

Investing with cryptocurrencies - A liquidity constrained investment approach

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The emergence of cryptocurrencies

- ▣ Satoshi Nakamoto found Bitcoin in 2009
- ▣ 1595 cryptos (10.05.2018)
- ▣ Market cap: 430 billion USD
- ▣ 24h trading volume: 22 billion USD
- ▣ Community driven currencies
- ▣ Source codes public

Crypto market: high return

CRIX - CRYPTO IndeX

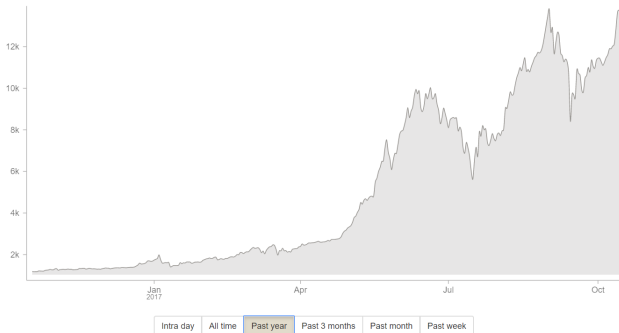
[Methodology](#)[References / Data](#)[Team](#)[Imprint](#)

Figure 1: hu.berlin/crix

Reference: [▶ Trimborn and Härdle \(2017\)](#)

Low correlation with conventional assets

	BTC	ETH	XRP	MAID	LTC	XEM	DASH	ETC	DOGE	XMR
USD/EUR	-0.01	0.00	0.04	-0.01	-0.04	0.00	0.02	0.01	-0.02	-0.04
JPY/USD	0.00	-0.02	-0.03	0.00	-0.02	-0.01	0.06	0.03	0.01	0.03
USD/GBP	-0.05	-0.05	0.03	-0.01	-0.06	-0.12	0.00	-0.01	-0.02	-0.03
Gold	0.05	0.03	0.04	0.06	0.04	0.05	0.00	-0.01	0.05	0.02
SP500	0.00	0.00	0.02	0.02	-0.01	0.00	0.05	0.01	0.03	0.05
XWD	0.02	-0.01	0.01	0.04	-0.04	0.00	0.04	0.02	0.00	0.07
EEM	-0.02	-0.03	0.02	0.01	-0.04	-0.01	0.03	0.02	0.02	0.03
REIT	0.02	-0.04	0.02	0.01	0.03	0.07	-0.02	0.01	0.00	0.01
DTB3	0.05	0.04	0.06	0.01	0.04	0.02	0.05	0.03	-0.01	0.07
DGS10	0.00	0.00	0.02	-0.04	0.01	0.01	0.02	-0.07	0.00	-0.01

Table 1: Correlations between cryptos and conventional financial assets: 3 exchange rates, gold, 3 stock indices, real estate and the US Treasury Bills Rates.

Source: [Elendner et al. \(2017\)](#)

Effect from world politics on BTC

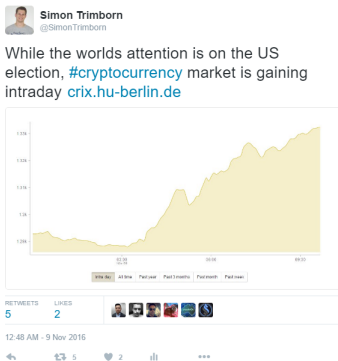


Figure 2: Possible effect of notification about Trumps election success on

Bitcoin

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Trading platforms

- Trading 24/7
- Against other crypto-currencies and USD, EUR, ruble
- Examples
 - ▶ Poloniex
 - ▶ btc-e
 - ▶ Kraken
 - ▶ ...

Initial Coin Offerings (ICO)

- Basically similar to an IPO
- Opportunity to get easy access to VC
- Only runs on Blockchains for Crypto assets
- Opportunity to collect money anonymously
- Became restricted in several countries (USA, China, Singapore)

Information platforms

- Bitcoin data: blockchain.info
- Bitcoin price: Coindesk Bitcoin price index
- Altcoin data: CoinMarketCap.com
- Altcoin ranking: CoinGecko.com
- Index data: crix.hu-berlin.de

Cryptos from an investment viewpoint I

- Elendner et al. (2017) & Yermack (2015): Cryptos show low correlation with traditional assets
- Eisl et al. (2015), Briere (2015): Bitcoin improves the risk-return trade-off of portfolios.
- Härdle and Trimborn (2015) & Trimborn and Härdle (2017): Constructing market index for cryptos (CRIX)
- Chen et al. (2017): Analyzing dynamics of CRIX

Cryptos from an investment viewpoint II

- Hafner (2018): Cryptos show frequent bubble behavior
- Scaillet et al. (2018): High tail risk
- Bouri et al. (2016): Bitcoin as hedge, safe haven or diversifier?
- Klein et al. (2018): Bitcoin is not the new gold

Challenge I: high risk

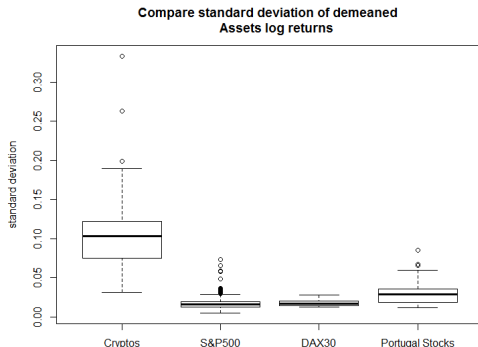



Figure 3: Cryptocurrencies have higher volatilities than stocks, highlighting the importance of risk management when investing on them  LIBRObox1

Challenge II: low trading volume

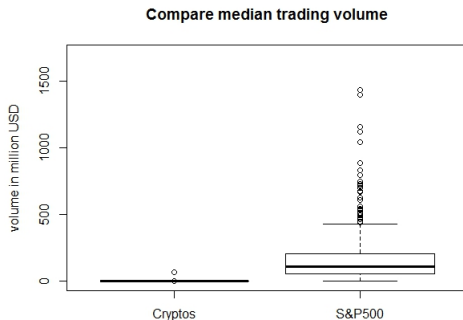



Figure 4: Cryptocurrencies have much lower trading volume compared to traditional assets  LIBRObox2

Investment strategies

- ▣ Volatility based: Markowitz
- ▣ Quantile based: Conditional Value-at-Risk
- ▣ Quantile & shrinkage: TEDAS
- ▣ LASSO: Smaller tracking portfolios

But:

- ▣ Perfect liquidity is assumed
- ▣ Might not hold in crypto markets

Challenges

- ▣ Adding low liquidity cryptocurrencies into standard portfolio
- ▣ Investment portfolios under liquidity restrictions
- ▣ How to measure liquidity?
- ▣ Errors due to chosen liquidity measure?

Outline

1. Motivation ✓
2. Optimization method
3. Data
4. Empirical results
5. Appendix

Optimization problem I

Target optimization problem:

$$\begin{aligned} \min \quad & w^\top \hat{\Sigma} w \\ \text{s.t.} \quad & \mu \leq w^\top r, \mathbf{1}_p^\top w = 1, \|w\|_1 = 1, \\ & w \leq \frac{1}{M} \cdot \widehat{Liq} = \widehat{a}, \end{aligned} \tag{1}$$

- $\widehat{Liq} = (TV_1 \cdot f_1, \dots, TV_N \cdot f_N)^\top$
- $\hat{\Sigma}$: estimated covariance matrix
- $w = (w_1, w_2, \dots, w_p)^\top$: weight on assets
- $\mathbf{1}_p^\top = (1, 1, \dots, 1)_{(1 \times p)}$
- M : investment amount
- μ : target return

Optimization problem II

Target optimization problem:

$$\begin{aligned} \min \quad & \text{CVaR}_\alpha(w) & (2) \\ \text{s.t.} \quad & \mu \leq w^\top r, \mathbf{1}_p^\top w = 1, \|w\|_1 = 1, \\ & w \leq \frac{1}{M} \cdot \widehat{Li}q = \widehat{a}. \end{aligned}$$

- $\text{CVaR}_\alpha(w) = \frac{1}{1-\alpha} \int_{f(w,r) \geq \text{VaR}_\alpha} f(w,r) p(r) dr$
- $\text{VaR}_\alpha = \inf \{r \mid F(w,r) \geq \alpha\}$

Data Information

- ▣ 42 crypto currencies
- ▣ S&P100 component (99 stocks)
- ▣ Barclays Capital US Aggregate Index (US-Bonds Index)
- ▣ S&P GSCI (Commodities Index)
- ▣ 2014-04-01 to 2017-10-30

Setting

- ▣ $f_1, \dots, f_N = 0.01$
- ▣ TV_i : Median of daily turnover values
- ▣ Expanding window for estimation, Monthly rebalanced
- ▣ Robustness test with weekly rebalancing
- ▣ Markowitz: μ chosen by $\max w^\top r / w^\top \hat{\Sigma} w$
- ▣ CVaR: μ chosen by $\max w^\top r / |\text{CVaR}_\alpha(w)|$

In-sample: CVaR & Markowitz portfolios

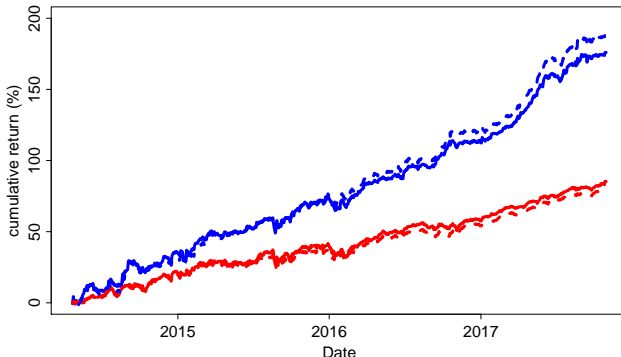


Figure 5: Lines indicate cumulative return of Markowitz (solid) and CVaR (dashed) portfolios respectively. S and S-CC portfolio.

In-sample with bounds

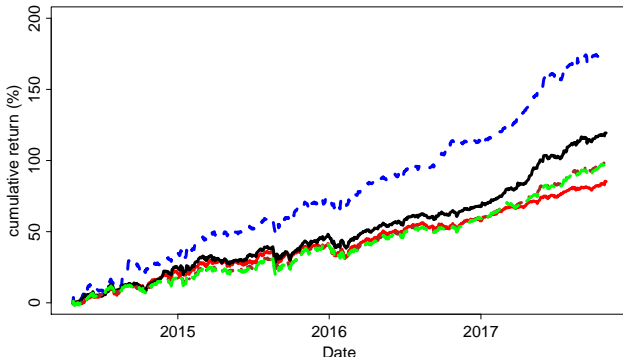


Figure 6: S and S-CC Markowitz portfolios are without liquidity constraints, the remaining 3 portfolios are S-CC ones containing the bounds $M = 1 \times 10^5$ USD, $M = 1 \times 10^6$ USD, $M = 1 \times 10^7$ USD.

In-sample with bounds

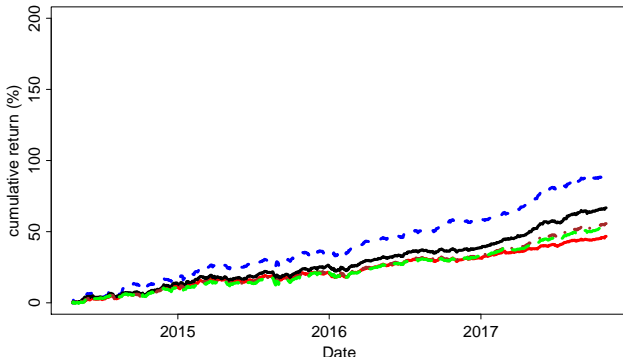


Figure 7: **SBC** and **SBC-CC** Markowitz portfolios are without liquidity constraints, the remaining 3 portfolios are SBC-CC ones containing the bounds

$M = 1 \times 10^5$ USD, $M = 1 \times 10^6$ USD, $M = 1 \times 10^7$ USD.

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Out-of-sample: Markowitz & S&P100

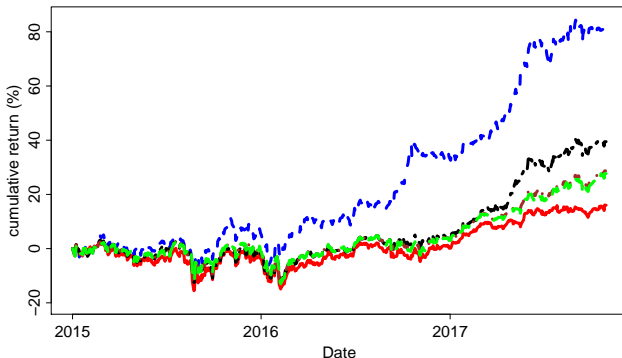


Figure 8: **S** and **S-CC** are monthly adjusted portfolios without liquidity constraints, while the remaining 3 portfolios are S-CC ones contain

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bounds $M = 1 \times 10^5$ USD, $M = 1 \times 10^6$ USD, $M = 1 \times 10^7$ USD

Out-of-sample: CVaR & S&P100

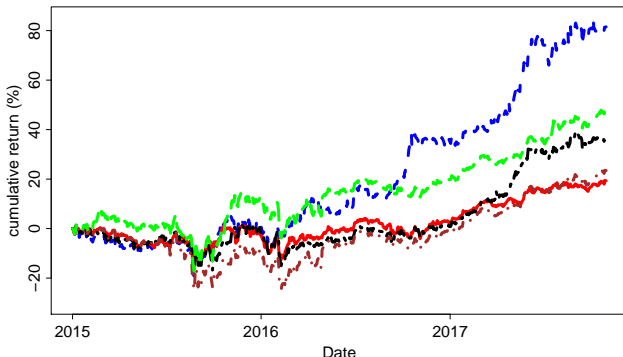
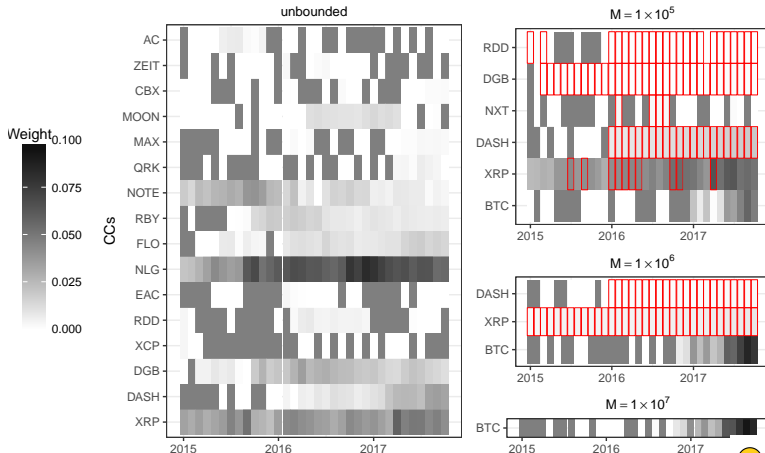


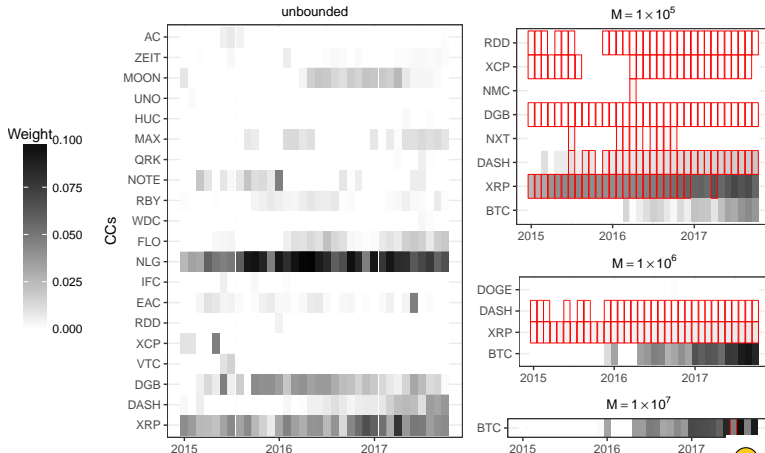
Figure 9: **S** and **S-CC** are monthly adjusted portfolios without liquidity constraints, while the remaining 3 portfolios are S-CC ones contain 'Investing with cryptocurrencies' bounds $M = 1 \times 10^5$ USD, $M = 1 \times 10^6$ USD, $M = 1 \times 10^7$ USD



Out-of-sample monthly adjusted Markowitz portfolio weights



Out-of-sample monthly adjusted CVaR portfolio weights



Conclusion

- We propose LIBRO: LIquidity Bounded Risk-return Optimization
- Including cryptos can provide better risk-return trade off
- Cryptos beside Bitcoin matter for portfolio optimization
- Less frequent adjustment (monthly contra weekly) enhances results
- LIBRO even enhances results in traditional markets

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