Cryptocurrency Elephant(s)

A discussion of Duchin, Solomon, Tu and Wang (2023)

by Nicola Borri (LUISS)

NBER Behavioral Finance Meeting
November 10, 2023

Elephant #1: What is the **optimal quantity** to invest in cryptocurrency?

1. "The cryptocurrency elephant in the room is *should I buy <u>any</u>?*"
2. Under Bayesian portfolio theory, **zero weights in crypto are difficult to generate**.
3. Optimal weights are small, non-trivial and frequently positive.

Made with DALL-E 3

Elephant #2: How should a large investor invest in crypto?

Two principles:

1. What should an investor NOT do?
2. What should an investor do?

The answers to these questions constitute an even **bigger elephant**.

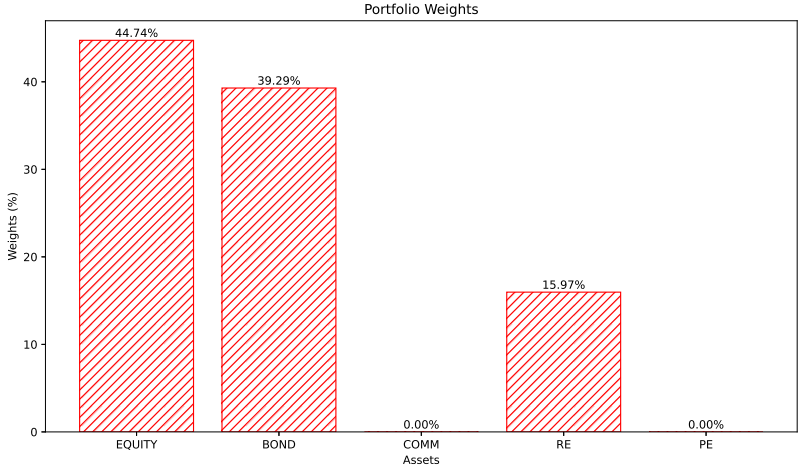
Made with DALL-E 3

Elephant #1: Optimal portfolio weights

A standard portfolio problem

- **Black-Litterman** model and **5 asset classes**: equity, bond, commodity, real estate and private equity (Liu and Tsyvinski, 2018).
- Inputs:
  - **market priors**: last 5 years prices, current market caps, market-implied risk premium (see, Black-Litterman JFI 1991 and Idzorek 2007)
  - **views**: based on long-term annualized nominal mean returns
    - equity: 10.6% (Jorda et al. QJE 2019)
    - bond: 5.5% (mean bill and bond, Jorda et al. QJE 2019)
    - commodity: 0.5% (Levine et al. FAJ 2018)
    - real estate: 11% (Jorda et al. QJE 2019)
    - private equity: 0.5% (iShares Private Listed Equities)
  - **confidence parameter**: set to 50%
  - **objective function**: quadratic utility with risk aversion of 3 (as in DSTW)

Optimal weights (no crypto)



↪ Only three assets (equity, bond and real-estate) with **non-negative** weights.

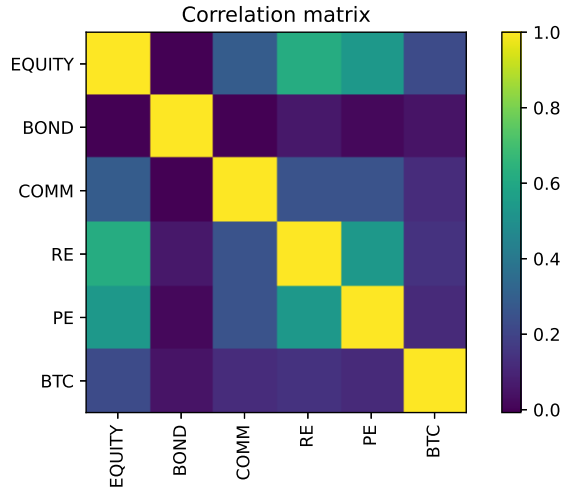
↪ **Performance** (in-sample): $E(r_p) = 5.8\%$, $\sigma(r_p) = 10.4\%$, $SR = 0.56$.

Add cryptocurrency to the set of assets

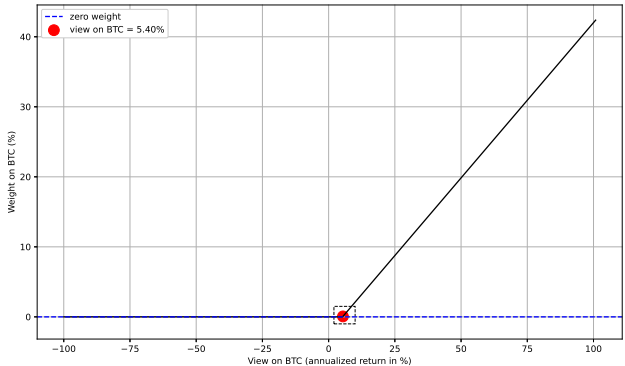
- Additional inputs:
  - **market prior**: last 5-year BTC prices, current crypto market cap (≈1.2 trillion USD), market risk premium ⟶ 3.8% annualized
  - **view**: reduce by 50% the long-term (5-year) annualized nominal mean BTC returns (trying to be conservative)
  - **confidence parameter**: set to 30% (trying to be conservative)
  - **experiments**: different market priors and views.

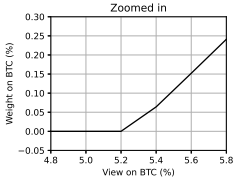
Properties of assets

Asset	Market Prior	SD
EQUITY	0.038	0.163
BOND	0.004	0.048
COMM	0.009	0.126
RE	0.041	0.258
PE	0.024	0.181
BTC	0.038	0.61



1. BTC weights for different *views*

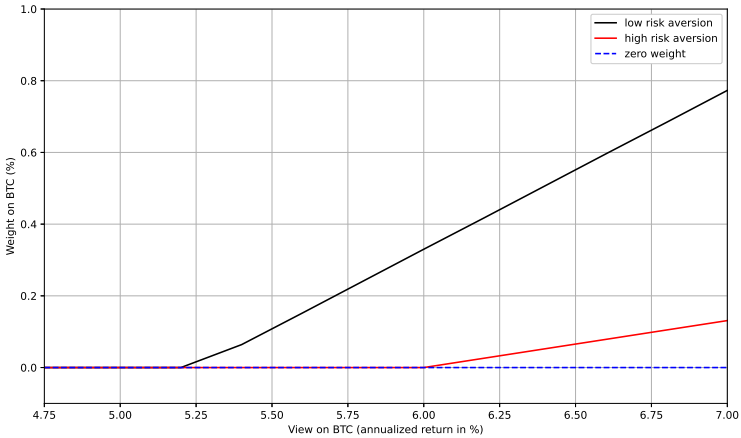




↪ Zero weight on BTC for views below ≈ 5%.

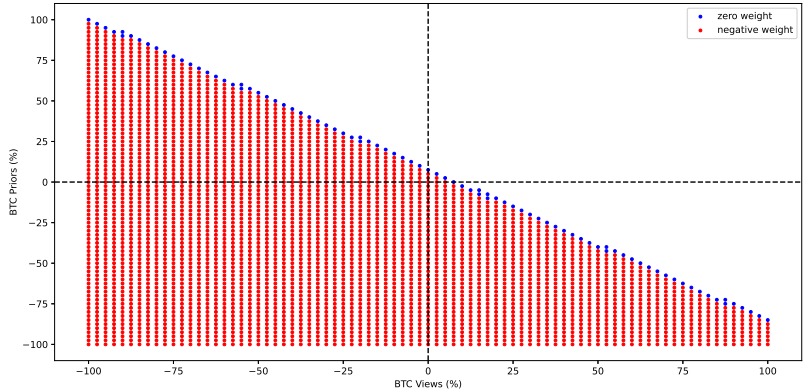
↪ With short-selling → negative weight for views below ≈ 5% (consistent with DSTW).

2. BTC weights for different *views* and risk aversion



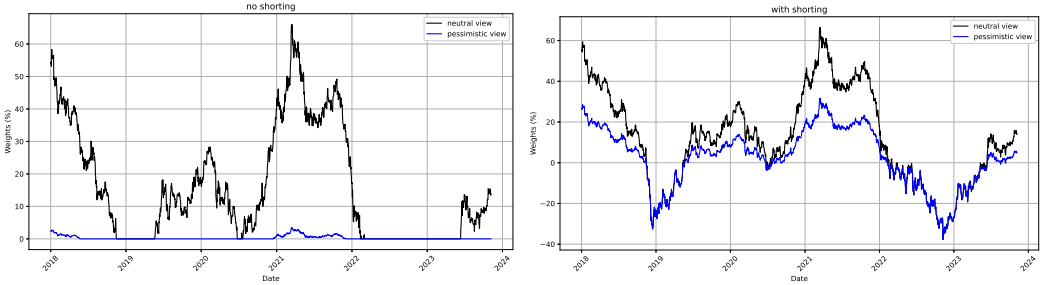
↪ More risk averse investors require **a more optimistic view** for a non-negative BTC weight (consistent with DSTW).

3. BTC views and priors for non-positive weights



↪ Zero weights require either **very pessimistic views and high priors**, or **very low priors and optimistic views** (consistent with DSTW)

4. BTC time-varying weights

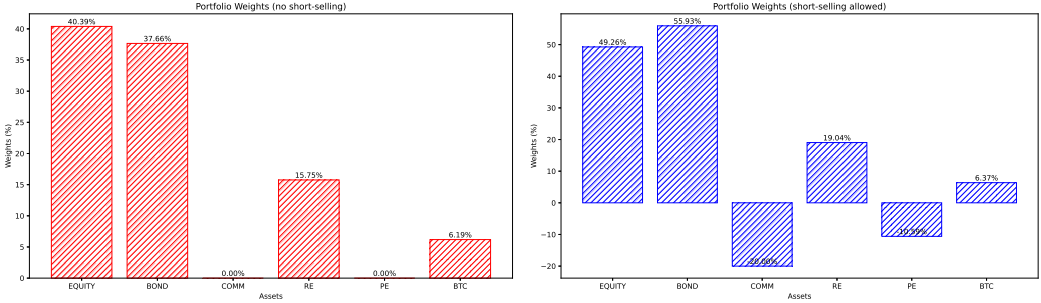


↪ Optimal weights are smooth (consistent with DSTW)

↪ Persistent zero weights require very pessimistic views & no shorting (consistent with DSTW)

Note: same priors of unconditional model; views for BTC based on return prev 365 days (neutral) or reduction by 50% (pessimistic); daily rebalancing of cov matrix and optimal weights

5. Optimal portfolio



↪ BTC weight is positive and around 6% regardless of whether short-selling is allowed or not.

★ this is the **first elephant** in the cryptocurrency room

↪ **Performance**:

- no short-selling: $E(r_p) = 6.4\%$, $\sigma(r_p) = 11.2\%$, $SR = 0.57$
- with short-selling: $E(r_p) = 7.1\%$, $\sigma(r_p) = 12.0\%$, $SR = 0.59$

The value of one bitcoin

- Given an optimal BTC weight ($\approx 6\%$) and the total market cap of assets considered ($\approx$250 trillions of USD), a simple back of the envelope puts the implied crypto market cap at $\approx$15 trillions of USD.

- Currently (Nov 2023), BTC accounts for $\approx 60\%$ of crypto market cap with a total circulating supply of 19.53M bitcoins (21M is the max)

$$1 \text{ bitcoin} = 0.6 \times 15 \text{ trillions of USD} / 19.5M \approx USD\ 460K$$

- For weights around 0.5%-1%

  $\hookrightarrow$ **the value 1 bitcoin should be** $\approx USD\ 35K - 80K$

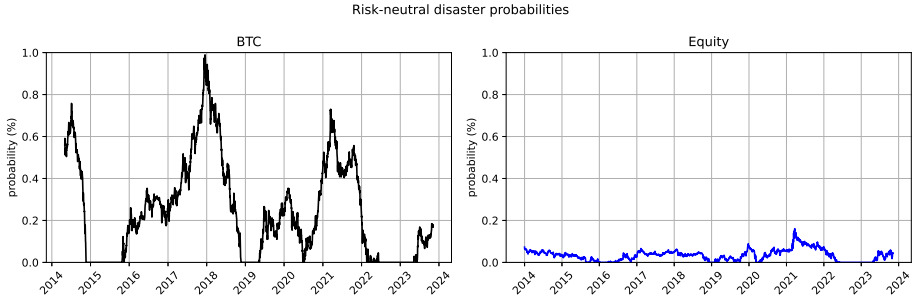
Jumps in daily returns (Borri and Santucci de Magistris, 2022)

Negative	Counts	Percentage	Positive	Counts	Percentage
Panel A: Bitcoin					
$< -30\%$	1	0.03%	$> 30\%$	1	0.03%
$< -20\%$	4	0.10%	$> 20\%$	6	0.16%
$< -10\%$	57	1.49%	$> 10\%$	69	1.80%
$< -5\%$	254	6.63%	$> 5\%$	290	7.57%
Panel B: Crypto Market (BTC+ETH+XRP)					
$< -30\%$	1	0.03%	$> 30\%$	4	0.10%
$< -20\%$	7	0.18%	$> 20\%$	9	0.23%
$< -10\%$	72	1.88%	$> 10\%$	99	2.58%
$< -5\%$	314	8.19%	$> 5\%$	372	9.71%

↪ Priors, views, confidence, risk premia are likely influenced by the frequency of jumps in cryptocurrency ("**extreme events**").

↪ For BTC, an"extreme event" of the daily 10% **negative** return happens with probability 1.49%, while a **positive** event of same size happens with probability of 1.80% (data from 2015 to yesterday).

Risk neutral disaster probability (Borri and Santucci de Magistris, 2022)



↪ The implied **disaster probability** for **BTC** ranges from 0 to 1%, for **Equity** from 0 to 0.16% (data from 2013 to yesterday).

Note: A **disaster** is as an event where the cryptocurrency price drops to zero in one day.

Elephant #2: *How* to invest in cryptocurrency?

Principle #1: What should investors NOT do

1. Cross-platform *arbitrage* strategies:
   - Allegedly first trades of SBF and Alameda Research
   - Based on coin price differences across exchanges
   - Largest price differences due to **limits to arbitrage** and **platform-specific risks** (see, e.g., Makarov and Schoar (JFE 2021) and Borri and Shakhnov (JIMF 2023))

Principle #1: What investors should NOT do

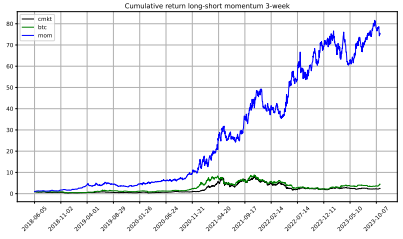
2. Portfolios based on **insignificant** return predictors from the equity **factor zoo**[1]
   - past 8-, 16-, 50-, and 100-week returns
   - volume and scaled volume
   - beta, beta squared, idiosyncratic volatility
   - standard deviation of returns, max day return, delay

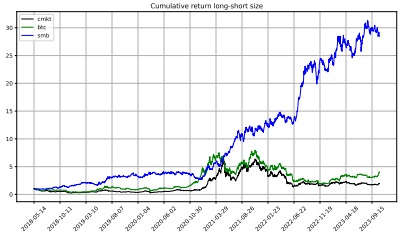
[1] See, e.g., Borri, Massacci, Rubin and Ruzzi (2022) and Liu, Tsyvinski and Wu (2022).

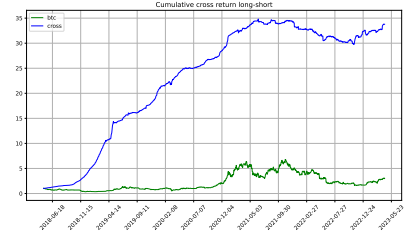
Principle #2: What should investors do

- Similar to traditional markets, there exist coin characteristics/covariances that **predict future return**
  - Liu, Tsyvinski and Wu (JF 2022) construct a momentum (CMOM) and size (CSMB) factor sorting coins on past returns (e.g., 2-week and 3-week) and size (e.g., market capitalization)
    - For this discussion → compute CMOM and CSMB since 2018 using daily data from coingecko up to yesterday for the top 30 coins by market cap (excluding stablecoins).
  - Crypto carry factor (Borri and Shakhnov, RAPS 2022).
    - For this discussion → compute CARRY since 2018 using daily data from coingecko up to yesterday for liquid USD pairs traded in exchanges in US, EU, UK and Japan.
  - Crypto carry futures (Christin, Routledge and Soska and Zetlin-Jones, 2022; Schmeling, Schrimpf and Todorov, 2023).

Crypto momentum, size and carry portfolios

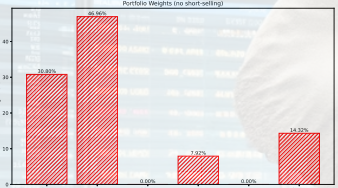


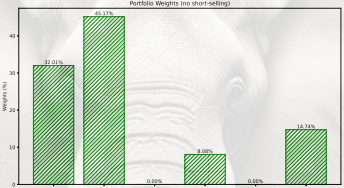


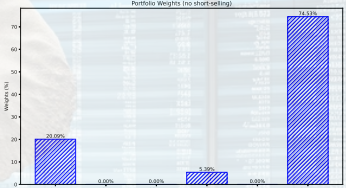


note: daily rebalancing, require shorting, no transaction costs for CMOM and CSMB, look-ahead bias in selection of top30 coins

An even bigger elephant in the room







↪ The weight on the momentum and size portfolios is **roughly double** the BTC weight, the weight on carry even **larger**

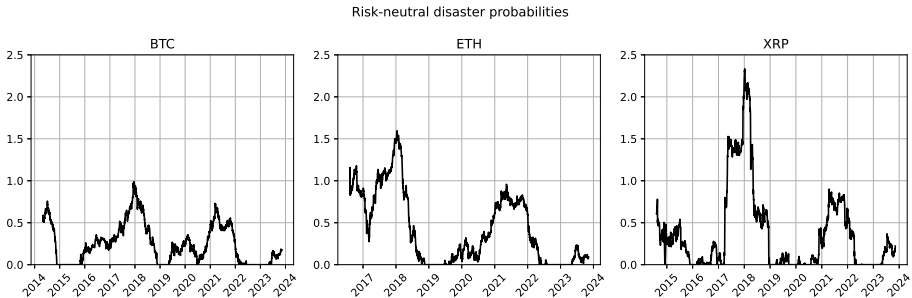
- ★ a **big elephant** in the cryptocurrency room

ADDITIONAL SLIDES

Extreme daily returns: XRP & CMKT

Negative	Counts	Percentage	Positive	Counts	Percentage
Panel A: Ripple					
$< -30\%$	5	0.13%	$> 30\%$	28	0.75%
$< -20\%$	21	0.56%	$> 20\%$	61	1.63%
$< -10\%$	122	3.27%	$> 10\%$	181	4.84%
$< -5\%$	406	10.87%	$> 5\%$	429	11.48%
Panel B: Crypto Market					
$< -30\%$	1	0.03%	$> 30\%$	4	0.10%
$< -20\%$	7	0.18%	$> 20\%$	9	0.23%
$< -10\%$	72	1.88%	$> 10\%$	99	2.58%
$< -5\%$	314	8.19%	$> 5\%$	372	9.71%

Risk neutral disaster probability (Borri and Santucci de Magistris, 2022)



Crypto carry returns (Borri and Shakhnov, RAPS 2022)

Portfolio	1	2	3	4	5	6	7	Long/short
	A. *Discounts*							
Mean	-0.97	-0.28	-0.08	0.08	0.26	0.51	1.52	
SD	1.41	0.66	0.59	0.62	0.73	0.94	1.82	
	B. Cross *returns* net of bid/ask							**7-1**
Mean	-0.23	0.16	0.26	0.35	0.46	0.62	1.10	0.58
SD	4.69	4.58	4.62	4.67	4.66	4.65	4.79	2.29
SE	0.12	0.12	0.12	0.12	0.12	0.12	0.13	0.06
SR	-0.05	0.03	0.06	0.08	0.10	0.13	0.23	0.25

↪ In a sample of reputable exchanges and countries with no or very low capital controls, cross daily returns net of transaction costs are **statistically significant**.

↪ The cross-section of portfolio returns is matched by covariances with a crypto **carry** factor, with low payoffs in *bad times* for cryptocurrency investors (e.g., low aggregate liquidity, sentiment and momentum returns).