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# Bitcoin Exchanges and Futures Price Discovery


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INSPIRING PEOPLE

# Financial technology – why should it be of interest?

- Recent technological developments have enabled a wide array of new applications in financial markets, e.g. big data, cloud computing, artificial intelligence, blockchain, cryptocurrencies, crowdfunding and robo-advisory**.**

- New Fintech is said to focus more on ‘users’ due to the opportunity for lower service costs and/or improve convenience.

- Enabling for new services. For instance crowdfunding.

- Provider of services also have a lower barriers of entry. (Marketing budgets/national level regulation remain a problem for scalability etc.)

# Bitcoin - Blockchain

- Most notable application of Blockchain technologies
- Blockchain technologies facilitate decentralised private currency
- 2007-2008 Financial crisis response to fractional deposit banking (based on notes)

Bitcoin was originally designed as a decentralised and private money payment system with founding motivations to facilitate irreversible online transactions (Nakamoto, 2008).

BUT

Regardless these main intentions, since then Bitcoin has found popularity as a store of value.

# Making Bitcoin Great again - Issues ‘remain’

## VALUATION

- Lack of fundamental value (traditional future cash flow valuations would not help)
- Price of Mining Bitcoins
- Sentiment
- Detecting Market Manipulation
- Spill Over – Factor analysis

## TECHONOLOGY

- Counter-effective Network Effects Induced By Scalability: Wider Popularity is Making the Transactions More Expensive
- The Safety Of Cryptocurrency Exchanges

# Bitcoin – CBOE Speficiations

- Initial margins 44% with the same maintenance margin.
- One CBOE Futures contract equals to 1 Bitcoin. Cash settled.
- Typical trading hours are 3:30p.m. – 3:15 p.m. CT on Mondays and 8:30 a.m. to 3:15 p.m Tuesday through Friday. Weekend related extended hours will be 5 p.m Sunday to 8:30 a.m. Monday.
- The contract is priced off on an auction at 3pm CT on a Gemini cryptocurrency exchange. There is a discretionary 20% trading limit for price fluctuations.

VS.

- Coindesk Bitcoin Price Index simple average weighted constituents of immediate bid and offer spread are Bitstamp, Coinbase/GDAX, itBit, Bitfinex

# Futures volumes are low

## Cboe XBT Bitcoin Futures Trading Data

| Symbol | Expiration | Last | Change | High | Low | Settlement | Volume |
|---|---|---|---|---|---|---|---|
| GXBT | - | 6285.00 | +268.15 | 6349.46 | 6075.19 | - | - |
| XBT/N8 | 07/18/2018 | 6290.00 | +152.50 | 6345.00 | 6070.00 | 6137.50 | 3215 |
| XBT/Q8 | 08/15/2018 | 6290.00 | +155.00 | 6335.00 | 6080.00 | 6135.00 | 134 |
| XBT/U8 | 09/19/2018 | 6320.00 | +175.00 | 6340.00 | 6100.00 | 6145.00 | 108 |
| XBT/V8 | - | | | | | - | - |

(DELAYED 10 MINUTES)

No large volumes – and lower open interest in the later term structured futures contracts

# Volatility of Bitcoin


60 Minute Volatility is dropping since the introduction of Bitcoin Futures

# Background, Aims and Objectives

## "Price Discovery in the Bitcoin Futures and Cash Markets"

| | |
|---|---|
| **Background** | **As Bitcoin futures were introduced only December 2017. There is no previous empirical inquiry on the potential price discovery of cryptocurrency futures.** |
| **Problem Statement** | Bitcoins do not have underlying asset or fundamental value, however they seem to have continuing interest and pricing regardless of them being highly volatile financial instrument. Large institutions due to the lack of valuation methods are mostly absent in the market. Futures were introduced to this market place for informed traders.<br><br>Does the futures introduction contribute to the Bitcoin market price discovery and can predictions be made on how two market places interact? |
| **Hypothesis** | $H_0^A$: The spot market does not lead the futures market<br>$H_1^A$: The spot market leads the futures market<br><br>$H_0^B$: The futures market does not lead the spot<br>$H_1^B$: The futures market leads the spot |

# Motivation

## A STUDY ABOUT PRICE DISCOVERY

- Claim: *`Empirical results suggest that during the dominance of the presumably uninformed private investors, the futures market does not contribute to price discovery.`* Bohl, Salm, Schuppli (2011)

- Empirical inquiry requires: Separation of the market idiosyncratic component from the efficient price. *(*Hasbrouck, 1995)

- Relevance (to financial-market participants): *'A further source of informational advantage of traders is their access to, and trained interpretation of, the information contained in the order flow`* Ito, Lyons and Melvin (1998)

# Novelty

## A STUDY ABOUT PRICE DISCOVERY

Bitcoin: "*The steady addition of a constant amount of new coins is analogous to gold miners expending resources to add gold to circulation. In our case, it is CPU time and electricity that is expended. The incentive can also be funded with transaction fees. "…" Once a predetermined number of coins have entered circulation, the incentive can transition entirely to transaction fees and be completely inflation free*" (Nakamoto, 2008)

- New futures market introduced for the first time
- The progress in the Bitcoin investing is being investigated
- Nature of the inefficiency present among the presence of uninformed investors.
- New time-series data on Bitcoin futures prices since inception, used for the first time in the literature, combined with data from 4 main exchanges for the spot market

# Methodology

| AREA OF STUDY AND METHODS | A STUDY ABOUT PRICE DISCOVERY |
|---|---|
| Methodology – Empirical investigation | Using time series methodologies developed by Engle and Granger (1987), Johansen (1991), Hasbrouck (1995), Gonzalo and Granger (1995).<br>• Granger causality test<br>• Cointegration analysis<br>• VECM model on log prices:<br>  • Information Share (IS), covariance of innovations<br>  • Component Share (CS), error correction coefficient<br>• (Supportive tests: Information Criteria, ADF, Durbin Watson and Impulse Response Function) |

# VECM

## Price discovery

Two most notable price discovery models, Information Share and Component Share utilise the Vector Error Correction Model

$$\Delta Y_t = \mu + \Pi Y_{t-1} + \sum_{i=1}^{k} A_i \Delta Y_{t-i} + \varepsilon_t$$

- Model is extended with measuring the impact to the common factors.
- Nevertheless, the IS and CS models definition of price discovery differ and thus the utilisation of VECM components.

# Information Share (IS)

## Price discovery

Relative contribution to the variance of the innovation in the efficient price is taken as the contribution to price discovery by a particular market.

Firstly, IS transforms the VECM into a vector moving average (VMA) model:

$$\Delta Y_t = \Psi(L)\varepsilon_t$$

Where $Y_t$ is the vector of the bivariate price series; $\varepsilon_t$ is a vector of serially uncorrelated innovations with covariance matrix $\Omega$. $\psi$ is a common row vector in the impact matrix which is the sum of the moving average coefficients. $\Psi(L)$ and $\Psi^*(L)$ are matrix polynomials in the lag operator $L$.

$$Y_t = \iota\psi\left(\sum_{i=1}^{t}\varepsilon_i\right) + \Psi^*(L)\varepsilon_t$$

Common factor innovation is the increment, $\psi\varepsilon_t$, with variance $Var(\psi\varepsilon_t) = \psi\Omega\psi^T$. The proportion of $Var(\psi\varepsilon_t)$ is attributable to the innovations in that market. Upon applying the Cholesky factorization of $\Omega = FF^T$ to eliminate the contemporaneous relationship, where $F$ is a lower triangular matrix, the information share is given as follows and will give maxima of variables depending of ordering of vectors – hence the need for :

$$IS_j = \frac{\left([\psi F]_j\right)^2}{\psi\Omega\psi^T}, \quad j = 1, 2, \ldots, n,$$

# Component Share (CS)

## Price discovery

The CS model measures the contribution to the efficient price for each market, where the contribution is defined as a function of the error correction coefficients of the markets.

$$Y_t = f_t + G_t$$

$$f_t = \Gamma^T Y_t = (\alpha^T_\perp \beta_\perp)^{-1} \alpha^T_\perp \; Y_t,$$

Where $f_t$ is the common factor and $G_t$ is the transitory component that has no permanent impact on $Y_t$. The CS model decomposes the efficient price $f_t$ into a linear combination of the prices: $f_t = \Gamma^T Y_t = (\alpha^T_\perp \beta_\perp)^{-1} \alpha^T_\perp \; Y_t$, where $\Gamma$ is the common factor coefficient vector. $\Gamma$ is normalized and the sum of its components is equal to 1.

# Data and Correlation

| | 1 min | 5 min | 15 min | 30 min | 1 hour | 1 day |
|---|---|---|---|---|---|---|
| **Correlation of returns** | 0.681 | 0.691 | 0.773 | 0.804 | 0.829 | 0.796 |
| **Observations** | 87,865 | 28,427 | 10,254 | 5,236 | 2,630 | 122 |

- Correlation of returns of CBOE Bitcoin Futures and Coindesk Bitcoin Index (spot).
- Sample is taken during the CBOE futures trading hours between 13/12/2017-13/06/2018. Futures do not trade during the weekend or during the daily 15 minutes settlement period. Bitcoin exchanges are open to trade 24/7.
- Mid-quotes.
- Price correlation is around 0.997 for the different time frequencies.

# Descriptives -1 minute level data


**Blue**: Bitcoin cash market Index, 1-minute level data from Coindesk. **Red**: represents the CBOE Bitcoin Futures Prices.

- The market places appear to be cointegrated.

# Cointegration

| JOHANSEN COINTEGRATION | 1 min | 5 min | 15 min | 30 min | 1 hour | 1 day* |
|---|---|---|---|---|---|---|
| **Trace Test Result** | Co-integrated | Co-integrated | Co-integrated | Co-integrated | Co-integrated | Co-integrated |
| **r=0** | 765.5*** | 383.1*** | 337.8*** | 177.2*** | 148.6*** | 50.7*** |
| **Critical value 5% = 17.95, Critical Value 1%= 23.52** | | | | | | |
| **r=1** | 4.5 | 4.4 | 4.2 | 4.3 | 4.5 | 3.86 |
| **Critical value 5% = 8.18, Critical Value 1%= 11.65** | | | | | | |
| **Lags** (simplest model by AIC, BIC and HQ) | 20 | 15 | 7 | 7 | 5 | 2 |
| **Observations** | 87,865 | 28,427 | 10,254 | 5,236 | 2,630 | 122 |

- Statistics show cointegration of Bitcoin spot and futures log price series. The log prices were tested for non-stationarity with the ADF test.

# Granger Causality

| p-value test | 1 min | 5 min | 15 min | 30 min | 1 hour | 1 day* |
|---|---|---|---|---|---|---|
| INDEX do not Granger cause FUTURES | (0.000) | (0.352) Does not G-Cause | (0.213) Does not G-Cause | (0.479) Does not G-Cause | (0.5877) Does not G-Cause | (0.413) Does not G-cause |
| FUTURES do not Granger cause INDEX | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Lags | 15 | 10 | 11 | 7 | 7 | 2 |
| Observations | 87,865 | 28,427 | 10,254 | 5,236 | 2,630 | 122 |

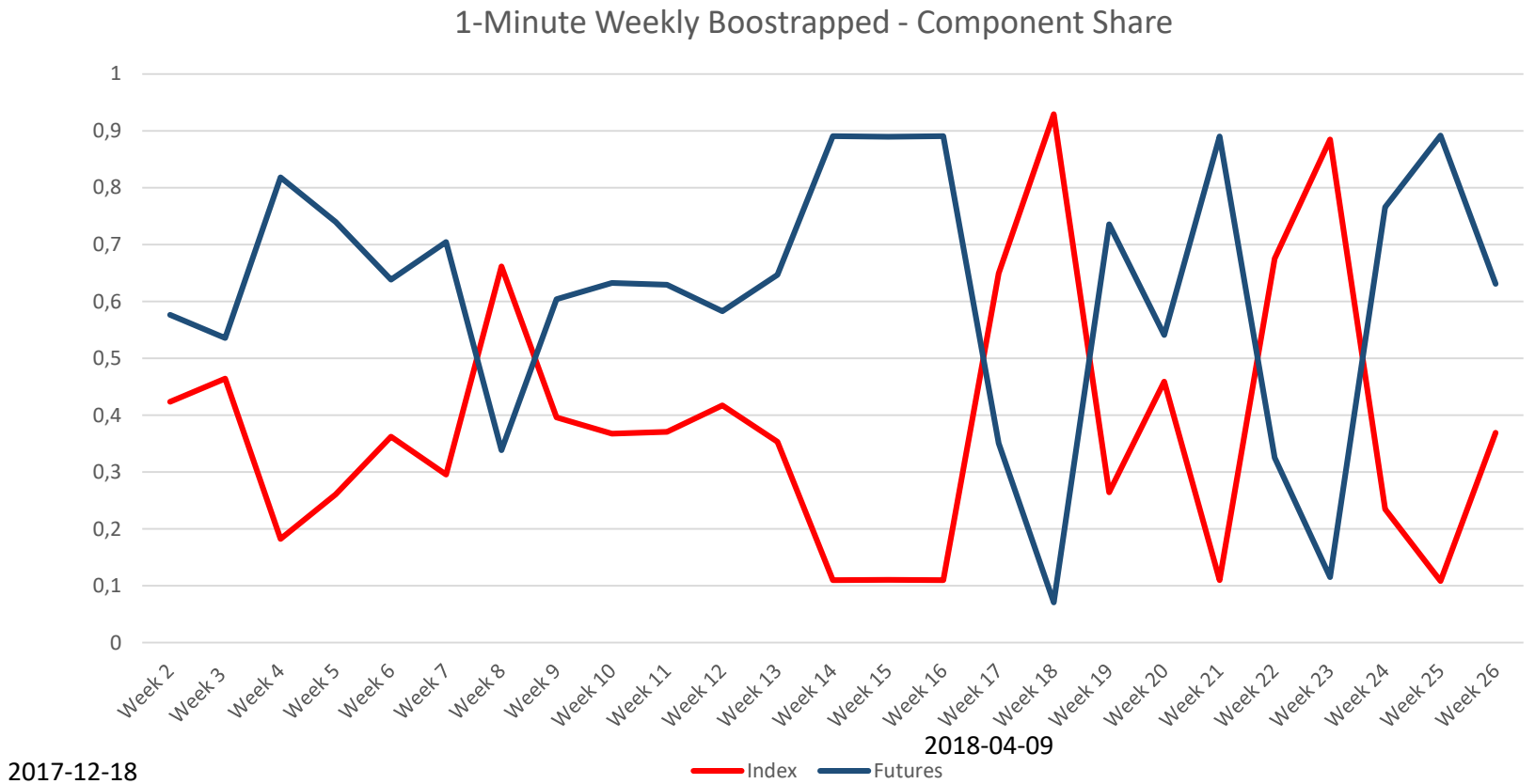
- The futures markets appear to be Granger Causing Bitcoin exchange markets.
- Lead-lag – cause and causality

# Preliminary findings: Noise trading and hedgers

| | 1 min | 5 min | 15 min | 30 min | 1 hour | 1 day* |
|---|---|---|---|---|---|---|
| **INFORMATION SHARE (aveg.)** | | | | | | |
| **FUTURES** | 65.6% | **65.7%** | 62.6% | 62.5% | 61.5% | 58.5% |
| **INDEX** | 34.4% | **34.3%** | 37.4% | 37.5% | 38.5% | 41.5% |
| **COMPONENT SHARE** | | | | | | |
| **FUTURES** | 81.3% | **89.7%** | 94.1% | 98.1% | 95% | 87.5% |
| **INDEX** | 18.7% | **10.3%** | 5.9% | 1.9% | 5% | 12.5% |
| **Lag** | 20 | 15 | 7 | 7 | 5 | 2 |
| **Observations** | 87,865 | 28,427 | 10,254 | 5,236 | 2,630 | 122 |

- The CS model does not consider the transitory element, which implies a more prevalent noise trading in the spot market.
- Natural 'long holders` or hedgers: the miners – up to 1800 new Bitcoins are created per a day until 2020.
- Bitcoin live spot data accessible readily at any exchange. Futures live data through brokerages.
- Informed traders – explaining the futures leading with lower volumes. <u>It has been a short trade.</u>

# Development of price discovery




thank you
danke
謝謝
ngiyabonga
شكراً جزيلاً
рахмат
teşekkür ederim
Баярлалаа
спасибо
faafetai lava
dank je
gracias
tapadh leat
хвала
bedankt
hvala
mauruuru
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감사합니다
তোমাকে ধন্যবাদ
terima kasih
grazie
sagolun
mochchakkeram
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