Price Manipulation in the Bitcoin Ecosystem

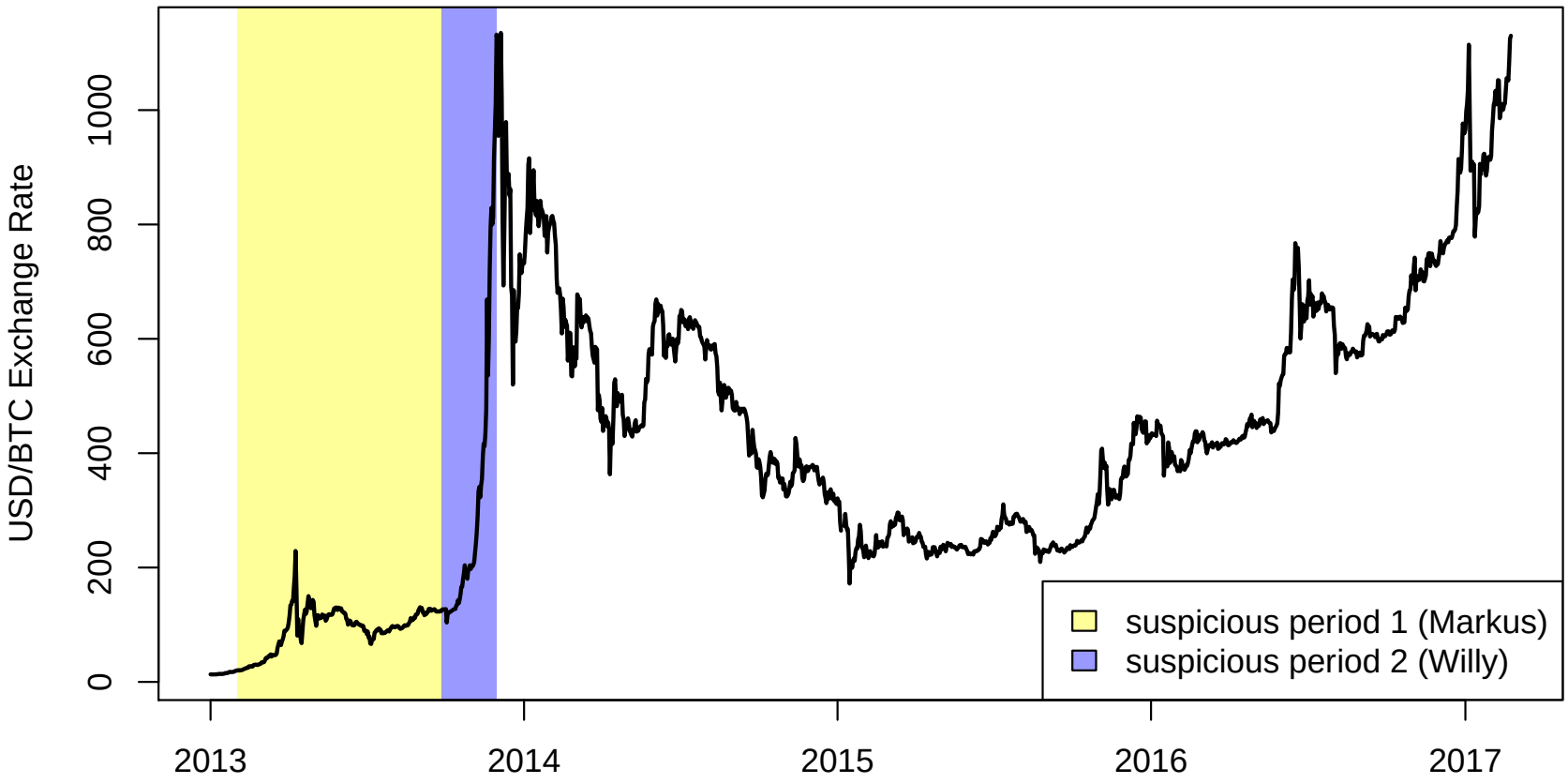
Neil Gandal, **JT Hamrick**, Tyler Moore, Tali Oberman

The University of Tulsa and Tel Aviv University

Workshop on the Economics of Information Security
La Jolla, California
June 26, 2017

BTC-USD Exchange Rate

BTC-USD Exchange Rate: Suspicious Trading Activity



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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	**21.85**	**-0.88**
# 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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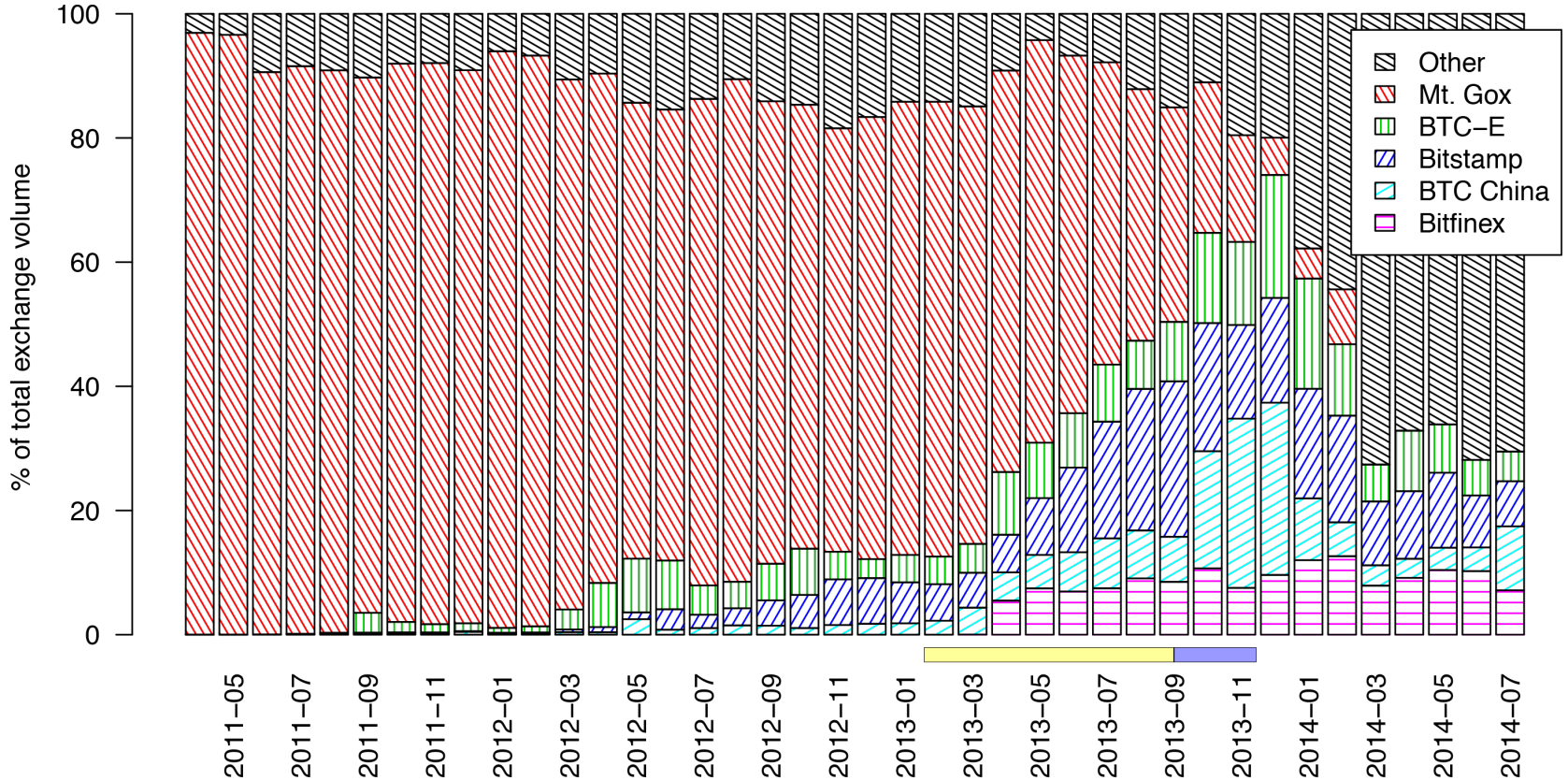
Mt. Gox

K.K. Tibanne [JP] https://mtgox.com
Last price:$93.30000
High:$93.80000
Low:$91.00000
Volume:20525 BTC
Weighted Avg:$92.72940
USD
Username
Password
Login
or Sign up
MT.GOX
Trade with confidence on the world's largest Bitcoin exchange!
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!
SIGN UP NOW
"As of July 2011, Mt. Gox handles over 80% of all Bitcoin trade"
WIKIPEDIA
Payments made easy.

Bitcoin Currency Exchange Market Share



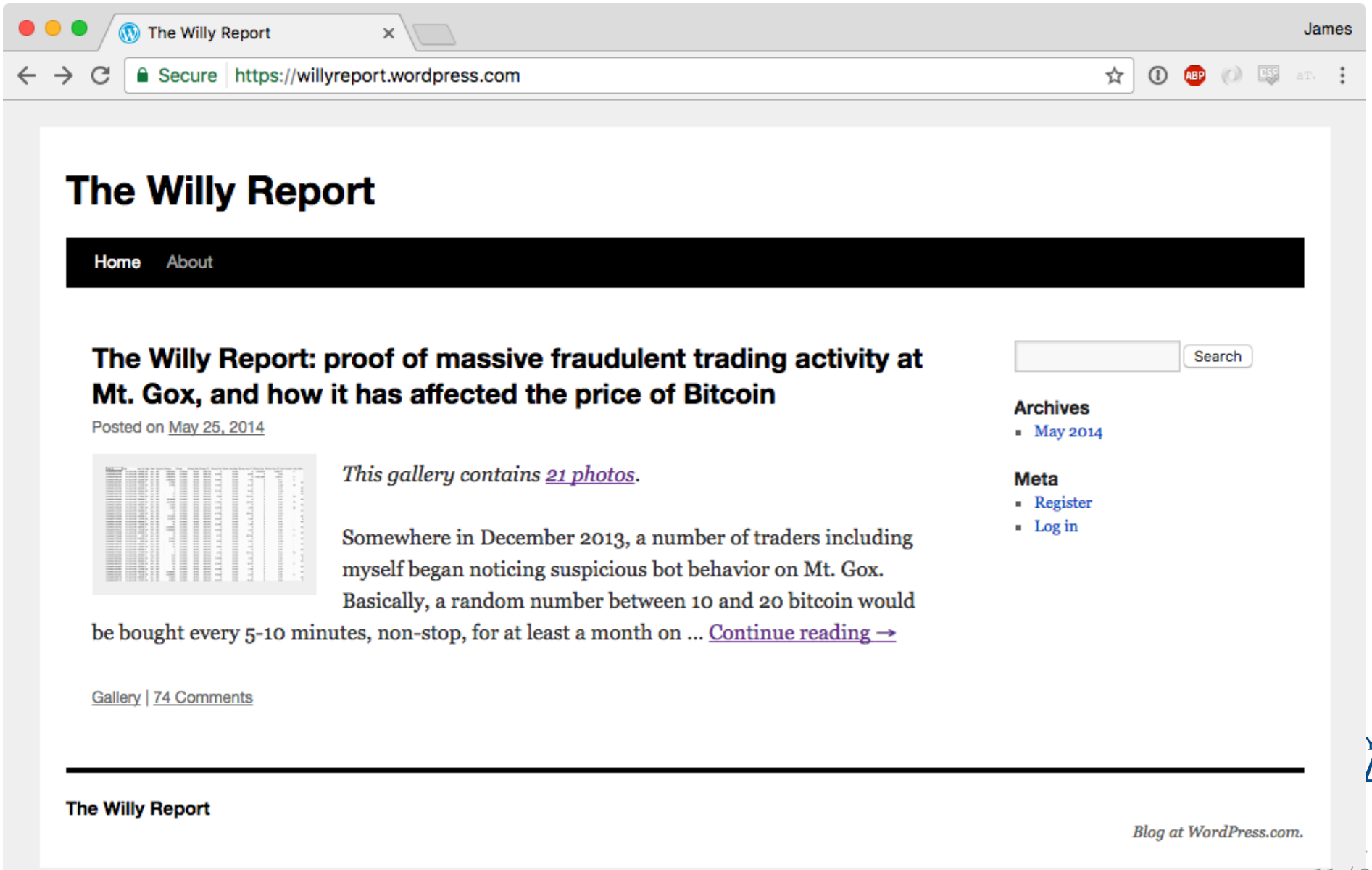
Mt. Gox Data Dump

- 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



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
1362466144485228	2013-03-05 06:49	238168	buy	0.3982007	15.13163	1415.442
1362466144485228	2013-03-05 06:49	132909	sell	0.3982007	15.13163	1415.442
1362466154623847	2013-03-05 06:49	**698630**	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	**698630**	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	**698630**	buy	**1**	**15.13163**	1415.442
1362466154714939	2013-03-05 06:49	201601	sell	1	38.11000	3564.883
1362466154714939	2013-03-05 06:49	**634**	buy	**1**	**38.11000**	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

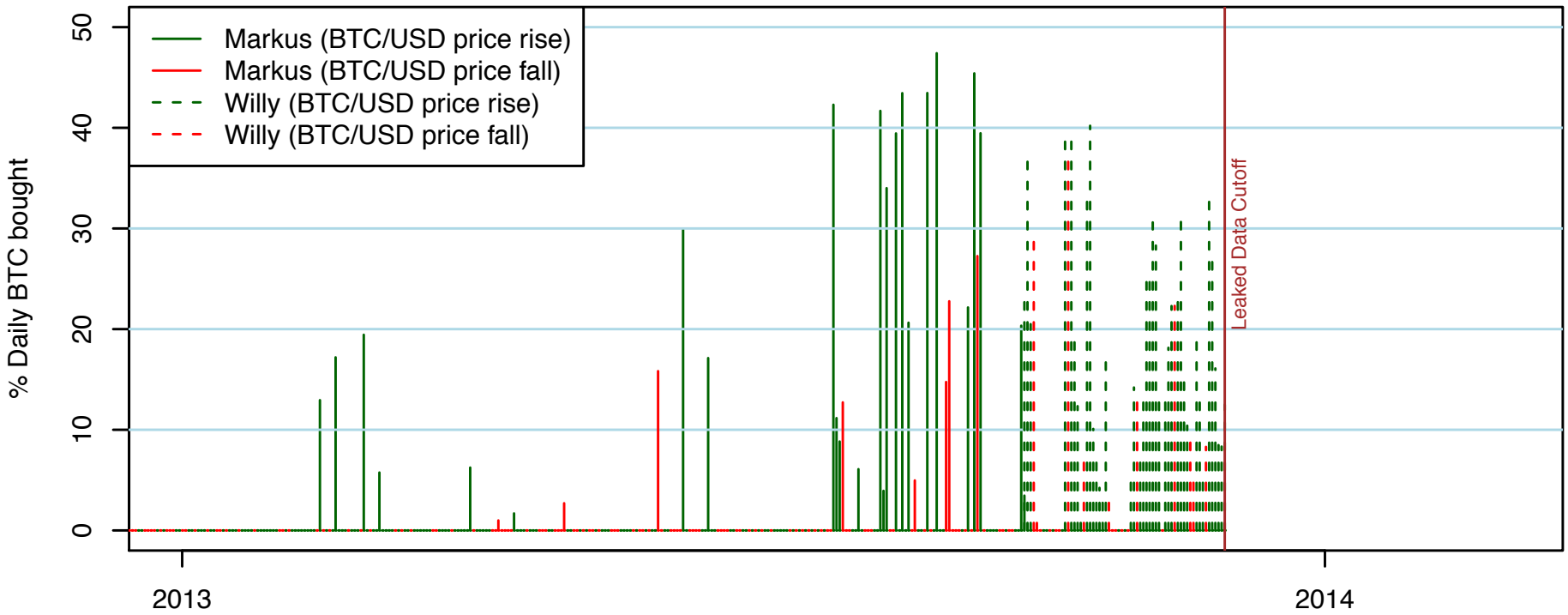

Figure: Percentage of total daily trade volume at Mt. Gox when Willy and Markus are active; shaded green if the BTC/USD exchange rate closed higher and red otherwise.

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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	**21**		17			
% of total trade	12		10			
Willy:						
BTC purchased	4,962	4,462	3,881	82	26,693	50
% of Mt.Gox daily trade	**18**		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	**55**	65	**79**

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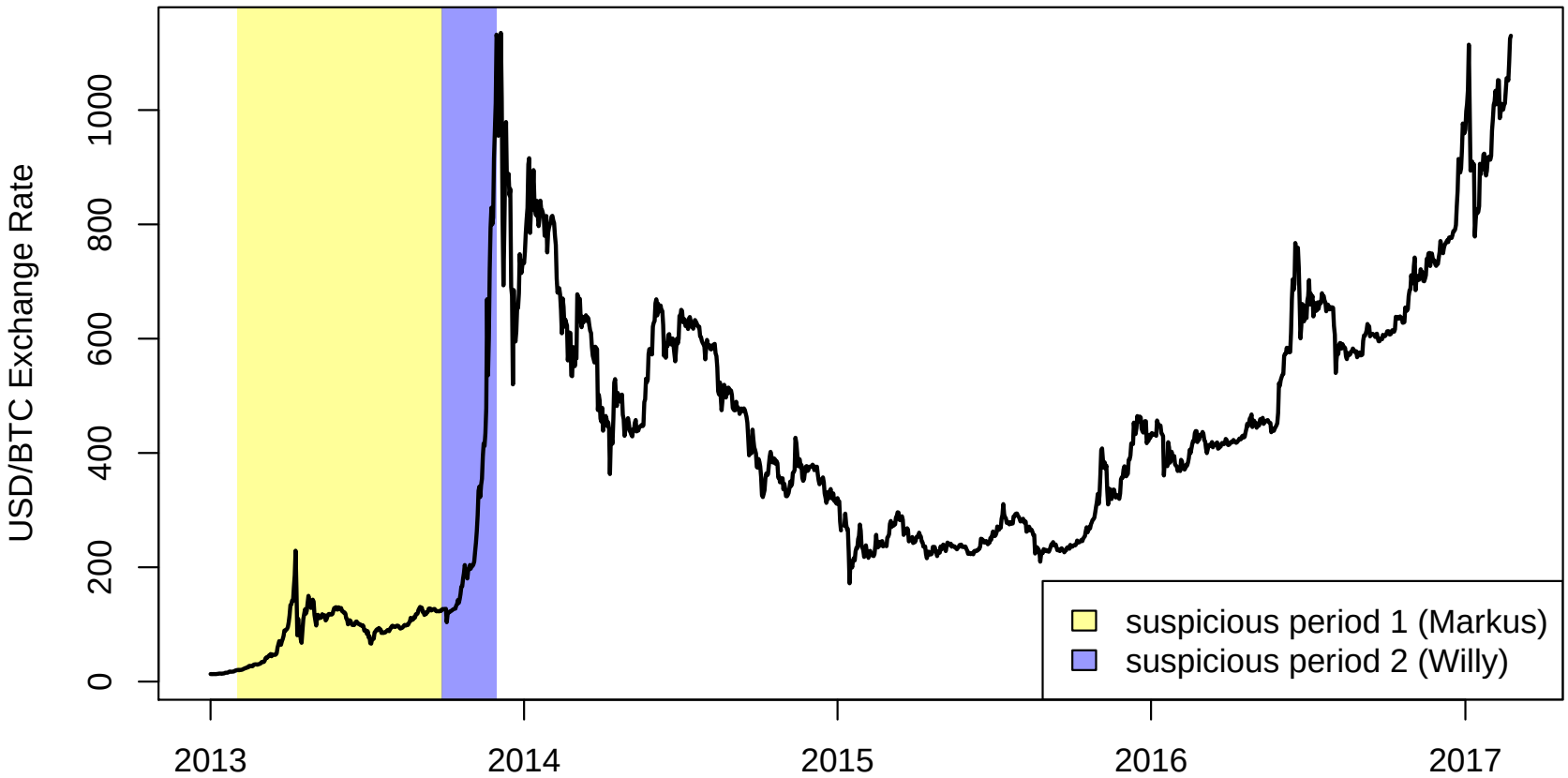
Impact of Suspicious Trades on BTC-USD Exchange Rate



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Regression Analysis

$$RateChange_t = \beta_0 + \beta_1 Markus_t + \beta_2 Willy_t + \beta_3 DDoS_t + \beta_4 DayAfterDDoS_t + \beta_5 Other_t + \epsilon_t$$

- *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

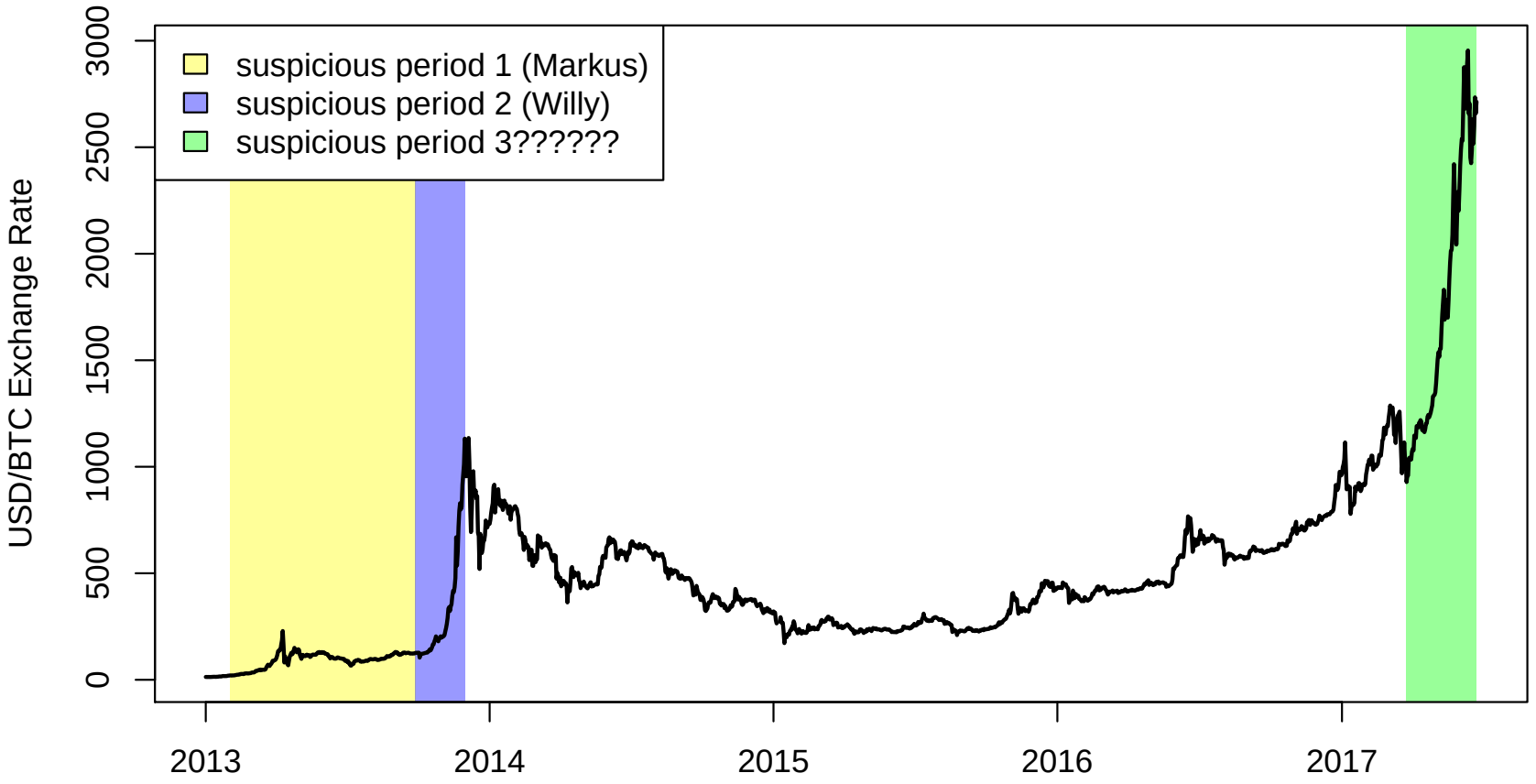
Dependent Variable / Independent Variables	Mt.Gox Rate Change	Bitstamp Rate Change	Bitfinex Rate Change	BTC-E Rate Change
Markus	2.79	3.24	2.06	2.37
	(0.72)	(0.96)	(0.31)	(0.71)
Willy	21.65***	20.21***	19.23***	19.04***
	(6.66)	(7.18)	(3.63)	(6.81)
DDoS	-2.38	-1.67	-1.87	-2.01
	(-0.55)	(-0.44)	(-0.26)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

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