

# Price Manipulation in the Bitcoin Ecosystem

Neil Gandal, **JT Hamrick**, Tyler Moore, Tali Oberman

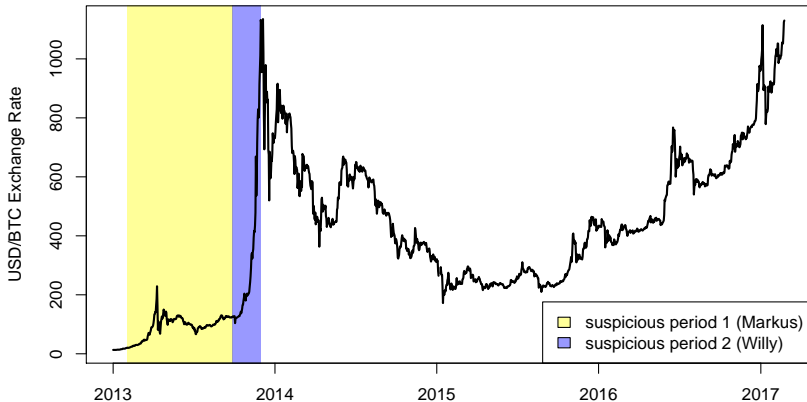
**The University of Tulsa** and Tel Aviv University

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La Jolla, California  
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# BTC-USD Exchange Rate



# BTC-USD Exchange Rate: Suspicious Trading Activity



# Suspicious Activity and Exchange Price Differences

Table: Average daily rate changes in USD-BTC exchange rate by period in \$

	2012-12-01 2013-02-28	2013-03-01 2013-05-31	2013-06-01 2013-08-31		2013-09-01 2013-11-30	
			Markus active	Markus not active	Willy active	Willy not active
Rate change	0.21	1.00	3.15	-0.51	<b>21.85</b>	<b>-0.88</b>
# days	90	92	17	75	50	41

# Outline

- 1 Identifying suspicious trading activity
  - Dataset
  - Suspicious Trader 1: Markus
  - Suspicious Trader 2: Willy
- 2 Impact of Suspicious Trading Activity
  - Summary statistics
  - Regression analysis

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# Mt. Gox



The screenshot shows the Mt. Gox website interface. At the top, a browser address bar displays "https://mtgox.com" with a security icon and the name "K.K. Tibanne [JP]". Below the address bar, a dark grey header bar contains market data: "Last price:\$93.30000", "High:\$93.80000", "Low:\$91.00000", "Volume:20525 BTC", and "Weighted Avg:\$92.72940". On the right of this bar is a "USD" dropdown menu. The main content area features the Mt. Gox logo on the left and a login section on the right with fields for "Username" and "Password", and a "Login" button. Below the login fields is a link "or Sign up". The central text reads "Trade with confidence on the world's largest Bitcoin exchange!" followed by a paragraph: "Mt.Gox is the world's most established Bitcoin exchange. You can quickly and securely trade bitcoins with other people around the world with your local currency!". A green "SIGN UP NOW" button is positioned below this text. To the right, there is a graphic of a computer monitor displaying a Bitcoin symbol, surrounded by a circular pattern of smaller Bitcoin symbols. At the bottom, a quote from Wikipedia states: "As of July 2011, Mt. Gox handles over 80% of all Bitcoin trade". A blue box on the right contains the text "Payments made easy."

Browser address bar: <https://mtgox.com>

Market Data: Last price:\$93.30000 High:\$93.80000 Low:\$91.00000 Volume:20525 BTC Weighted Avg:\$92.72940 USD

**MT.GOX**

Username Password Login

or Sign up

**Trade with confidence on the world's largest Bitcoin exchange!**

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**SIGN UP NOW**

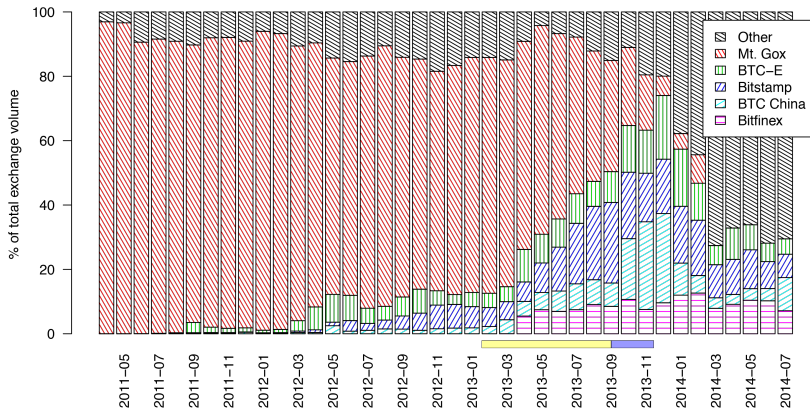
**Payments made easy.**

**"As of July 2011, Mt. Gox handles over 80% of all Bitcoin trade"**

WIKIPEDIA

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# Bitcoin Currency Exchange Market Share





# Mt. Gox Data Dump

- In early 2014, dump of 18 million matching buy and sell transactions on Mt. Gox between April 2011 and November 2013 was leaked
- Transaction fields
  - Unique trade identifier
  - Timestamp
  - Amount traded
  - Currency
  - Exchange rate
  - Internal numeric user identifier
- Deduplicated to 14 million trades by selecting unique (user ID, timestamp, transaction type, amount traded) per transaction

## Mt. Gox Data Dump

- Q: But isn't the blockchain public?
- A: Yes, but most trades never are recorded on the blockchain
- The Gox dump sheds light on internal trades on the biggest Bitcoin currency exchange
- It also links trades made by the same user

# Identifying Suspicious Trading Activity

The Willy Report x James

Secure https://willyreport.wordpress.com

## The Willy Report

Home About

### The Willy Report: proof of massive fraudulent trading activity at Mt. Gox, and how it has affected the price of Bitcoin

Posted on [May 25, 2014](#)

*This gallery contains [21 photos](#).*

Somewhere in December 2013, a number of traders including myself began noticing suspicious bot behavior on Mt. Gox.

Basically, a random number between 10 and 20 bitcoin would be bought every 5-10 minutes, non-stop, for at least a month on ... [Continue reading →](#)

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The Willy Report

Blog at [WordPress.com](#).

Y of A

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# Suspicious Trader 1: Markus

- Began buying bitcoin 2013-02-14 and became inactive 2013-09-27
- Acquired 335,898 bitcoin worth around 76 million USD on 33 days
- Only fraudulent account to buy and sell bitcoin, but mostly bought
- Never paid transaction fees
- Paid seemingly random values for bitcoin
- Records within the leaked data show altered transactions
  - Price was modified to values more consistent with exchange rate

# Suspicious Trader 1: Markus

Table: Fraudulent transactions initiated by Markus (user ID in bold)

Trade_Id	Date	User_Id	Type	Bitcoins	Money	Money_JPY
1362466099116388	2013-03-05 6:48	238168	buy	0.58932091	22.39419	2094.796
1362466099116388	2013-03-05 6:48	109955	sell	0.58932091	22.39419	2094.796
<b>1362466144485228</b>	<b>2013-03-05 06:49</b>	<b>238168</b>	buy	<b>0.3982007</b>	<b>15.13163</b>	<b>1415.442</b>
<b>1362466144485228</b>	<b>2013-03-05 06:49</b>	<b>132909</b>	sell	<b>0.3982007</b>	<b>15.13163</b>	<b>1415.442</b>
1362466154623847	2013-03-05 06:49	<b>698630</b>	buy	1.70382	15.13163	1415.442
1362466154623847	2013-03-05 06:49	96376	sell	1.70382	15.13163	1415.442
1362466154714939	2013-03-05 06:49	<b>698630</b>	buy	1	15.13163	1415.442
1362466154714939	2013-03-05 06:49	201601	sell	1	15.13163	1415.442

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# Suspicious Trader 1: Evidence for a Cover-Up

Table: Duplicate Markus Transactions

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1362466154714939	2013-03-05 06:49	<b>698630</b>	buy	<b>1</b>	<b>15.13163</b>	1415.442
1362466154714939	2013-03-05 06:49	201601	sell	1	38.11000	3564.883
1362466154714939	2013-03-05 06:49	<b>634</b>	buy	<b>1</b>	<b>38.11000</b>	3564.883



## Suspicious Trader 2: Willy

- Collection of 49 accounts with identical trading activity
- Began buying bitcoin 2013-09-27 and was active through 2013-11-30
- Traded on 50 of the 91 days in period 4
- Bought around 268,132 bitcoin for 112 million USD
  - Each rapidly bought 2.5 million USD
  - Never sold
- Abnormally high user IDs for time period
  - IDs for this time period capped around 650000
  - Willy account IDs ranged from 658152 - 832432

## Suspicious Trader 2: Willy

- Unlike for Markus, Willy did not create altered duplicate transactions
- Instead, he “bought” BTC at market rates from real users by crediting their fiat currency balance
  - Willy did not actually deposit fiat currency in his account
- In effect, this created an artificial BTC surplus at Mt. Gox and a fiat deficit
- Customers who tried to withdraw fiat were slowed by currency controls imposed by Mt. Gox

# What Motivated Willy's Behavior

## Theory 1: Pump and Dump

- Bad coding practices led to the ability to initiate costless bitcoin purchases
- After driving up the price of bitcoin, balances sold off at a profit

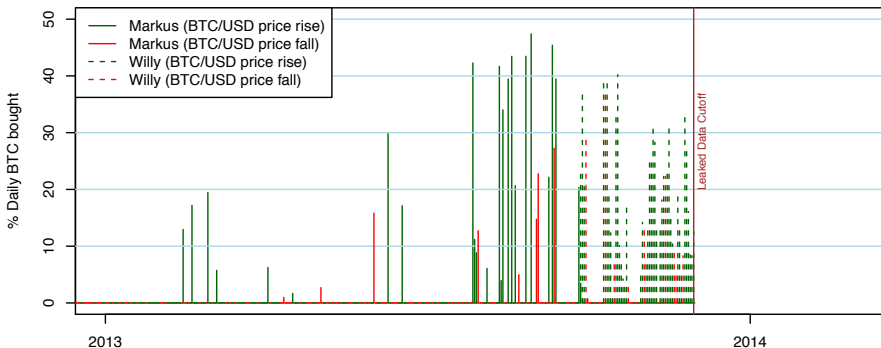
## Theory 2: Incompetence turned Ponzi scheme

- Hackers stole massive amount of bitcoin in June 2011 and Mt. Gox founder, Mark Karpales, took extraordinary steps to cover up loss.
  - Allegedly 1,000,000 BTC lost
  - Accounts bought BTC attempting to turn the BTC deficit into a fiat deficit
  - Thought to use trading fees instead of customer funds

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# Suspicious Purchases and Price Changes



**Figure:** Percentage of total daily trade volume at Mt. Gox when Willy and Markus are active; shaded green if the BTC/USD exchange rate closed higher and red otherwise.

# Daily BTC purchased by Markus and Willy

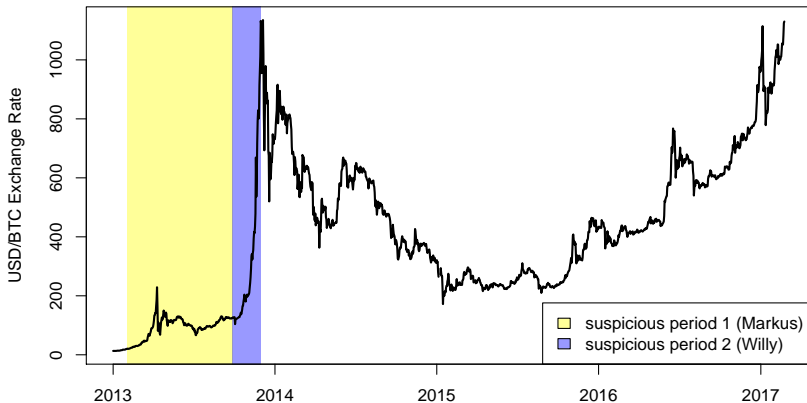
	Mean	SD	Median	Min	Max	N
Markus:						
BTC purchased	9,302	7,310	5,874	696	24,785	33
% of Mt.Gox daily trade	<b>21</b>		17			
% of total trade	12		10			
Willy:						
BTC purchased	4,962	4,462	3,881	82	26,693	50
% of Mt.Gox daily trade	<b>18</b>		15			
% of total trade	6		5			

# Suspicious Purchases and Price Changes

Table: Unauthorized activity and price changes on Mt. Gox

		Days with no STA		Days with STA	
		days	%	Days	%
Markus	Daily rate decrease	84	44	7	21
	Daily rate increase	109	56	26	79
Willy	Daily rate decrease	9	60	10	20
	Daily rate increase	6	40	40	80
Total	Daily rate decrease	93	45	17	21
	Daily rate increase	115	<b>55</b>	65	<b>79</b>

# Impact of Suspicious Trades on BTC-USD Exchange Rate





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# Regression Analysis

$$\text{RateChange}_t = \beta_0 + \beta_1 \text{Markus}_t + \beta_2 \text{Willy}_t + \beta_3 \text{DDoS}_t + \beta_4 \text{DayAfterDDoS}_t + \beta_5 \text{Other}_t + \epsilon_t$$

- *Dependent variable*: daily USD/BTC price change
- *Independent variables*
  - **Markus**: dummy variable (1 on days where Markus is active)
  - **Willy**: dummy variable (1 on days where Willy is active)
  - **DDoS**: dummy variable (1 on days with reported DDoS)
  - **Day after DDoS**: dummy variable (1 on days after reported DDoS)
  - **Other**: dummy variable (1 on days after reported non DDoS event)

## Results

Table: Examining Price Changes Within Mt. Gox and the other platforms

Independent Variables	Dependent Variable	Mt.Gox Rate Change	Bitstamp Rate Change	Bitfinex Rate Change	BTC-E Rate Change
Markus		2.79 (0.72)	3.24 (0.96)	2.06 (0.31)	2.37 (0.71)
Willy		21.65*** (6.66)	20.21*** (7.18)	19.23*** (3.63)	19.04*** (6.81)
DDoS		-2.38 (-0.55)	-1.67 (-0.44)	-1.87 (-0.26)	-2.01 (-0.54)
Day After DDoS		-3.50 (-0.80)	-3.25 (-0.86)	-2.9 (-0.41)	-2.68 (-0.72)
Other Attacks		7.16 (0.82)	5.70 (0.75)	7.35 (0.44)	5.61 (0.75)
<i>N</i>		365	365	244	0.108
adj. <i>R</i> <sup>2</sup>		0.104	0.120	0.037	0.108

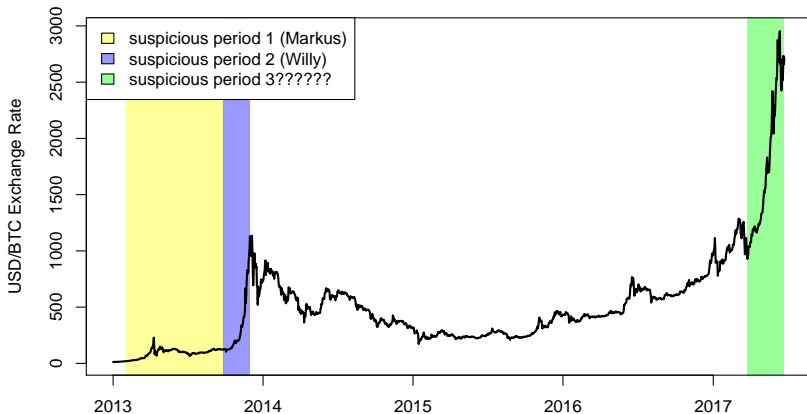
*t* statistics in parentheses

\**p* < 0.05, \*\**p* < 0.01, \*\*\**p* < 0.001

# Conclusion (1)

- Manipulations can have important, real effects
  - Unauthorized trades by a single actor caused a massive spike in USD-BTC exchange rate (from \$150 to \$1000 in two months)
  - DDoS attacks, other shocks did not affect price, but fraudulent trades did
  - Within 3 months of the fraud, Mt. Gox collapsed and the USD-BTC price fell by half

## Conclusion (2) – Why is this important?



## Conclusion (3)

- Why is this important?
  - Massive cryptocurrency market cap growth (over 1,900%)
  - Cryptocurrencies remain susceptible to fraud
  - Currency exchanges still subject to little regulatory oversight
- What should be done to prevent fraud now?
  - Exchange operators should share anonymized trade data with regulators and outside researchers
  - Operational security practices should also be audited
  - Suspicious activity, if detected early, could forestall a fraud-stoked bubble
- For more: <http://secon.utulsa.edu>