

Does mining fuel bubbles?

An experimental study on cryptocurrency markets

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Motivation

- high price volatility of cryptocurrencies
- contradicts intended use as a currency
- effects might spill over to other markets
- isolating and analysing the influence of mining (PoW) with real-world data contains too many confounds
- thus, we do so using a controlled lab setting

Bitcoin Mining



Mining Farm

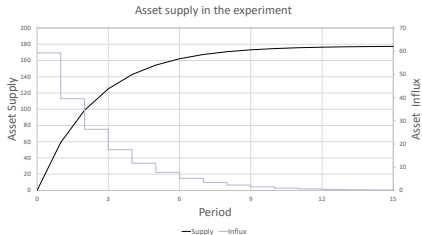
Experimental Design

		<i>Concentration</i>	
		<i>All</i>	<i>Half</i>
<i>Asset Influx</i>	<i>Gift Mining</i>	Gift-All Mining-All	Gift-Half Mining-Half

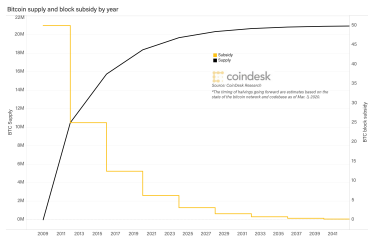
- we invite students to the labs in Frankfurt and Heidelberg
- monetary incentives for each task
- 8 participants per market, 9 markets per treatment
- continuous double auction, 15 periods of trading
- simple asset: no dividends, single redemption value at the end of the experiment
- asset generation at (weakly) increasing cost over time in Mining treatments

Asset generation

Contrasting asset supply between experimental PoW implementation and Bitcoin:



Experimental asset supply over time.



Bitcoin supply (www.coindesk.com).

Literature

Gift vs. Mining

Smith et al. (2000): trading around FV

Bostian et al. (2005): bubbles in flat FV settings, but with frequent dividends

Saleh (2019), Hinzen et al. (2020): sluggish supply

All vs. Half

Jannsen et al. (2019), Tucker and Xu (2020): larger bubbles if endowments are asymmetric

Weber and Camerer (1998): balanced portfolios

Note: Weitzel et al. (2020) show that experiments with students yield similar results as with financial professionals

Research Hypotheses

Hypothesis 1

Prices in Gift-All do not exhibit a pattern of bubbles and crashes.

Hypothesis 2

Prices in Gift-Half are higher than prices in Gift-All.

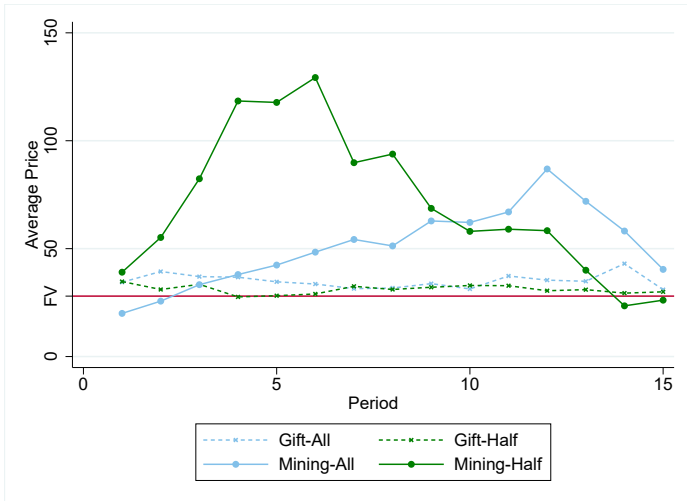
Hypothesis 3

Prices in Mining treatments are higher than prices in Gift treatments, exhibiting a pattern of bubbles and crashes.

Hypothesis 4

Prices in Mining-Half are higher than prices in Mining-All.

Prices across the four treatments



Median weighted average price per period

Bubble measure statistics

	Gift-All vs. Gift-Half	Gift-All vs. Mining-All	Gift-Half vs. Mining-Half	Mining-All vs. Mining-Half
RAD	0.546	0.004	0.003	0.666
RD	0.387	0.006	0.004	0.605
CRASH	0.673	0.005	0.001	0.606
SPREAD	0.340	0.006	0.000	0.136

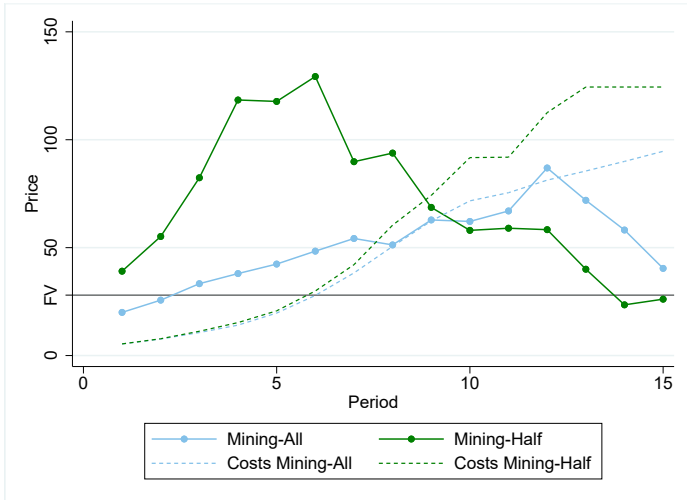
p-values of exact Mann-Whitney-U tests comparing bubble measures of different treatments (pairwise)

Effect of mining concentration

		Mining-All	Mining-Half	Mining-All vs. Mining-Half (M-W-U test)
RAD	First half	0.60	2.20	p=0.011
	Second half	1.33	0.81	p=0.436
RD	First half	0.47	2.20	p=0.008
	Second half	1.33	0.81	p=0.340

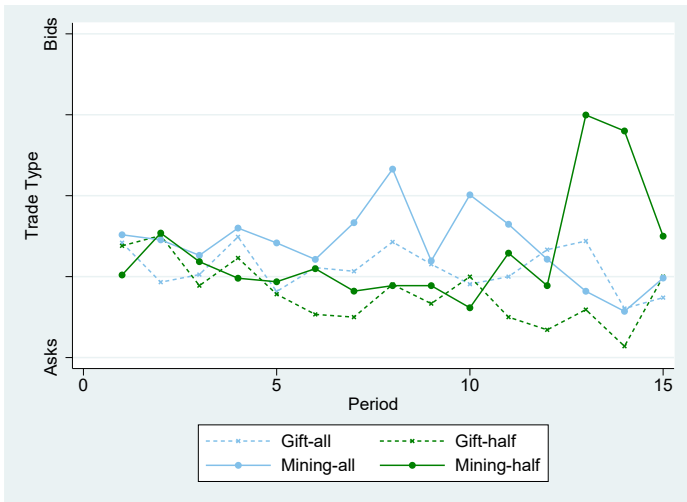
Exact Mann-Whitney-U tests of bubble measure RAD, comparing first half and second half of mining treatments.

Trading prices and asset generation costs



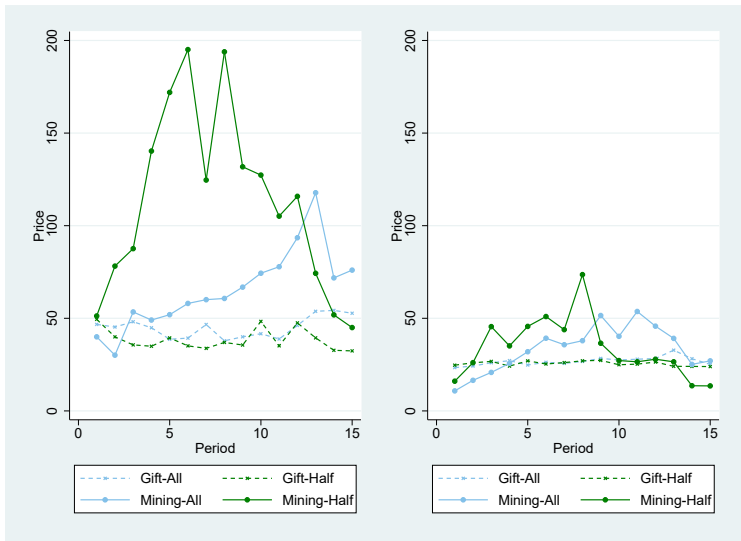
Median weighted average price and mining cost per period in Mining treatments

Order Book Analysis



Accepted trades - median ratio per treatment

Bid Ask Analysis



Median weighted average asks (left) and average bids (right) per treatment

Debriefing Survey Analysis

Do traders change their evaluation of the asset due to costly generation?

	Gift	Mining	Gift vs. Mining (M-W-U test)
own value	28	30	$p=0.0668$
market value	30	40	$p=0.0036$

Mann-Whitney-U tests of survey answers, comparing gift and mining treatments

	Miners	Non-Miners	Miners vs. Non-Miners (M-W-U test)
own value	29	30	$p=0.2402$
market value	30.5	40	$p=0.7178$

Mann-Whitney-U tests of survey answers, comparing role A and role B traders in Mining-Half

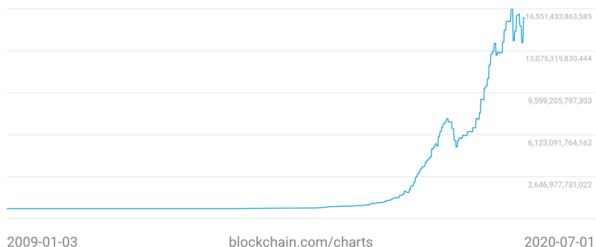
Conclusion

- generation of assets at increasing costs (as in PoW) contributes to price volatility and overpricing
- **cryptocurrencies** that are intended to be stable might need other mechanisms to ensure stability (PoS, StableCoins)
- further discussion: other mechanisms at play

Mining difficulty

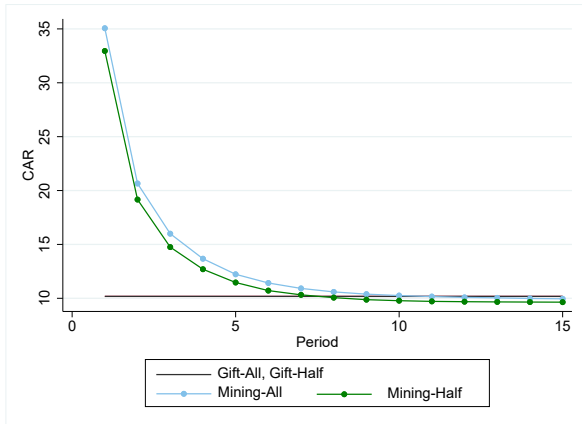
Difficulty

15,784,217,546,288



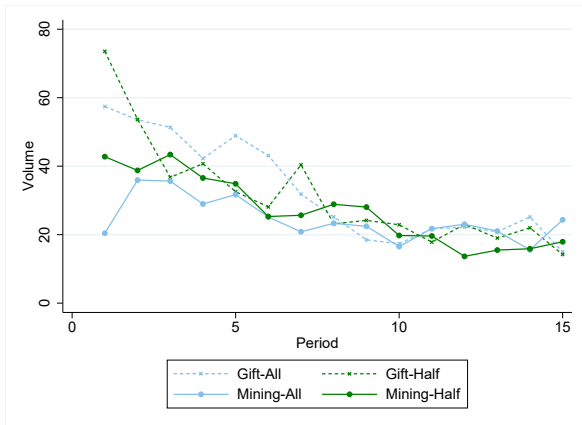
Difficulty of Bitcoin mining over time

Cash to Asset Ratio



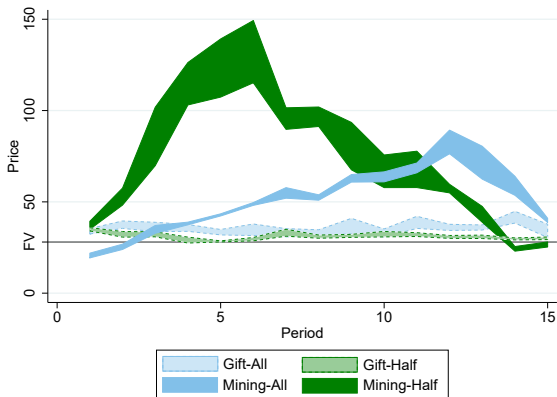
Average Cash to Asset Ratio in our treatments

Trading volumes



Average trading volume across the four treatments

Robustness



Median weighted average price per period of all but one session in all treatments, which yields eight graphs per treatment. We shade the area between the highest and lowest period prices per treatment, i.e. all eight graphs of a treatment lie within the shaded area of the respective treatment.

Bubble Measure Statistics

	Gift-All median mean (std.dev.)	Gift-Half median mean (std.dev.)	Mining-All median mean (std.dev.)	Mining-Half median mean (std.dev.)
RAD	0.4 0.5 (0.5)	0.1 0.5 (0.8)	1.0 1.9 (1.9)	2.1 2.3 (1.5)
RD	0.4 0.4 (0.5)	0.1 0.5 (0.9)	1.0 1.9 (1.9)	2.0 2.2 (1.5)
RDMAX	1.0 0.9 (0.6)	0.3 0.9 (1.4)	3.6 7.7 (10.7)	3.6 6.1 (5.2)
AMP	0.8 0.7 (0.3)	0.3 0.6 (0.6)	3.8 7.9 (10.7)	3.2 5.6 (5.0)
CRASH	-0.5 -0.6 (0.6)	-0.3 -0.7 (0.9)	-2.9 -7.5 (11.3)	-4.0 -6.2 (5.4)
TURN	0.2 0.2 (0.1)	0.2 0.2 (0.1)	0.2 0.2 (0.1)	0.2 0.2 (0.1)
LQ	0.6 0.8 (0.7)	1.0 5.5 (13.9)	0.5 0.7 (0.6)	0.8 5.2 (12.8)
SR	20.9 20.4 (4.4)	19.3 21.1 (4.9)	17.1 16.3 (3.5)	22.1 21.9 (3.5)
SPREAD	0.2 0.3 (0.2)	0.1 0.2 (0.3)	0.5 1.4 (2.3)	1.2 1.5 (1.2)
VOLA	0.2 0.3 (0.3)	0.1 0.2 (0.1)	0.3 0.3 (0.2)	0.4 0.5 (0.3)

Summary statistics of bubble measures by treatment