Economics Letters 171 (2018) 140–143

Contents lists available at ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

How investible is Bitcoin? Analyzing the liquidity and transaction costs of Bitcoin markets

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HIGHLIGHTS

- Using high-frequency quote data, we show Bitcoin is investible at the retail level.
- We examine transactions costs and liquidity of major Bitcoin exchanges.
- Trading induces additional volatility in Bitcoin.
- We show intraday patterns consistent with retail participants.

ARTICLE INFO

Article history:
Received 29 May 2018
Received in revised form 16 July 2018
Accepted 21 July 2018
Available online 24 July 2018

JEL classification:
G14
G15
C580

Keywords:
Bitcoin
Cryptocurrency
Market microstructure
Intraday patterns

ABSTRACT

We examine the investibility of Bitcoin by exploring the trading dynamics and market microstructure of Bitcoin on three US cryptocurrency exchanges using high frequency intraday data of individual trades and quotes. Although all exchanges offer continuous trading, we find that the highest trading activity, highest volatility and lowest spreads coincide with US market trading hours, suggesting that most trades are non-algorithmic and executed by retail investors. We further find that average quoted and effective spreads for Bitcoin are lower than spreads on major equity exchanges, implying that Bitcoin is highly investible for retail size transactions.

1. Introduction

Bitcoin is the most prominent open source peer-to-peer digital currency operating without central authority (Nakamoto, 2008).[1] The recent increased interest in Bitcoin briefly propelled its price above $20,000, valuing the cryptocurrency at more than $300 billion. But how investible is Bitcoin? On one hand, literature shows that the informational efficiency of Bitcoin is increasing (Urquhart, 2016; Nadarajah and Chu, 2017; Tiwari et al., 2018) and its independence of monetary policy (Vidal-Tomas and Ibanez, 2018) and macroeconomic developments (Ciaian et al., 2016), provides useful diversification benefits (Brière et al., 2015; Dyhrberg, 2016; Bouri et al., 2017a,b). On the other hand, Cheah and Fry (2015) argue that Bitcoin has no intrinsic value, is more volatile than gold or foreign currency markets (Yermack, 2015; Dwyer, 2015), exhibits price clustering at round numbers (Urquhart, 2017) and is subject to frequent speculative bubbles (Cheung et al., 2015; Cheah and Fry, 2015; Corbet et al., 2017).

While cryptocurrencies exhibit many features of other financial markets such as foreign exchange and equity, their market structure is fundamentally different. Bitcoin serves not only as an electronic medium of exchange but also as a speculative investment asset with trading available 24-hours a day, seven-days a week. The decentralized network is largely unregulated and consequently institutional investors are largely absent. Yermack (2015) and Baur et al. (2017) show that most Bitcoin transactions are between speculative investors, and only a minority are used for purchases of goods and services. Consequently, they argue that Bitcoin behaves more like a speculative investment than a currency. From a taxation perspective, the US treats Bitcoin as property while the U.K. and European Union classify it as a currency. Most other countries are yet to determine the legal status of cryptocurrencies.

Using a unique dataset of high frequency trade and quote data from three major order-driven US-based cryptocurrency exchanges, we add to this debate by exploring the intraday trading activity of the BTC–USD (Bitcoin/US dollar) exchange rate market.

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[1] For a detailed description of the users, security, mining and transaction processes see Böhme et al. (2015), Dwyer (2015), Easley et al. (2017), or Foley et al. (2018).

https://doi.org/10.1016/j.econlet.2018.07.032
0165-1765/

Table 1
Cryptocurrency market structure summary and trading statistics. This table presents daily averages for the marketplaces Gdax, Gemini and Kraken, from 7th September, 2017 to 10th May, 2018 in US dollars. Fee discounts typically follow a sliding scale, and we have documented the point at which they first begin applying. Quoted spread is time weighted whilst effective spread is volume weighted in each currency-minute time bucket. Depth at best is the time weighted average dollar volume depth quoted across the best bid and ask. Depth is winsorized at the 99% level by date and market.

	Gdax	Gemini	Kraken
Fiat currencies	USD, EUR, GBP	USD	USD, EUR, CAD, JPY, GBP
Number of currency pairs	12	6	57
Highest fee for maker (bps)	0	100	16
Highest fee for taker (bps)	30	100	26
Fee discount beginning	$10,000,000	5 BTC	$50,000
Tick Size ($)	0.01	0.01	0.1
Tick Size (bps)	0.0025	0.0025	0.0252
Mean number of trades	36,774.83	11,524.84	13,877.07
Mean price	9,089.34	9,072.71	9,047.41
Min price	2,975.01	2,955.23	2,997.41
Max price	19,891.99	19,999.00	19,660.00
Standard deviation of price	3,604.85	3,583.05	3,553.04
Mean volume	0.47	0.72	0.49
Min volume	1E−8	1E−10	1E−8
Max volume	252.22	900.00	400.44
Mean dollar volume per trade	4,692.58	6,450.51	4,172.03
Mean quoted spread (bps)	0.54	2.94	7.80
Mean effective spread (bps)	5.60	9.82	22.51
Mean depth at best ($)	168,465.98	89,761.21	29,902.69

We shed light on the execution costs and compare our findings with empirical results from other markets.

Our results show that there are on average between 13,729 and 35,849 trades per day on each exchange with an average transaction value of between $3912 and $6230. The average quoted spread across the three exchanges is between 0.54 and 7.80 bps while the average effective spread ranges between 5.60 and 22.51 bps. Both are substantially lower than relative spreads faced by traders in equity markets. The average dollar value of depth at the best bid and ask varies between $29,903 and $168,466.

We find that despite continuous trading, the BTC–USD exchange rate exhibits a significant intraday trading pattern. Trading activity, averaged across the three exchanges, is the lowest early in the morning (US time) as the European markets open and then increases rapidly to peak as the US markets open. Trading monotonically declines through the US market close and then drops rapidly as the Asian markets close. Volatility follows the same pattern, while quoted and effective spreads display an inverse relationship with the number of trades and volatility. We find that the trading patterns persist over weekends, in contrast to the continuously traded foreign exchange market that typically exhibits little activity (Bollersev and Domowitz, 1993). The evidence is consistent with BTC–USD trades being dominated by retail investors. Overall, our empirical findings suggest that with low spreads and sufficient market depth for average sized transactions, Bitcoin is investible.

The remainder of the paper is structured as follows. Section 2 introduces the market structure of the cryptocurrency markets. Section 3 presents the intraday trading patterns while Section 4 concludes.

2. Cryptocurrency exchange market structure

Bitcoin transaction data is readily available from several online sources including Coindesk, Datastream and Blockchain.info. However, the data is generally limited to daily closing prices. We use intraday trade and quote data spanning from 7th September, 2017 to 10th May, 2018, sourced directly from the Kraken, Gdax and Gemini exchanges through their public Application Programming Interfaces (API).[2] The API is polled twice a second to get a snapshot of the full order book. Our choice of exchanges is motivated by data availability and ranking of exchanges based on transactions in the BTC–USD market. All three exchanges consistently rank in the top five based on highest volume transacted and lowest bid/ask spreads.[3]

All three exchanges are headquartered in the US but Gdax and Kraken also have a large European customer base. The exchanges have electronic limit order books, a variety of order types and different access to margin trading, auctions and dark pools. Kraken has the most fiat and cryptocurrency pairs, while Gemini has the highest explicit fees.

Table 1 shows that the minimum tick size is $0.01 at Gdax and Gemini and $0.10 at Kraken which, given the high price of Bitcoin, equates to less than 0.03 bps, significantly less than on other equity exchanges. There are between 13,729 and 35,849 trades per day depending on the exchange, with an average transaction value of between $3912 and $6230. Gemini has the least trades per day but the highest dollar volume per trade.

Trading costs across the three exchanges are estimated using the average quoted spread (bid–ask spread) which represents the cost of liquidity provision, and the average effective spread (twice the distance between the transaction price and the midquote) which represents the execution cost when liquidity is demanded. Both spreads are expressed in basis points (bps) and are scaled by the quoted midpoint. In contrast to quote-driven markets, where effective spreads are generally smaller than quoted spreads as some trades take place within the spread, traders in fully electronic order-driven cryptocurrency markets cannot trade inside the quotes. Furthermore, trades frequently do not execute at the best prices as quoted spreads are very small and order quantity exceeds the best posted depth. Consequently, traders are forced to "walk" the limit order book, resulting in effective spreads which are typically larger than quoted spreads. The quoted (effective) spread ranges from 0.54 (5.60) bps at GDax to 7.80 (22.51) bps at Kraken. This is significantly lower than the average quoted (effective) spread of 37.2 (23.9) bps of stocks on the NYSE (Boehmer et al., 2005), 25.9 (25.0) bps on the centralized electronic order book of Euronext, and 70.5 (40.2) bps on the hybrid order-driven segment of the LSE (Gajewski and Gresse, 2007). The spreads are comparable to the one hundred most liquid stocks on the NYSE which display an average quoted (effective) spread of 10.9 (7.3) bps

[2] Kraken increased the tick size from $0.001 to $0.1 on the 6th September, 2017.

[3] http://data.bitcoinity.org/markets/exchanges/USD/2y#volume_desc.

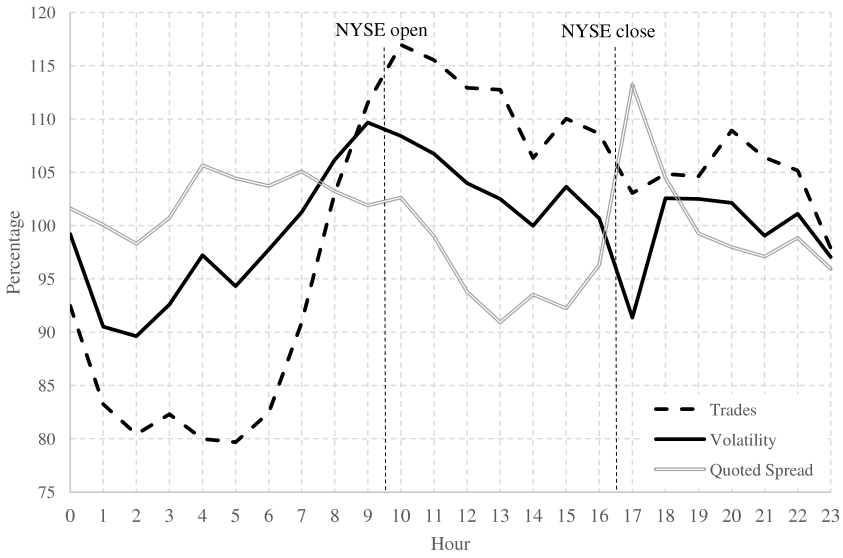

Fig. 1. Intraday variation in the number of trades, spread and volatility for the BTC–USD exchange rate. All variables are averaged on an hourly basis for Gemini, Gdax and Kraken, then scaled by the variable average and averaged across exchanges.

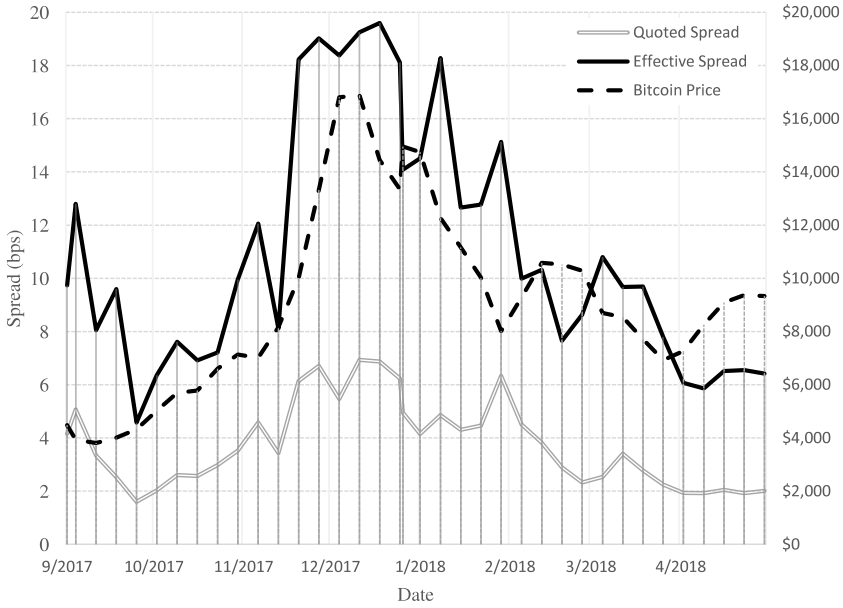

Fig. 2. Time series variation in quoted and effective spreads of the BTC–USD exchange rate. Quoted and effective spreads (left axis) are averaged on a weekly basis for each exchange, then averaged across exchanges. Quoted spreads are time weighted, whilst effective spreads are volume weighted. Bitcoin price (right axis) is in US dollars.

(Boehmer et al., 2005). The average dollar volume depth at the best bid and ask averages $96,043.

3. Intraday patterns

The intraday variations in number of trades, spread and volatility presented in Fig. 1 provide information about trader behavior throughout the day. Due to high price volatility over our short time period, the data is averaged across the three exchanges to provide a general idea of the liquidity of the overall BTC–USD market. As cryptocurrency markets do not have opening and closing times, we do not observe the typical U-shape bid–ask spread and volatility commonly found in equity markets (Mcinish and Wood, 1992; Madhavan et al., 1997). We find that the trading activity, averaged across all three exchanges, is the lowest early in the morning (US time) as the European markets open and then increases rapidly to peak as the US markets opens. Trading then monotonically declines through the US market close and drops rapidly as the Asian market close. These observed trading patterns in Bitcoin are more consistent with intraday patterns commonly found in the foreign exchange markets (Bollersev and Domowitz, 1993), as compared to equity markets. The observed pattern indicates that trades on the cryptocurrency exchanges originate mostly in the US during normal trading hours. Interestingly, weekend patterns are not overly different, which contrasts with the subdued trading activity observed by Bollersev and Domowitz (1993) in the foreign exchange market. These results are consistent with orders from non-algorithmic retail traders, who trade predominantly during the day.

Fig. 1 shows that volatility follows a similar intraday pattern to the number of trades ($\rho = 0.77$), but the peak and trough are not as pronounced. A significant positive relationship between trading activity and volatility is consistent with Daigler and Wiley (1999), who find a similar relation in the futures markets caused

by the greater dispersion of beliefs among uniformed traders. By contrast, informed traders with knowledge of the true value of the asset trade within a relatively small range of prices around the fair value and often decrease volatility. Since Bitcoin has no intrinsic value (Cheah and Fry, 2015; Yermack, 2015), all traders are essentially uniformed and likely to trade over a wider range of prices, leading to higher volatility. This is consistent with Dwyer (2015) who observes Bitcoin is more volatile than other markets where informed investors are more likely to be present. The time-weighted quoted spread exhibits an inverse relationship with the number of trades ($\rho = -0.39$) and volatility ($\rho = -0.24$), implying that during periods of increased trading activity volatility increases but spreads narrow. The time variation of quoted and effective spreads depicted in Fig. 2 shows that spreads vary through time and are positively related to the Bitcoin price.

4. Conclusion

We examine the investibility of Bitcoin by estimating the transaction costs and intraday trading patterns of the BTC–USD exchange rate. We find that the implicit trading costs are low, with quoted and effective spreads typically narrower than in major global equity markets. The depth is adequate for average sized transactions. Bitcoin exhibits a distinct intraday pattern with considerable trading during daytime hours. The volume of trades is positively correlated with volatility and negatively correlated with spreads. Overall, our results suggest that Bitcoin is investible, particularly for retail sized trades.

Acknowledgment

Anne Haubo Dyhrberg acknowledges financial support from the Capital Markets Cooperative Research Centre.

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