



BTC SPOT PRICE DISCOVERY UPDATE - Q1 2021

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SUMMARY

- **Q1 2021** update of DAR's public lead-lag study, evaluating price discovery in the **BTC spot market** using volatility events. See [Appendix 1](#) for links to prior reports.
- **170 exchanges** were included and **181 Volatility Events** were analyzed.
- Includes **18 Vetted Exchanges** and **12 Watchlist Exchanges**.
- Watchlist Exchanges were price leaders **47.42%** of the time and Vetted Exchanges were price leaders **30.95%** of the time.
- In Q1 2020, **81.29%** of the time a Vetted or Watchlist Exchange was in the top 3 exchanges to lead price discovery.
- In Q1 2021, Disqualified Exchanges gained close to 10% of price leadership share over Watchlist and Vetted Exchanges compared to the Q4 2020 period. This is partly because DAR expanded the analyzed exchange universe from 111 to 170 exchanges.
- Please contact DAR for analysis of other crypto asset markets.

OVERVIEW

One concern in the lightly regulated digital asset market is where price discovery happens. DAR's lead-lag study intends to help illuminate and show where price formation is occurring in the Bitcoin spot market. Each quarter, DAR looks at distinct moments of price volatility and, for each of those moments, determines which exchanges were first to experience that event (lead) and which exchanges followed (lag).

METHODOLOGY RECAP

DAR uses a multistep quantitative process inspired by multiple academic papers^[1] to measure the lead-lag relationship of Bitcoin trading between various spot exchanges. DAR looks for volatility events, defined as a change in the price of Bitcoin by more than \$100 in a 5.5-minute window. For each volatility event, DAR determines the correlation value between each exchange that experienced that event. The exchange's reported trades in that time window are then incrementally shifted forward and backward in time. The relative time shift needed to reach the highest possible correlation value indicates which exchange experienced the volatility event first and which reflected that price discovery after. For a full discussion of the methodology, please refer to the [initial study](#).

There are multiple methods to assess lead-lag relationships and this method is by no means the only applicable one.

Exchange Vetting

DAR uses a vetting methodology that looks at both quantitative and qualitative criteria to classify exchanges into the following categories: Vetted, Watchlist and Disqualified. Vetting results are updated each quarter. A full vetting methodology is available from DAR upon request.

Vetted Exchanges have passed all quantitative and qualitative criteria. These are the most trustworthy exchanges that are not known to report inflated volumes and have robust policies and practices in place to prevent manipulative practices by clients.

Watchlist Exchanges have passed only DAR's preliminary vetting, which includes data science testing and some qualitative diligence. These exchanges are not known to report inflated volumes or have manipulated trades but may not have the institutional policies and practices in place in order to prevent future manipulation and to pass full vetting.

Disqualified Exchanges fail to meet the requirements of our vetting process, failing data science tests for manipulation, qualitative diligence, or a liquidity threshold.

¹ de Jong, F.C.J.M. & Donders, M.W.M., 1996. "Intraday Lead-Lag Relationships between the Futures-, Options and Stock Market," Discussion Paper 1996-108, Tilburg University, Center for Economic Research; de Jong, Frank & Nijman, Theo, 1997. "High frequency analysis of lead-lag relationships between financial markets," Journal of Empirical Finance, Elsevier, vol. 4(2-3), pages 259-277, June; Kawaller, Ira G & Koch, Paul D & Koch, Timothy W, 1987. "The Temporal Price Relationship between S&P 500 Futures and the S and P 500 Index," Journal of Finance, American Finance Association, vol. 42(5), pages 1309-1329, December.

RESULTS

This quarter, 170 exchanges were included in the study and 181 volatility events were analyzed. For each event, the first 5 exchanges to experience the event are considered “Price Leaders” for that event. The exchanges listed in Figure A appeared as Price Leaders in Q1 2021.

FIGURE A - BTC PRICE LEADER TALLY

Vetted	
Exchange	Price Leader Appearances
VCC Exchange	132
Liquid	95
Coincheck	55
Bitstamp	12
Coinbase	7
Bitfinex	5
Luno	3
Gemini	3
bitFlyer	2
Bittrex	1
Zaif	1
Kraken	1

Watchlist	
Exchange	Price Leader Appearances
Huobi	171
Binance	170
ZB.com	49
HBTC	42
Gate.io	15
Bitrue	9
CoinTiger	8
OceanEx	3
BEQUANT	2
HitBTC	2
LATOKEN	1
HBTC	1
LakeBTC	1

Disqualified	
Exchange	Price Leader Appearances
OKEx	131
Bithumb	44
Coinone	22
KuCoin	20
Goku	16
MXC	14
CBX	13
BigONE	12
Bitubu	10
Omgfin	10
Bibox	9
Vindax	8
YoBit	8
EXX	7
Korbit	7
Mercado Bitcoin	6
Coinmate	6
STEX	6
Bitmart	5
ZebPay	5
CoinHe	5
AscendEX (BitMax)	5
Bitci	5
The Rock Trading	4
BitoPro	4
CoinJar	3
GoPax	3
C2CX	3
Bidesk	3
GDAC	3
Krytono	3
AlterDice	3
CoinEgg	2
Cryptology	2
WhiteBIT	2
RightBTC	2
FTX.US	2
ZBG	2
Bitasset	2
Exrates	2
Coinfield	1
ProBit	1
Indodax	1
Coinzo	1
Max Maicoin	1
LBank	1
Cat.Ex	1
Simex	1
Tidex	1
Lucent	1

Source: Digital Asset Research

This quarter, Watchlist Exchanges were price leaders **47.42%** of the time and Vetted Exchanges were price leaders **30.95%** of the time.

FIGURE B - TOP 10 PRICE LEADER APPEARANCES

Figure B shows the 10 most frequent Price Leaders for each quarter going back to Q2 of 2020, with “n” representing the number of volatility events analyzed in that quarter.

Exchange	Price Leader Appearances
Liquid	10
Bitstamp	9
Huobi	8
Huobi Russia	8
Binance	5
TagZ	5
BEQUANT	5
HitBTC	5
Coinbase	4
KuCoin	3

Q2 2020 Price Leader Appearances (n=15)

Exchange	Price Leader Appearances
Binance	18
Huobi	16
OKEx	16
Liquid	13
Bitstamp	11
BEQUANT	6
HitBTC	6
HBTC	4
Cat.Ex	4
MXC	3

Q3 2020 Price Leader Appearances (n=21)

Exchange	Price Leader Appearances
Huobi	166
Liquid	150
Binance	145
VCC Exchange	93
ZB.com	69
Bitstamp	60
KuCoin	55
Bithumb	52
BEQUANT	49
HitBTC	43

Q4 2020 Price Leader Appearances (n=181)

Exchange	Price Leader Appearances
Huobi	171
Binance	170
VCC Exchange	132
OKEx	131
Liquid	95
Coincheck	55
ZB.com	49
Bithumb	44
HBTC	42
Coinone	22

Q1 2021 Price Leader Appearances (n=181)

Vetted

Watchlist

Disqualified

Source: Digital Asset Research

See [Appendix 3](#) for a list of exchange participation by quarter. Not all exchanges have been considered each quarter.

Figure C, below, shows the number of times each of the 10 most frequent Price Leaders were first, second, third, fourth, or fifth, to experience a volatility event. Out of the top ten Price Leaders, Vetted or Watchlist Exchanges were first to experience the event **78.38%** of the time, and **81.29%** of the time a Vetted or Watchlist Exchange was in the top 3 exchanges to lead price discovery.

FIGURE C - FREQUENCY OF APPEARANCES

Exchange	Number of Times Ranked				
	First	Second	Third	Fourth	Fifth
Huobi	60	49	36	17	9
Binance	58	52	30	20	10
VCC Exchange	45	40	20	19	8
OKEEx	1	29	38	29	34
Liquid	7	6	23	27	32
Coincheck	5	6	8	14	22
ZB.com	3	5	10	22	9
Bithumb	8	12	6	6	12
HBTC	1	4	10	15	12
Coinone	5	5	6	0	6



Vetted



Watchlist



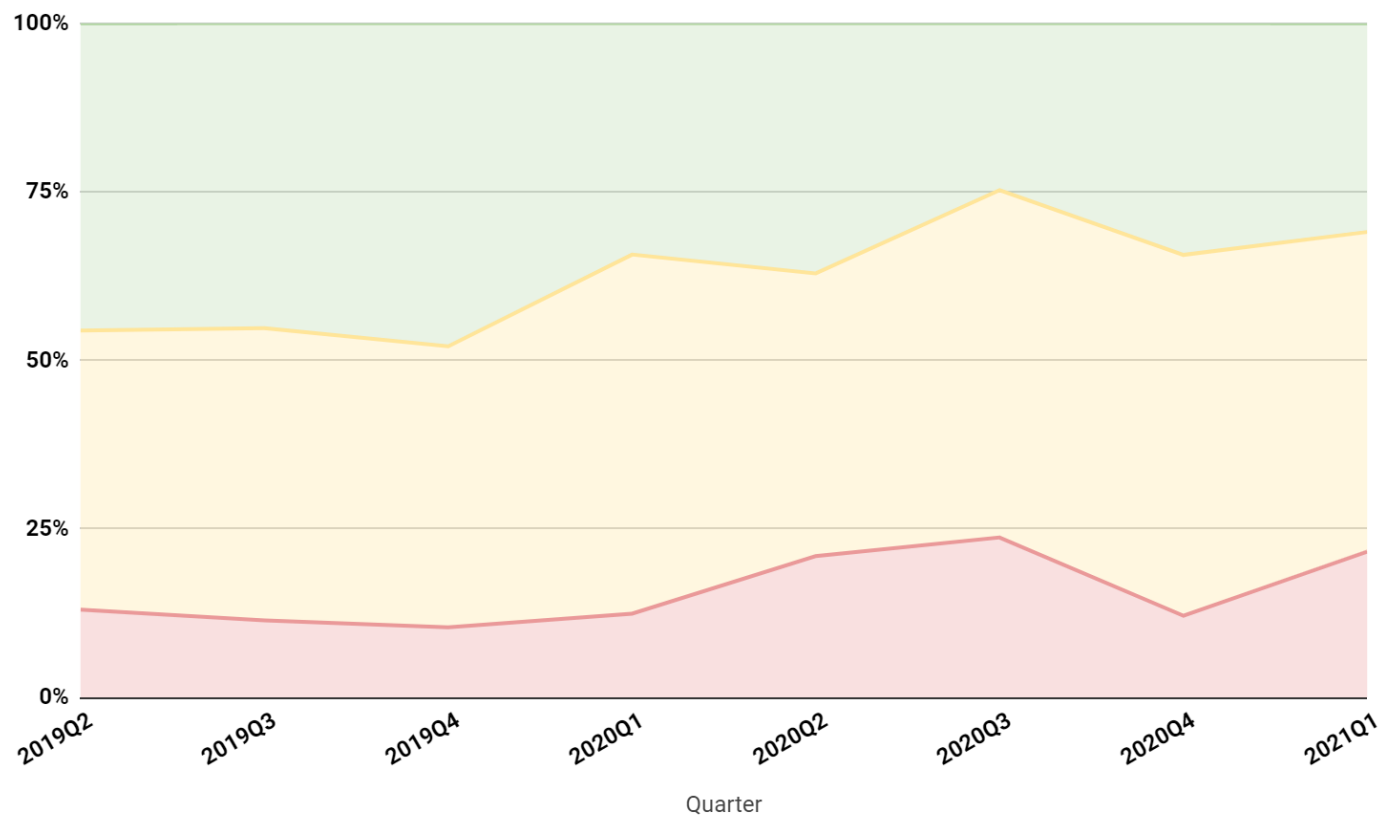
Disqualified

Source: Digital Asset Research

HISTORICAL COMPARISON

Figure D shows the breakdown of volatility events amongst Vetted, Watchlist, and Disqualified exchanges for each quarter going back to Q2 of 2019.

FIGURE D - QUARTERLY COMPARISONS



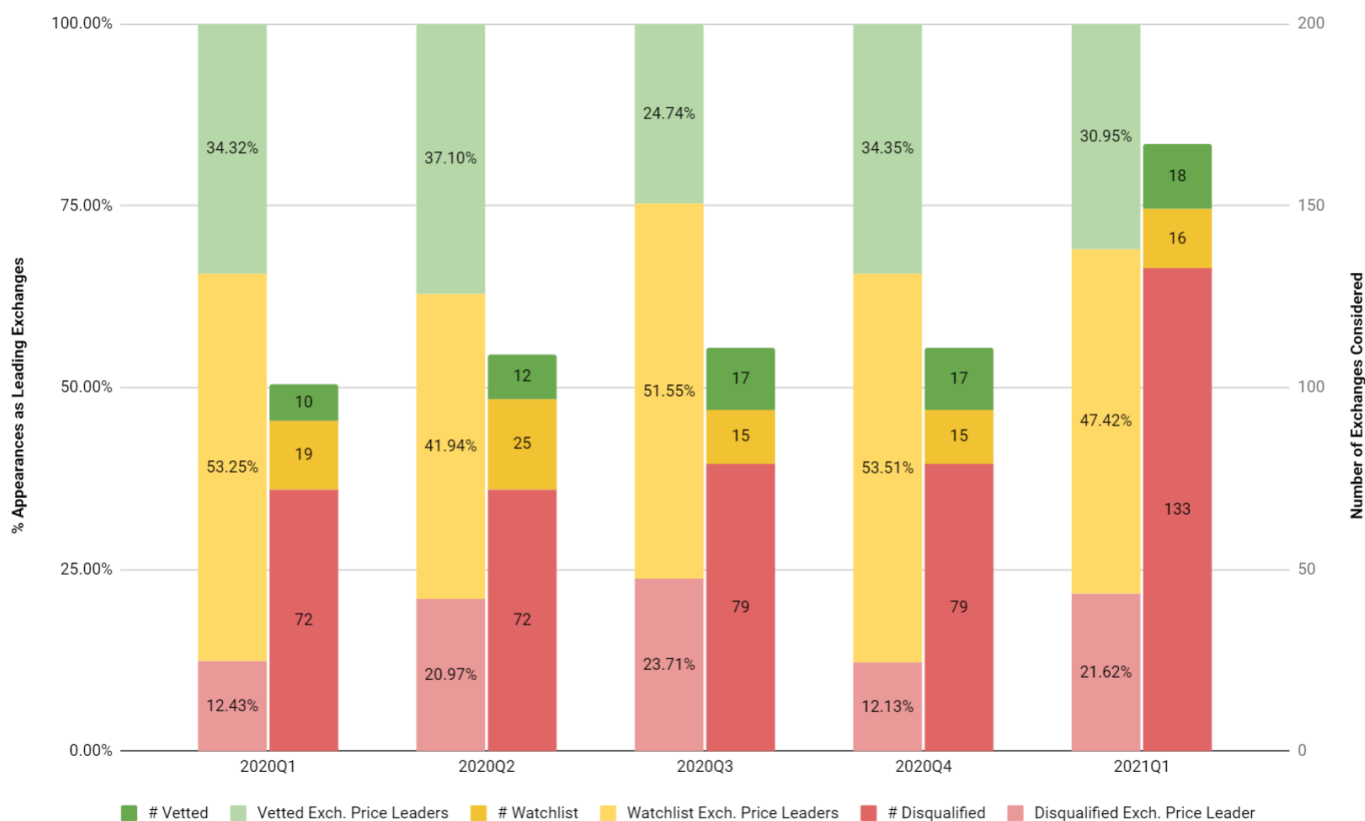
*See [Appendix 3](#) for quarterly exchange participation. Not all exchanges have been evaluated in all quarters.



Source: Digital Asset Research

Although each quarter has seen different Price Leaders, the lead-lag test results from the past four quarters showed a relatively stable distribution of Price Leaders between Vetted, Watchlist, and Disqualified exchanges. In Q1 2021, Disqualified Exchanges gained close to 10% over Watchlist and Vetted Exchanges. This is because the universe of Disqualified Exchanges increased significantly from Q4 2020 to Q1 2021.

FIGURE E - PRICE LEADERS DISTRIBUTION



*Figure E does not include perpetuals. Exchanges were added or removed according to DAR's methodology. See [Appendix 3](#) for quarterly exchange participation.

*The percentages show the distribution of price leaders and the numerical values show the number of exchanges assessed in each category over time.

Source: Digital Asset Research

PERPETUALS

In digital asset markets, derivatives, including perpetual products, increasingly play an important role within the trading ecosystem. DAR's Q1 2021 Lead-Lag study included 5 of the market's largest Bitcoin perpetual products.

Please contact DAR for price discovery analysis in other derivative markets and for other contract types.

FIGURE F - TOP 10 PRICE LEADERS PERPETUAL COMPARISON

Exchange	Price Leader Appearances
Huobi	171
Binance	170
VCC Exchange	132
OKEx	131
Liquid	95
Coincheck	55
ZB.com	49
Bithumb	44
HBTC	42
Coinone	22

*Q1 2021 Price Leader Appearances
Without Perpetuals*

Exchange	Price Leader Appearances
Binance	172
Huobi	170
VCC Exchange	132
OKEx	129
Liquid	92
Coincheck	52
ZB.com	49
HBTC	44
Bithumb	43
Coinone	22

*Q1 2021 Price Leader Appearances
With Perpetuals*

Perpetual	
Exchange	Price Leader Appearances
Deribit^P	6
Okex^P	5
Binance^P	1
Bybit^P	0
BitMEX^P	0

Vetted

Watchlist

Disqualified

Perpetual

Source: Digital Asset Research

1.0 Prior Lead-Lag Reports

- An Analysis of Price Discovery in Bitcoin Spot Markets ([Initial Report](#))
- BTC Spot Price Discovery Update [Q1 2020](#)
- BTC Spot Price Discovery Update [Q2 2020](#)
- BTC Spot Price Discovery Update [Q3 2020](#)
- BTC Spot Price Discovery Update [Q4 2020](#)

2.0 Volatility Event Example Analysis

Figure G shows an example of a volatility moment that happened on 22 February 2021. The red line shows the price of Bitcoin across all exchanges in this study during the time period and the black line is the polynomial used to test the volatility moment. The full green rows on the heat map in Figure H show that Korbit led other exchanges during this specific volatility event.

FIGURE G - VOLATILITY MOMENT 22-FEB-2021 16:10:20

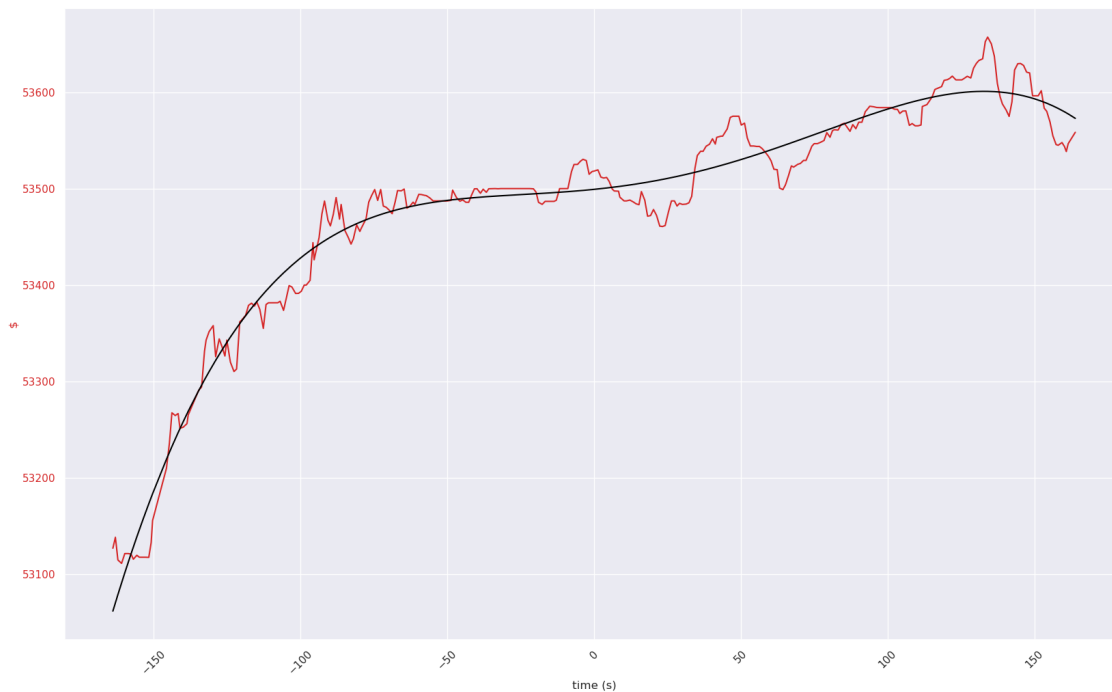


FIGURE H - EXCHANGE HEATMAP 22-FEB-2021 16:10:20

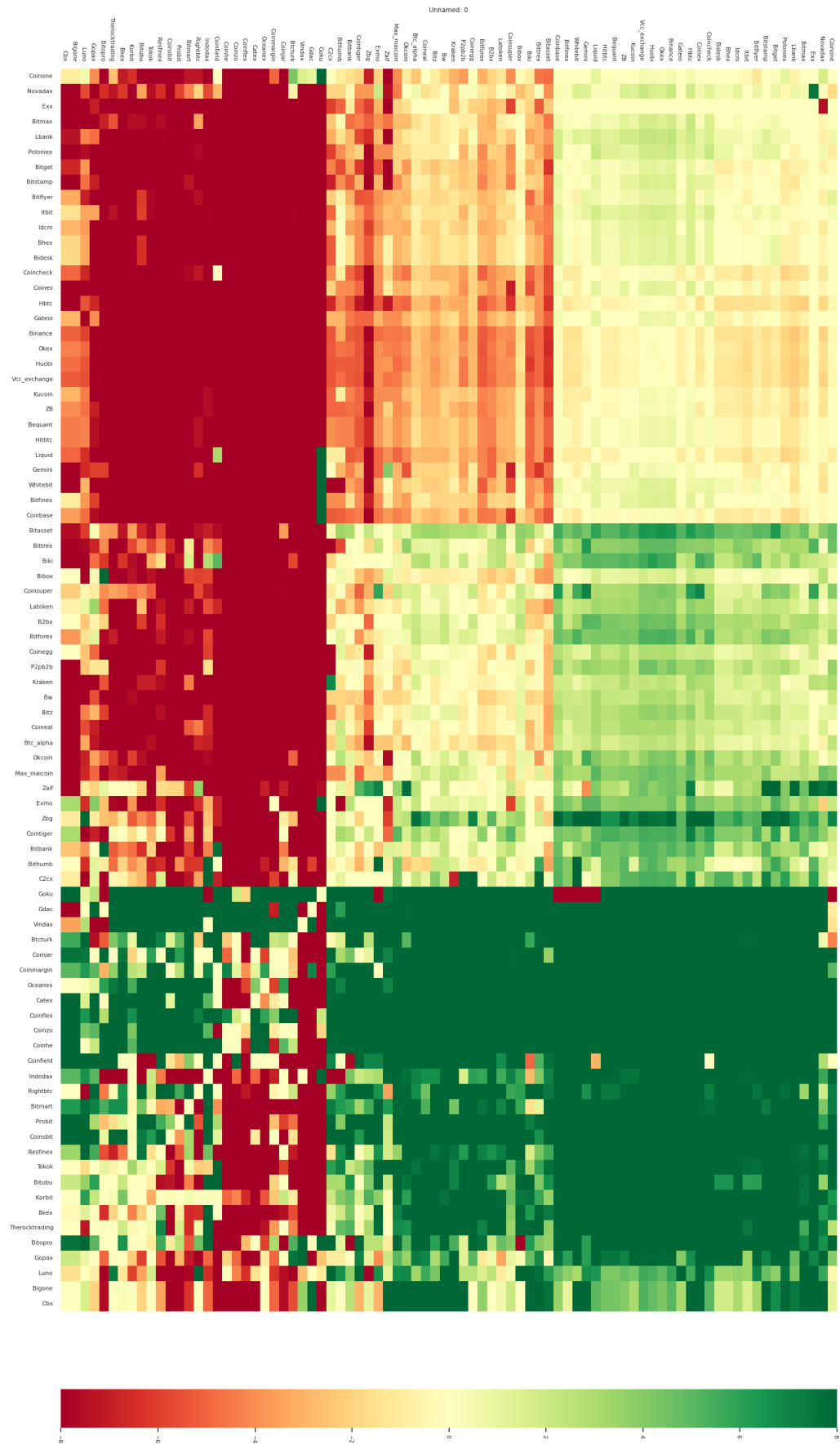
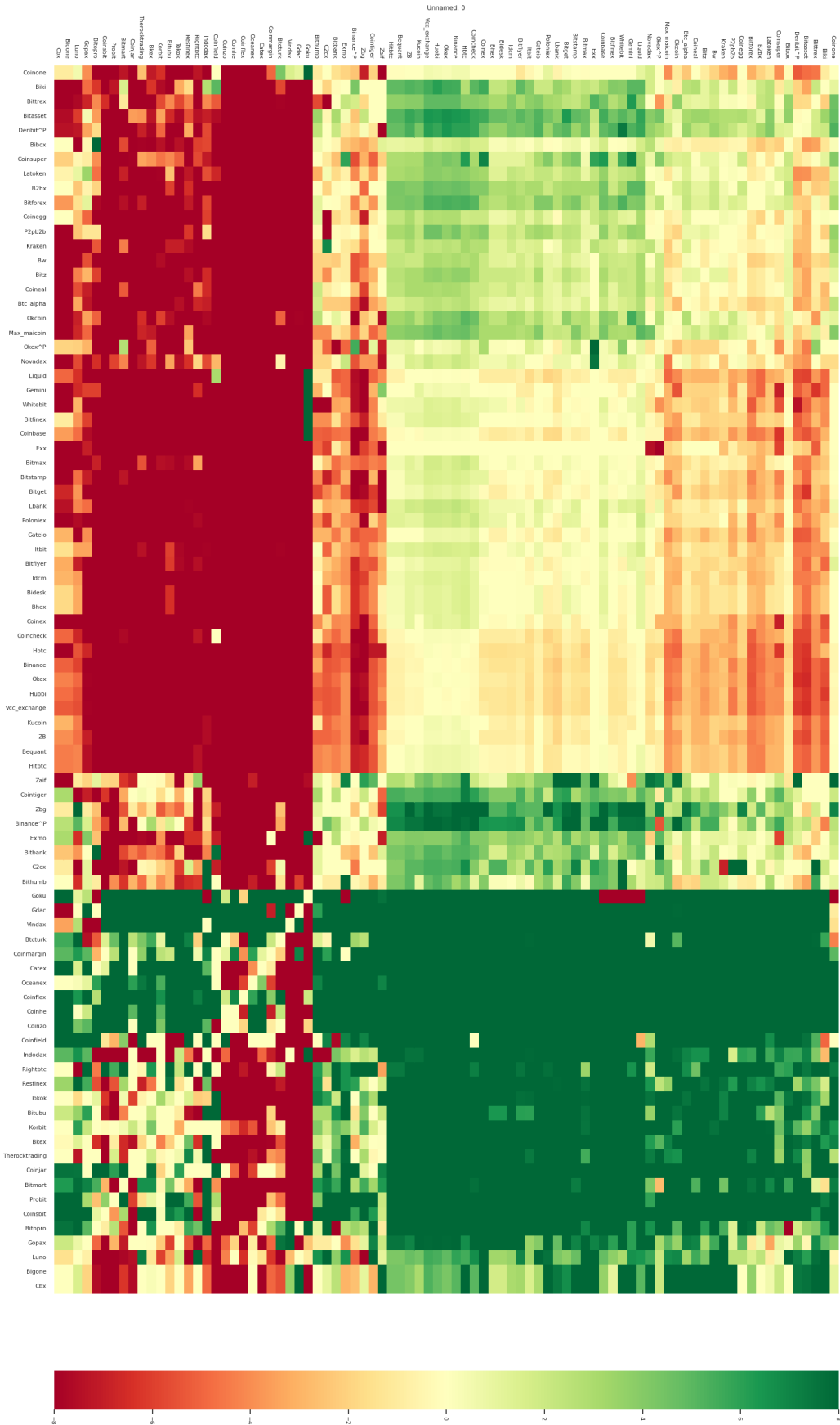


FIGURE I - EXCHANGE HEATMAP 22-FEB-2021 16:10:20 WITH PERPETUAL



3.0 Lead-Lag Exchange Universe

Exchange	Q1 2021	Q4 2020	Q3 2020	Q2 2020	Q1 2020
Aax	x				
Alterdice	x	x	x	x	
Atomars	x				
B2BX	x				
BBX	x	x	x	x	x
BCEX	x	x	x	x	x
Beaxy	x				
BEQUANT	x	x	x	x	x
BHEX (HBTC)	x	x	x	x	x
Bibox	x	x	x	x	x
Bidesk	x				
BigONE	x	x	x	x	x
Biki	x	x	x	x	x
Bilaxy	x	x	x	x	x
Binance	x	x	x	x	x
Binance US	x	x	x	x	
Binance^P	x	x	x	x	
Bitasset	x	x	x	x	x
BitBank	x	x	x	x	x
Bitbay	x	x	x	x	
Bitci	x				
Bitcoin.com	x				
BITFRONT	x				
Bitfinex	x	x	x	x	x
BitFlyer	x	x	x	x	x
Bitforex	x	x	x	x	x
Bitget	x				
Bithash	x				
Bithumb	x	x	x	x	x
Bithumb Global	x				
Bitkub	x				
BitMart	x	x	x	x	x
Bitmax	x	x	x	x	x
BitMEX^P	x	x	x	x	
Bitoffer	x				
Bitopro	x				
Bitrue	x	x	x	x	x
Bitso	x	x	x	x	x
Bitstamp	x	x	x	x	x
Bittrex	x	x	x	x	x
Bitubu	x	x	x	x	x
BitZ	x	x	x	x	x
BKEX	x	x	x	x	x
Bleutrade	x	x	x	x	x
BTC-Alpha	x	x	x	x	x
BTC Markets	x	x	x	x	x
BTCBox	x	x	x	x	x
BTCTurk	x	x	x	x	x
BTSE	x				
BW	x	x	x	x	x

Vetted

Watchlist

Disqualified

Perpetual

Not Included

Exchange	Q1 2021	Q4 2020	Q3 2020	Q2 2020	Q1 2020
BybitAP	x	x	x	x	
C2CX	x	x	x	x	x
Cat.Ex	x	x	x	x	x
CBX	x	x	x	x	x
CCX Canada	x	x	x	x	
Cexio	x	x	x	x	x
Chaoex	x	x	x	x	x
Coinall		x	x	x	
Coinbase	x	x	x	x	x
Coinbene	x				
Coinbig	x				
Coincheck	x	x	x		
Coineal	x	x	x	x	x
Coinegg	x	x	x	x	x
Coinex	x	x	x	x	x
Coinfield	x	x	x	x	x
Coinhe	x	x	x	x	x
Coinmate	x	x	x	x	x
Coinmex	x	x	x	x	x
Coinone	x	x	x	x	x
Coinsbank	x	x	x	x	x
Coinsbit	x	x	x	x	x
Coinsuper	x	x	x	x	
CoinTiger	x	x	x	x	x
Coinflex	x				
Coinjar	x				
Coinmargin	x				
Coinpark	x				
Coinzo	x				
Citex	x				
CrossTower	x				
Cryptology	x	x	x	x	x
Decoin	x				
DeribitAP	x	x	x	x	
Dextrade	x				
Digifinex	x	x	x		x
DSX	x	x	x	x	x
ExMarkets	x				
EXMO	x	x	x	x	x
Exrates	x	x	x	x	x
ExtStock	x				
EXX	x	x	x	x	x
Fifty Five	x	x	x	x	x
Folgory	x				
FTX Spot	x				
FTX.US	x				
Gate.io	x	x	x	x	x
GDAC	x	x	x	x	x
Gemini	x	x	x	x	x
GMO Coin Co.	x				
Goku	x				
GOPAX	x	x	x	x	x
Hb.top	x				
Hcoin	x	x	x	x	x
HitBTC	x	x	x	x	x
Hoo	x				
Hopex	x				
Huobi	x	x	x	x	x
Huobi Korea	x				
Huobi Russia	x	x	x	x	x

Exchange	Q1 2021	Q4 2020	Q3 2020	Q2 2020	Q1 2020
IDAX	x	x	x	x	
IDCM	x	x	x	x	x
Indodax	x	x	x	x	x
Indoex	x				
itBit	x	x	x	x	x
KKCoin	x				
Korbit	x	x	x	x	x
Kraken	x	x	x	x	x
Kryptono	x	x	x	x	x
KuCoin	x	x	x	x	x
LakeBTC	x	x	x	x	x
LATOKEN	x	x	x	x	x
LBANK	x	x	x	x	x
Liquid	x	x	x	x	x
Livecoin	x	x	x	x	x
LMAX	x	x	x	x	x
Lucent	x				
Luno	x	x	x	x	x
Max Maicoi	x				
Mercado Bitcoin	x	x	x	x	x
Mercatox	x	x	x	x	
MXC	x	x	x	x	x
Novadax	x				
OceanEx	x	x	x	x	x
OKCoin	x	x	x	x	x
OKEx	x	x	x	x	x
OKExAP	x	x	x	x	
OMGFIN	x	x	x	x	x
p2pb2b	x	x	x	x	x
Phemex	x				
Poloniex	x	x	x	x	x
Probit	x	x	x	x	x
Resfinex	x				
RightBTC	x	x	x	x	x
Simex	x	x	x	x	x
Sistemkoin	x	x	x	x	x
SouthXchange	x				
STEX	x	x	x	x	x
TagZ	x	x	x	x	x
TheRockTrading	x	x	x	x	x
Tidebit	x	x	x	x	x
Tidex	x	x	x	x	x
Tokenize	x				
Tokok	x	x	x	x	x
Upbit	x	x	x	x	x
VB	x				
VCC Exchange	x	x	x	x	x
Vebitcoin	x				
Velic	x				
Vindax	x	x	x	x	x
WazirX	x				
whiteBIT	x	x	x	x	x
XT	x				
YoBit	x	x	x	x	
Yunex	x				
Zaif	x	x	x	x	x
ZB.com	x	x	x	x	x
ZBG	x	x	x	x	x
ZebPay	x				
ZG	x				

4.0 Definitions

Terminology Definitions	
Disqualified Exchanges*	Digital Asset Exchanges that fail to meet the vetting process requirements, including failing data science tests for manipulation, qualitative diligence, or a liquidity threshold.
Know Your Customer (KYC)	A process implemented by financial services firms to verify customers' identities in order to identify and prevent market manipulation and other fraudulent activities.
Lead-Lag Relationship	A means to determine where price formation occurs by looking at the correlation of price movements between exchanges during a specific time window, and determining which exchange(s) saw the price movement first (lead) and which saw the price movement at a later time (lag).
Price Leaders	Digital asset exchanges that were among the first 5 exchanges to experience price movement in a single volatility event.
Vetted Exchanges*	Digital Asset Exchanges that have passed all of DAR's quantitative and qualitative criteria. These are the most trustworthy exchanges that are not known to report inflated volumes and have robust policies and practices in place to prevent manipulative behavior by customers.
Volatility Events	A change in the price of bitcoin of more than \$100 in either direction within a 5.5-minute window, identified by looking at trades on a 30 second rolling basis. Qualifying events are also filtered by shape and must-see price movement in both directions.
Watchlist Exchanges*	Digital Asset Exchanges that have passed only DAR's preliminary vetting, which includes data science testing and some qualitative diligence. These exchanges are not known to report inflated volumes or have manipulated transactions but may not have institutional policies and practices in place in order to prevent future manipulation and pass full vetting.

***Contact DAR for full details on our vetting criteria and process**

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