.40%	46.41% - 72.40%
Jun '19	55.07%	45.51% - 64.63%	62.55%*	50.89% - 74.22%
Jul '19	63.16%*	57.07% - 69.25%	65.70%*	54.52% - 76.88%
Aug '19	65.04%*	58.24% - 71.84%	71.53%*	61.69% - 81.38%
Sep '19	59.07%*	53.04% - 65.10%	54.61%	45.99% - 63.23%
Oct '19	61.49%*	54.81% - 68.17%	59.07%	49.08% - 69.06%
Nov '19	53.70%	47.51% - 59.89%	51.73%	41.54% - 61.92%
Dec '19	65.24%*	59.47% - 71.00%	68.34%*	59.34% - 77.35%
Jan '20	52.13%	43.76% - 60.49%	44.35%	32.74% - 55.95%
Feb '20	60.22%*	51.29% - 69.16%	60.38%	48.70% - 72.06%
Mar '20	53.20%	46.13% - 60.26%	52.59%	41.50% - 63.69%
Apr '20	57.02%*	51.38% - 62.65%	62.60%*	50.40% - 74.80%
May '20	63.87%*	57.95% - 69.79%	65.08%*	56.99% - 73.17%
Jun '20	60.97%*	54.73% - 67.21%	64.16%*	54.69% - 73.64%
Jul '20	62.44%*	55.18% - 69.71%	60.97%*	51.28% - 70.67%
Aug '20	58.57%	49.26% - 67.87%	54.05%	41.49% - 66.61%
Sep '20	57.66%*	51.43% - 63.88%	51.12%	38.88% - 63.37%
Oct '20	52.81%	44.79% - 60.83%	48.25%	37.68% - 58.82%
Nov '20	56.14%*	51.43% - 60.86%	61.68%*	50.97% - 72.38%
Dec '20	49.31%	41.06% - 57.56%	45.64%	33.47% - 57.82%
Jan '21	56.91%*	51.43% - 62.39%	60.18%	46.90% - 73.45%
Feb '21	52.34%	44.71% - 59.98%	46.79%	34.07% - 59.51%
Mar '21	48.59%	43.03% - 54.14%	46.04%	32.52% - 59.56%

2018-08-14 - 2021-03-31	56.91%*	55.56% - 58.26%	56.20%*	54.23% - 58.17%

CME vs. FTX Perpetual Futures (Chart)

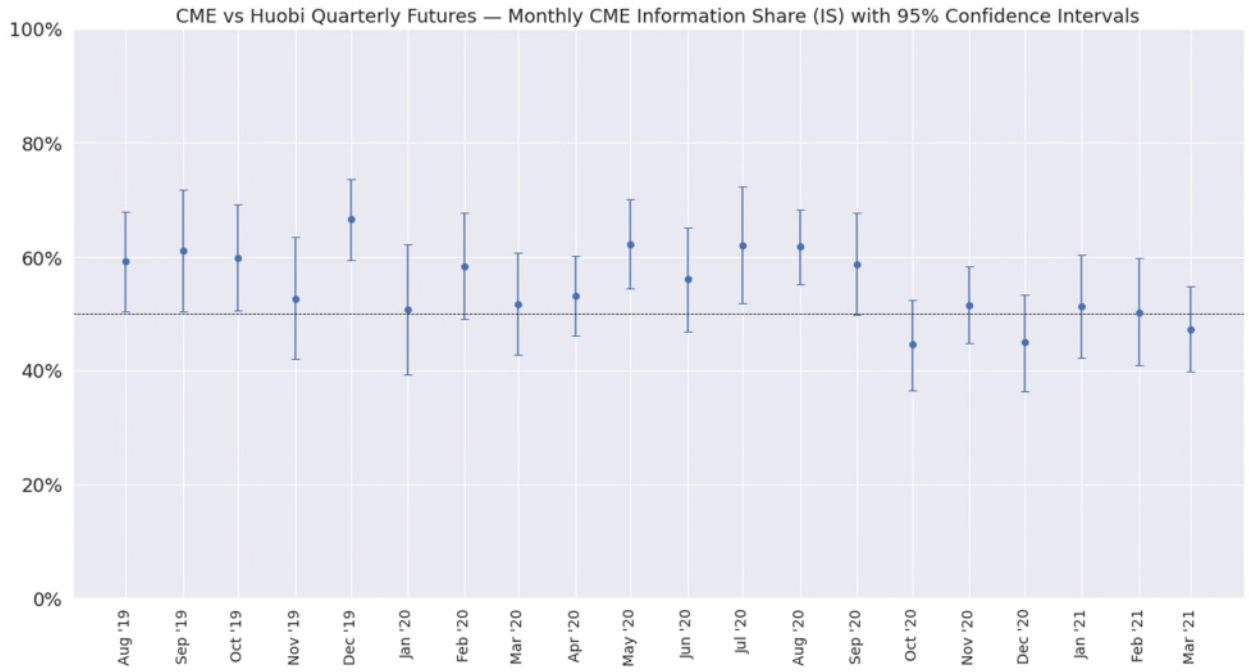


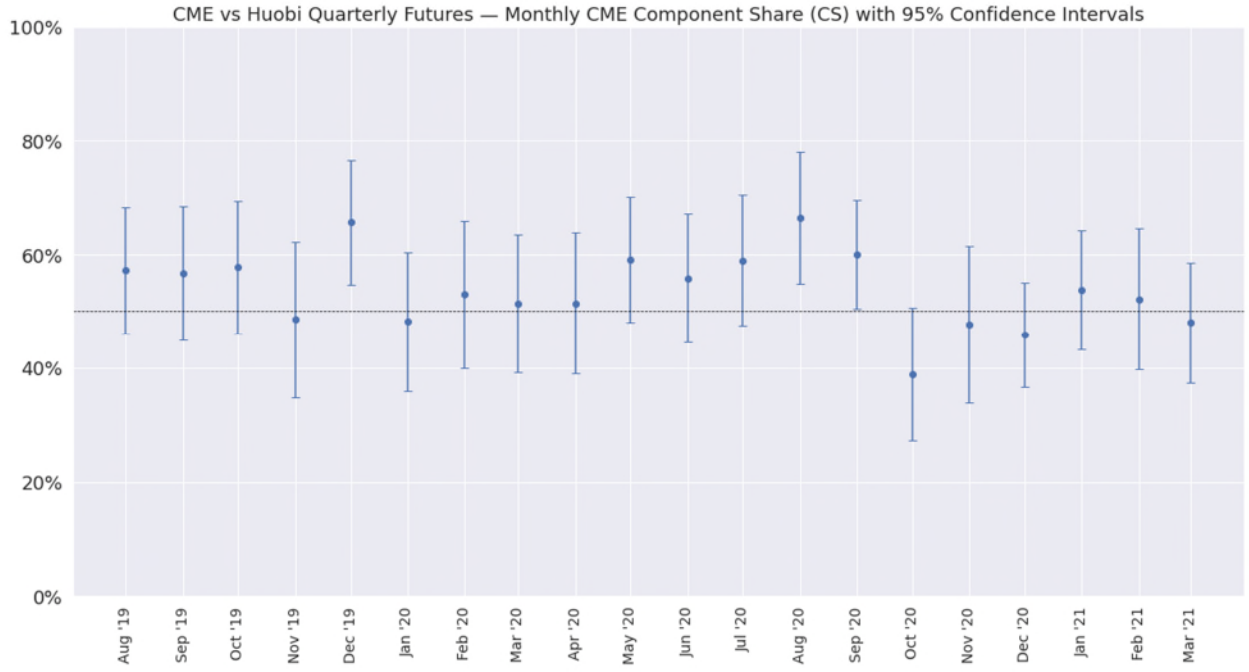


CME vs. FTX Perpetual Futures (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Jul '19	56.20%*	51.89% - 60.50%	54.61%	46.46% - 62.76%
Aug '19	53.27%	42.81% - 63.74%	57.90%	45.76% - 70.04%
Sep '19	49.65%	40.26% - 59.03%	53.79%	41.62% - 65.97%
Oct '19	52.86%	44.58% - 61.13%	53.12%	41.66% - 64.58%
Nov '19	51.15%	43.36% - 58.93%	55.66%	45.52% - 65.81%
Dec '19	62.96%*	57.42% - 68.49%	68.15%*	59.59% - 76.70%
Jan '20	59.39%*	50.09% - 68.69%	55.18%	44.72% - 65.64%
Feb '20	55.02%	46.16% - 63.88%	58.78%	43.40% - 74.16%
Mar '20	53.29%	44.61% - 61.98%	57.91%	46.31% - 69.51%
Apr '20	59.38%*	54.43% - 64.34%	64.94%*	55.91% - 73.98%
May '20	60.01%*	53.93% - 66.10%	62.34%*	51.64% - 73.04%
Jun '20	56.43%	49.58% - 63.27%	65.03%*	53.25% - 76.80%
Jul '20	61.48%*	54.36% - 68.60%	60.89%*	50.33% - 71.45%
Aug '20	63.27%*	54.41% - 72.13%	62.62%*	50.66% - 74.58%
Sep '20	65.94%*	59.27% - 72.61%	67.35%*	55.45% - 79.25%
Oct '20	58.44%	48.91% - 67.97%	56.62%	45.55% - 67.68%
Nov '20	58.18%*	51.65% - 64.72%	60.40%*	50.66% - 70.13%
Dec '20	49.47%	41.42% - 57.52%	48.17%	34.06% - 62.28%
Jan '21	55.62%*	50.12% - 61.12%	60.72%*	50.03% - 71.41%
Feb '21	56.97%*	50.21% - 63.74%	56.99%	42.69% - 71.29%
Mar '21	50.83%	44.75% - 56.91%	50.53%	37.88% - 63.18%
2019-07-01 - 2021-03-31	56.73%*	55.13% - 58.32%	58.72%*	56.33% - 61.10%

CME vs. Huobi Quarterly Futures (Chart)



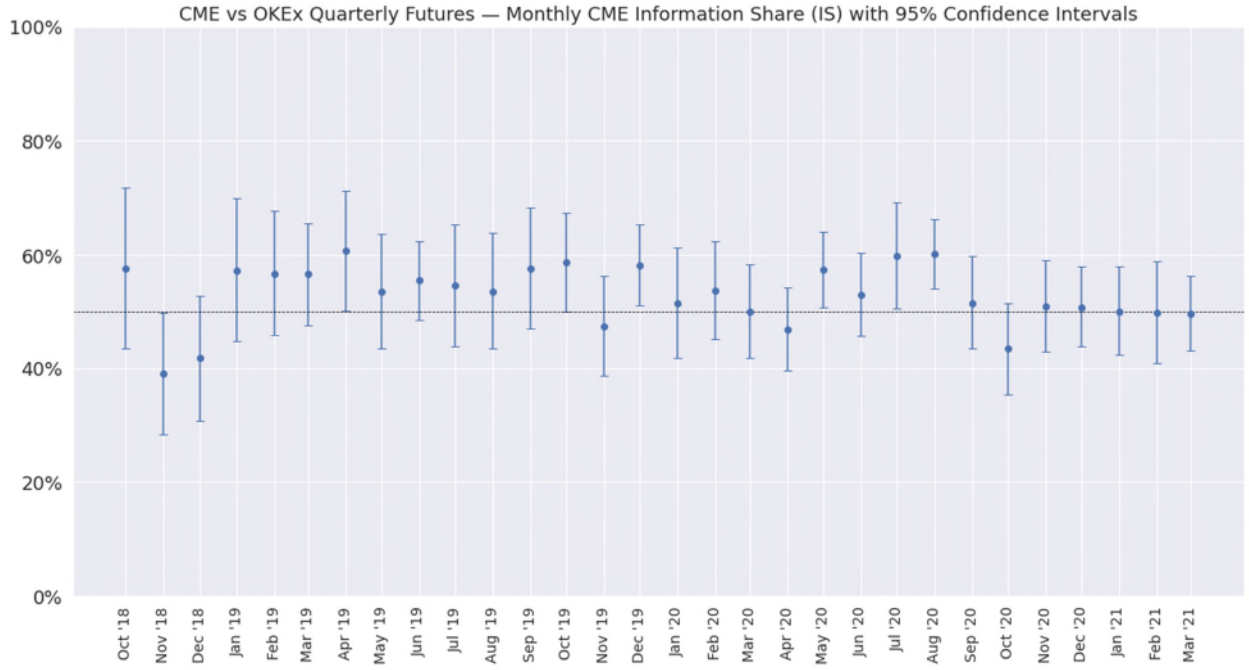


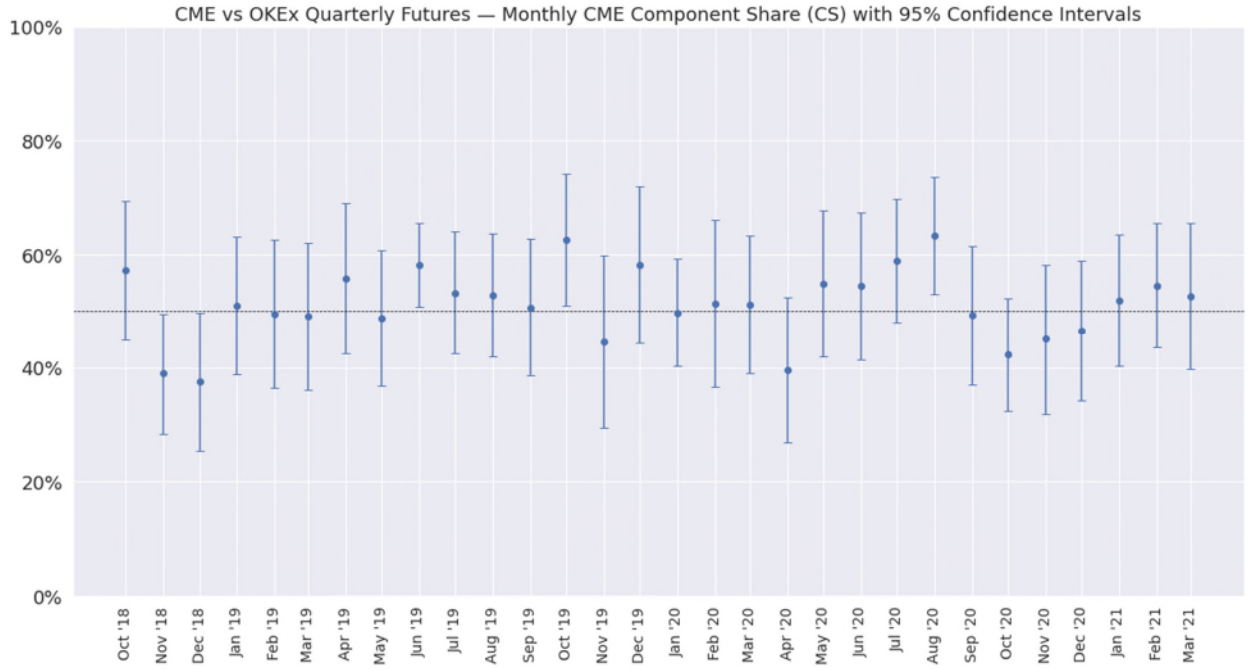
CME vs. Huobi Quarterly Futures (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Aug '19	59.26%*	50.51% - 68.01%	57.18%	46.00% - 68.36%
Sep '19	61.11%*	50.50% - 71.73%	56.69%	44.90% - 68.49%
Oct '19	59.93%*	50.62% - 69.23%	57.76%	46.12% - 69.40%
Nov '19	52.74%	41.92% - 63.56%	48.58%	34.86% - 62.31%
Dec '19	66.59%*	59.53% - 73.65%	65.67%*	54.67% - 76.67%
Jan '20	50.80%	39.32% - 62.28%	48.19%	35.93% - 60.46%
Feb '20	58.46%	49.13% - 67.79%	52.99%	40.04% - 65.94%
Mar '20	51.83%	42.81% - 60.84%	51.37%	39.30% - 63.44%
Apr '20	53.23%	46.28% - 60.17%	51.40%	38.97% - 63.83%
May '20	62.29%*	54.49% - 70.09%	59.10%	48.14% - 70.06%
Jun '20	56.07%	46.94% - 65.20%	55.88%	44.49% - 67.26%
Jul '20	62.10%*	51.86% - 72.35%	58.99%	47.46% - 70.51%
Aug '20	61.82%*	55.32% - 68.32%	66.42%*	54.80% - 78.04%
Sep '20	58.81%	49.90% - 67.73%	60.03%*	50.48% - 69.57%
Oct '20	44.52%	36.53% - 52.51%	38.91%	27.20% - 50.62%
Nov '20	51.51%	44.68% - 58.33%	47.78%	33.99% - 61.58%
Dec '20	44.86%	36.33% - 53.40%	45.93%	36.74% - 55.12%
Jan '21	51.31%	42.25% - 60.37%	53.78%	43.30% - 64.26%
Feb '21	50.35%	40.93% - 59.77%	52.16%	39.77% - 64.55%
Mar '21	47.34%	39.83% - 54.84%	48.01%	37.40% - 58.62%

2019-08-01 - 2021-03-31	55.25%*	53.33% - 57.17%	53.85%*	51.36% - 56.33%

CME vs. OKEx Quarterly Futures (Chart)





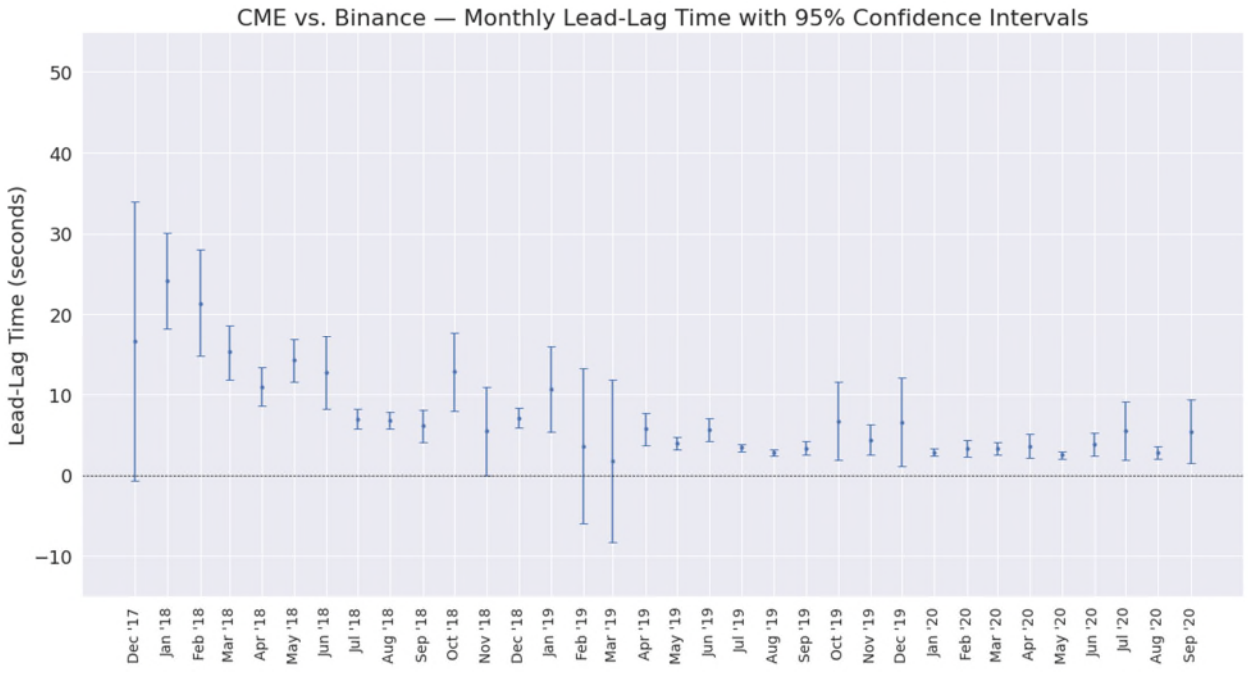
CME vs. OKEx Quarterly Futures (Table)

Month	CME IS	Confidence Interval	CME CS	Confidence Interval
Oct '18	57.57%	43.38% - 71.76%	57.20%	44.97% - 69.43%
Nov '18	39.06%*	28.29% - 49.84%	38.94%*	28.32% - 49.57%
Dec '18	41.80%	30.72% - 52.88%	37.58%*	25.48% - 49.67%
Jan '19	57.28%	44.70% - 69.87%	50.95%	38.77% - 63.14%
Feb '19	56.77%	45.78% - 67.77%	49.54%	36.46% - 62.62%
Mar '19	56.63%	47.74% - 65.51%	49.10%	36.09% - 62.10%
Apr '19	60.75%*	50.24% - 71.27%	55.78%	42.55% - 69.01%
May '19	53.63%	43.54% - 63.73%	48.78%	36.89% - 60.66%
Jun '19	55.51%	48.60% - 62.42%	58.15%*	50.82% - 65.47%
Jul '19	54.64%	43.89% - 65.39%	53.26%	42.51% - 64.01%
Aug '19	53.63%	43.47% - 63.78%	52.86%	42.02% - 63.71%
Sep '19	57.66%	47.06% - 68.25%	50.70%	38.69% - 62.72%
Oct '19	58.75%*	50.13% - 67.38%	62.58%*	51.03% - 74.13%
Nov '19	47.52%	38.75% - 56.29%	44.62%	29.40% - 59.84%
Dec '19	58.20%*	51.15% - 65.26%	58.16%	44.40% - 71.91%
Jan '20	51.61%	41.84% - 61.37%	49.79%	40.25% - 59.33%
Feb '20	53.77%	45.17% - 62.36%	51.43%	36.71% - 66.14%
Mar '20	50.08%	41.87% - 58.29%	51.18%	39.02% - 63.34%
Apr '20	46.90%	39.53% - 54.27%	39.67%	26.92% - 52.41%
May '20	57.45%*	50.84% - 64.06%	54.88%	41.96% - 67.80%
Jun '20	53.02%	45.62% - 60.43%	54.44%	41.44% - 67.44%
Jul '20	59.85%*	50.53% - 69.17%	58.92%	48.01% - 69.84%
Aug '20	60.21%*	54.11% - 66.30%	63.33%*	53.10% - 73.56%
Sep '20	51.62%	43.40% - 59.85%	49.27%	37.06% - 61.47%
Oct '20	43.50%	35.44% - 51.56%	42.26%	32.32% - 52.19%
Nov '20	51.00%	42.86% - 59.14%	45.03%	31.94% - 58.12%
Dec '20	50.85%	43.75% - 57.96%	46.57%	34.26% - 58.87%
Jan '21	50.14%	42.27% - 58.01%	51.95%	40.36% - 63.54%
Feb '21	49.91%	40.85% - 58.96%	54.53%	43.62% - 65.44%
Mar '21	49.72%	43.08% - 56.36%	52.63%	39.75% - 65.51%

2018-10-03 - 2021-03-31	53.04%*	51.45% - 54.63%	51.22%	49.14% - 53.31%

Appendix C: List Of Time-Shift Lead-Lag Analysis Monthly Results

CME vs. Binance (Chart)

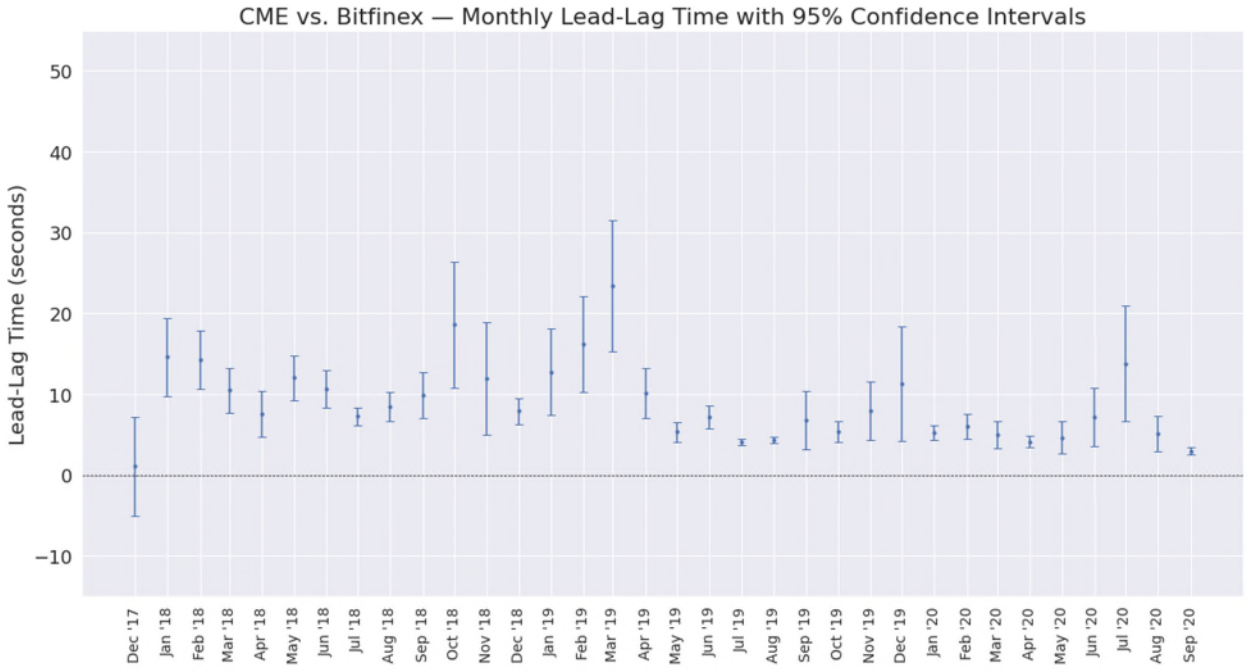


CME vs. Binance (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Dec '17	16.58	-0.74 - 33.90
Jan '18	24.16*	18.24 - 30.09
Feb '18	21.38*	14.71 - 28.05
Mar '18	15.23*	11.83 - 18.62
Apr '18	10.94*	8.55 - 13.34
May '18	14.19*	11.61 - 16.77
Jun '18	12.76*	8.26 - 17.27
Jul '18	6.97*	5.80 - 8.14
Aug '18	6.76*	5.71 - 7.80
Sep '18	6.08*	4.07 - 8.09
Oct '18	12.85*	8.00 - 17.70
Nov '18	5.47	-0.01 - 10.94
Dec '18	7.10*	5.83 - 8.37
Jan '19	10.65*	5.42 - 15.87
Feb '19	3.6	-5.97 - 13.17
Mar '19	1.76	-8.27 - 11.79
Apr '19	5.70*	3.69 - 7.72
May '19	3.95*	3.18 - 4.71
Jun '19	5.64*	4.24 - 7.04
Jul '19	3.37*	2.92 - 3.83
Aug '19	2.81*	2.40 - 3.22
Sep '19	3.36*	2.58 - 4.15
Oct '19	6.70*	1.84 - 11.55
Nov '19	4.38*	2.48 - 6.28
Dec '19	6.58*	1.14 - 12.03
Jan '20	2.81*	2.34 - 3.28
Feb '20	3.28*	2.22 - 4.35
Mar '20	3.28*	2.47 - 4.09
Apr '20	3.63*	2.20 - 5.05
May '20	2.49*	2.02 - 2.95
Jun '20	3.86*	2.45 - 5.28
Jul '20	5.48*	1.92 - 9.04
Aug '20	2.77*	2.04 - 3.50
Sep '20	5.39*	1.47 - 9.31

2017-12-18 - 2020-09-30	7.28*	6.53 - 8.03

CME vs. Bitfinex (Chart)

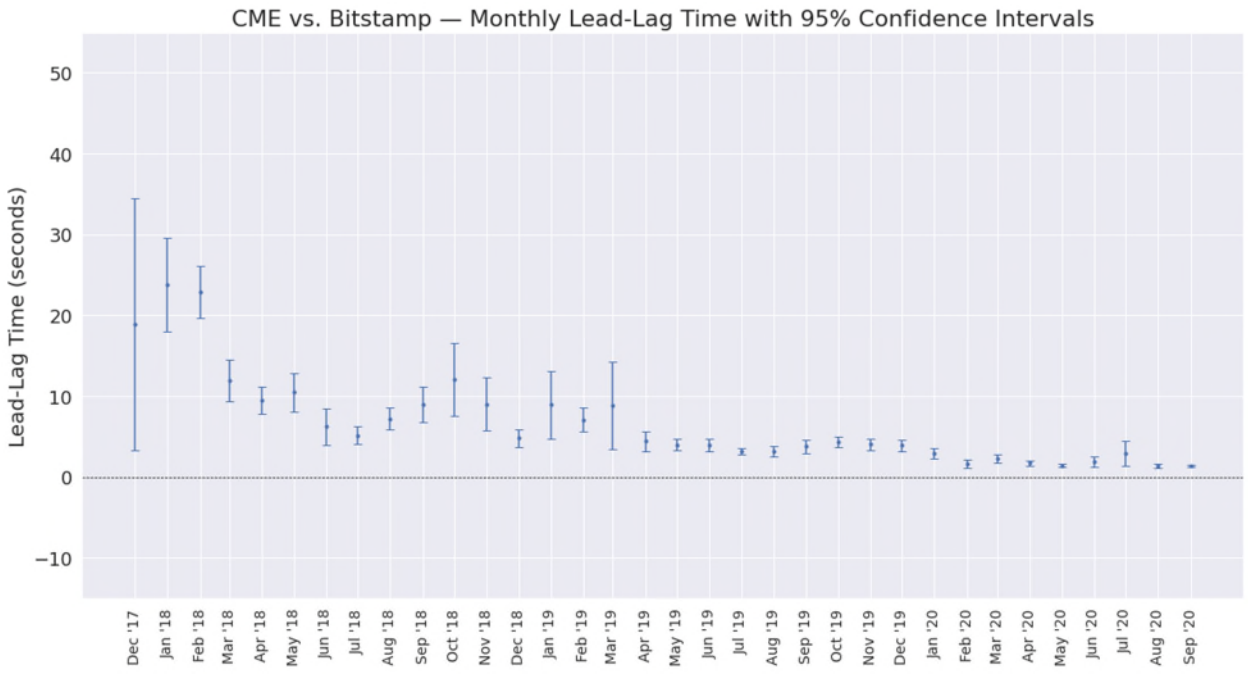


CME vs. Bitfinex (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Dec '17	1.09	-5.05 - 7.23
Jan '18	14.59*	9.79 - 19.40
Feb '18	14.29*	10.70 - 17.88
Mar '18	10.48*	7.70 - 13.25
Apr '18	7.58*	4.73 - 10.43
May '18	12.03*	9.23 - 14.82
Jun '18	10.62*	8.31 - 12.93
Jul '18	7.25*	6.11 - 8.38
Aug '18	8.46*	6.65 - 10.27
Sep '18	9.90*	7.05 - 12.75
Oct '18	18.61*	10.84 - 26.38
Nov '18	11.96*	4.97 - 18.95
Dec '18	7.89*	6.26 - 9.52
Jan '19	12.77*	7.42 - 18.12
Feb '19	16.14*	10.20 - 22.08
Mar '19	23.33*	15.22 - 31.45
Apr '19	10.11*	6.99 - 13.24
May '19	5.35*	4.14 - 6.57
Jun '19	7.14*	5.74 - 8.54
Jul '19	4.11*	3.72 - 4.51
Aug '19	4.34*	3.91 - 4.77
Sep '19	6.81*	3.22 - 10.40
Oct '19	5.35*	4.10 - 6.60
Nov '19	7.96*	4.35 - 11.57
Dec '19	11.28*	4.18 - 18.37
Jan '20	5.23*	4.31 - 6.15
Feb '20	6.03*	4.52 - 7.54
Mar '20	4.95*	3.30 - 6.61
Apr '20	4.12*	3.38 - 4.87
May '20	4.66*	2.64 - 6.68
Jun '20	7.16*	3.53 - 10.79
Jul '20	13.80*	6.64 - 20.96
Aug '20	5.10*	2.95 - 7.24
Sep '20	2.95*	2.52 - 3.38

2017-12-18 - 2020-09-30	9.03*	8.33 - 9.73

CME vs. Bitstamp (Chart)

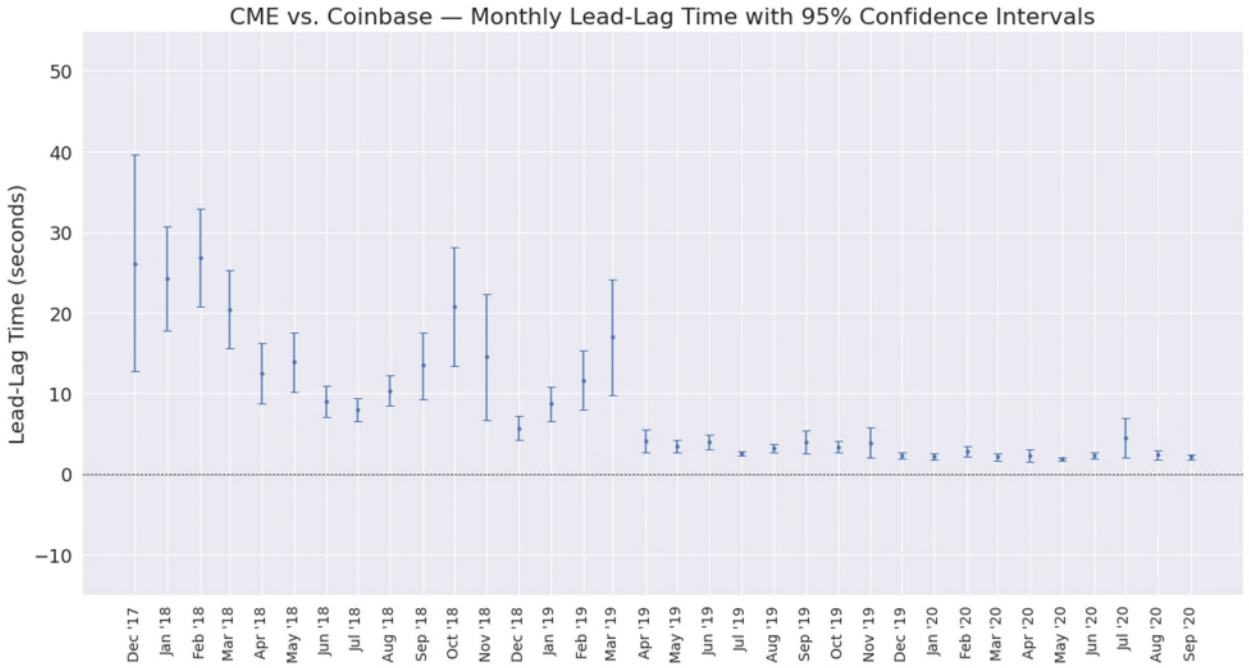


CME vs. Bitstamp (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Dec '17	18.87*	3.31 - 34.43
Jan '18	23.77*	17.94 - 29.61
Feb '18	22.90*	19.72 - 26.08
Mar '18	11.96*	9.37 - 14.56
Apr '18	9.50*	7.82 - 11.19
May '18	10.46*	8.08 - 12.84
Jun '18	6.23*	3.94 - 8.51
Jul '18	5.14*	4.05 - 6.22
Aug '18	7.23*	5.88 - 8.59
Sep '18	8.98*	6.83 - 11.13
Oct '18	12.04*	7.55 - 16.54
Nov '18	9.04*	5.81 - 12.27
Dec '18	4.80*	3.74 - 5.86
Jan '19	8.92*	4.76 - 13.09
Feb '19	7.10*	5.63 - 8.57
Mar '19	8.86*	3.40 - 14.32
Apr '19	4.46*	3.24 - 5.68
May '19	3.98*	3.30 - 4.66
Jun '19	4.00*	3.22 - 4.78
Jul '19	3.16*	2.81 - 3.51
Aug '19	3.15*	2.49 - 3.80
Sep '19	3.79*	2.95 - 4.63
Oct '19	4.30*	3.68 - 4.93
Nov '19	4.02*	3.28 - 4.76
Dec '19	3.93*	3.22 - 4.64
Jan '20	2.95*	2.31 - 3.59
Feb '20	1.65*	1.10 - 2.21
Mar '20	2.31*	1.81 - 2.81
Apr '20	1.71*	1.36 - 2.07
May '20	1.43*	1.26 - 1.60
Jun '20	1.87*	1.27 - 2.48
Jul '20	2.94*	1.44 - 4.44
Aug '20	1.42*	1.18 - 1.66
Sep '20	1.38*	1.22 - 1.54

2017-12-18 - 2020-09-30	6.52*	5.96 - 7.08

CME vs. Coinbase (Chart)

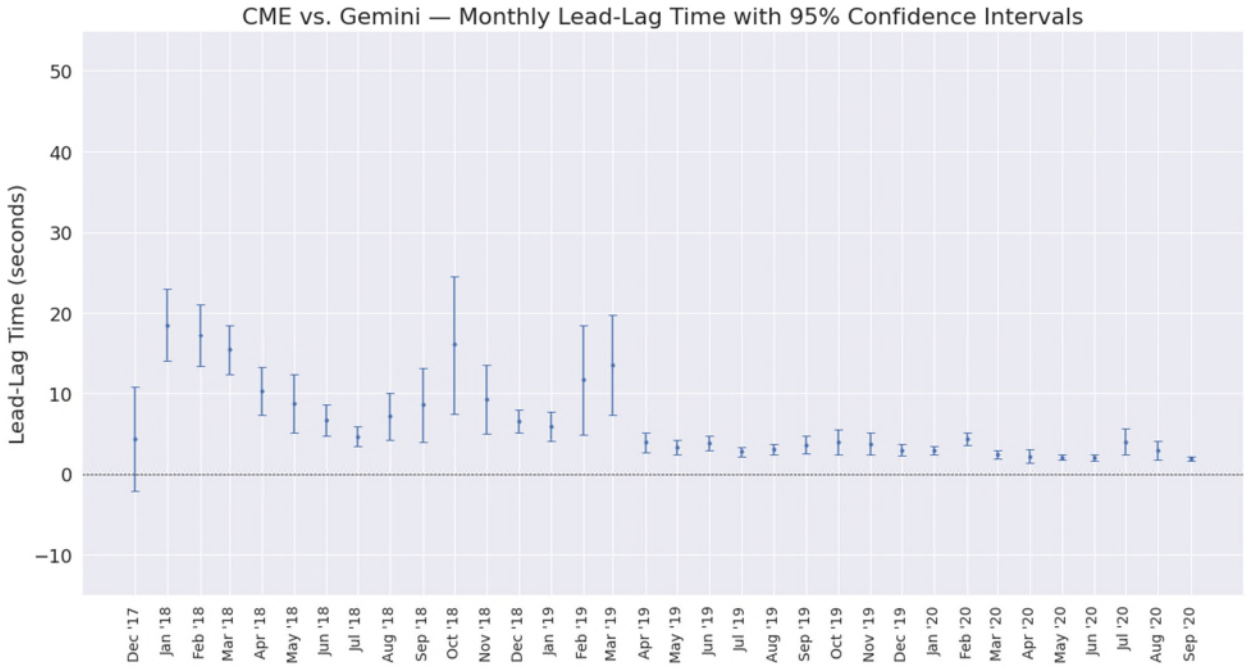

CME vs. Coinbase — Monthly Lead-Lag Time with 95% Confidence Intervals
Lead-Lag Time (seconds)
50
40
30
20
10
0
−10
Dec '17
Jan '18
Feb '18
Mar '18
Apr '18
May '18
Jun '18
Jul '18
Aug '18
Sep '18
Oct '18
Nov '18
Dec '18
Jan '19
Feb '19
Mar '19
Apr '19
May '19
Jun '19
Jul '19
Aug '19
Sep '19
Oct '19
Nov '19
Dec '19
Jan '20
Feb '20
Mar '20
Apr '20
May '20
Jun '20
Jul '20
Aug '20
Sep '20

CME vs. Coinbase (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Dec '17	26.16*	12.72 - 39.59
Jan '18	24.31*	17.89 - 30.73
Feb '18	26.91*	20.86 - 32.96
Mar '18	20.43*	15.52 - 25.34
Apr '18	12.46*	8.74 - 16.17
May '18	13.85*	10.11 - 17.59
Jun '18	8.92*	7.00 - 10.85
Jul '18	7.91*	6.49 - 9.33
Aug '18	10.30*	8.47 - 12.14
Sep '18	13.42*	9.22 - 17.62
Oct '18	20.79*	13.38 - 28.20
Nov '18	14.52*	6.63 - 22.42
Dec '18	5.67*	4.22 - 7.12
Jan '19	8.66*	6.48 - 10.83
Feb '19	11.58*	7.90 - 15.26
Mar '19	16.95*	9.75 - 24.16
Apr '19	4.07*	2.65 - 5.48
May '19	3.39*	2.62 - 4.16
Jun '19	3.93*	3.03 - 4.83
Jul '19	2.49*	2.23 - 2.75
Aug '19	3.17*	2.70 - 3.64
Sep '19	3.96*	2.58 - 5.35
Oct '19	3.37*	2.67 - 4.06
Nov '19	3.88*	2.00 - 5.75
Dec '19	2.32*	1.94 - 2.70
Jan '20	2.17*	1.79 - 2.55
Feb '20	2.80*	2.11 - 3.49
Mar '20	2.12*	1.65 - 2.58
Apr '20	2.26*	1.51 - 3.01
May '20	1.83*	1.69 - 1.96
Jun '20	2.26*	1.85 - 2.68
Jul '20	4.51*	2.08 - 6.93
Aug '20	2.36*	1.77 - 2.96
Sep '20	2.11*	1.77 - 2.46

2017-12-18 - 2020-09-30	8.42*	7.65 - 9.18

CME vs. Gemini (Chart)


CME vs. Gemini — Monthly Lead-Lag Time with 95% Confidence Intervals
Lead-Lag Time (seconds)
50
40
30
20
10
0
−10
Dec '17
Jan '18
Feb '18
Mar '18
Apr '18
May '18
Jun '18
Jul '18
Aug '18
Sep '18
Oct '18
Nov '18
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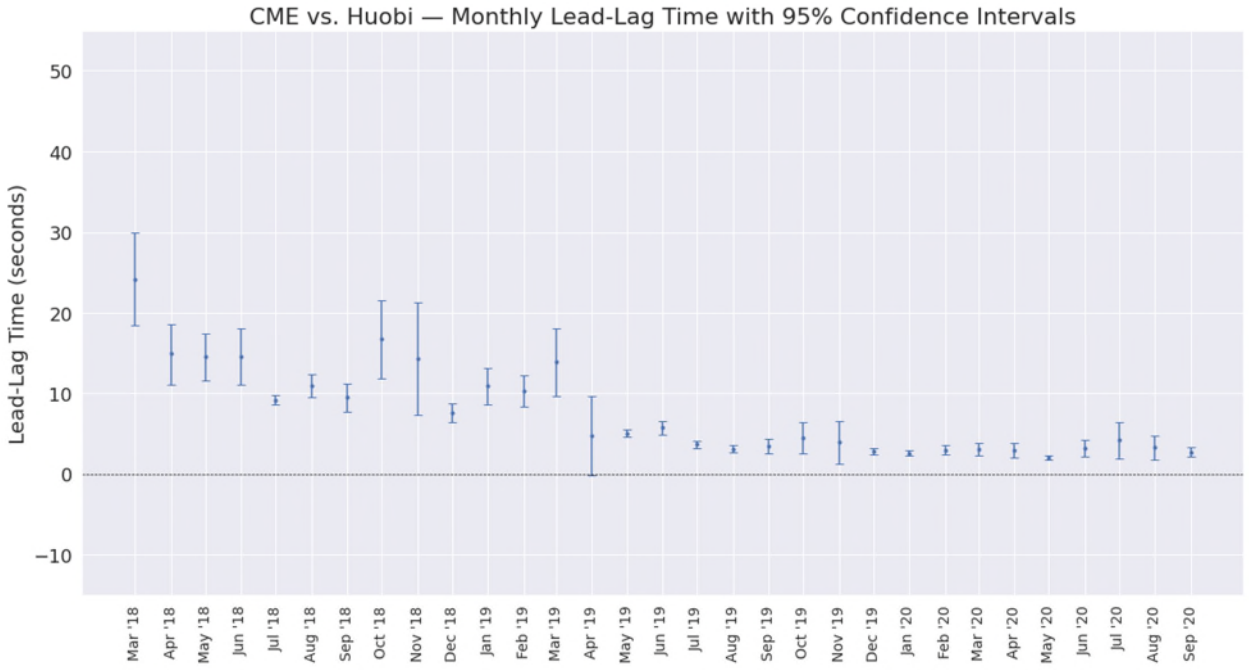
Jun '20
Jul '20
Aug '20
Sep '20

CME vs. Gemini (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Dec '17	4.36	-2.08 - 10.80
Jan '18	18.52*	14.00 - 23.04
Feb '18	17.22*	13.38 - 21.06
Mar '18	15.40*	12.35 - 18.45
Apr '18	10.29*	7.29 - 13.28
May '18	8.71*	5.07 - 12.36
Jun '18	6.70*	4.75 - 8.64
Jul '18	4.65*	3.46 - 5.85
Aug '18	7.11*	4.17 - 10.06
Sep '18	8.54*	3.93 - 13.15
Oct '18	16.00*	7.40 - 24.60
Nov '18	9.21*	4.93 - 13.49
Dec '18	6.51*	5.09 - 7.93
Jan '19	5.90*	4.07 - 7.72
Feb '19	11.64*	4.81 - 18.47
Mar '19	13.49*	7.24 - 19.74
Apr '19	3.93*	2.72 - 5.14
May '19	3.28*	2.40 - 4.16
Jun '19	3.87*	2.97 - 4.77
Jul '19	2.75*	2.17 - 3.32
Aug '19	3.04*	2.41 - 3.66
Sep '19	3.63*	2.55 - 4.71
Oct '19	3.90*	2.34 - 5.45
Nov '19	3.75*	2.42 - 5.09
Dec '19	2.97*	2.30 - 3.64
Jan '20	2.92*	2.41 - 3.44
Feb '20	4.37*	3.58 - 5.16
Mar '20	2.37*	1.88 - 2.87
Apr '20	2.20*	1.41 - 2.99
May '20	2.06*	1.77 - 2.35
Jun '20	2.00*	1.62 - 2.38
Jul '20	3.97*	2.34 - 5.59
Aug '20	2.91*	1.74 - 4.08
Sep '20	1.86*	1.59 - 2.12

2017-12-18 - 2020-09-30	6.51*	5.91 - 7.11

CME vs. Huobi (Chart)

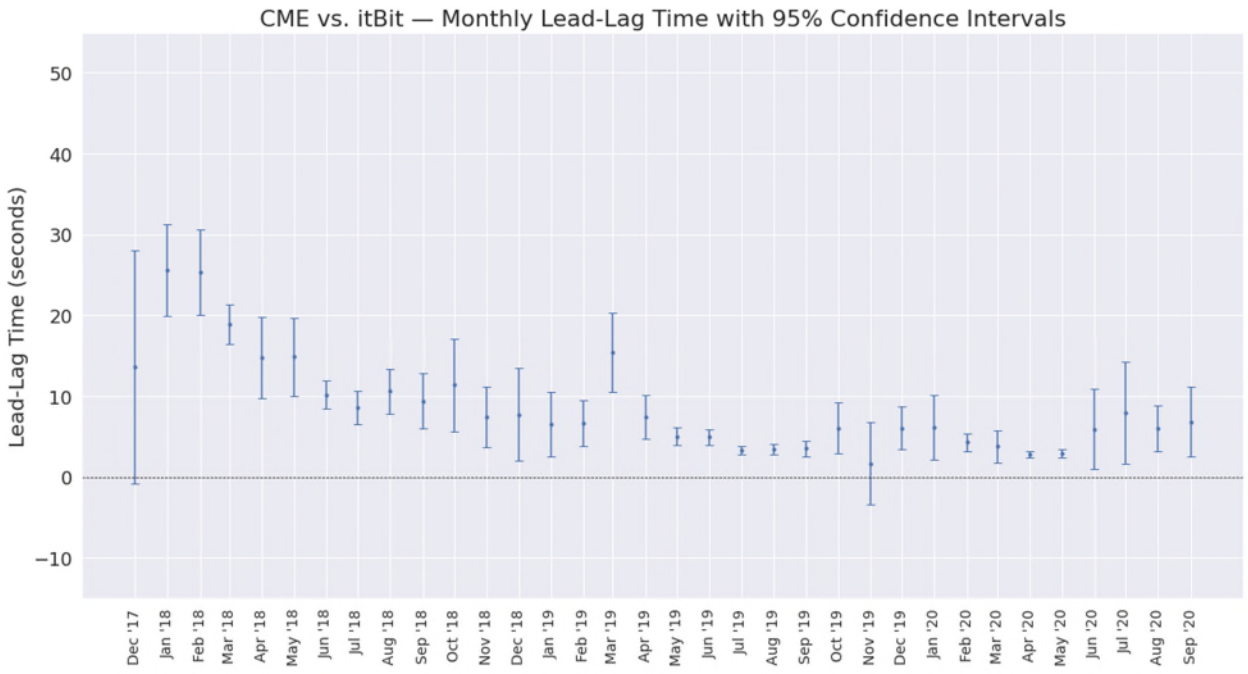

CME vs. Huobi — Monthly Lead-Lag Time with 95% Confidence Intervals
Lead-Lag Time (seconds)
50
40
30
20
10
0
−10
Mar '18
Apr '18
May '18
Jun '18
Jul '18
Aug '18
Sep '18
Oct '18
Nov '18
Dec '18
Jan '19
Feb '19
Mar '19
Apr '19
May '19
Jun '19
Jul '19
Aug '19
Sep '19
Oct '19
Nov '19
Dec '19
Jan '20
Feb '20
Mar '20
Apr '20
May '20
Jun '20
Jul '20
Aug '20
Sep '20

CME vs. Huobi (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Mar '18	24.21*	18.46 - 29.95
Apr '18	14.86*	11.03 - 18.69
May '18	14.50*	11.59 - 17.41
Jun '18	14.56*	11.00 - 18.13
Jul '18	9.14*	8.54 - 9.73
Aug '18	10.92*	9.49 - 12.36
Sep '18	9.44*	7.68 - 11.20
Oct '18	16.70*	11.80 - 21.59
Nov '18	14.30*	7.24 - 21.35
Dec '18	7.57*	6.43 - 8.71
Jan '19	10.87*	8.62 - 13.12
Feb '19	10.28*	8.32 - 12.24
Mar '19	13.88*	9.65 - 18.11
Apr '19	4.78	-0.11 - 9.67
May '19	5.02*	4.58 - 5.46
Jun '19	5.75*	4.91 - 6.59
Jul '19	3.64*	3.18 - 4.11
Aug '19	3.10*	2.62 - 3.58
Sep '19	3.46*	2.55 - 4.36
Oct '19	4.43*	2.48 - 6.37
Nov '19	3.94*	1.31 - 6.57
Dec '19	2.76*	2.37 - 3.16
Jan '20	2.56*	2.26 - 2.86
Feb '20	2.96*	2.38 - 3.54
Mar '20	3.07*	2.34 - 3.81
Apr '20	2.91*	2.03 - 3.80
May '20	2.02*	1.72 - 2.32
Jun '20	3.15*	2.14 - 4.17
Jul '20	4.15*	1.90 - 6.39
Aug '20	3.25*	1.77 - 4.73
Sep '20	2.70*	2.13 - 3.26

2018-03-01 - 2020-09-30	7.57*	6.96 - 8.18

CME vs. itBit (Chart)

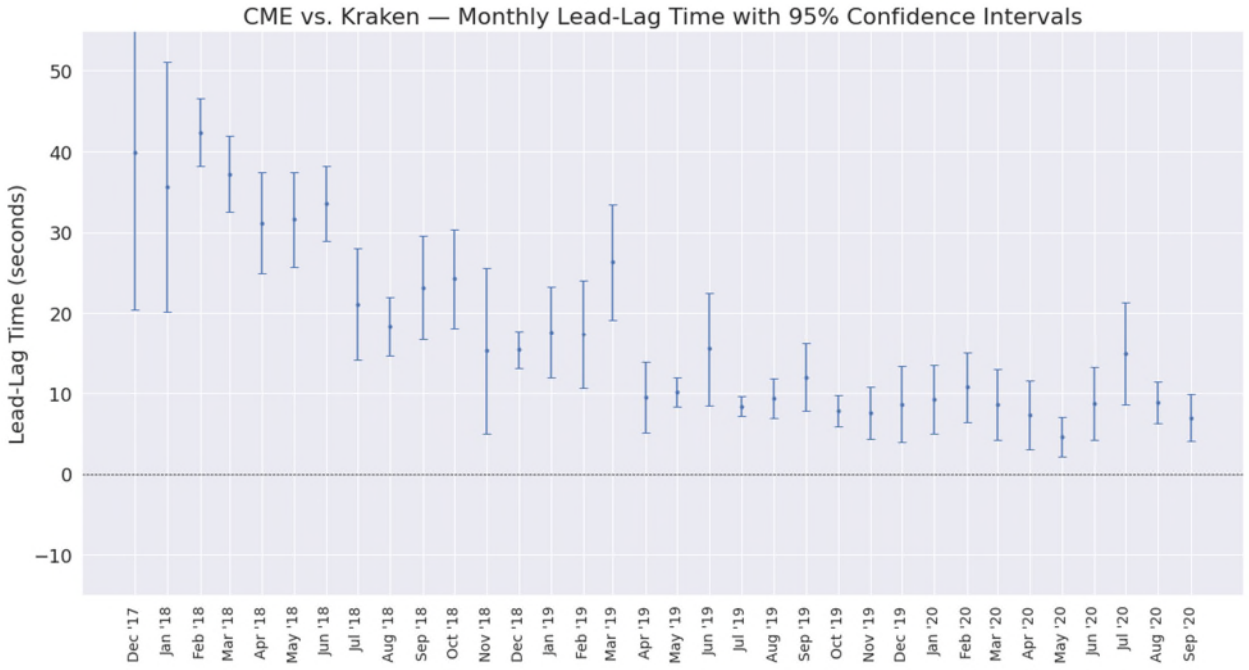


CME vs. itBit (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Dec '17	13.58	-0.86 - 28.01
Jan '18	25.57*	19.88 - 31.27
Feb '18	25.33*	20.01 - 30.65
Mar '18	18.86*	16.42 - 21.29
Apr '18	14.77*	9.81 - 19.73
May '18	14.83*	10.00 - 19.67
Jun '18	10.15*	8.40 - 11.90
Jul '18	8.56*	6.53 - 10.60
Aug '18	10.59*	7.84 - 13.34
Sep '18	9.42*	6.02 - 12.82
Oct '18	11.40*	5.65 - 17.15
Nov '18	7.43*	3.66 - 11.20
Dec '18	7.72*	1.97 - 13.47
Jan '19	6.54*	2.53 - 10.56
Feb '19	6.67*	3.83 - 9.52
Mar '19	15.44*	10.54 - 20.34
Apr '19	7.38*	4.69 - 10.07
May '19	5.03*	3.96 - 6.10
Jun '19	4.95*	3.99 - 5.91
Jul '19	3.30*	2.75 - 3.85
Aug '19	3.49*	2.84 - 4.14
Sep '19	3.51*	2.52 - 4.51
Oct '19	6.02*	2.87 - 9.17
Nov '19	1.66	-3.45 - 6.76
Dec '19	6.08*	3.47 - 8.68
Jan '20	6.10*	2.09 - 10.12
Feb '20	4.33*	3.22 - 5.43
Mar '20	3.76*	1.75 - 5.78
Apr '20	2.76*	2.36 - 3.16
May '20	2.89*	2.36 - 3.41
Jun '20	5.92*	0.96 - 10.88
Jul '20	7.97*	1.65 - 14.28
Aug '20	5.97*	3.14 - 8.80
Sep '20	6.84*	2.49 - 11.19

2017-12-18 - 2020-09-30	8.63*	7.89 - 9.37

CME vs. Kraken (Chart)

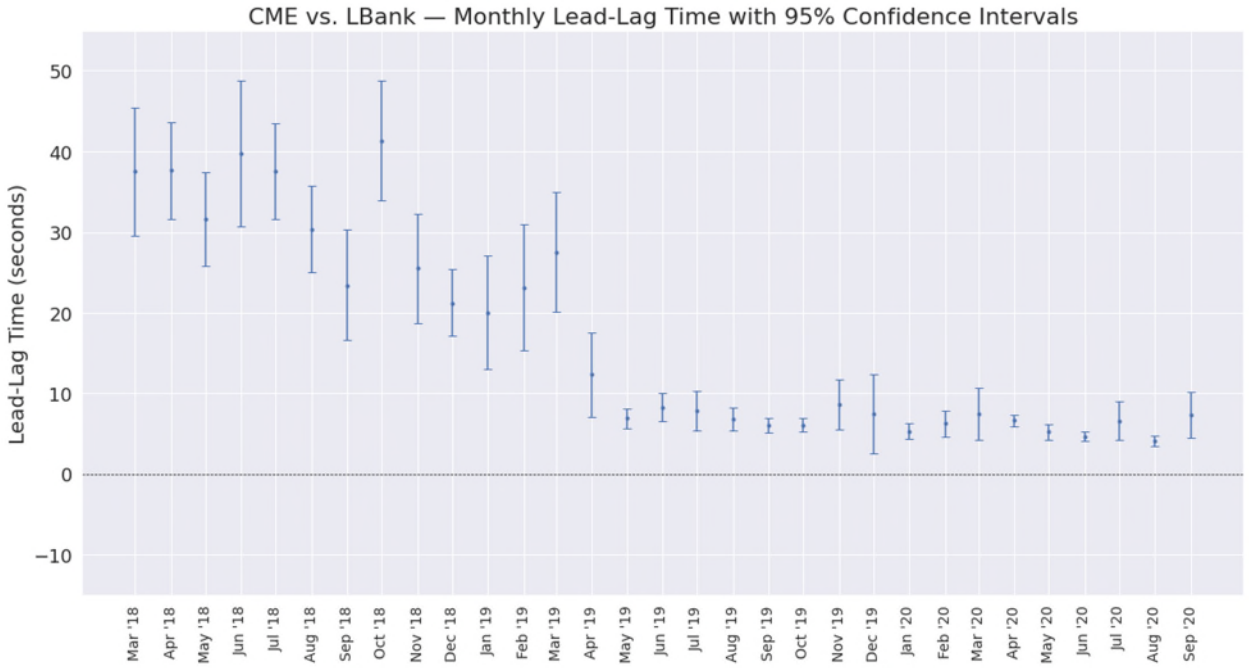

CME vs. Kraken — Monthly Lead-Lag Time with 95% Confidence Intervals
Lead-Lag Time (seconds)
50
40
30
20
10
0
−10
Dec '17
Jan '18
Feb '18
Mar '18
Apr '18
May '18
Jun '18
Jul '18
Aug '18
Sep '18
Oct '18
Nov '18
Dec '18
Jan '19
Feb '19
Mar '19
Apr '19
May '19
Jun '19
Jul '19
Aug '19
Sep '19
Oct '19
Nov '19
Dec '19
Jan '20
Feb '20
Mar '20
Apr '20
May '20
Jun '20
Jul '20
Aug '20
Sep '20

CME vs. Kraken (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Dec '17	39.91*	20.45 - 59.38
Jan '18	35.66*	20.18 - 51.13
Feb '18	42.38*	38.21 - 46.55
Mar '18	37.23*	32.49 - 41.97
Apr '18	31.17*	24.90 - 37.45
May '18	31.59*	25.75 - 37.43
Jun '18	33.53*	28.91 - 38.16
Jul '18	21.09*	14.18 - 28.00
Aug '18	18.33*	14.62 - 22.04
Sep '18	23.13*	16.66 - 29.60
Oct '18	24.24*	18.12 - 30.37
Nov '18	15.29*	5.03 - 25.54
Dec '18	15.35*	13.03 - 17.67
Jan '19	17.63*	11.96 - 23.30
Feb '19	17.34*	10.70 - 23.98
Mar '19	26.30*	19.11 - 33.48
Apr '19	9.49*	5.13 - 13.85
May '19	10.15*	8.35 - 11.96
Jun '19	15.48*	8.50 - 22.46
Jul '19	8.37*	7.17 - 9.56
Aug '19	9.35*	6.97 - 11.74
Sep '19	11.97*	7.77 - 16.18
Oct '19	7.82*	5.87 - 9.77
Nov '19	7.52*	4.32 - 10.73
Dec '19	8.65*	3.93 - 13.37
Jan '20	9.24*	5.02 - 13.46
Feb '20	10.76*	6.43 - 15.09
Mar '20	8.62*	4.26 - 12.98
Apr '20	7.30*	3.02 - 11.57
May '20	4.57*	2.12 - 7.02
Jun '20	8.73*	4.22 - 13.23
Jul '20	14.94*	8.56 - 21.31
Aug '20	8.82*	6.23 - 11.41
Sep '20	6.96*	4.04 - 9.88

2017-12-18 - 2020-09-30	17.19*	16.00 - 18.38

CME vs. LBank (Chart)

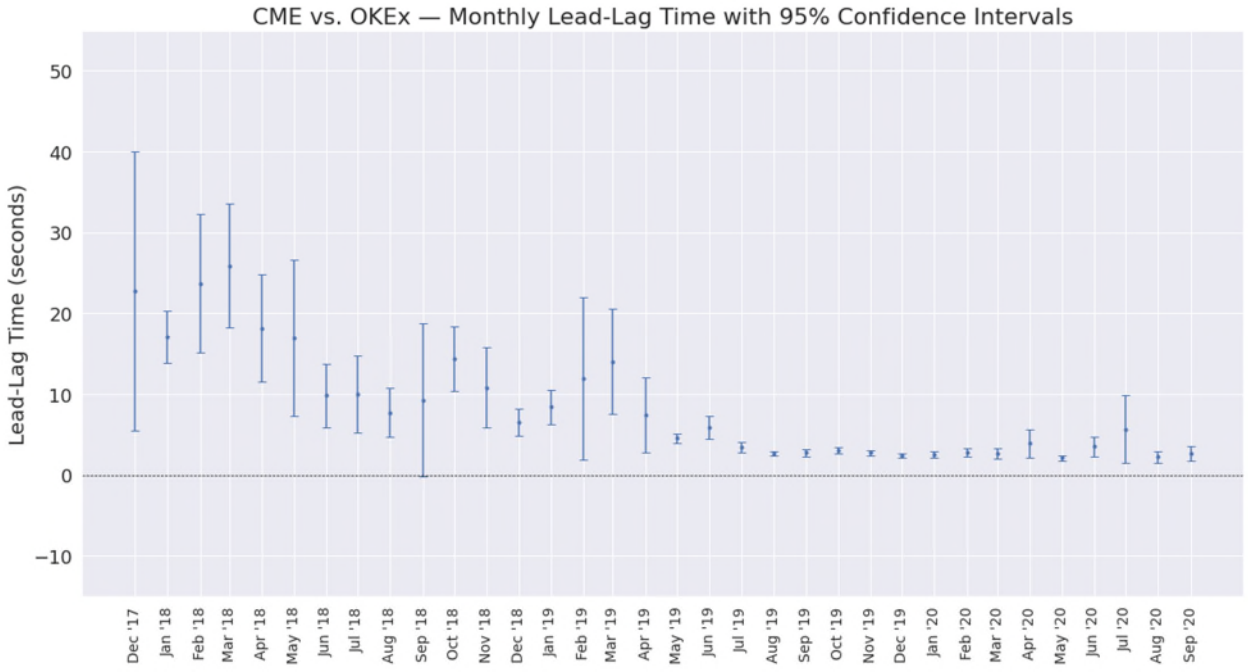

CME vs. LBank — Monthly Lead-Lag Time with 95% Confidence Intervals
Lead-Lag Time (seconds)
50
40
30
20
10
0
−10
Mar '18
Apr '18
May '18
Jun '18
Jul '18
Aug '18
Sep '18
Oct '18
Nov '18
Dec '18
Jan '19
Feb '19
Mar '19
Apr '19
May '19
Jun '19
Jul '19
Aug '19
Sep '19
Oct '19
Nov '19
Dec '19
Jan '20
Feb '20
Mar '20
Apr '20
May '20
Jun '20
Jul '20
Aug '20
Sep '20

CME vs. LBank (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Mar '18	37.55*	29.64 - 45.46
Apr '18	37.64*	31.68 - 43.59
May '18	31.65*	25.83 - 37.47
Jun '18	39.79*	30.78 - 48.80
Jul '18	37.56*	31.61 - 43.52
Aug '18	30.40*	25.05 - 35.75
Sep '18	23.45*	16.56 - 30.34
Oct '18	41.35*	33.97 - 48.73
Nov '18	25.55*	18.79 - 32.32
Dec '18	21.23*	17.05 - 25.41
Jan '19	20.04*	12.93 - 27.15
Feb '19	23.18*	15.32 - 31.04
Mar '19	27.57*	20.13 - 35.01
Apr '19	12.37*	7.10 - 17.64
May '19	6.86*	5.61 - 8.12
Jun '19	8.22*	6.47 - 9.97
Jul '19	7.83*	5.42 - 10.23
Aug '19	6.76*	5.36 - 8.17
Sep '19	5.99*	5.08 - 6.90
Oct '19	6.07*	5.18 - 6.96
Nov '19	8.62*	5.51 - 11.73
Dec '19	7.42*	2.47 - 12.37
Jan '20	5.29*	4.34 - 6.23
Feb '20	6.21*	4.60 - 7.82
Mar '20	7.42*	4.16 - 10.68
Apr '20	6.65*	5.95 - 7.35
May '20	5.21*	4.25 - 6.17
Jun '20	4.61*	4.02 - 5.20
Jul '20	6.54*	4.15 - 8.93
Aug '20	4.04*	3.41 - 4.67
Sep '20	7.32*	4.52 - 10.13

2018-03-14 - 2020-09-30	16.62*	15.37 - 17.87

CME vs. OKEx (Chart)

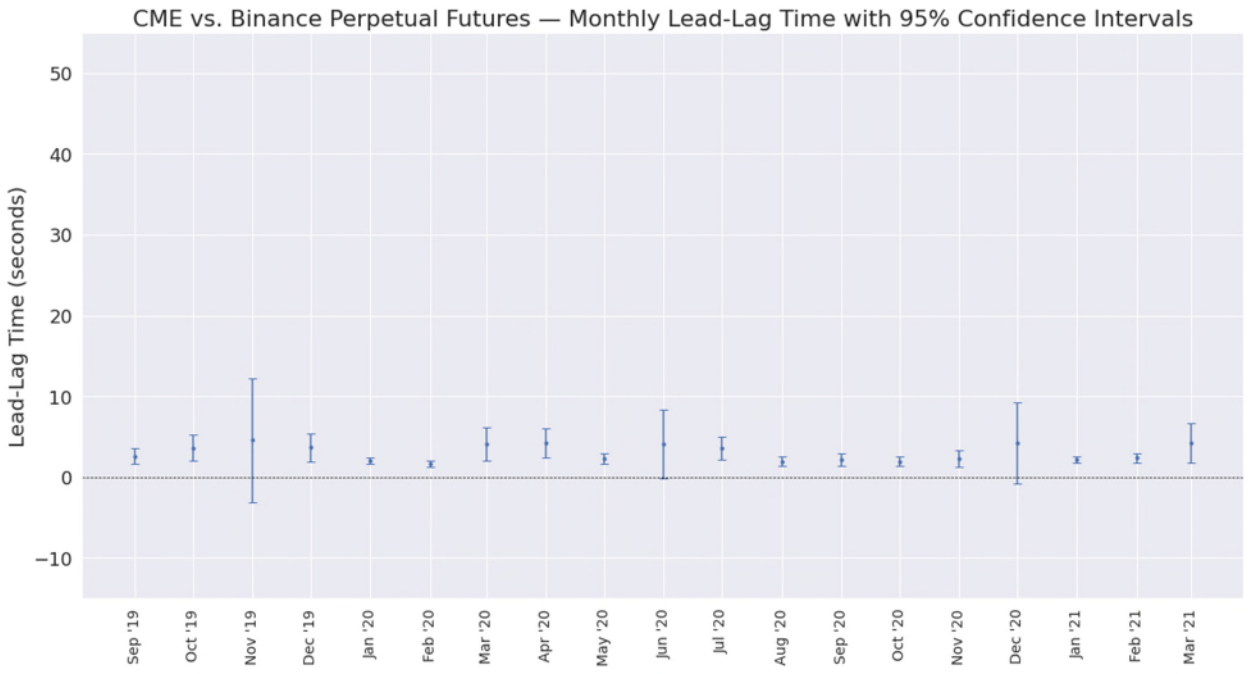


CME vs. OKEx (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Dec '17	22.71*	5.45 - 39.97
Jan '18	17.06*	13.82 - 20.30
Feb '18	23.70*	15.14 - 32.26
Mar '18	25.89*	18.20 - 33.58
Apr '18	18.18*	11.57 - 24.79
May '18	16.97*	7.33 - 26.61
Jun '18	9.83*	5.90 - 13.77
Jul '18	9.99*	5.24 - 14.74
Aug '18	7.73*	4.68 - 10.78
Sep '18	9.28	-0.23 - 18.79
Oct '18	14.37*	10.34 - 18.41
Nov '18	10.79*	5.82 - 15.76
Dec '18	6.57*	4.88 - 8.26
Jan '19	8.41*	6.29 - 10.53
Feb '19	11.96*	1.94 - 21.98
Mar '19	14.02*	7.52 - 20.52
Apr '19	7.43*	2.86 - 12.00
May '19	4.56*	3.98 - 5.15
Jun '19	5.84*	4.43 - 7.25
Jul '19	3.41*	2.73 - 4.09
Aug '19	2.63*	2.38 - 2.88
Sep '19	2.73*	2.32 - 3.14
Oct '19	3.02*	2.64 - 3.39
Nov '19	2.75*	2.46 - 3.04
Dec '19	2.41*	2.20 - 2.62
Jan '20	2.51*	2.10 - 2.92
Feb '20	2.76*	2.23 - 3.29
Mar '20	2.65*	2.00 - 3.30
Apr '20	3.90*	2.19 - 5.60
May '20	2.11*	1.78 - 2.45
Jun '20	3.52*	2.32 - 4.72
Jul '20	5.65*	1.49 - 9.82
Aug '20	2.24*	1.53 - 2.95
Sep '20	2.62*	1.73 - 3.51

2017-12-18 - 2020-09-30	8.27*	7.41 - 9.13

CME vs. Binance Perpetual Futures (Chart)

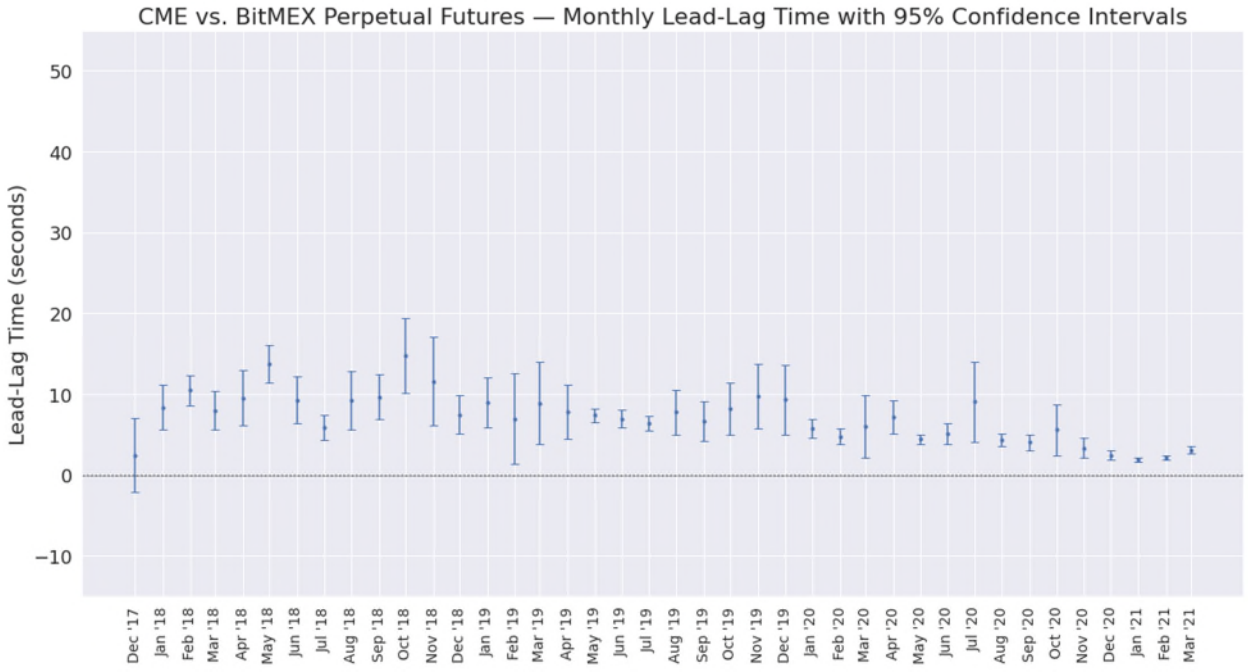


CME vs. Binance Perpetual Futures (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Sep '19	2.60*	1.64 - 3.56
Oct '19	3.63*	2.03 - 5.24
Nov '19	4.56	-3.10 - 12.22
Dec '19	3.70*	1.97 - 5.42
Jan '20	2.03*	1.64 - 2.42
Feb '20	1.64*	1.21 - 2.07
Mar '20	4.12*	2.03 - 6.20
Apr '20	4.21*	2.41 - 6.00
May '20	2.32*	1.66 - 2.99
Jun '20	4.08	-0.20 - 8.36
Jul '20	3.59*	2.14 - 5.04
Aug '20	1.94*	1.38 - 2.51
Sep '20	2.19*	1.41 - 2.97
Oct '20	1.95*	1.41 - 2.50
Nov '20	2.29*	1.29 - 3.29
Dec '20	4.21	-0.80 - 9.22
Jan '21	2.19*	1.84 - 2.54
Feb '21	2.41*	1.84 - 2.98
Mar '21	4.28*	1.83 - 6.73

2019-09-09 - 2021-03-31	3.07*	2.50 - 3.65

CME vs. BitMEX Perpetual Futures (Chart)



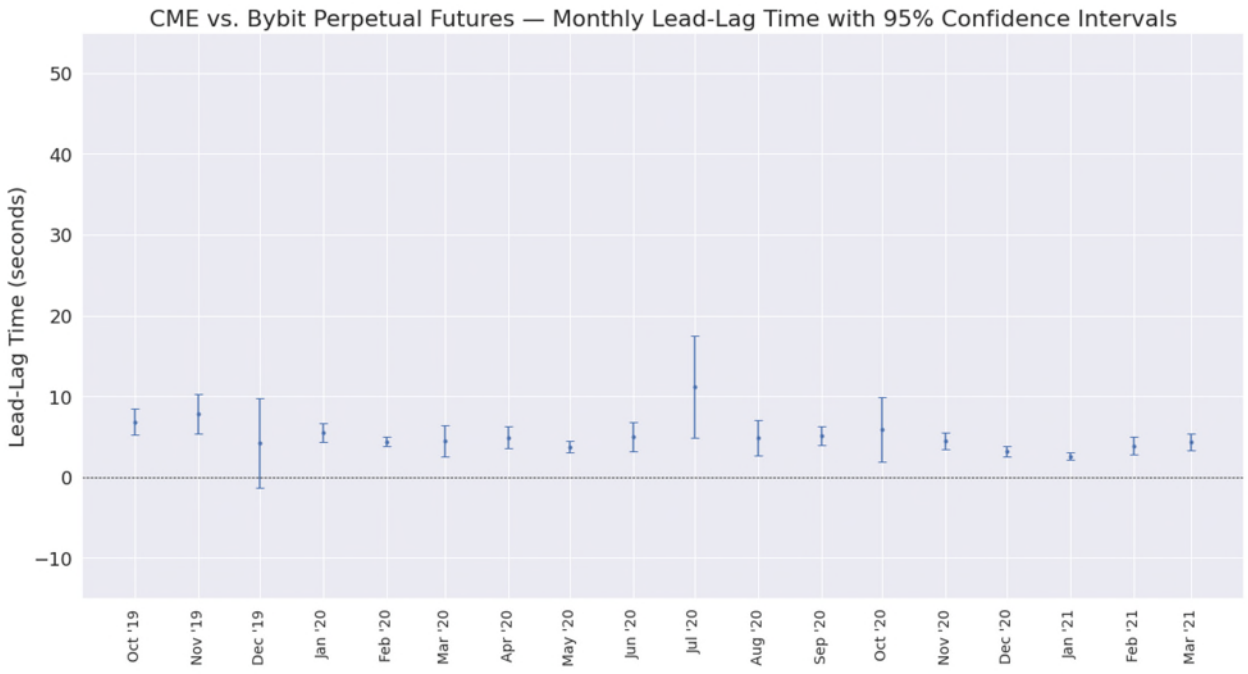
CME vs. BitMEX Perpetual Futures (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Dec '17	2.47	-2.12 - 7.06
Jan '18	8.39*	5.57 - 11.21
Feb '18	10.47*	8.60 - 12.34
Mar '18	8.00*	5.56 - 10.44
Apr '18	9.52*	6.09 - 12.96
May '18	13.73*	11.42 - 16.04
Jun '18	9.29*	6.35 - 12.23
Jul '18	5.85*	4.31 - 7.40
Aug '18	9.24*	5.67 - 12.82
Sep '18	9.66*	6.87 - 12.45
Oct '18	14.77*	10.09 - 19.46
Nov '18	11.61*	6.14 - 17.08
Dec '18	7.47*	5.07 - 9.87
Jan '19	8.98*	5.87 - 12.09
Feb '19	6.96*	1.38 - 12.54
Mar '19	8.90*	3.76 - 14.05
Apr '19	7.84*	4.52 - 11.15
May '19	7.38*	6.58 - 8.18
Jun '19	6.95*	5.86 - 8.04
Jul '19	6.42*	5.49 - 7.35
Aug '19	7.78*	4.98 - 10.58
Sep '19	6.69*	4.23 - 9.14
Oct '19	8.18*	4.96 - 11.41
Nov '19	9.74*	5.69 - 13.80
Dec '19	9.34*	5.01 - 13.67
Jan '20	5.79*	4.62 - 6.96
Feb '20	4.76*	3.79 - 5.72
Mar '20	6.00*	2.15 - 9.85
Apr '20	7.17*	5.09 - 9.25
May '20	4.42*	3.85 - 4.99
Jun '20	5.09*	3.84 - 6.34
Jul '20	9.04*	4.10 - 13.98
Aug '20	4.33*	3.60 - 5.06
Sep '20	4.02*	3.03 - 5.00
Oct '20	5.57*	2.38 - 8.77
Nov '20	3.36*	2.09 - 4.63
Dec '20	2.42*	1.85 - 2.99
Jan '21	1.87*	1.61 - 2.13
Feb '21	2.17*	1.94 - 2.40

Mar '21	3.11*	2.61 - 3.61

2017-12-18 - 2021-03-31	7.23*	6.76 - 7.70

CME vs. Bybit Perpetual Futures (Chart)

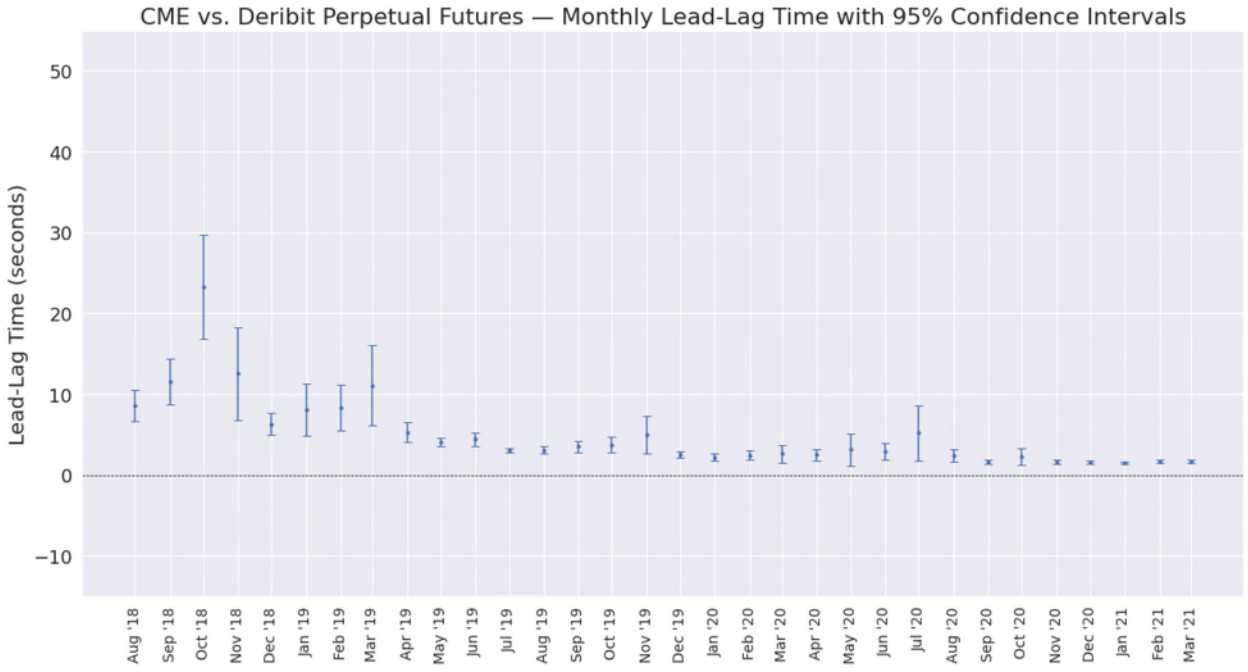


CME vs. Bybit Perpetual Futures (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Oct '19	6.82*	5.20 - 8.43
Nov '19	7.82*	5.36 - 10.28
Dec '19	4.25	-1.30 - 9.80
Jan '20	5.51*	4.36 - 6.67
Feb '20	4.40*	3.81 - 4.99
Mar '20	4.46*	2.53 - 6.40
Apr '20	4.91*	3.55 - 6.27
May '20	3.75*	3.01 - 4.49
Jun '20	4.99*	3.18 - 6.80
Jul '20	11.15*	4.87 - 17.43
Aug '20	4.86*	2.70 - 7.01
Sep '20	5.12*	3.99 - 6.26
Oct '20	5.95*	1.97 - 9.92
Nov '20	4.44*	3.39 - 5.49
Dec '20	3.23*	2.59 - 3.87
Jan '21	2.59*	2.12 - 3.06
Feb '21	3.89*	2.83 - 4.95
Mar '21	4.38*	3.34 - 5.43

2019-10-01 - 2021-03-31	5.13*	4.56 - 5.70

CME vs. Deribit Perpetual Futures (Chart)

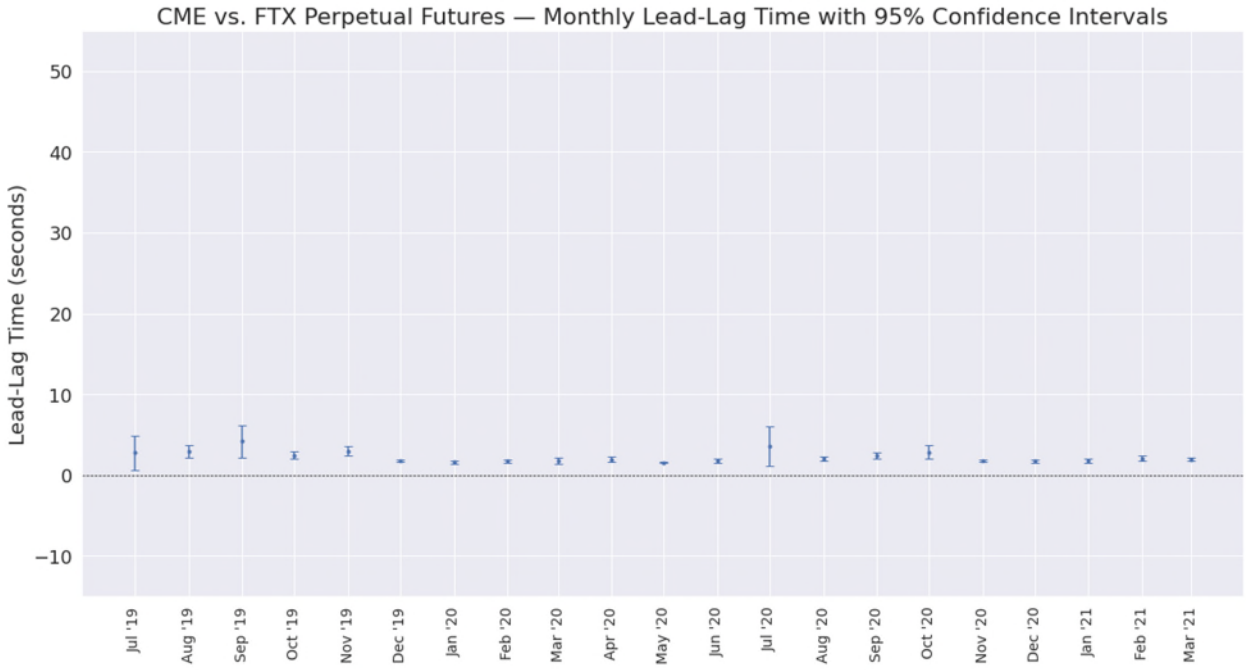


CME vs. Deribit Perpetual Futures (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Aug '18	8.59*	6.69 - 10.48
Sep '18	11.50*	8.67 - 14.33
Oct '18	23.22*	16.78 - 29.66
Nov '18	12.56*	6.82 - 18.30
Dec '18	6.30*	4.93 - 7.67
Jan '19	8.10*	4.87 - 11.32
Feb '19	8.36*	5.56 - 11.16
Mar '19	11.06*	6.11 - 16.01
Apr '19	5.30*	4.03 - 6.56
May '19	4.08*	3.52 - 4.64
Jun '19	4.43*	3.62 - 5.24
Jul '19	3.09*	2.84 - 3.34
Aug '19	3.06*	2.61 - 3.52
Sep '19	3.56*	2.85 - 4.27
Oct '19	3.73*	2.77 - 4.69
Nov '19	4.97*	2.70 - 7.24
Dec '19	2.50*	2.10 - 2.91
Jan '20	2.17*	1.73 - 2.62
Feb '20	2.46*	1.92 - 3.01
Mar '20	2.61*	1.52 - 3.70
Apr '20	2.50*	1.79 - 3.20
May '20	3.13*	1.14 - 5.12
Jun '20	2.94*	1.91 - 3.96
Jul '20	5.20*	1.80 - 8.60
Aug '20	2.37*	1.60 - 3.14
Sep '20	1.64*	1.40 - 1.88
Oct '20	2.26*	1.27 - 3.26
Nov '20	1.64*	1.41 - 1.87
Dec '20	1.62*	1.42 - 1.82
Jan '21	1.47*	1.34 - 1.60
Feb '21	1.67*	1.44 - 1.90
Mar '21	1.65*	1.46 - 1.84

2018-08-14 - 2021-03-31	4.98*	4.47 - 5.49

CME vs. FTX Perpetual Futures (Chart)

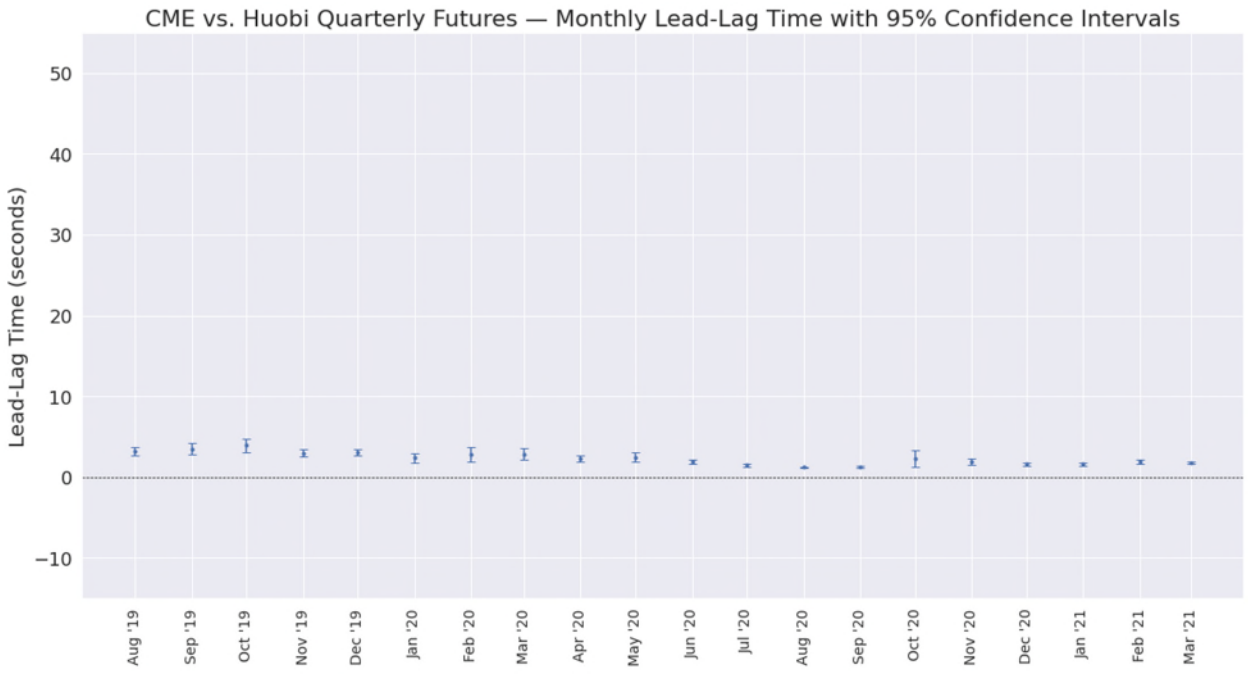


CME vs. FTX Perpetual Futures (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Jul '19	2.76*	0.59 - 4.92
Aug '19	2.92*	2.16 - 3.67
Sep '19	4.16*	2.22 - 6.10
Oct '19	2.48*	2.06 - 2.90
Nov '19	3.00*	2.38 - 3.62
Dec '19	1.77*	1.60 - 1.95
Jan '20	1.59*	1.43 - 1.75
Feb '20	1.72*	1.51 - 1.92
Mar '20	1.75*	1.36 - 2.13
Apr '20	1.97*	1.70 - 2.24
May '20	1.58*	1.47 - 1.69
Jun '20	1.76*	1.55 - 1.97
Jul '20	3.56*	1.11 - 6.00
Aug '20	2.04*	1.83 - 2.25
Sep '20	2.39*	1.98 - 2.81
Oct '20	2.87*	2.00 - 3.74
Nov '20	1.78*	1.61 - 1.95
Dec '20	1.72*	1.50 - 1.95
Jan '21	1.78*	1.56 - 2.00
Feb '21	2.09*	1.77 - 2.41
Mar '21	1.96*	1.77 - 2.15

2019-07-01 - 2021-03-31	2.27*	2.08 - 2.46

CME vs. Huobi Quarterly Futures (Chart)

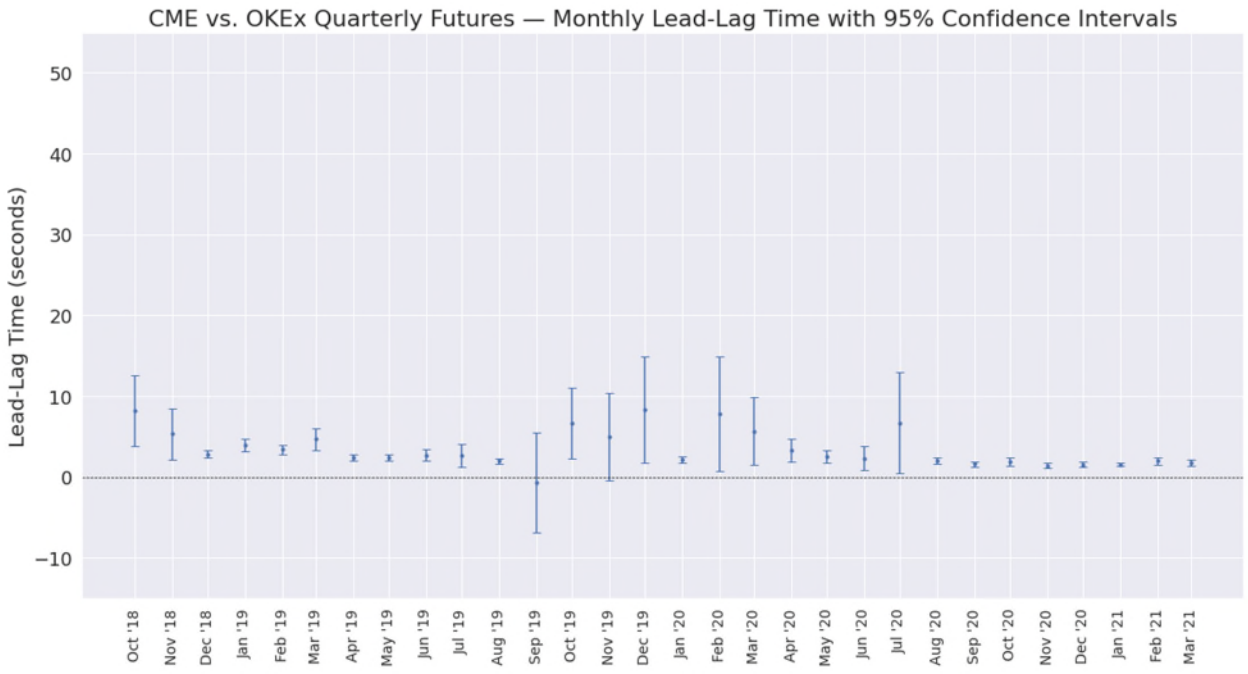


CME vs. Huobi Quarterly Futures (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Aug '19	3.20*	2.73 - 3.67
Sep '19	3.50*	2.76 - 4.23
Oct '19	3.91*	3.12 - 4.70
Nov '19	2.95*	2.49 - 3.42
Dec '19	3.05*	2.65 - 3.45
Jan '20	2.40*	1.84 - 2.96
Feb '20	2.81*	1.95 - 3.67
Mar '20	2.85*	2.17 - 3.52
Apr '20	2.29*	1.92 - 2.66
May '20	2.47*	1.93 - 3.00
Jun '20	1.92*	1.63 - 2.20
Jul '20	1.51*	1.33 - 1.69
Aug '20	1.26*	1.20 - 1.32
Sep '20	1.24*	1.14 - 1.33
Oct '20	2.31*	1.31 - 3.31
Nov '20	1.86*	1.48 - 2.24
Dec '20	1.64*	1.45 - 1.83
Jan '21	1.64*	1.45 - 1.83
Feb '21	1.96*	1.69 - 2.23
Mar '21	1.77*	1.61 - 1.94

2019-08-01 - 2021-03-31	2.34*	2.21 - 2.47

CME vs. OKEx Quarterly Futures (Chart)



CME vs. OKEx Quarterly Futures (Table)

Month	Lead-Lag Time (seconds)	Confidence Interval (seconds)
Oct '18	8.20*	3.80 - 12.60
Nov '18	5.32*	2.20 - 8.44
Dec '18	2.83*	2.39 - 3.27
Jan '19	3.98*	3.19 - 4.77
Feb '19	3.38*	2.82 - 3.94
Mar '19	4.70*	3.34 - 6.05
Apr '19	2.36*	1.98 - 2.75
May '19	2.44*	2.08 - 2.79
Jun '19	2.69*	1.96 - 3.42
Jul '19	2.69*	1.27 - 4.11
Aug '19	1.96*	1.62 - 2.31
Sep '19	-0.73	-6.92 - 5.46
Oct '19	6.63*	2.29 - 10.98
Nov '19	5.01	-0.40 - 10.42
Dec '19	8.30*	1.70 - 14.89
Jan '20	2.13*	1.74 - 2.53
Feb '20	7.85*	0.78 - 14.92
Mar '20	5.66*	1.49 - 9.83
Apr '20	3.30*	1.85 - 4.74
May '20	2.57*	1.81 - 3.34
Jun '20	2.33*	0.80 - 3.85
Jul '20	6.69*	0.42 - 12.97
Aug '20	2.01*	1.59 - 2.43
Sep '20	1.61*	1.30 - 1.91
Oct '20	1.88*	1.35 - 2.41
Nov '20	1.44*	1.16 - 1.72
Dec '20	1.51*	1.19 - 1.83
Jan '21	1.55*	1.38 - 1.72
Feb '21	1.96*	1.55 - 2.37
Mar '21	1.82*	1.42 - 2.21

2018-10-01 - 2021-03-31	3.47*	2.94 - 4.00

EXHIBIT 3B

Is It Likely That A US Bitcoin ETP, If Approved, Will Become The Predominant Influence On Prices In The CME Bitcoin Futures Market?

By Matthew Hougan, Hong Kim, and Satyajeet Pal

Bitwise Asset Management

June 11, 2021

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I. Introduction

One important question that surrounds a potential U.S. bitcoin ETP is whether it is likely that such an ETP, if approved, would become the predominant influence on prices in the CME bitcoin futures market ("CME Market").[1]

This paper takes a replicable, data-driven approach to answering that question, relying on extensive historical data on U.S. ETPs and a widely available, publicly quoted bitcoin trust to make its evaluation.[2]

The study demonstrates that, even using aggressive assumptions for the product's success, it is unlikely that a bitcoin ETP would become the predominant influence on prices in the CME Market.

[1] See, for example, Securities and Exchange Commission Release No. 34-87267; File No. SR-NYSEArca_2019-01, October 9, 2019, Order Disapproving a Proposed Rule Change, as Modified by Amendment No. 1, Relating to the Listing and Trading of Shares of the Bitwise Bitcoin ETF Trust Under NYSE Arca Rule 8.201-E. Page 5.

[2] Although this analysis is focused on the U.S. market, in Appendix B, we also examine data from bitcoin ETPs that recently launched in Canada and Europe to provide additional context to our findings.

II. Methodology

We take four steps to evaluate whether a bitcoin ETP is likely to become the predominant influence on prices in the CME Market. We:

1. Estimate the potential flows into a bitcoin ETP
2. Evaluate the likely impact of those flows on prices in the CME Market
3. Estimate the potential trading volume of a bitcoin ETP
4. Evaluate the likely impact of that trading on prices in the CME Market

In forecasting inflows and trading volume, we err on the side of making aggressive estimates for the success of the ETP in the market. Our goal in doing so is to demonstrate that, even in outlier scenarios where the new ETP is among the most successful ETP launches in history, it is unlikely that a bitcoin ETP will become the predominant influence on prices in the CME Market.

III. Estimating The Potential Flows Into A Bitcoin ETP

We examine extensive and directly pertinent data from other ETPs and a well-known, publicly traded bitcoin trust to estimate the likely first-year flows into a newly approved bitcoin ETP.

Historical Context: First-Year Net Flows Into All U.S.-listed ETPs

The first U.S. ETP launched in 1993, when State Street Global Advisors debuted the SPDR S&P 500 ETF Trust (NYSEArca: SPY). Since then, thousands of ETPs have followed, offering exposure to stocks, bonds, commodities, and other assets.

We examine the first-year net flows into all ETPs currently listed on the market, using data from FactSet.[3] We exclude ETPs with negative first-year flows.

Of the more than 2,200 ETPs with positive or flat first-year flows:

- The median ETP attracted $28 million in flows during its first year on the market.
- The ETP with the highest first-year flows in history—the Invesco QQQ Trust (Nasdaq: QQQ)—attracted $5.35 billion in flows.

The table below highlights the 10 ETPs with the highest first-year flows in ETP history.

Fund	**Ticker**	**Year-One Flows ($M)**
Invesco QQQ Trust	QQQ	5,351
Communication Services Select Sector SPDR	XLC	5,186
iShares MSCI EAFE ETF	EFA	4,292
JPMorgan BetaBuilders Europe ETF	BBEU	4,187
PIMCO Active Bond ETF	BOND	4,116
JPMorgan BetaBuilders Japan ETF	BBJP	3,755
JPMorgan BetaBuilders Canada ETF	BBCA	3,656
iShares Select Dividend ETF	DVY	3,245
Real Estate Select Sector SPDR Fund	XLRE	3,171
SPDR Gold Shares	GLD	3,010

[3] Data was pulled from FactSet on November 30, 2020.

Based on this analysis, we consider $5.35 billion to be the outer limit of possible first-year flows into a bitcoin ETP. There is no precedent for an ETP attracting more than this in its first year on the market. We find it unlikely that a bitcoin ETP will experience the highest first-year flows in history, particularly given the relative size of the bitcoin market compared to the markets captured by the ETPs above, which target parts or all of the equity, bond, real estate, and gold markets.[4]

Additional Context: First-Year Flows Into First-To-Market Commodity ETPs

To provide a more detailed comparison, we examine first-year flows into first-to-market single-commodity ETPs. Bitcoin is considered a commodity by the Commodity Futures Trading Commission,[5] and one way to view a potential bitcoin ETP is as a first-to-market single-commodity ETP offering exposure to bitcoin in the same manner that the SPDR Gold Shares (GLD) is a first-to-market single-commodity ETP offering exposure to gold, and the iShares Silver Trust (SLV) is a first-to-market single-commodity ETP offering exposure to silver.

The following table shows the first-year flows into every first-to-market single-commodity ETP currently available in the U.S., again using data from FactSet.[6] First-year flows range from $3.01 billion for the SPDR Gold Shares (NYSEArca: GLD) to negative $1 million for the iPath Bloomberg Lead Subindex Total Return ETN (NYSEArca: LD).[7]

Commodity	**Ticker**	**Year-One Flows ($M)**
Gold	GLD	$3,010
Silver	SLV	$1,730
Crude Oil	USO	$827
Platinum	PPLT	$708
Palladium	PALL	$603

[4] At year-end 2020, the total market capitalization of bitcoin was $539 billion, according to Blockchain.com. By comparison, the global market capitalization of the equity market was $95 trillion, and the outstanding value of the global bond market was $106 trillion in 2019, according to the most recently published SIFMA Capital Markets Fact Book (September 2020) (https://www.sifma.org/wp-content/uploads/2020/09/US-Fact-Book-2020-SIFMA.pdf); the professionally managed global real estate market was $9.6 trillion in 2019, according to MSCI's Market Size Report on Global Real Estate (https://www.msci.com/real-estate/market-size-report); and the total value of above-ground gold was $10 trillion on December 31, 2020, according to the World Gold Council (https://www.gold.org/goldhub/data/above-ground-stocks).

[5] The Commodity Futures Trading Commission has argued successfully in federal courts that cryptocurrencies such as bitcoin are commodities. See, e.g., Commodity Futures Trading Commission v McDonnell and CabbageTech, Corp., 18-CV-361 (E.D.N.Y. March 6, 2018) and Commodity Futures Trading Commission v My Big Coin Pay, Inc., 18-cv-10077-RWZ (D. Mass. Sept. 26, 2018).

[6] Data was pulled from FactSet on November 30, 2020.

[7] Negative flows occur when a product is seeded with a certain amount of capital, but some of that capital is redeemed over time, and there are no offsetting creations.

Natural Gas	UNG	$374
Corn	CORN	$115
Coffee	JO	$48
Gasoline	UGA	$28
Sugar	SSG	$12
Soybeans	SOYB	$10
Cotton	BAL	$7
Nickel	JJN	$2
Copper	CPER	$2
Wheat	WEAT	$1
Cocoa	NIB	$1
Aluminum	JJU	$1
Carbon Credits	GRN	$0
Tin	JJT	$0
Lead	LD	-$1

These figures provide additional context on the likely upper bound of potential flows into a bitcoin ETP.

Maximum One-Year Flows Into The Grayscale Bitcoin Trust (GBTC)

The Grayscale Bitcoin Trust (OTCQX: GBTC) is a publicly traded grantor trust that holds bitcoin directly with a third-party custodian. Shares of GBTC have been accessible to U.S. investors through traditional brokerage accounts like Charles Schwab, Fidelity, and TD Ameritrade since May 2015.[8] As of December 31, 2020, GBTC was the only product that allowed investors to gain exposure to bitcoin through a traditional brokerage window. A bitcoin ETP will compete with GBTC for these investors if such an ETP launches.

GBTC is different from an ETP in certain ways, including that the structure does not allow for redemptions, that it has a different regulatory status than an ETP, and that shares of GBTC are materially more likely to trade at significant and variable premiums and/or discounts to the net asset value of the trust. GBTC does, however, permit creations, allowing it to accommodate inflows to reflect investor demand. As such, it can be a useful data set for analyzing investor

[8] OTC Markets Group Inc., press release, May 5, 2015. OTC Markets Group Welcomes Bitcoin Investments Trust to OTCQX (https://www.prnewswire.com/news-releases/otc-markets-group-welcomes-bitcoin-investment-trust-to-otcqx-300077150.html)

demand for exposure to bitcoin through a traditional brokerage window and what impact flows from such demand can have on prices in the CME Market.

GBTC attracted a record $4.7 billion in inflows in 2020, according to Grayscale Investments,[9] its highest year ever. Its previous record was $472 million, set in 2019. 2020's record inflows occurred during a sustained bull market for bitcoin, as bitcoin's price rose 306% in 2020.[10]

Our Estimate For Future Analysis

For the purposes of this paper, we use $4.7 billion as our estimate for first-year flows into a new bitcoin ETP.

We consider this level to be aggressive. It assumes that a bitcoin ETP will:

- Be the third-fastest-growing ETP in history, out of more than 2,200 products with positive year-one flows
- Significantly surpass (by more than 50%) the first-year flows into GLD, which experienced the highest first-year flows in first-to-market single-commodity ETP history
- Match the highest annual flow in GBTC's history, achieved during a strong bull market, all while the new ETP is forced to compete for market share with GBTC itself

[9] Grayscale Investments, Digital Asset Investment Report, Q4 2020. (https://grayscale.co/insights/grayscale-q4-2020-digital-asset-investment-report/)
[10] Bitcoin's price rose from $7,147 on December 31, 2019 to $29,026 on December 31, 2020, according to the Coin Metrics bitcoin reference rate.

IV. Evaluating The Potential Impact Of ETP Flows On Prices In The CME Market

The flows into GBTC are publicly available. This means we have a direct test case to evaluate whether $4.7 billion in positive flows into a bitcoin investment product in a single year is likely to cause that product to become the predominant influence on prices in the CME Market, as we can analyze the experience of GBTC itself in 2020.

We conduct a statistical analysis examining the relationship of flows into GBTC in 2020 and changes in the price of bitcoin, using both daily and weekly flows.

Daily (or weekly) flows were calculated from Bloomberg data by multiplying the change in outstanding shares of the trust by the net asset value per share of that day (or week). Daily (or weekly) percentage price changes of bitcoin were calculated using the 4 p.m. ET bitcoin reference rate from Coin Metrics.[11]

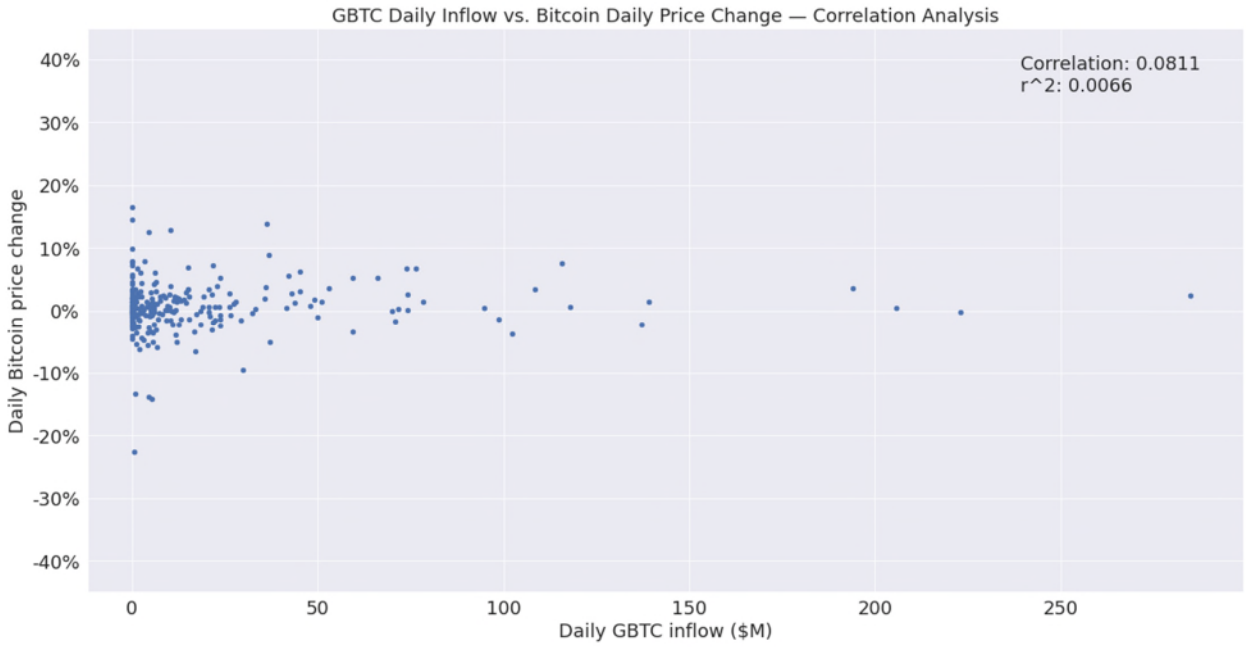
While GBTC allows for daily creations, unlike an ETF, those shares are not immediately available to be sold in the secondary market. After purchasing shares, an investor must hold the shares for 6-months before they are permitted to be traded on the secondary market. This creates a longer holding period for an arbitrageur, as compared to a typical ETF arbitrage trade where an authorized participant may immediately trade newly created shares into the secondary market. For example, to capture arbitrage on GBTC shares trading at a premium, an arbitrageur would need to short sell GBTC shares while buying spot bitcoin, deliver the bitcoin for creation of GBTC shares, and hold those shares for six months until they are released from transfer restriction and can be delivered to the short sellers to close out the trade.

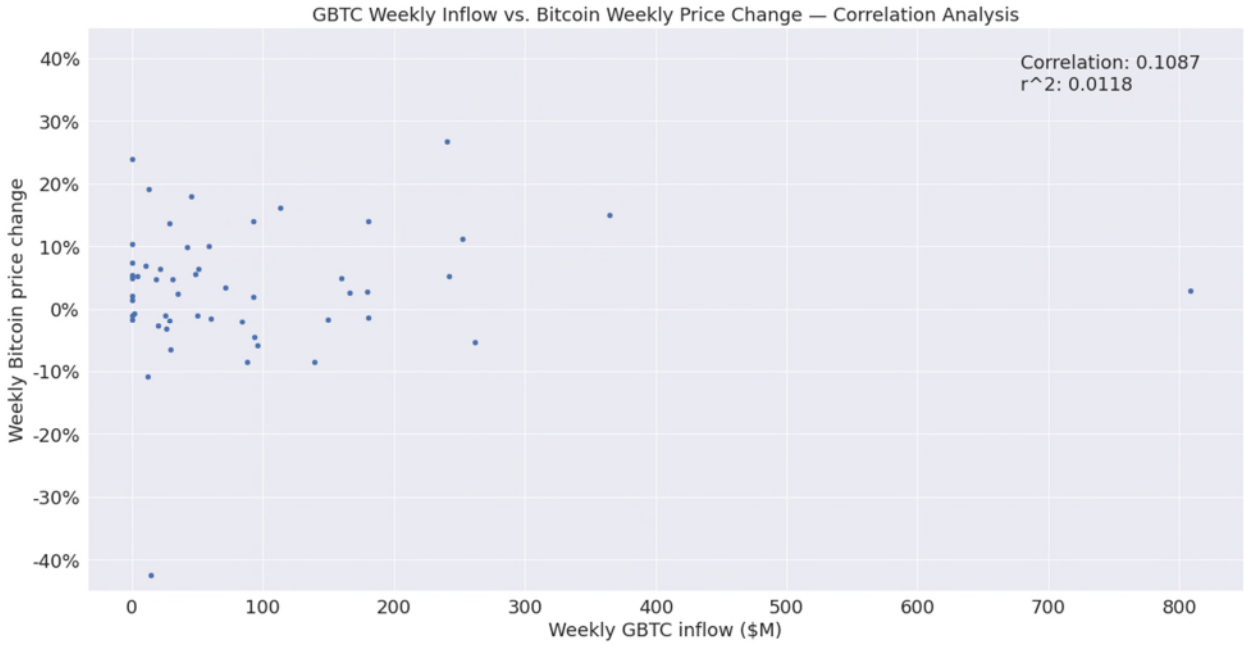
However, while the holding period of the GBTC share premium arbitrage is at minimum 6 months, the buying in the spot bitcoin market occurs, in this case, right before the creation date, which is the date the inflows are recorded. Of course, a single day leading up to the creation might not capture all the buying activity that an arbitrageur can accumulate, which is why we elected to explore the relationship between flows into GBTC and changes in the price of bitcoin on both a weekly and daily basis. In addition, institutional arbitrageurs are not the only cohort that could create shares for GBTC. Accredited investors may also subscribe for GBTC shares either by contributing bitcoin or delivering cash. For cash orders, Genesis Trading Global, Inc., the “authorized participant” of the trust, purchases the bitcoin for the given cash amount by 6 p.m. ET on the day the cash is provided by the subscriber.

The charts below show the results. Each dot represents a daily (or weekly) flow into GBTC and the corresponding daily (or weekly) change in the price of bitcoin. As such, there are 253 dots in

[11] https://coinmetrics.io/reference-rates

the first chart representing each trading day, and 52 dots in the second chart representing each week in 2020.





The data show there is no meaningful relationship between daily and weekly flows into GBTC and changes in the price of bitcoin, despite the aggregate flows being $4.7 billion: The correlation for daily results is 0.08, and the correlation for weekly results is 0.11.

The experience of outlier days and weeks with large flows adds to this conviction. For instance,

the largest one-day flow occurred on December 22, 2020, when $285 million flowed into the fund; bitcoin's price moved 2.3% that day, within the normal daily range for a bitcoin price move.

Similarly, the largest one-week flow occurred for the week ending December 27, 2020, when GBTC attracted approximately $809 million in inflows; bitcoin's price settled up just 2.9% that week, again within the normal range for a weekly price move.

Based on this direct data-driven comparison, we conclude it is unlikely that $4.7 billion in flows into a bitcoin ETP in a single year will cause it to become the predominant influence on prices in the CME Market.

V. Estimating The Likely Trading Volume Of A Bitcoin ETP

Now that we have considered the potential impact that flows into a bitcoin ETP could have on the underlying market, the next step is to evaluate the potential impact that the secondary trading of shares of the ETP could have on the underlying market.

To make this evaluation, we need to estimate the amount of trading activity there will be in a bitcoin ETP. We use two comparisons:

Comparison to GBTC

Shares of the GBTC are publicly quoted on the OTCQX Best Market and are widely available to U.S. investors through traditional brokerage accounts. As such, although GBTC operates under a different regulatory structure than an ETP and has historically traded at significant and variable premiums and discounts to its net asset value, the historical turnover of GBTC provides one estimate of the future turnover of a bitcoin ETP.

GBTC's average daily trading volume in 2020 was $103 million. On a monthly basis, that figure ranged from $37 million in April 2020 to $368 million December 2020, as reported in the table below.

Examining ADV in isolation offers only a partial picture, however. As might be expected, trading activity in GBTC is strongly linked with the product's assets under management (AUM), which is in turn linked to bitcoin's price.

The table below shows the "ADV/AUM Ratio" for GBTC for each month in 2020, using the month-end AUM as the denominator. Although the absolute size of the ADV ranges widely across 2020, the ADV/AUM Ratio stays fairly consistent, running from 1.10% (April and September) to 2.21% (February). The average ADV/AUM ratio for the year was 1.54%.

Month	ADV (M)	AUM (M)	ADV/AUM RATIO
Jan 2020	$43	$3,191	1.36%
Feb 2020	$66	$2,997	2.21%
Mar 2020	$44	$2,249	1.96%
Apr 2020	$37	$3,313	1.10%
May 2020	$68	$4,034	1.68%
Jun 2020	$52	$3,870	1.33%
Jul 2020	$65	$5,264	1.23%

Aug 2020	$89	$6,018	1.47%
Sep 2020	$57	$5,167	1.10%
Oct 2020	$95	$7,728	1.23%
Nov 2020	$259	$13,060	1.98%
Dec 2020	$368	$20,445	1.80%
Average	**$103**	**$6,445**	**1.54%**

Applying this average ADV/AUM ratio to our $4.7 billion estimate of first-year flows into a bitcoin ETP, we estimate its daily trading volume to be approximately $72 million at the end of its first year.

Comparison to GLD

A second comparison that may be useful is to examine the case of other first-to-market commodity ETPs. GLD is the largest such ETP, and therefore may provide a useful comparison.

Using the same methodology as we did with GBTC, we examine the ADV/AUM Ratio of GLD for every month in 2020. The average ratio is 3.04%.

Month	**ADV (M)**	**AUM (M)**	**ADV/AUM RATIO**
Jan 2020	$1,206	$46,053	2.62%
Feb 2020	$2,010	$47,348	4.25%
Mar 2020	$2,903	$48,916	5.93%
Apr 2020	$1,828	$57,343	3.19%
May 2020	$1,819	$62,557	2.91%
Jun 2020	$1,606	$67,484	2.38%
Jul 2020	$2,215	$78,789	2.81%
Aug 2020	$3,312	$79,163	4.18%
Sep 2020	$1,272	$76,941	1.65%
Oct 2020	$1,376	$75,889	1.81%
Nov 2020	$1,855	$73,285	2.53%
Dec 2020	$1,369	$71,558	1.91%

Average	**$1,901**	**$65,022**	**3.04%**

Applying GLD's ADV/AUM ratio to our $4.7 billion estimate of first-year inflows into a bitcoin ETP, we estimate its daily trading volume to be approximately $143 million at the end of its first year.

Our Estimate For Future Analysis

For the purposes of this paper, we use the higher figure—$143 million—as our estimate for a new bitcoin ETP's average daily trading volume after a year on the market.

We consider this to be an aggressive estimate. It assumes that a bitcoin ETP will:

- Be the third-fastest-growing ETP in history, out of more than 2,200 products with positive year-one flows

- Have an ADV/AUM ratio two times higher than that of GBTC, which competes in the same market

VI. Evaluating The Potential Impact Of ETP Trading On Prices In The CME Market

Our goal in analyzing the potential impact of trading in a bitcoin ETP is to determine if it is likely that such trading will cause the ETP to be the predominant influence on prices in the CME Market.

We believe it is unlikely that trading in the ETP will become the predominant influence on prices in the CME Market if such trading activity is substantially smaller than the trading activity on the CME bitcoin futures market, which we have demonstrated is the leading source of price discovery in the bitcoin market.[12]

The CME bitcoin futures market had an average daily trading volume of $392 million in 2020. This volume was consistently high: The lowest month, April 2020, had an average daily trading volume of $176 million, and the highest month, December 2020, had an average daily trading volume of $935 million. The table below shows the ADV of the CME bitcoin futures market each month in 2020.

Month	**CME ADV (M)**
Jan 2020	$408
Feb 2020	$401
Mar 2020	$202
Apr 2020	$176
May 2020	$305
Jun 2020	$223
Jul 2020	$252
Aug 2020	$455
Sep 2020	$397
Oct 2020	$329
Nov 2020	$665
Dec 2020	$935

Given that the average daily trading volume of the CME bitcoin futures market in 2020 was 174% higher, at $392 million, than our aggressive estimate of a new bitcoin ETP's likely trading volume of $143 million, we find it unlikely that trading in a new bitcoin ETP will cause it to

[12] Hougan, M., Kim, H., and Pal, S. Bitwise Asset Management. Price Discovery In The Modern Bitcoin Market: Examining Lead-Lag Relationships Between The Bitcoin Spot And Bitcoin Futures Market.

become the predominant influence on prices in the CME Market.

VII. Conclusion

We are fortunate that we have a number of real-world examples we can turn to when evaluating whether it is likely that a bitcoin ETP, if approved, would become the predominant influence on prices in the CME Market.

Drawing on 30 years of data on U.S. ETPs, as well as the direct experience of a publicly traded bitcoin trust that is accessible through the brokerage window, we conclude it is unlikely that a bitcoin ETP would become the predominant influence on prices in the CME Market.

Appendix A: Is A GLD-Like Rapid Launch Likely?

In evaluating whether a bitcoin ETP is likely to become the predominant influence on prices in the CME Market, it is worth considering whether such an ETP is likely to experience extraordinary demand during its initial days after listing. While most ETPs are slow to gather assets, a few have attracted significant initial interest shortly after launch.

The table below highlights the 20 largest first-week flows into U.S. ETPs in history. This represents approximately the top 1% of all U.S.-listed ETPs with non-zero one-week flows (20 out of more than 2,000). These top-1% ETPs gained between $288 million and $1.26 billion in flows in their first week on the market.

TWENTY LARGEST ONE-WEEK NET FLOWS IN ETF HISTORY

Fund	Ticker	1-Week Flows	1-Month Flows
SPDR Gold Trust	GLD	$1,264,656,000	$1,151,131,999
iShares iBoxx USD Investment Grade Corporate Bond ETF	LQD	$1,024,821,000	$1,332,271,000
iShares ESG MSCI USA Leaders ETF	SUSL	$847,058,170	$1,129,155,690
Xtrackers MSCI U.S.A. ESG Leaders Equity ETF	USSG	$843,472,000	$843,472,000
iShares 7-10 Year Treasury Bond ETF	IEF	$670,351,334	$670,351,334
iShares 20+ Year Treasury Bond ETF	TLT	$667,986,369	$667,986,369
SPDR S&P North American Natural Resources ETF	NANR	$662,433,857	$681,061,393
iShares ESG MSCI EM Leaders ETF	LDEM	$627,181,210	$627,181,210
iShares 1-3 Year Treasury Bond ETF	SHY	$593,208,629	$609,506,154
iShares Exponential Technologies ETF	XT	$568,215,100	$621,564,425
Cabana Target Drawdown 10 ETF	TDSC	$466,296,350	$490,758,650
Franklin Liberty U.S. Core Bond ETF	FLCB	$354,897,000	$757,657,000
iShares Core S&P 500 ETF	IVV	$351,825,000	$518,325,000
SPDR Russell 1000 Low Volatility Focus ETF	ONEV	$329,518,801	$329,518,801
SPDR Russell 1000 Yield Focus ETF	ONEY	$329,428,454	$329,428,454
Fidelity NASDAQ Composite Index Tracking Stock	ONEQ	$328,670,868	$328,670,868
Invesco QQQ Trust	QQQ	$324,006,804	$847,143,019
Cabana Target Drawdown 7 ETF	TDSB	$301,363,200	$322,769,800
iShares National Muni Bond ETF	MUB	$288,637,000	$328,801,000
VanEck Vectors Junior Gold Miners ETF	GDXJ	$288,356,209	$652,103,035

Source: FactSet data via ETF.com. Data as of 11/1/20.

Is a bitcoin ETP likely to experience one-week flows similar to GLD, the largest in ETP history, in its first week?

A Bitcoin ETP Is Unlikely To Experience A GLD-Style Rapid Start

It is unlikely that a bitcoin ETP will experience inflows similar to GLD in its first week on the market, for the following three reasons.

1. Bitcoin is a substantially smaller market (approximately 74% smaller) than gold was in 2004.

According to the World Gold Council, the global above-ground gold market was worth roughly $2.1 trillion when GLD debuted in 2004.[13] By comparison, the global bitcoin market was worth $539 billion as of December 31, 2020.[14]

It is unlikely that a market that is approximately 25% the size of gold would see similar levels of inflows following the debut of a new ETP.

2. Unlike GLD, U.S. retail investors already have multiple easy ways to directly purchase bitcoin.

When GLD came to market, it offered a stepwise improvement over other mechanisms for purchasing exposure to gold. Gold bullion dealers charged high markup fees, had uneven pricing, and could not be easily accessed through a brokerage setting. Meanwhile, the primary investable alternative—mutual funds that focused on gold mining stocks—was not particularly well-correlated with the price of gold itself. As such, GLD was able to tap into pent-up retail demand for easy access to gold bullion exposure.

By contrast, U.S. investors enjoy a wealth of convenient ways to access bitcoin today. Bitcoin purchases are available in the PayPal app, which is used by more than 200 million Americans.[15] Purchases can also be made through the Cash App, which boasts 24 million users worldwide,[16] or through crypto-specific apps like Coinbase, which has 35 million users worldwide.[17]

3. ***Unlike GLD, a bitcoin ETP will face stiff competition from GBTC, a $20 billion product with high levels of liquidity that can be easily accessed through a brokerage setting.***

Unlike with GLD, U.S. investors already have a large, liquid, publicly traded investment trust that offers exposure to bitcoin.

A new bitcoin ETP will face stiff competition from GBTC, which had $20 billion in assets as of December 31, 2020, and $368 million in average daily trade volume in the month of December 2020. While some investors may prefer the new ETP, others will prefer the size, liquidity, and familiarity of GBTC. It is also reasonable to assume, given the size of GBTC, that a good portion of the brokerage-access demand that would otherwise be waiting for an ETP is already being met

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[13] Gold market capitalization as of 2004 is calculated by taking the World Gold Council's estimate of above-ground gold stocks in 2004 multiplied by the price of gold as reported by Macrotrends in November 2004.
[14] Bitcoin market capitalization as of December 31, 2020 was $539 billion according to Blockchain.com.
[15] https://ventureburn.com/2020/11/2020s-biggest-crypto-news-paypal-announces-its-all-in-on-crypto/
[16] Monthly active users of Cash App from Square's Q4 2019 shareholder letter (https://s21.q4cdn.com/114365585/files/doc_financials/2019/q4/2019-Q4-Shareholder-Letter-Square.pdf).
[17] Verified user count from Coinbase's About Us page (https://www.coinbase.com/about) as of November 19, 2020.

by GBTC.

Conclusion

While there is interest in a bitcoin ETP, it is unlikely to match the level of demand experienced by GLD after its launch in 2004. The bitcoin market is approximately one-quarter the size of the gold market at that time, and any new ETP will compete indirectly with other convenient access options such as Paypal and Coinbase, and directly with an established, $20 billion, publicly traded bitcoin trust.

For these reasons, we believe it is unlikely that a bitcoin ETP will experience the kind of first-week inflows that GLD enjoyed.[18]

[18] Anecdotal evidence from historical flows into GBTC suggests that even very large flows into a bitcoin investment trust are not correlated with large price changes: GBTC had $808 million in inflows in the week ending December 27, 2020, and the weekly return of bitcoin was well within the normal distribution of bitcoin's returns (+2.8%). Therefore, even in the unlikely case that such a large inflow occurs, the evidence in the data does not suggest it would cause the ETP to become the predominant influence on prices in the CME Market.

Appendix B: Recent Experiences With Internationally Listed Bitcoin ETPs

Bitcoin exchange-traded products have been approved in certain overseas jurisdictions, including Brazil, Canada, Broader Europe, Sweden, and Switzerland. The exact structure of each ETP varies by jurisdiction, as does the regulatory process and the local ETP marketplace.

In the following section, we analyze the experience and reception of bitcoin ETPs in the two largest markets—Broader Europe and Canada—to consider if they may be helpful in determining whether it is likely that a bitcoin ETP, if approved in the U.S., is likely to become the predominant influence on prices.[19]

ETC Group Physical Bitcoin ETP (BTCE): The First Bitcoin ETP In Broader Europe

The ETC Group Physical Bitcoin ETP (BTCE) launched on June 8, 2020 on the Xetra exchange in Germany. The fund was the first bitcoin ETP widely available for sale throughout Europe, and is currently eligible for sale in 20 countries in the region.[20] [21]

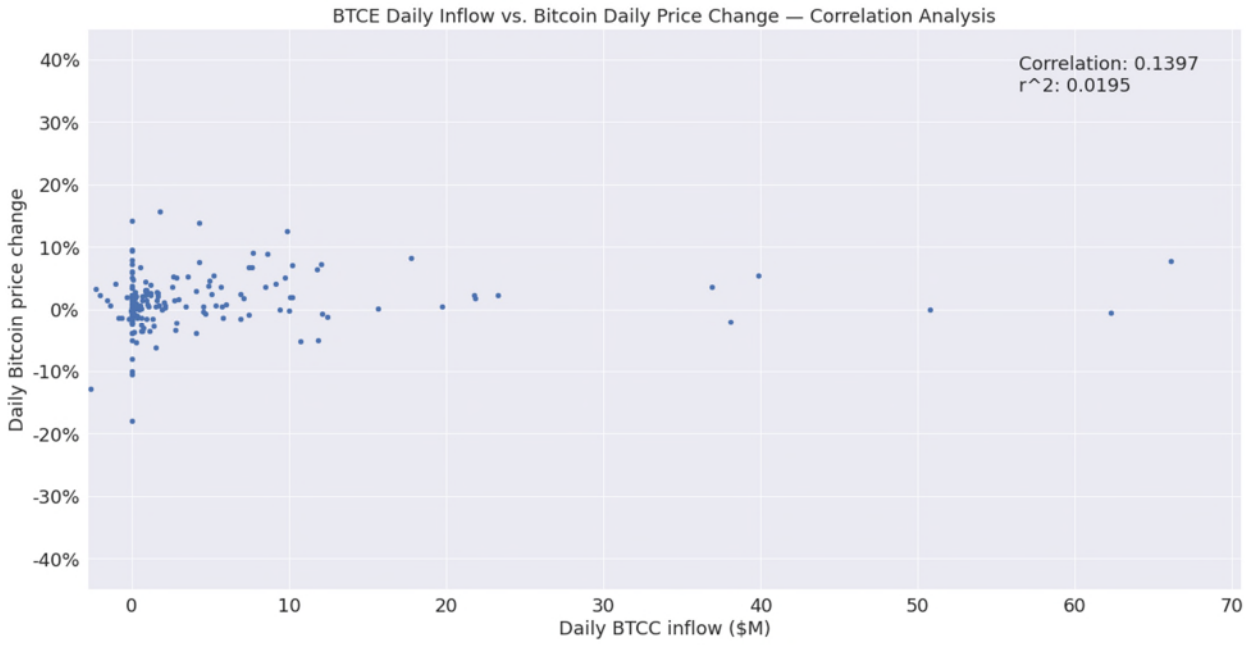
The fund is issued by ETC Group, and is marketed and distributed by HANetf. The fund custodies bitcoin with BitGo Trust Company.[22] As a European ETP, BTCE's create/redeem procedure differs somewhat from the traditional create/redeem procedure for U.S. ETFs. Nonetheless, the pass-through impact on the underlying market remains similar.

BTCE utilizes authorized participants to create new shares, which are debt securities tied to the value of underlying bitcoin assets, which are held as collateral against the debt obligation. Authorized participants may subscribe for shares on a principal basis or for their institutional and/or retail customers. According to the registration statement for BTCE, authorized participants may create shares by delivering bitcoin to the fund pursuant to a subscription order, which shares may immediately be sold into the secondary market to capture any secondary market premium to net asset value. Authorized participants must acquire bitcoin before delivery

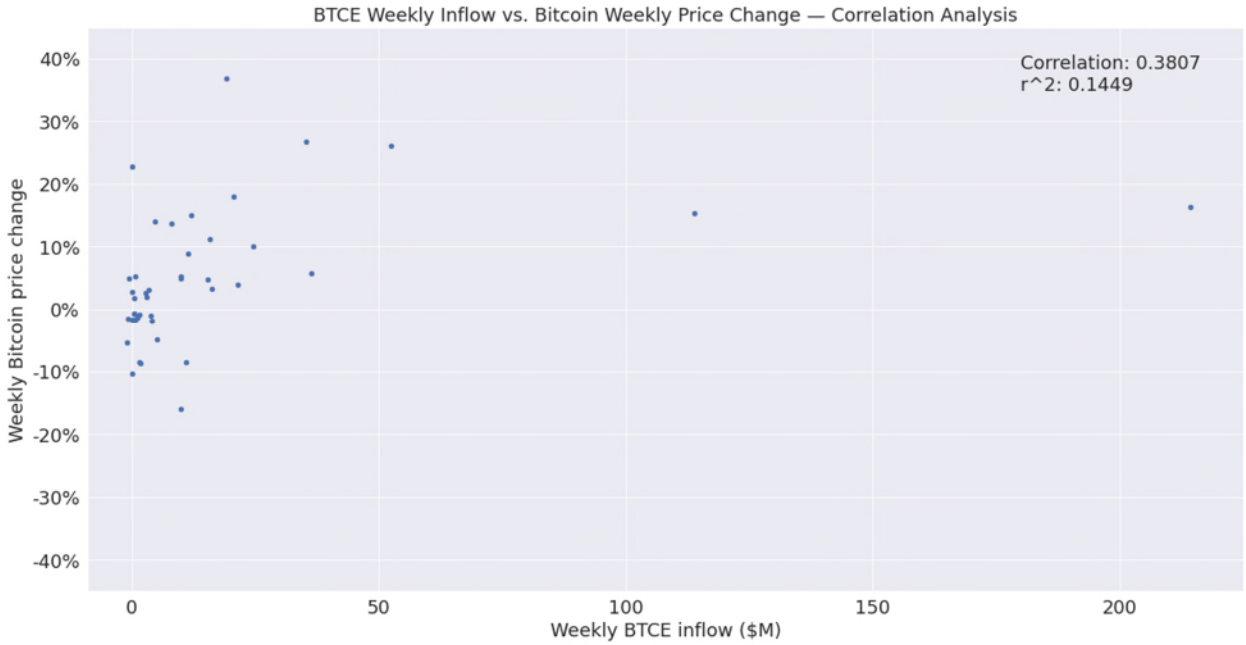
[19] This analysis was conducted at a later date than the other portions of the paper, and therefore has been extended to included data through March 31, 2021.
[20] The fund is listed in Germany and is registered for sale in 20 different countries: Austria, Croatia, Cyprus, Denmark, Estonia, Finland, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Norway, Poland, Malta, Slovakia, Slovenia, Spain, Switzerland, and the United Kingdom. (https://www.hanetf.com/product/8/fund/btcetc-bitcoin-exchange-traded-crypto-btce)
[21] BTCE is generally considered the first widely available bitcoin ETP in Europe. However, there were other products with distribution restrictions that launched before it. For instance, the Bitcoin Tracker One is a bitcoin-tracking certificate that listed on NASDAQ/OMX in Stockholm in 2015. Additionally, the 21Shares Bitcoin ETP debuted on the Six Swiss Exchange in 2019. While noteworthy and important, these products did not have the immediate, broad availability of BTCE, and experienced slower growth, making them less relevant for this comparison.
[22] More information is available from the fund page: https://www.hanetf.com/product/8/fund/btcetc-bitcoin-exchange-traded-crypto-btce

thereof in settlement of the share subscription. The fund does not permit primary market cash subscriptions, although authorized participants may receive cash from institutional or retail customers to facilitate or settle trades where the authorized participant acquires bitcoin for primary market creation activity.

From inception through March 31, 2021, BTCE had net inflows of $689 million.[23] As we did with GBTC, we are able to plot these inflows on a daily and weekly basis against changes in the price of bitcoin:



[23] Data pulled from Bloomberg.



The data shows there is no meaningful relationship between flows into BTCE and changes in the price of bitcoin over the time period studied. The correlations are lower than 0.5 (0.14 for the daily correlation and 0.38 for the weekly correlation), and as indicated by the R-squareds, the explanatory strength of these relationships are weak.

An examination of the outlier days/weeks of high inflows support this view: The two highest inflow days, for instance, occurred on February 17 and 18, when BTCE saw $66 million and $62 million in net flows, respectively. Bitcoin's price rose 7.7% on the 17th and fell 0.5% on February 18. Both returns were within the normal distribution of returns for this time period.

Canada: Purpose Bitcoin ETF (BTCC)

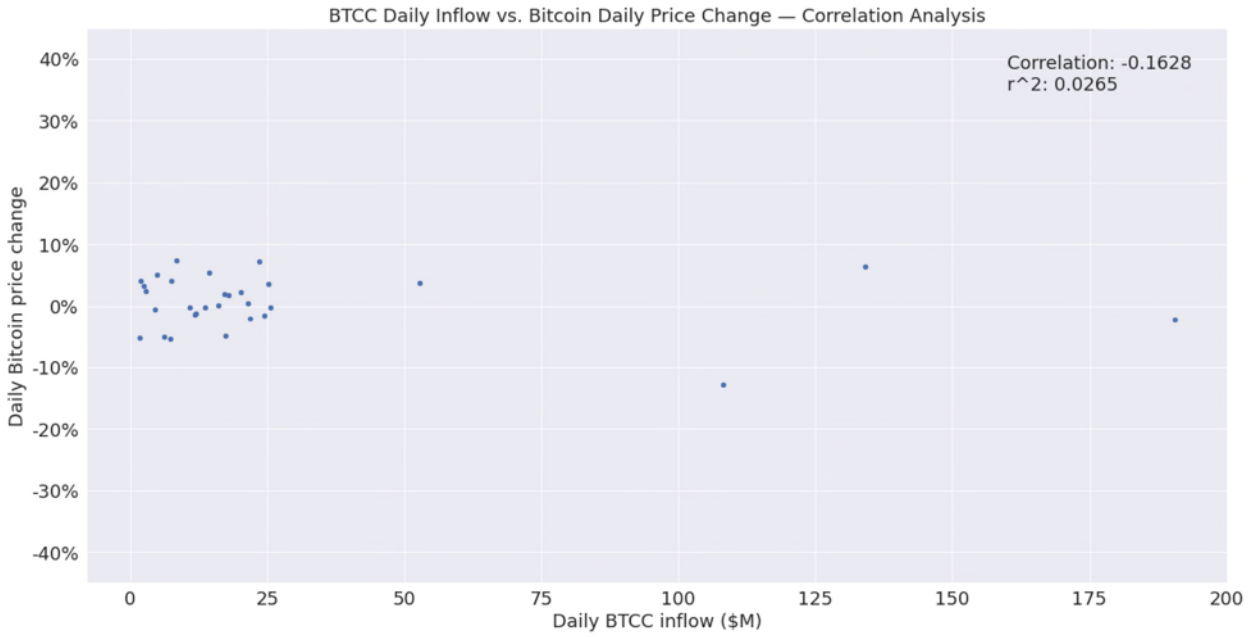
The Purpose Bitcoin ETF (BTCC) launched on the TSX Venture Exchange in Canada on February 18, 2021. It was the first bitcoin ETP launched in Canada.

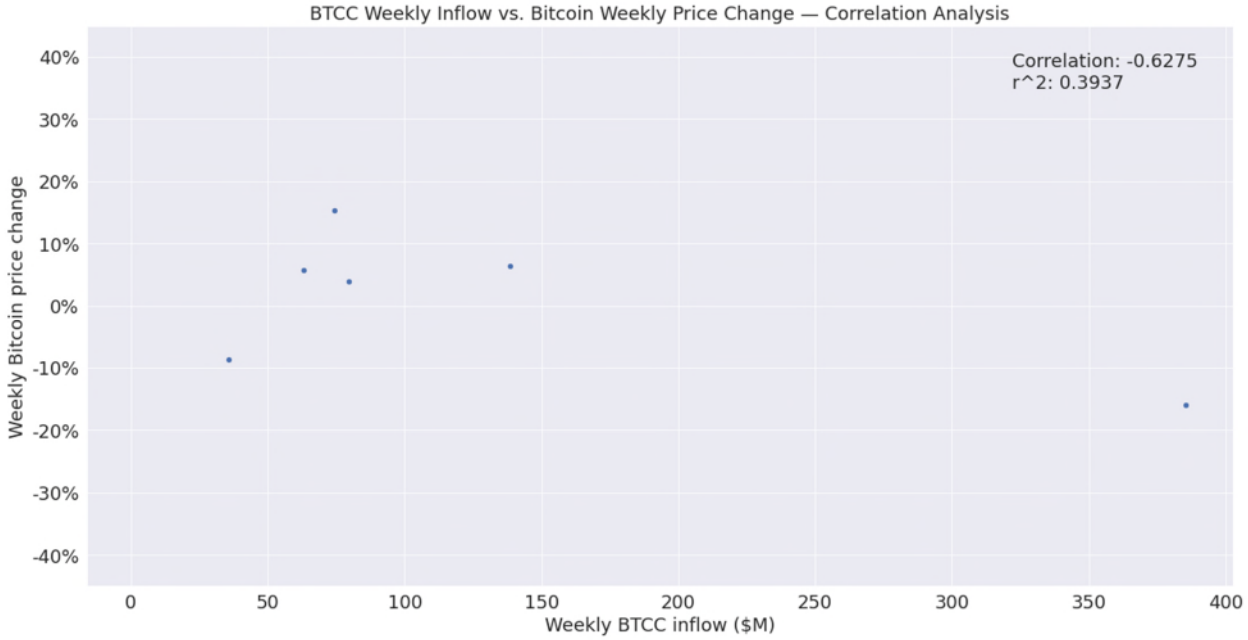
The fund is managed by Purpose Investments. It custodies bitcoin with Gemini.[24] BTCC utilizes authorized participants to create new shares, which are securities representing beneficial interests in underlying bitcoin held by the fund. Authorized participants may subscribe for shares on a principal basis or for their customers. According to the registration statement for BTCC, authorized participants may create shares by placing a creation order, with delivery of cash and issuance of shares on the second business day after order acceptance. Subsequent to receipt of cash, the fund will issue shares to the authorized participant and acquire bitcoin on a best

[24] More information available from fund page: https://www.purposeinvest.com/funds/purpose-bitcoin-etf

execution basis from its authorized trading venues. The fund does not permit in-kind subscriptions.

From inception through March 31, 2021, BTCE had net inflows of $826 million.[25] As we did with GBTC and BTCE, we are able to plot BTCC's inflows on a daily and weekly basis against changes in the price of bitcoin:





[25] Data pulled from Bloomberg.

These are very short sample periods, covering just 30 trading days and six weekly periods. Nonetheless, the charts show no meaningful relationship between daily or weekly flows into BTCC and daily or weekly changes in the price of bitcoin. The correlations are -0.16 for daily flows and -0.63 for weekly flows.

Of note, BTCC experienced three days of very high flows shortly after its launch: The fund took in $134 million on February 19, $191 million on February 22, and $108 million February 23. The returns of bitcoin on those days may be instructive for considering the potential impact of large inflow days should those materialize shortly after the launch of a bitcoin ETP in the U.S.: Bitcoin rose 6.34% on February 19, fell 2.18% on February 22, and fell 12.88% on February 23. For the three-day period, during which the fund brought in $433 million, bitcoin's price fell 9.38%. This suggests that even high inflows did not cause BTCC to be the predominant influence on the prices in the CME Market on these days.

Conclusion

The experience of bitcoin ETPs in overseas jurisdictions provides additional context for considering whether a U.S. bitcoin ETP, if approved, is likely to become the predominant influence on prices in the CME Market. The data shows, at least in an anecdotal fashion, that even substantial inflows into newly launched ETPs have not correlated with changes in the price of bitcoin in a statistically significant fashion.