



## BTC SPOT PRICE DISCOVERY UPDATE - Q2 2021

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### SUMMARY

- **Q2 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.
- **171 exchanges** were included and **103 Volatility Events** were analyzed.
- Includes **22 Vetted Exchanges** and **18 Watchlist Exchanges**.
- Watchlist Exchanges were price leaders **48.59%** of the time and Vetted Exchanges were price leaders **19.31%** of the time.
- In Q2 2021, **73.82%** of the time a Vetted or Watchlist Exchange was in the top 3 exchanges to lead price discovery.
- In Q2 2021, Disqualified Exchanges gained close to 10% of price leadership share over Vetted Exchanges compared to the Q1 2021 period.
- 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 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<sup>[1]</sup> 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.

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<sup>1</sup> 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, 172 exchanges were included in the study and 103 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 Q2 2021.

**FIGURE A - BTC PRICE LEADER TALLY**

Vetted		Watchlist		Disqualified		Disqualified	
Exchange	Price Leader Appearances	Exchange	Price Leader Appearances	Exchange	Price Leader Appearances	Exchange	Price Leader Appearances
VCC Exchange	42	Binance	92	Huobi Korea	53	BTCBOX	2
Liquid	27	Huobi	68	OKEx	50	BtcTurk	2
Coincheck	20	BHEX	64	Hopex	34	COINBIG	2
Coinbase	8	Bitcoin.com	5	BitHash	11	Coinmate	2
GMO Coin Co.	8	FTX	2	Coinone	11	Coinsbit	2
LMAX	4	Bitoffer	1	VinDAX	10	Coinzo	2
Bitstamp	2	CoinEx	1	EXX	8	ExMarkets	2
Bittrex	1	CoinTiger	1	KuCoin	8	FTX.US	2
		LATOKEN	1	Lucent	8	GokuMarket	2
		OceanEx	1	MEXC	8	GOPAX	2
				Bithumb	7	Stormgain	2
				ZebPay	7	The Rock Trading	2
				BigONE	6	XT	2
				CBX	6	Yobit	2
				STEX	6	Alterdice	1
				VB	6	BitBay	1
				Bitci	5	Bitrue	1
				BTC Markets	5	Bitubu	1
				CoinJar	5	BTSE	1
				Tokenize	5	C2CX	1
				Bithumb Global	4	CoinEx	1
				ExtStock	4	CoinPark	1
				Korbit	4	CrossTower	1
				Mercado Bitcoin	4	IDCM	1
				OMGFIN	4	KKcoin	1
				Bitalong	3	LBank	1
				Decoin	3	MAX Exchange	1
				Hoo	3	NovaDAX	1
				Indodax	3	P2PB2B	1
				Atomars	2	ProBit	1
				Bitkub	2	whiteBIT	1
				BitoPro	2	ZG	1

Source: Digital Asset Research

This quarter, Watchlist Exchanges were price leaders **48.59%** of the time and Vetted Exchanges were price leaders **19.31%** 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 Q3 of 2020, with “n” representing the number of volatility events analyzed in that quarter.

Exchange	Price Leader Appearances
Binance	18
Huobi	16
OKEx	16
Liquid	13
Bitstamp	11
BEQUANT	6
HitBTC	6
BHEX	4
Cat.Ex	4
MEXC	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
BHEX	42
Coinone	22

Q1 2021 Price Leader Appearances (n=181)

Exchange	Price Leader Appearances
Binance	92
Huobi	68
BHEX	64
Huobi Korea	53
OKEx	50
VCC Exchange	42
Hopex	34
Liquid	27
Coincheck	20
BitHash	11

Q2 2021 Price Leader Appearances (n=103)



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 **67.90%** of the time, and **73.82%** 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
Binance	26	23	25	13	5
Huobi	7	15	22	12	12
BHEX	19	14	7	12	12
Huobi Korea	6	10	17	9	11
OKEx	0	6	6	22	16
VCC Exchange	9	14	4	11	4
Hopex	4	7	8	9	6
Liquid	1	2	9	7	8
Coincheck	1	1	4	6	8
BitHash	3	2	3	2	1



Vetted



Watchlist



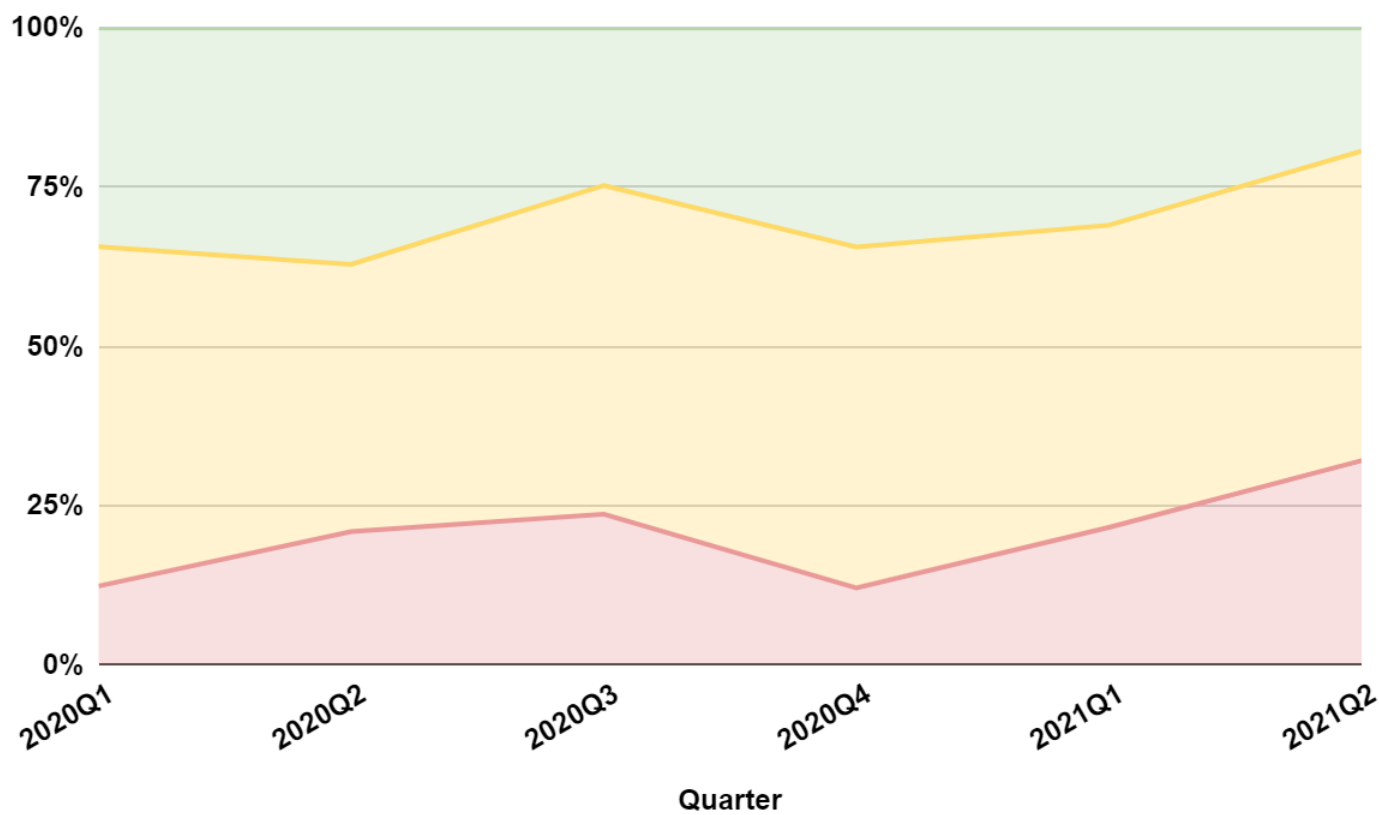
Disqualified

Source: Digital Asset Research

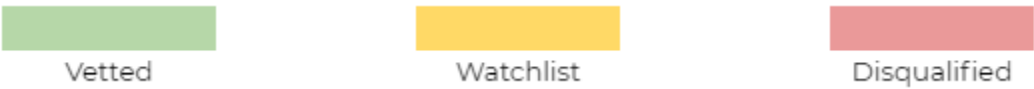
# HISTORICAL COMPARISON

Figure D shows the breakdown of volatility events amongst Vetted, Watchlist, and Disqualified exchanges for each quarter going back to Q1 of 2020.

FIGURE D - QUARTERLY COMPARISONS



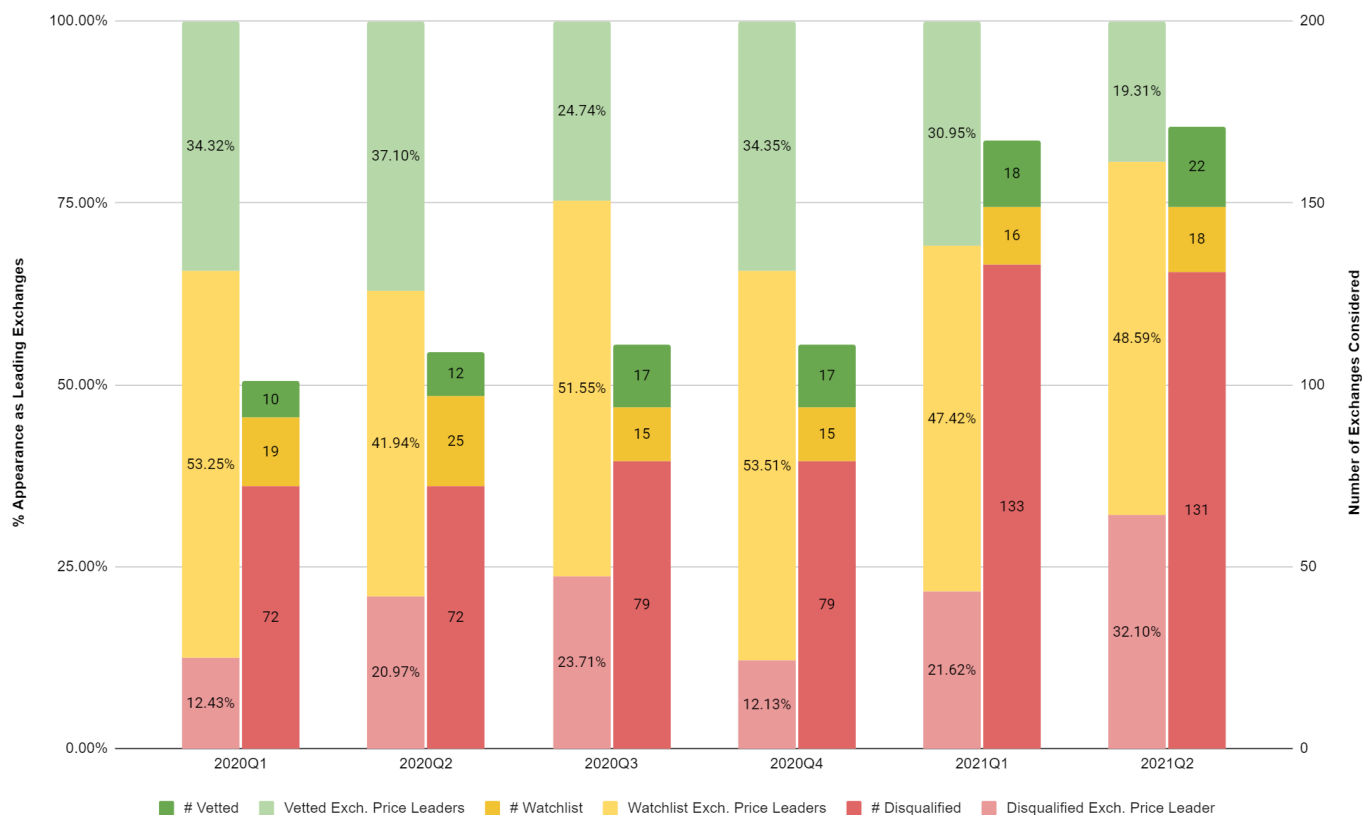
*\*See [Appendix 3](#) for quarterly exchange participation. Not all exchanges have been evaluated in all quarters.*



Source: Digital Asset Research

Although each quarter has seen different Price Leaders, in Q2 2021 there was a notable increase in the percentage of Disqualified Exchange appearances as Price Leaders; this increase occurred while the number of Disqualified Exchanges included in the assessment stayed relatively similar when compared to the previous quarter.

**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 Q2 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
Binance	92
Huobi	68
BHEX	64
Huobi Korea	53
OKEx	50
VCC Exchange	42
Hopex	34
Liquid	27
Coincheck	20
BitHash	11

*Q2 2021 Price Leader Appearances  
Without Perpetuals*

Exchange	Price Leader Appearances
Binance	111
Huobi	81
BHEX	75
Huobi Korea	68
OKEx	64
VCC Exchange	48
Hopex	41
Liquid	36
Coincheck	22
BitHash	12

*Q2 2021 Price Leader Appearances  
With Perpetuals*

Perpetual	
Exchange	Price Leader Appearances
Bybit^P	2
Deribit^P	1
Binance^P	0
BitMEX^P	0
OKEx^P	0



Vetted



Watchlist



Disqualified



Perpetual

Source: Digital Asset Research



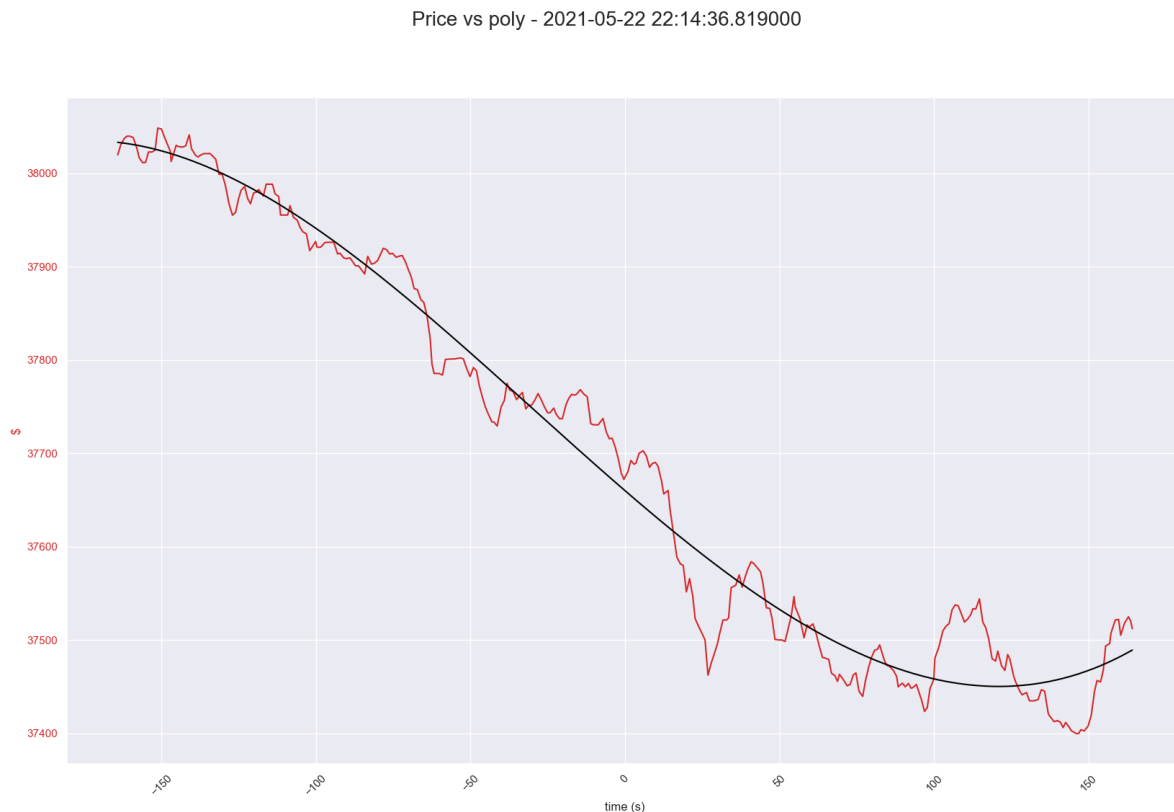
## 1.0 Prior Lead-Lag Reports

- 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](#)
- BTC Spot Price Discovery Update [Q1 2021](#)

## 2.0 Volatility Event Example Analysis

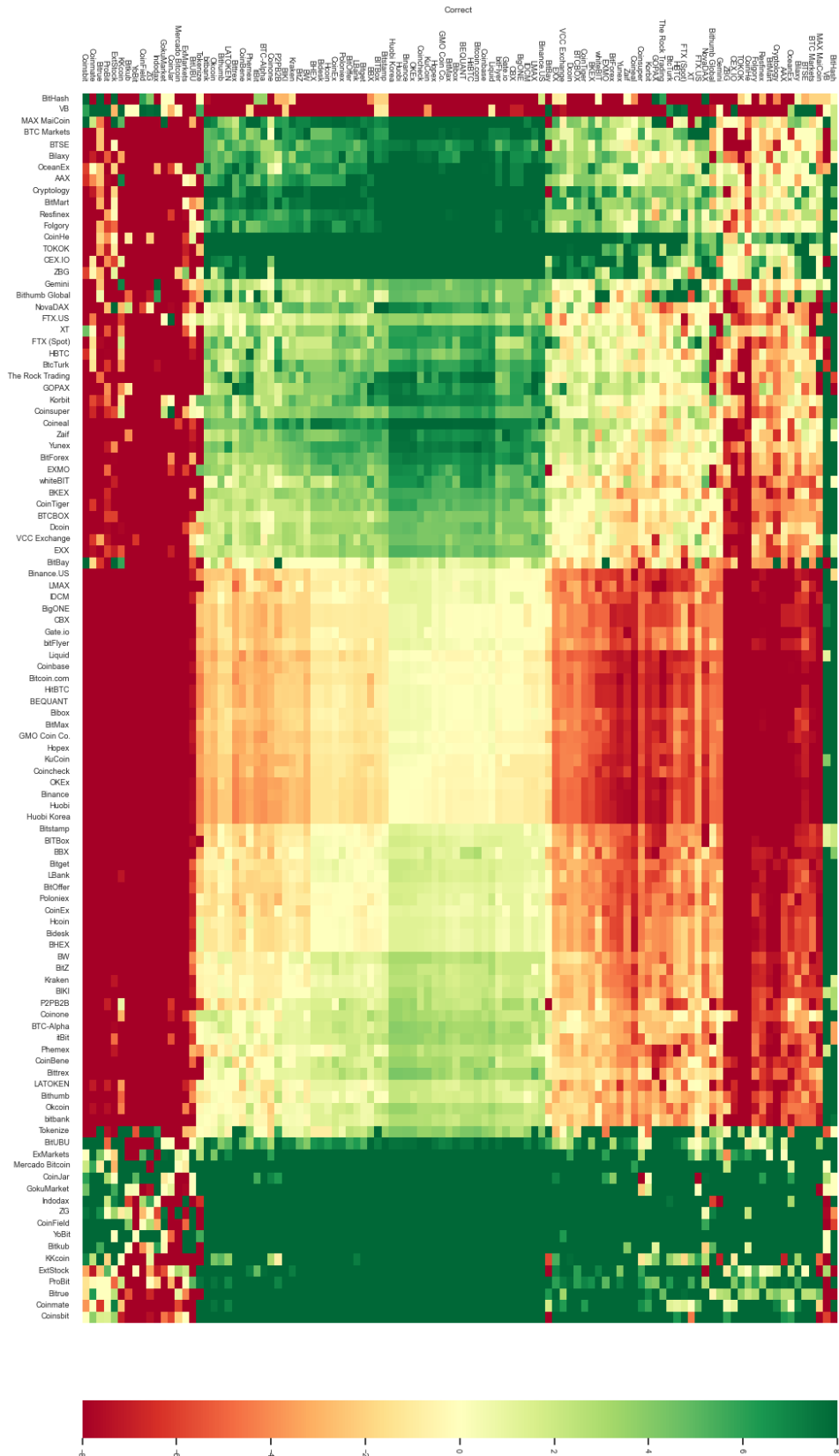
Figure G shows an example of a volatility moment that happened on 22 May 2021. The red line shows the price of Bitcoin across all exchanges in this study during the time period and the black line is the polynomial used to test the volatility moment. The full green columns on the heat map in Figure H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

**FIGURE G - VOLATILITY MOMENT 22-MAY-2021 22:14:37**



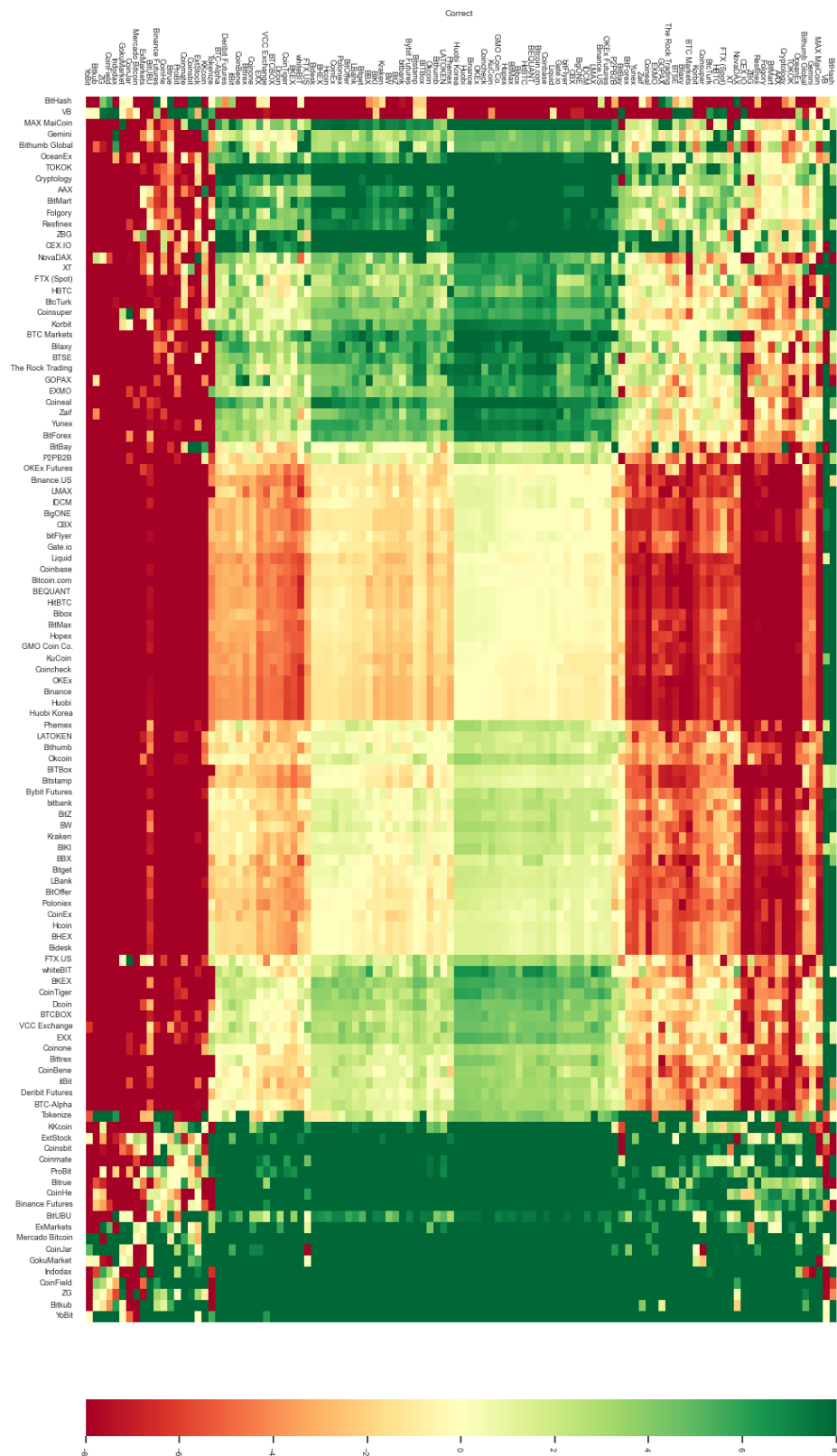
**FIGURE H - EXCHANGE HEATMAP 22-MAY-2021 22:14:37**

[Link to heatmap here](#)



# FIGURE I - EXCHANGE HEATMAP 22-MAY-2021 22:14:37 WITH PERPETUALS

[Link to heatmap here](#)



### 3.0 Lead-Lag Exchange Universe

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



Vetted



Watchlist



Disqualified



Perpetual



Not Included

Exchange	Q2 2021	Q1 2021	Q4 2020	Q3 2020	Q2 2020	Q1 2020
Bybit^P	x	x	x	x	x	
C2CX	x	x	x	x	x	x
Cat.Ex	x	x	x	x	x	x
CBX	x	x	x	x	x	x
CCX Canada	x	x	x	x	x	
CEX.IO	x	x	x	x	x	x
Chaoex	x	x	x	x	x	x
Coinall	x	x	x	x	x	
Coinbase	x	x	x	x	x	x
Coinbene	x	x				
COINBIG	x	x				
Coincheck	x	x	x	x		
Coineal	x	x	x	x	x	x
Coinegg	x	x	x	x	x	x
CoinEx	x	x	x	x	x	x
Coinfield	x	x	x	x	x	x
Coinhe	x	x	x	x	x	x
Coinmate	x	x	x	x	x	x
Coinmex	x	x	x	x	x	x
Coinone	x	x	x	x	x	x
Coinsbank	x	x	x	x	x	x
Coinsbit	x	x	x	x	x	x
Coinsuper	x	x	x	x	x	
CoinTiger	x	x	x	x	x	x
Coinflex	x	x				
CoinJar	x	x				
Coinmargin	x	x				
CoinPark	x	x				
Coinzo	x	x				
Citex		x				
CrossTower	x	x				
Cryptology	x	x	x	x	x	x
Decoin	x	x				
Deribit^P	x	x	x	x	x	
Dextrade	x	x				
Digifinex	x	x	x	x		x
DSX	x	x	x	x	x	x
ExMarkets	x	x				
EXMO	x	x	x	x	x	x
Exrates	x	x	x	x	x	x
ExtStock	x	x				
EXX	x	x	x	x	x	x
Fifty Five	x	x	x	x	x	x
Folgory	x	x				
FTX	x	x				
FTX.US		x				
Gate.io	x	x	x	x	x	x
GDAC	x	x	x	x	x	x
Gemini	x	x	x	x	x	x
GMO Coin Co.	x	x				
GokuMarket	x	x				
GOPAX	x	x	x	x	x	x
Hb.top	x	x				
Hcoin		x	x	x	x	x
HitBTC	x	x	x	x	x	x
Hoo	x	x				
Hopex	x	x				
Huobi	x	x	x	x	x	x
Huobi Korea	x	x				
Huobi Russia	x	x	x	x	x	x

Exchange	Q2 2021	Q1 2021	Q4 2020	Q3 2020	Q2 2020	Q1 2020
IDAX	x	x	x	x	x	
IDCM	x	x	x	x	x	x
Indodax	x	x	x	x	x	x
Indoex	x	x				
itBit	x	x	x	x	x	x
KKcoin	x	x				
Korbit	x	x	x	x	x	x
Kraken	x	x	x	x	x	x
Kryptono	x	x	x	x	x	x
KuCoin	x	x	x	x	x	x
LakeBTC	x	x	x	x	x	x
LATOKEN	x	x	x	x	x	x
LBank	x	x	x	x	x	x
Liquid	x	x	x	x	x	x
Livecoin	x	x	x	x	x	x
LMAX	x	x	x	x	x	x
Lucent	x	x				
Luno	x	x	x	x	x	x
MAX Exchange	x	x				
Mercado Bitcoin	x	x	x	x	x	x
Mercatox	x	x	x	x	x	
MEXC	x	x	x	x	x	x
NovaDAX	x	x				
OceanEx	x	x	x	x	x	x
OKCoin	x	x	x	x	x	x
OKEx	x	x	x	x	x	x
OKEx^P	x	x	x	x	x	
OMGFIN	x	x	x	x	x	x
P2PB2B	x	x	x	x	x	x
Phemex	x	x				
Poloniex	x	x	x	x	x	x
ProBit	x	x	x	x	x	x
Resfinex	x	x				
RightBTC	x	x	x	x	x	x
Simex	x	x	x	x	x	x
Sistemkoin	x	x	x	x	x	x
SouthXchange		x				
STEX	x	x	x	x	x	x
TagZ	x	x	x	x	x	x
The Rock Trading	x	x	x	x	x	x
Tidebit		x	x	x	x	x
Tidex	x	x	x	x	x	x
Tokenize	x	x				
Tokok	x	x	x	x	x	x
Upbit	x	x	x	x	x	x
VB	x	x				
VCC Exchange	x	x	x	x	x	x
Vebitcoin	x	x				
Velic	x	x				
VinDAX	x	x	x	x	x	x
WazirX	x	x				
whiteBIT	x	x	x	x	x	x
XT	x	x				
YoBit	x	x	x	x	x	
Yunex	x	x				
Zaif	x	x	x	x	x	x
ZB.com	x	x	x	x	x	x
ZBG	x	x	x	x	x	x
ZebPay	x	x				
ZG	x	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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