

# Risks and Returns of Cryptocurrency

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Working paper

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# Introduction – Backgrounds

- Cryptocurrency is receiving significant attention
- It's based on a new technology which is not fully understood.
- At least in the current form, it's similar to traditional assets.

# Introduction – Related literature

- Individual facts related to cryptocurrency:
    - Stoffels, 2017, Borri, 2018, Borri and Shakhnov, 2018, Foley, Karlsen, and Putniņš (2018), and Hu, Parlour, and Rajan, 2018
  - Develop models of cryptocurrency:
    - Weber (2016), Huberman, Leshno, and Moallemi (2017), Biais et al. (2018), Chiu and Koeppl (2017), Cong and He, 2018, Cong, Li, and Wang, 2018.....
- How should we understand cryptocurrency by standard tools of empirical asset pricing?

# Introduction – Research Problem

- Can cryptocurrency be priced by the factors available for other asset classes?
- If not, what are the potential predictors for cryptocurrency?
- Which industries may be affected by the development of blockchain technology?

# Research Design – Data

- Cryptocurrency price data: CoinDesk website.
  - **Bitcoin**: 2011.1.1~ 2018.5.31
  - **Ripple**: 2013.8.4~ 2018.5.31
  - **Ethereum**: 2015.8.7~ 2018.5.31
- Attention data:
  - Google search data series
  - Twitter post counts for “Bitcoin”: Crimson Hexagon
  - The number of Bitcoin Wallet users: blockchain.info
- Traditional data: FRB/ CRSP/ CSMAR/ .....

# Research Design

- 1. Risk Exposure
  - CAPM/ FF3/ C4/ FF5/ FF6
  - Currency: Australia/ Canada/ Euro/ Singapore/ UK
  - Precious Metal Commodities: Gold/ Platinum/ Silver
  - Factor Zoo (155 factors)
  - Macroeconomic Factors:
    - Non-durable consumption growth
    - Durable consumption growth
    - Industrial production growth
    - Personal income growth

# Research Design

- 2. Cryptocurrency Specific Factors
- Cryptocurrency momentum
  - Daily/ Weekly momentum
  - Group weekly returns into quantiles and evaluate performance
  - Group and evaluate out-of-sample performance (calculate the cutoffs by the first two years of data)
- Cryptocurrency investor attention
  - Proxy: Deviation of Google searches in a given week compared to the average of the preceding 4 weeks
  - Group and evaluate performance / out-of-sample performance
  - Whether returns influence attention?  $R_{t-i} \sim \text{Google deviation}$



# Research Design

- 2. Cryptocurrency Specific Factors
- Negative investor attention
  - Proxy: “bitcoin hack”/ “bitcoin” (normalized)
- Crypto Price-to-Dividend
  - Fundamental value proxy: the number of Bitcoin Wallet users
- Realized volatility
- Supply factors
  - Electricity: US listed electricity industries/ value-weighted stock returns of the China-listed electricity industries/ Sinopec stock returns
  - Computer power: the stock returns of the companies that are major manufacturers of GPU/ASIC mining chips

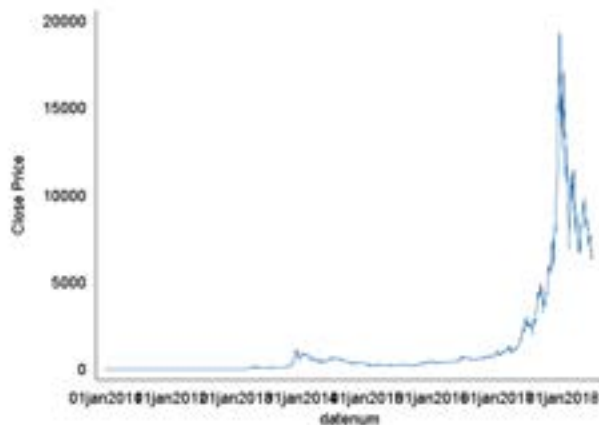
# Research Design

- 3. Industry Exposures to Bitcoin Risk
  - Fama French 30 industry groups
  - 354 SIC industries in US and 137 CIC industries in China

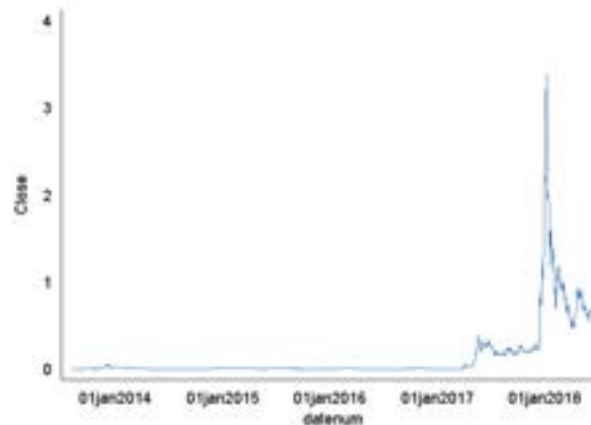
# Empirical Results

- Basic Characteristics

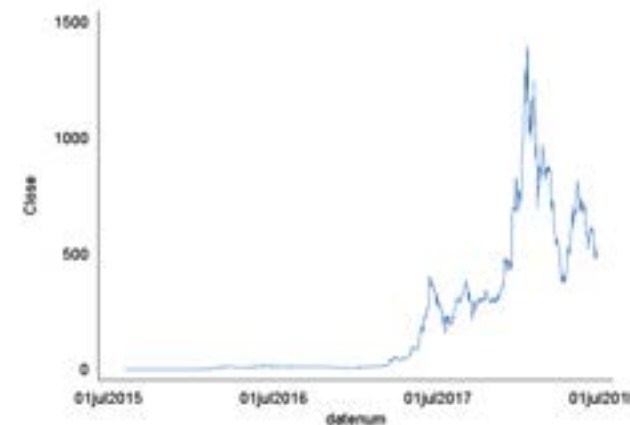
**Figure 1: Price Movements**



**(a)** Bitcoin



**(b)** Ripple



**(c)** Ethereum

## • Basic Characteristics

**Table 1:** Bitcoin Returns Summary Statistics and Comparison with Traditional Asset Classes

Monthly	Mean	SD	T-Statistics	Sharpe	Skewness	Kurtosis	% Return >0
Bitcoin	21.60%	69.46%	2.95	0.31	4.32	25.38	60.00
Stock	1.08%	3.24%	3.12	0.33	-0.10	3.78	68.89
Stock*	0.91%	4.27%	5.36	0.12	-0.51	5.02	62.16
Bond	0.95%	3.00%	2.18	0.32	-0.10	2.73	64.58
Housing	0.40%	0.72%	5.15	0.55	-0.01	3.17	73.56
<b>Ripple</b>							
Monthly	36.20%	143.31%	1.94	0.25	3.82	18.69	40.68
<b>Ethereum</b>							
Monthly	30.26%	67.56%	2.65	0.53	1.24	3.95	54.29

- Both the means and the standard deviations are an order of magnitude higher than those for traditional asset classes.
- Ripple and Ethereum returns have higher mean and SD, but comparable Sharpe

# Empirical Results——Risk Exposure

- (1) Stock factor loadings

**Table 5:** Bitcoin Returns Factor Loadings

(Percentage)	CAPM	3-Fac	4-Fac	5-Fac	6-Fac
ALPHA	18.91**	18.20**	17.66**	16.72**	15.98*
	(2.42)	(2.30)	(2.18)	(2.07)	(1.94)
	[2.55]	[2.34]	[2.28]	[2.61]	[2.54]
MKTRF	3.34	3.79	4.00	4.57*	4.85*
	(1.45)	(1.56)	(1.60)	(1.81)	(1.86)
	[1.94]	[2.08]	[1.94]	[2.14]	[2.06]
SMB		-1.29	-1.26	0.45	0.55
		(-0.36)	(-0.35)	(0.12)	(0.14)

- The alphas for all the considered models are statistically significant. But exposures to factors are not significant.

# Empirical Results——Risk Exposure

- (1) Stock factor loadings

	Ethereum Return				
(Percentage)	CAPM	3-Fac	4-Fac	5-Fac	6-Fac
ALPHA	31.42**	33.04***	35.69***	31.55***	33.28***
	(2.49)	(2.82)	(3.19)	(2.80)	(2.99)
	[2.54]	[2.93]	[2.93]	[2.57]	[2.70]
MKTRE	1.61	2.04	-0.86	2.86	0.50
HML		-10.25**	-13.65**	-15.15**	-16.05***
		(-2.07)	(-2.74)	(-2.69)	(-2.89)
		[-1.66]	[-1.83]	[-2.10]	[-2.38]

- In contrast to Bitcoin, there is significant large negative loadings on the HML factor for Ripple and Ethereum, suggesting returns may comove more with growth rather than with value firms.

# Empirical Results——Risk Exposure

- (2) Currency

Panel A: Bitcoin	(1)	(2)	(3)	(4)	(5)
APLHA	23.79***	24.27***	23.68***	23.41***	23.95***
	(3.23)	(3.28)	(3.23)	(3.20)	(3.27)
	[2.82]	[2.86]	[2.75]	[2.71]	[2.69]
AUSTRALIA	1.46				
	(0.66)				
	[0.56]				
CANADA		3.51			
		(0.84)			
		[0.92]			

- The exposures of all other cryptocurrencies to these commodities are not statistically significant and the alpha estimates barely change.

# Empirical Results——Risk Exposure

- (3) Precious Metals Commodities

Panel A: Bitcoin	(1)	(2)	(3)
APLHA	22.32*** (2.97) [3.01]	22.53*** (2.75) [3.49]	22.54*** (2.98) [3.01]
GOLD	-0.59 (-0.39) [-0.26]		
PLATINUM		24.05 (0.22) [0.29]	
SILVER			0.08 (0.10) [0.05]
R-Squared	0.00	0.00	0.00



# Empirical Results——Risk Exposure

- (4) Factor Zoo

We find that only 4 out of the 155 factors are significant, but those 4 factors do not form any discernible patterns.

- (5) Macroeconomic Factors

For Bitcoin and Ripple, all of the exposures are not statistically significant. For Ethereum, notably, the durable consumption growth factor has a significant loading

Panel C: Ethereum	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)
$\alpha$	0.19 (1.03) [1.58]	0.22** (2.59) [3.40]	0.17* (1.88) [2.86]	0.22* (1.70) [2.51]	0.17 (0.94) [1.46]	0.19** (2.16) [2.97]	0.13 (1.41) [2.48]	0.24* (1.86) [2.54]
$\Delta c^{nd}$	-7.52 (-0.16) [-0.24]				-11.22 (-0.24) [-0.27]			
$\Delta c^d$		-17.59** (-2.11) [-2.71]				-16.91* (-2.04) [-2.27]		

# Empirical Results

## — — Cryptocurrency Specific Factors

- 1. Cryptocurrency Momentum

Panel A							
Daily	$R_{t+1}$ (1)	$R_{t+2}$ (2)	$R_{t+3}$ (3)	$R_{t+4}$ (4)	$R_{t+5}$ (5)	$R_{t+6}$ (6)	$R_{t+7}$ (7)
$R_t$	0.06*** (2.96) [1.22]	-0.02 (-1.14) [-0.71]	0.03* (1.71) [0.80]	0.02 (1.22) [0.95]	0.07*** (3.51) [2.00]	0.08*** (4.14) [2.97]	-0.03 (-1.58) [-0.97]
R-Squared	0.00	0.00	0.00	0.00	0.01	0.01	0.00

Panel B				
Weekly	$R_{t+1}$ (1)	$R_{t+2}$ (2)	$R_{t+3}$ (3)	$R_{t+4}$ (4)
$R_t$	0.19*** (3.73) [2.17]	0.22*** (4.52) [2.73]	0.21*** (4.26) [2.47]	0.09* (1.72) [1.40]
R-Squared	0.03	0.05	0.05	0.01

- there is very strong evidence of momentum at various time horizons.
- Little difference on time horizons for Ripple and Ethereum

# • 1. Cryptocurrency Momentum

**Table 15:** Time-Series Momentum by Groups

Weekly Level (Percentage)							
Rank	Formation Return	$R_{t+1}$	T-Statistics	Sharpe	$R_{t+2}$	T-Statistics	Sharpe
Low	-14.95	2.60*	(1.69)	0.19	-1.23	(-0.89)	-0.10
2	-2.56	0.27	(0.19)	0.02	4.40**	(2.32)	0.26
3	1.84	1.15	(0.87)	0.10	2.92**	(2.52)	0.29
4	7.59	3.75*	(2.20)	0.25	2.62*	(1.71)	0.19
5	27.44	11.22***	(3.95)	0.45	10.05***	(3.52)	0.40
Difference		8.62			11.28		

**Table 17:** Time-Series Momentum by Groups – No Lookahead

Weekly Level (Percentage)							
Rank	Formation Return	$R_{t+1}$	T-Statistics	Sharpe	$R_{t+2}$	T-Statistics	Sharpe
Low	-14.97	3.35*	(1.82)	0.25	0.09	(0.05)	0.01
2	-2.88	0.39	(0.31)	0.04	0.78	(0.65)	0.09
3	1.77	1.33	(0.91)	0.11	3.52***	(2.75)	0.33
4	8.12	3.25**	(2.10)	0.28	2.87	(1.60)	0.22
5	24.14	7.88**	(2.70)	0.37	8.32***	(2.83)	0.39
Difference		4.53			8.23		

## • 2. Cryptocurrency Investor Attention

Google search data for “Bitcoin” minus the average of previous four weeks, normalized.

Weekly	$R_{t+1}$ (1)	$R_{t+2}$ (2)	$R_{t+3}$ (3)	$R_{t+4}$ (4)	$R_{t+5}$ (5)	$R_{t+6}$ (6)	$R_{t+7}$ (7)
$Google_t$	1.84** (2.17) [1.76]	2.30*** (2.81) [2.07]	1.04 (1.25) [0.76]	0.59 (0.72) [0.54]	1.03 (1.25) [1.00]	-0.01 (-0.01) [-0.01]	-1.30 (-1.39) [-1.34]
R-Squared	0.01	0.02	0.00	0.00	0.00	0.00	0.01

**Table 20:** Google Searches by Groups

Weekly Level (Percentage)							
Rank	Google	$R_{t+1}$	T-Statistics	Sharpe	$R_{t+2}$	T-Statistics	Sharpe
Low	-0.71	1.07	(0.74)	0.08	0.34	(0.23)	0.03
2	-0.05	-1.20	(-1.06)	-0.11	0.24	(0.20)	0.02
3	-0.01	3.92**	(2.26)	0.24	4.23***	(2.75)	0.29
4	0.04	6.03**	(2.65)	0.35	5.21**	(2.36)	0.31
5	0.87	11.20***	(3.95)	0.48	8.99***	(3.17)	0.39
Difference		10.13			8.66		

- 2. Cryptocurrency Investor Attention

**Table 25:** Google Searches and Past Returns

Weekly	$Google_t$ (1)	$Google_t$ (2)	$Google_t$ (3)	$Google_t$ (4)	$Google_t$ (5)
$R_t$	0.01*** (3.64)	0.01*** (2.91)	0.01*** (2.73)	0.01*** (2.94)	0.01*** (2.93)
$R_{t-1}$		0.01*** (4.04)	0.01*** (3.90)	0.01*** (4.12)	0.01*** (4.17)
$R_{t-2}$			0.00 (0.63)	0.00 (0.82)	0.00 (0.93)
$R_{t-3}$				-0.00 (-1.59)	-0.00 (-1.50)
$R_{t-4}$					-0.00 (-0.68)
R-Squared	0.03	0.07	0.07	0.08	0.098

- The deviations in Google searches are significantly associated with the contemporaneous and previous weeks Bitcoin returns.
- Twitter have similar results

# Empirical Results

## — — Cryptocurrency Specific Factors

### • 3. Negative Investor Attention

Table 28: Bitcoin Hack

Weekly	$R_{t+1}$ (1)	$R_{t+2}$ (2)	$R_{t+3}$ (3)	$R_{t+4}$ (4)	$R_{t+5}$ (5)	$R_{t+6}$ (6)	$R_{t+7}$ (7)
$Hack_t$	-2.75*** (-3.30) [-3.53]	-2.26*** (-2.70) [-2.52]	-1.86** (-2.20) [-2.01]	-1.54* (-1.82) [-1.85]	-2.18** (-2.58) [-2.58]	-1.18 (-1.43) [-1.38]	-0.96 (-1.16) [-0.88]
R-Squared	0.03	0.02	0.01	0.01	0.02	0.01	0.00

Weekly Level (Percentage)							
Rank	Hack	$R_{t+1}$	T-Statistics	Sharpe	$R_{t+2}$	T-Statistics	Sharpe
Low	-1.21	8.62***	2.91	0.33	8.18***	3.17	0.36
2	-0.65	5.59***	2.69	0.30	4.23*	1.76	0.20
3	-0.11	2.36	1.54	0.18	2.16	1.26	0.15
4	0.49	1.14	1.28	0.14	3.09***	3.13	0.35
5	1.54	1.09	1.11	0.13	1.09	1.11	0.13
Difference		-7.52			-7.09		

# Empirical Results

## — — Cryptocurrency Specific Factors

- 4. Crypto Price-to- “Dividend” and Crypto Volatility

Table 30: Bitcoin Market Price-to-“Dividend” Ratio

Bitcoin	Predictive regression at the daily level						
	$R_{t+1}$ (1)	$R_{t+2}$ (2)	$R_{t+3}$ (3)	$R_{t+4}$ (4)	$R_{t+5}$ (5)	$R_{t+6}$ (6)	$R_{t+7}$ (7)
Bitcoin PD	0.13 (1.34)	0.05 (0.49)	-0.13 (-1.36)	-0.12 (-1.25)	0.05 (0.57)	0.09 (0.99)	0.05 (0.55)
R-Squared	0.00	0.00	0.00	0.00	0.00	0.00	0.00

- There is very weak relation between the future Bitcoin returns and the current price-to-“dividend” ratio.

# Empirical Results

## — — Cryptocurrency Specific Factors

- 4. Crypto Price-to- “Dividend” and Crypto Volatility

**Table 31:** Market Volatility as Predictor

Bitcoin	$R_{t+1}$ (1)	$R_{t+2}$ (2)	$R_{t+3}$ (3)	$R_{t+4}$ (4)	$R_{t+5}$ (5)	$R_{t+6}$ (6)	$R_{t+7}$ (7)
Bitcoin Volatility	1.27 (1.52) [0.79]	0.79 (0.95) [0.50]	0.57 (0.69) [0.38]	0.03 (0.03) [0.02]	0.02 (0.03) [0.01]	-0.21 (-0.25) [-0.18]	-0.15 (-0.18) [-0.11]
R-Squared	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ripple	$R_{t+1}$ (1)	$R_{t+2}$ (2)	$R_{t+3}$ (3)	$R_{t+4}$ (4)	$R_{t+5}$ (5)	$R_{t+6}$ (6)	$R_{t+7}$ (7)
Ripple Volatility	0.62 (1.03) [0.61]	0.97 (1.61) [1.43]	0.87 (1.45) [1.37]	1.14* (1.90) [1.37]	1.05* (1.75) [1.13]	0.99 (1.65) [1.13]	1.22** (2.03) [1.63]
R-Squared	0.00	0.00	0.00	0.00	0.00	0.00	0.00

- There is very weak relation between future cryptocurrency returns and the realized volatility for Bitcoin and Ethereum.



# Empirical Results

## — — Cryptocurrency Specific Factors

- 5. Supply Factors

**Table 32:** Cryptocurrency Return Loadings to Supply Proxies

Panel A: Bitcoin							
(Percentage)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ALPHA	0.19** (2.28) [2.65]	0.19* (2.09) [2.27]	0.20** (2.37) [2.93]	0.20** (2.37) [2.93]	0.21** (2.50) [2.79]	0.20** (2.42) [3.06]	0.20** (2.45) [2.94]
U.S. Elec	1.33 (0.56) [0.65]						
China Elec		-0.48 (-0.79) [-1.27]					

- Somewhat surprisingly, the Bitcoin and Ripple returns are not statistically significantly exposed to any of these supply factors proxies.
- There is some evidence that Ethereum returns are exposed to the AMD stock returns.

# Empirical Results

## — Industry Exposure to Bitcoin Risk

- 1. Estimating Broad Industry Exposures

x100	food	beer	smoke	games	books	hshld	clths	hlth	chems	txtls
BITCOIN	0.56	0.52	-0.27	-0.03	-0.61	0.71*	0.69	0.64*	-0.40	0.20
	(1.63)	(1.23)	(-0.39)	(-0.06)	(-1.35)	(1.87)	(1.16)	(1.81)	(-1.06)	(0.36)
	[1.23]	[0.98]	[-0.38]	[-0.08]	[-1.49]	[2.29]	[1.17]	[2.03]	[-1.08]	[0.51]
MKTRF	0.59***	0.39***	0.59***	1.36***	1.26***	0.56***	0.74***	0.84***	1.39***	1.20***
	(8.04)	(4.32)	(3.96)	(10.62)	(12.85)	(6.85)	(5.79)	(11.07)	(17.01)	(10.09)
	[8.60]	[4.41]	[4.38]	[11.52]	[14.35]	[5.65]	[4.97]	[9.15]	[14.33]	[9.29]
ALPHA	0.06	0.53*	0.59	0.11	-0.39	-0.12	0.25	0.21	-0.33	0.11
	(0.24)	(1.69)	(1.14)	(0.25)	(-1.16)	(-0.42)	(0.56)	(0.81)	(-1.15)	(0.28)
	[0.22]	[1.52]	[1.14]	[0.20]	[-1.31]	[-0.44]	[0.58]	[0.65]	[-1.01]	[0.26]
R-Squared	0.46	0.21	0.16	0.58	0.66	0.40	0.32	0.61	0.77	0.55

- The Consumer Goods (Hshld) and Healthcare (Hlth) industries are positively and statistically significantly affected while the Fabricated Products (FabPr) and Metal Mining (Mines) industries are negatively and statistically significantly affected.
- Surprisingly, the often mentioned Finance, Retail, and Wholesale industries have no statistically significant exposure, and the magnitude of the point estimates is very

# Empirical Results

## — — Industry Exposure to Bitcoin Risk

- 1. Estimating Broad Industry Exposures

**Table 36:** Country Exposure to Bitcoin Returns

x100	U.S.	Europe	Japan	AsiaExJapan	North America
BITCOIN	0.72 (1.45)	0.95 (1.42)	0.77 (1.40)	0.33 (0.46)	0.68 (1.35)
ALPHA	0.90** (2.49)	0.43 (0.89)	0.55 (1.37)	0.36 (0.69)	0.82** (2.24)
R-squared	0.02	0.02	0.02	0.00	0.02

- All positive but not statistically significant.

# Conclusion

- Cryptocurrency returns have low exposures to traditional asset classes
- The returns of cryptocurrency can be predicted by two factors specific to its markets – momentum and investors attention.
- The blockchain technology embodied in cryptocurrencies has a potential to affect a number of important industries.