

# Bitcoin: A hub of criminal activity?

Gina Pieters\*  
Trinity University

Sofia Vivanco  
Trinity University

March 20, 2015

## Abstract

We examine bitcoin prices across seven exchanges, and find that although decentralized exchanges charge a higher premium, all seven are highly correlated. This implies that bitcoin exchanges are well integrated, and no exchange is used purely for criminal transactions. We then compare the implied USD-Euro bitcoin exchange rate to the official exchange rate, and find that bitcoin exchange rates follow official rates closely. This implies that bitcoin prices are not de-linked from standard financial markets due to criminal activity, and, as a sizeable global financial market, deserve further study.

Keywords: Bitcoin, Digital Currency, Cybercurrency Illegal Activity  
JEL Codes: G1, G2

## 1 Introduction

Despite being a sizeable market of international financial exchange, no systematic economic study of bitcoin markets has been undertaken.<sup>1</sup> Papers have focused on whether bitcoin is money (Lo and Wang (2014)), or used google trend data to determine whether it is used by criminals (Wilson and Yelowitz (ming)). In this paper we provide the first characterization of bitcoin prices across exchanges, and use it to analyze the extent of criminal content on bitcoin exchanges. Unlike most financial exchanges, bitcoin exchanges operate 24/7, current pricing data is freely available, and trades can be executed by any individual with Internet access. The only reason bitcoin prices would not equalize across markets is if a sufficient magnitude of trades were not price-based.

There are two ways bitcoins can be used as payment for criminal activities. The first involves a bitcoin market where individuals can choose to conduct a transaction with each other. The potential anonymity is more important than the market price – and the bitcoin price could be set artificially high or low as a payment requirement – so price equalization with other markets is prevented. In section (3.1) we test this by comparing prices across seven exchanges.

---

\*Contact Author. Email: gpieters@trinity.edu

<sup>1</sup>On March 15, 2015, the bitcoin economy was approximately US\$4.18 billion.

The second method involves the purchase of bitcoin to use for illicit purchases at a different location, for example Silk Road.<sup>2</sup> There is no reason to believe criminals would not seek the lowest available price for their acquisition of bitcoins, so these purchases would not interfere with price equalization forces across bitcoin markets. We therefore compare the bitcoin facilitated USD-Euro exchange rate to official USD-Euro exchange rate to see if there are any consistent deviations – since only bitcoins can be used for illicit purchases, there should be a consistent difference.

Both exercises reveal that the markets are cointegrated and highly correlated, although a notable premium exists for what we name decentralized exchanges. As only prices from decentralized exchange show signs of being distorted by criminal activities, and those distortions are only in levels not trends, bitcoins present a new globally traded financial asset that deserves further study.

## 2 Bitcoins

### 2.1 What are Bitcoins?

Bitcoins are a digital currency, also called a cybercurrency. Every Bitcoin is a string containing numbers and letters that identifies it within the bitcoin economy. Bitcoins are mathematically generated; the process of solving these increasingly complex mathematical algorithms is called “mining”. Approximately 13.9 million bitcoins have been discovered. A bitcoin, or fraction thereof, can be sold for currency, used as payment for retail purchases (some bitcoin exchanges issue credit cards, and many retailers accept bitcoins), or kept as an investment vehicle. For a more detailed review, readers should consult [Velde \(2013\)](#).

### 2.2 Exchanges

Bitcoins are commonly purchased through a bitcoin trading site (“exchange”).<sup>3</sup> Once an exchange account is created, users are granted a “wallet” to store both bitcoins and currencies accepted on the exchange. Each wallet is associated with a particular exchange, so users must transfer contents between wallets for use on different exchanges.

We identify three types of exchanges: Clearing, Decentralized, and Centralized. In the most common type, “clearing” exchanges, buyers and sellers post prices, and the exchange electronically matches the bid with the closest acceptable offer. The five clearing exchanges are btc-e, itbit, HitBTC, Kraken, and The Rock. Unusually, btc-e charges for bitcoin wallet transfers.

On the decentralized exchange, LocalBitcoin, buyers and sellers select who they trade with. LocalBitcoin lists individual offers by username, price, and zipcode. This makes decentralized exchanges the likeliest venue of direct payment for criminal activity. Even after limiting ourselves to transactions in US dollars, a non-exhaustive list of

---

<sup>2</sup>Silk Road was not a bitcoin exchange, it was an online marketplace for the sale of drugs and other illegal activities where transactions were conducted in bitcoins to reduce the ability of law enforcement to trace payments.

<sup>3</sup>Early exchanges involved transaction risk: Buyers could reverse payments; and sellers disappear without transferring bitcoins. All exchanges we study have implemented security safeguards to prevent this.

payment options includes cash deposit into a bank account, transfer through paypal, or a face-to-face meet. Unlike other exchanges, LocalBitcoin does not provide an online platform for bitcoin-currency swaps.

Users on the “centralized” exchange ANXBTC never transact with each other. Instead, they submit the number of bitcoins to buy or sell to the ANXBTC exchange, and then have 30 seconds to accept a quoted price for their trade.<sup>4</sup>

### 3 Empirical Evidence

We obtain bitcoin price data from [Bitcoincharts.com](http://Bitcoincharts.com), selecting data for seven exchanges reporting 200 or more days of transactions in both USD and Euro’s between January 1 and December 31, 2014, limited to dates all seven report trades. We apply a 3 observation smoothing filter to the volume weighted daily price data, measured from midnight to midnight. The pricing data is freely available to the public. Exchange rate data comes from [Oanda.com](http://Oanda.com), which reports the average exchange rate over a 24 hour period of global trading, seven days of the week.

#### 3.1 Bitcoin Prices

Figure (1) shows the high, low, and average bitcoin price in USD for one day, February 6, 2014. LocalBitcoin prices clearly look different. Table (1) summarizes the bitcoin prices in both USD and Euro’s, the correlation across exchanges, and reports results from the OLS regression

$$B_{i,t}^C = \beta B_{HitBTC,t}^C + c \quad (1)$$

using the bitcoin price on exchange  $i$  at time  $t$  in currency  $C$ ,  $B_{i,t}^C$ . If markets were perfectly linked,  $c = 0$ ,  $\beta = 1$ . HitBTC prices are used as it has the lowest price volatility of the four normal exchanges.

LocalBitcoin posts the highest average price, median price, and standard deviation in both USD and Euro, and the lowest  $R^2$ . Despite this level difference, Johansen cointegration tests confirm the existence of a cointegrating relationship between the HitBTC prices and every other exchanges prices, which is corroborated by both the very high correlations and  $R^2$  values. Therefore, while it is highly likely there are direct criminal payments taking place on LocalBitcoin, these are not sufficient in relative magnitude to de-couple LocalBitcoin from the other exchanges.

#### 3.2 USD to Euro Bitcoin Exchange Rate

A bitcoin price is a floating exchange rate between a bitcoin and the transaction currency, for example 1 Bitcoin=US\$500. The bitcoin exchange rate,  $E_{i,t}^B$ , between the Euro and the US dollar is calculated using

$$E_{i,t}^B = \frac{B_{i,t}^{Euro}}{B_{i,t}^{USD}} \quad (2)$$

---

<sup>4</sup>Stop and limit orders are available on all exchanges except LocalBitcoin.

As we cannot track bitcoin transfers between wallets, we must assume that trades occur on the same exchange. This underestimates gains from using bitcoin instead of the official exchange rate, which may be why we find both positive and negative gains,  $G_{i,t}$

$$G_{i,t} = \frac{E_{i,t}^B - E_t^O}{E_t^O} \quad (3)$$

Figure (2) depicts a possible LocalBitcoin transaction on 9 December 2014. US dollars are changed into Euro's using the official exchange, the Euro's are used to buy 1 bitcoin which is sold for USD. The absolute value of the gain from this transaction is 5.19%.

A visual analysis of exchange rates and gains can be conducted using Figure (3), while a summary of gains, correlation, and regression results using the official exchange rate can be found in Table (2). All exchanges except LocalBitcoins report both positive and negative gains, with the average ranging from -5.81% to 1.60%.

Table (3) shows transfer and trading fees associated with each bitcoin exchange. Wallet transfers of *bitcoins* are free except on btc-e. We select bank wires as the currency transfer method, instead of virtual (paypal) or credit card as it is available for all exchanges. As LocalBitcoin does not accept currency deposits it has no transfer fees. Euro transfer fees depend upon whether the originating bank is in a SEPA-zone.<sup>5</sup> Trading fees do not depend upon the currency or trade type, varying only by volume or activeness. For example, posting on LocalBitcoin – buying or selling – has a 1% fee on the posted price. Accepting has no fee.

Fees clearly do not explain the patterns of gains. The type of the exchange does, with the centralized ANXBTC posting the smallest gains, the largest deviations existing on LocalBitcoin, and the clearing exchanges inbetween. Amongst the clearing exchanges, btc-e posts the largest deviations.

Despite level differences, the bitcoin exchange rate follows the official exchange rate trend: all are correlated over 90%, with ANXBTC almost perfectly so. Johansen cointegration tests confirm the existence of a cointegrating relationship between the official exchange rate and each bitcoin exchange.

## 4 Conclusion

This work examines the pricing behaviour across seven different bitcoin exchanges. Overall, the evidence shows that the bitcoin exchanges are well integrated, both with each other and the official exchange rate. The limited exception is for the mark-ups on the decentralized exchange. This finding implies that bitcoins behave like a non-criminal market, though researchers should take care to ascertain the type of exchange from which data is gathered.

---

<sup>5</sup>Single Euro Payments Area, approximately the European Union, European Free Trade Association, Monaco, and San Marino.

## References

- Bitcoincharts.com. Website: [www.bitcoincharts.com](http://www.bitcoincharts.com). Retrieved: 1 January 2015.
- Lo, S. and Wang, J. C. (2014). Bitcoin as money? *Federal Reserve Bank of Boston: Current Policy Perspectives*, 14-4.
- Oanda.com. Website: [www.oanda.com/currency/historical-rates](http://www.oanda.com/currency/historical-rates). Retrieved: 1 January 2015.
- Velde, F. R. (2013). Bitcoin: A primer. *Chicago Fed Letter*.
- Wilson, M. and Yelowitz, A. (forthcoming). Characteristics of bitcoin users: An analysis of google search data. *Applied Economics Letters*.

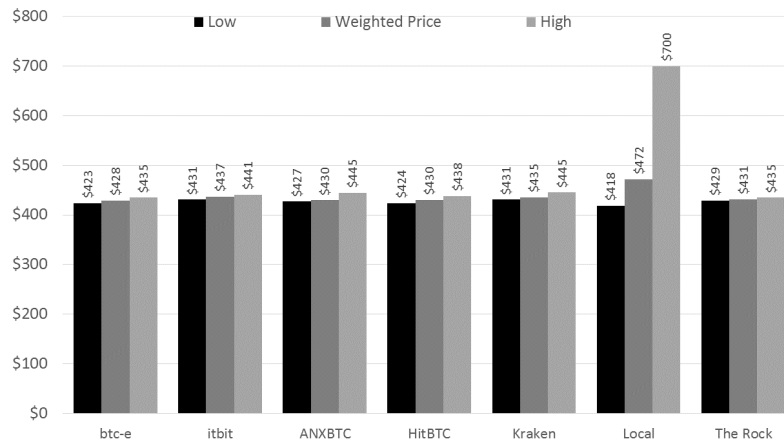


Figure 1: High, low and average USD bitcoin price, February 6, 2014

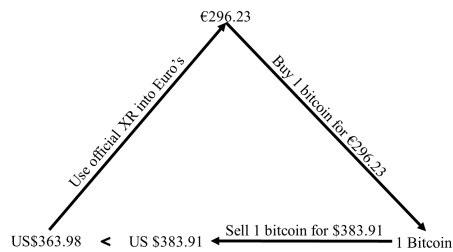


Figure 2: Exchange Rate Example

<i>USD price, 320 Observations, January 7 - December 31</i>							
<i>Summary Statistics</i>	ANXBTC	LocalBitcoin	btc-e	Kraken	itBit	HitBTC	The Rock
Average	514.56	562.42	505.55	516.37	512.46	510.13	513.66
Median	499.77	550.39	489.90	500.16	498.02	492.90	495.26
Std. Deviation	135.48	140.45	130.65	132.89	133.57	131.30	132.86
<i>Correlation</i>	ANXBTC	LocalBitcoin	btc-e	Kraken	itBit	HitBTC	The Rock
ANXBTC	1.000	-	-	-	-	-	-
LocalBitcoin	0.993	1.000	-	-	-	-	-
btc-e	0.996	0.993	1.000	-	-	-	-
Kraken	0.996	0.994	0.998	1.000	-	-	-
itBit	0.996	0.995	0.998	0.997	1.000	-	-
HitBTC	0.994	0.989	0.998	0.996	0.996	1.000	-
TheRock	0.996	0.994	0.998	0.997	0.997	0.996	1.000
<i>USD Price Regression, *** 1% significance, ** 5% significance</i>							
HitBTC Price	1.026***	1.058***	0.993***	1.007***	1.012***	-	1.008***
Constant	-8.593**	22.834***	-0.808	2.524	-4.248	-	-0.521
R <sup>2</sup>	0.988	0.978	0.995	0.990	0.991	-	0.992
<i>Euro price, 204 Observations, May 20,2014-December 31,2014</i>							
<i>Summary Statistics</i>	ANXBTC	LocalBitcoin	btc-e	Kraken	itBit	HitBTC	The Rock
Average	362.32	374.84	363.78	362.81	361.59	363.33	366.07
Median	361.60	379.76	373.98	365.17	365.85	368.05	371.82
Std. Deviation	75.72	74.86	74.12	74.33	74.97	73.99	74.28
<i>Correlation</i>	ANXBTC	LocalBitcoin	btc-e	Kraken	itBit	HitBTC	The Rock
ANXBTC	1.000	-	-	-	-	-	-
LocalBitcoin	0.990	1.000	-	-	-	-	-
btc-e	0.995	0.989	1.000	-	-	-	-
Kraken	0.997	0.989	0.998	1.000	-	-	-
itBit	0.996	0.998	0.996	0.998	1.000	-	-
HitBTC	0.996	0.988	0.998	0.999	0.997	1.000	-
TheRock	0.996	0.989	0.998	0.998	0.996	0.997	1.000
<i>EUR Price Regression, *** 1% significance, ** 5% significance</i>							
HitBTC Price	1.020***	0.999***	0.999***	1.004***	1.010***	-	1.001***
Constant	-8.106***	11.736***	0.688	-1.987**	-5.551***	-	2.209
R <sup>2</sup>	0.992	0.976	0.995	0.999	0.994	-	0.995

Table 1: Bitcoin Prices

<i>Gains Summary</i>	ANXBTC	LocalBitcoin	btc-e	Kraken	itBit	HitBTC	The Rock
Max (%)	1.065	11.430	5.709	2.215	1.270	3.537	3.953
Min (%)	-0.538	-11.319	-1.890	-5.531	-2.257	-0.757	-3.417
Average(%)	0.059	-5.807	1.601	-0.457	-0.149	0.056	0.755
Median (%)	0.028	-5.856	1.285	-0.207	-0.107	-0.037	0.675
Std. Deviation	0.210	2.831	1.454	1.233	0.571	0.515	1.320
<i>Gains Absolute Value Summary</i>							
Average (%)	0.135	6.070	1.769	0.902	0.429	0.308	1.174
Median (%)	0.070	5.915	1.336	0.627	0.342	0.176	0.971
Std. Deviation	0.172	2.207	1.243	0.955	0.404	0.415	0.965
<i>Correlation</i>	ANXBTC	LocalBitcoin	btc-e	Kraken	itBit	HitBTC	The Rock
Official	0.999	0.789	0.946	0.950	0.990	0.993	0.945
<i>USD-EUR Regression, *** 1% significance, ** 5% significance</i>							
Official XR	1.005***	0.927***	1.070***	0.930***	0.992***	1.043***	0.945***
Constant	-0.003	0.011	-0.041**	0.050***	0.005	-0.033***	0.048***
R <sup>2</sup>	0.997	0.623	0.895	0.902	0.980	0.986	0.893

Table 2: USD-EUR Exchange Rates, 188 Obs., May 20-December 31,2014

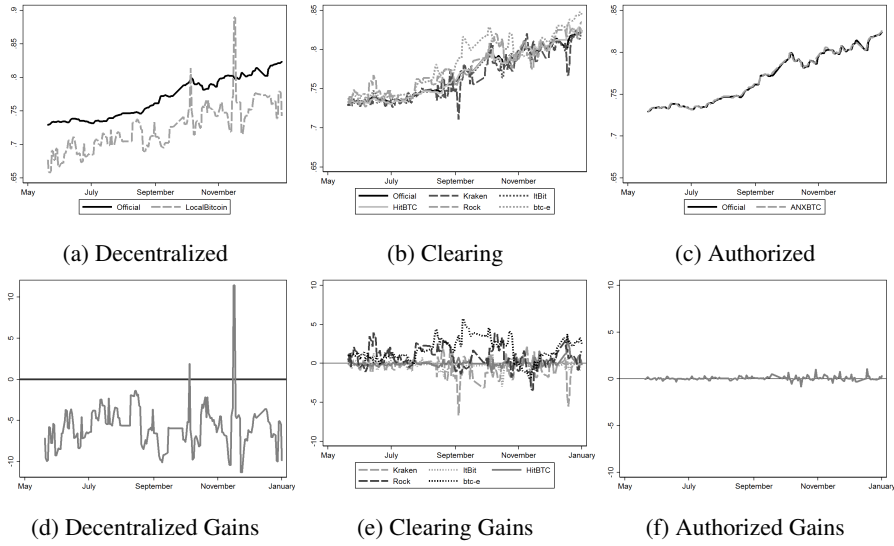


Figure 3: Official and Bitcoin USD-EUR Exchange Rate

	ANXBTC	LocalBitcoin	btc-e	Kraken	itBit	HitBTC	The Rock
Type	Centralized	Decentralized	Clearing	Clearing	Clearing	Clearing	Clearing
Trading Fee	0%	0%-1.00%	0.20%	0.10%-0.35%	0.25%-0.50%	0.10%	0.50%
Deposit Fee							
\$	0%	N/A	0%-6%	0.19%	\$5	\$9	0%
SEPA €	0%	N/A	0%-6%	0%	€3.64	0%	0%
Non-SEPA €	0%	N/A	0%-6%	€5	1%	€6	0%
Withdrawal Fee	0%						
\$	0.5%+\$25	N/A	0%-6%	0.19%	\$30	€9	0.125%
SEPA €	1%	N/A	0%-6%	0%	€8.03	0%	€1
Non-SEPA €	0.5%+€20	N/A	0%-6%	€40	€8.03	€6	0.125%
Average Abs. Gains(%)	0.135	6.070	1.769	0.902	0.429	0.308	1.174
Median Abs. Gains (%)	0.070	5.915	1.336	0.627	0.342	0.176	0.971

Table 3: Trade and Transfer Fees