# Equity Risk in the Cross-Section of Cryptocurrencies: Strong Exposure, Changing Prices

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# Motivation

- Crypto prices now rise and fall with the stock market.
- **Question:** do crypto investors get paid for this stock-market risk as much as stock investors do?
- **Integration:** a common risk carries a common price. **Segmentation**: its price depends on who holds the asset.
- Cryptocurrencies combine three rare ingredients:
  - strong, time-varying exposure to equity risk;
  - prices of that risk measured outside crypto, from the S&P 500 and the VIX;
  - a change in who can hold it: US spot bitcoin ETFs, January 2024.
- Does crypto's equity exposure carry the equity-market price of risk?

# Related literature

- Crypto-specific drivers and factor models
  - Liu and Tsyvinski (2021): little exposure to traditional factors.
  - Liu, Tsyvinski and Wu (2022): crypto market, size and momentum.
- Links to equity-market risk
  - Dobrynskaya and Dubrovskiy (2023): equity downside risk.
  - Babiak and Bianchi (2026): crypto and equity market risk.
  - Kang and Lee (2026); Li et al. (2026): bitcoin after the spot ETFs.
- Market integration: Errunza and Losq (1985); Bekaert and Harvey (1995); Henry (2000)
- **Our contribution**
  - Prices of risk taken from the stock and options markets, not fitted to crypto data.

# Preview of findings

- **Strong exposure**. Crypto's daily equity beta is 1.02 ($t$ = 6.92) over 2018–2023; the rolling beta peaks at 2.02 in June 2026.
- **Before 2024**, net of crypto-market risk, coins most exposed to equity risk earn 3.90% per month more than the least exposed, against 0.09% implied by equity prices.
- **After the spot ETFs**, high-market, low-variance coins lose 5.67% per month; equity-implied prices are rejected (Wald $p < 0.001$).
- Data: ticker-reassignment errors in common crypto price files.

# Theoretical framework: coins as levered claims

- Equity index and variance follow Heston (1993) under *P*:

$$\frac{dS_t}{S_t} = \mu\, dt + \sqrt{v_t}\, dW_t^S, \qquad dv_t = \kappa(\bar{v} - v_t)\, dt + \sigma_v \sqrt{v_t}\, dW_t^v \tag{1}$$

- The price of coin *i* loads on both equity shocks:

$$P_{i,t} = e^{-\beta_i t}\, S_t^{\eta_i^S}\, v_t^{\eta_i^v}\, X_{i,t}, \qquad \frac{dX_{i,t}}{X_{i,t}} = \sigma_i\, dZ_{i,t} \tag{2}$$

- $\eta_i^s > 1$: a levered claim on the equity market; $\eta_i^v < 0$: loses value when equity variance rises.

- $X_{i,t}$: idiosyncratic forces (adoption, tokenomics, attention).

# The cryptocurrency risk premium

- **No arbitrage and Girsanov:** the price of each shock is its drift change between $P$ and $Q$.

$$E[R_i^e] = \eta_i^S \lambda^{MKT} + \eta_i^v \lambda^v \tag{3}$$
$$\lambda^{MKT} = \mu - r_f, \qquad \lambda^v = \kappa^Q - \kappa$$

- Constant prices of risk, one pair across volatility regimes.
- Sign prediction: VIX² exceeds expected realized variance, so $\lambda^v < 0$: coins with $\eta_i{}^v < 0$ earn a premium.
- Magnitude restrictions: $\lambda^{MKT}$ from the equity premium, $\lambda^v$ from S&P 500 options. No crypto data used.

# Integration, segmentation and access

- Integration: crypto's marginal investor also bears equity risk
  - prices of risk equal $\lambda^{MKT}$ and $\lambda^{v}$; the model-implied SDF prices crypto portfolios.
  - Test: are the prices of risk estimated in crypto equal to the equity ones? (Wald test)
- Segmentation (Errunza and Losq, 1985; Merton, 1987)
  - equity exposure inside crypto can be priced at any level, in either direction, even when exposure is large.
  - Test: do the estimated prices differ in size or sign from the equity ones?
- Partial access through vehicles holding a few large assets
  - new demand lifts those assets and close substitutes (Barberis et al., 2005; Basak and Pavlova, 2013);
  - realized returns favour large coins, whatever their exposure.
  - Test: do large coins earn more after 2023, beyond their equity exposure?

# Equity-market prices of risk

- Joint maximum likelihood on daily S&P 500 and VIX (Aït-Sahalia and Kimmel, 2007); $VIX^2$ is affine in $v_t$, so variance is observed.

| Heston estimates, Oct 2013–Dec 2023 | Estimate |
|---|---|
| Leverage correlation ρ | −0.71 |
| Long-run volatility | 17.8% |
| Variance half-life | 30 trading days |
| Variance risk price $\lambda^v$ | −7.27 (t = −5.8) |
| Re-estimated through August 2026 | −8.03 (t = −7.0) |

- Implied high-minus-low spread in crypto: only 0.09% per month.
- Monte Carlo: sign of $\lambda^v$ recovered in 98% of samples.

# Data

- 200 largest coins by market cap each January, 2018–2026 (CoinMarketCap); stablecoins, wrapped, liquid-staking and asset-backed tokens excluded.

- Returns between consecutive equity trading dates: aligns 24/7 crypto with stocks.

- Ticker-reassignment errors in Yahoo Finance price files:

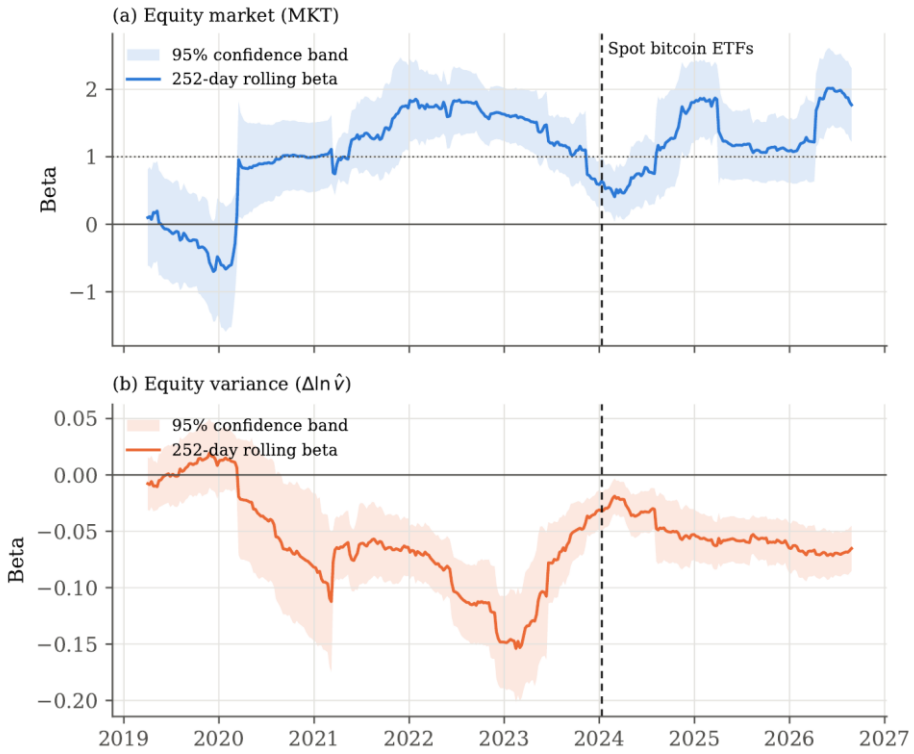
| Error type | Example | Scale, 2018–2023 |
|---|---|---|
| One-day jump to another token | YOUC-USD: ×540,000 | 49 of 1,210 coin-years |
| Wrong token all year | UNI-USD: $0.0001 vs. $17 | 8 large-cap tickers |

- Rule: drop at any one-day move above ×10; validate every series against CoinMarketCap (×1.5).

# Empirical design

- HŇŅRØÞQĚ ĨÍJ ŇØŊ ffĩ ŎØ $\hat{v}$ (variance from inverting the model's VIX formula); correlation −0.67, so joint slopes only.
- Exposures: rolling 180-day joint regressions of daily coin excess returns.
- Test assets: 20 value-weighted portfolios, rebalanced every 21 days
  - quartiles on $\eta^s$, $\eta^v$, size and momentum; 2 × 2 double sort.
- Tests:
  - portfolio sorts (Newey-West);
  - Hansen-Jagannathan distance, misspecification-robust;
  - Kan-Robotti model comparison; two-pass regression.
- **Key strategy:** *buy coins that move most with stocks (high $\eta^s$) and drop most when stock volatility jumps (low $\eta^v$); sell coins with the opposite profile.*
  - **The bought coin should carry the most equity risk, so the model predicts a positive return.**

# Crypto's exposure to equity risk




252-day rolling betas, 95% bands

- Beta ≈ 0 in 2018–19
- ÇĈÈD ÕØ DĊDÇC ÇĈEĎ ÕØ DĊDD
- 1.02 over 2018–2023
- 1.37 over 2024–2026
- Peak 2.02, June 2026
- Negative variance beta every year since 2020

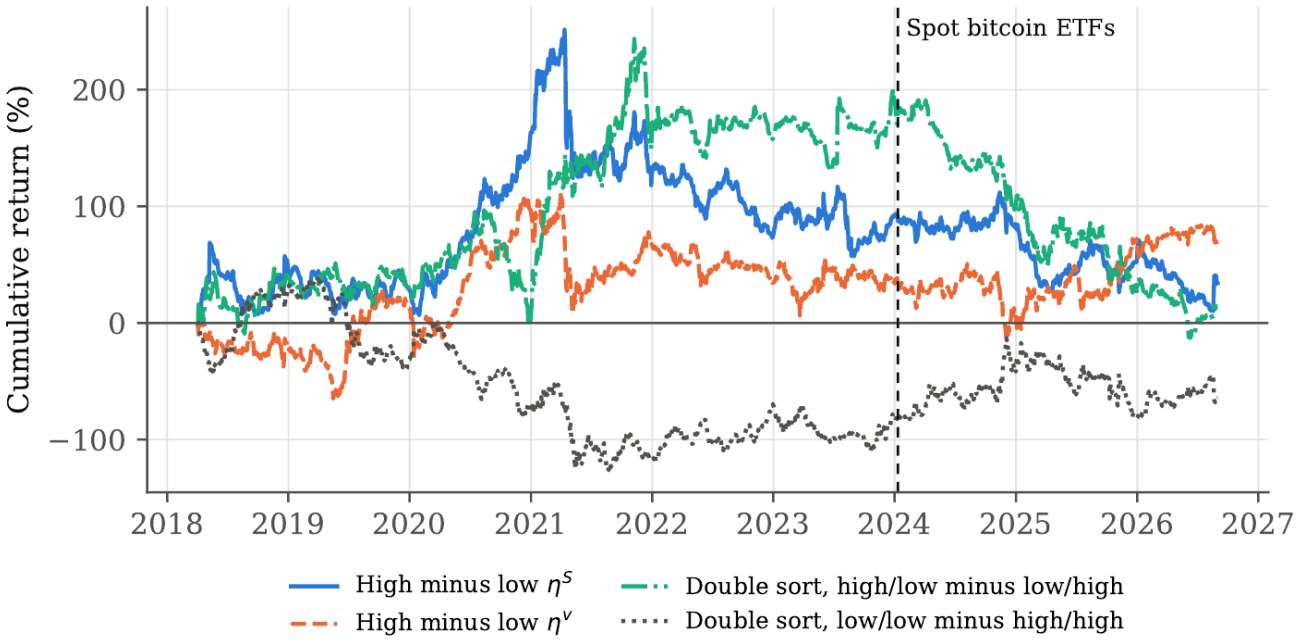
Crypto behaves like levered equity for much of the sample.

# Pricing equity exposure, 2018–2023

| VW strategy, % per month | Prediction | Return (t) |
|---|---|---|
| Panel A: elasticities to MKT and Δ ln $\hat{v}$ | | |
| High − low $\eta^s$ | > 0 | 1.35 (0.59) |
| High $\eta^s$/low $\eta^v$ − reverse | > 0 | 2.76 (1.22) |
| Panel B: net of crypto-market exposure | | |
| High $\eta^s$/low $\eta^v$ − reverse | > 0 | 3.56 (1.63) |
| Low/low − high/high | ± | −3.90 (−2.56) |

- **Formal test (Hansen-Jagannathan):** the stock-market model ($p$ = 0.040) and crypto's own factor model ($p$ = 0.062) perform similarly; ***a direct comparison cannot tell them apart.***
- Coins most exposed to stock-market risk earn 3.90% more per month; stock-market prices imply only 0.09%. ***Crypto pays far more for this risk than stocks do.***

# After the spot ETFs: the relation reverses




Cumulative VW strategy returns, April 2018–August 2026

- High $\eta^s$/low $\eta^v$: −5.67%/month ($t$ = −2.33), vs. +2.76% before; change −8.42% ($t$ = −2.54).
- Stock-market prices of risk no longer fit crypto ($p < 0.001$): crypto now rewards these risks the opposite way.

# Robustness and timing of the reversal

| 2024–2026, % per month | Return (t) |
|---|---|
| Main | −5.67 (−2.33) |
| Net of crypto market | −6.41 (−2.66) |
| Winsorized 5% | −5.98 (−2.94) |
| Size-adjusted | −5.22 (−2.27) |
| Excl. coins with US ETF | −4.89 (−1.89) |
| Crypto 3-factor alpha | −4.08 (−1.76) |

| Sub-period | % / month |
|---|---|
| Apr 2018–Nov 2021 | 5.64 |
| Nov 2021–Dec 2023 | −1.92 |
| Jan 2024–Aug 2026 | −5.67 |

- When did it change? A break test lets the data pick the date: 9 Nov 2021, the crypto market peak ($p$ = 0.07). Losses then deepen after the spot ETFs (2024).
- Size effect reverses: larger coins earn more (1.26% per s.d., $t$ = 2.83).
- Unrelated to daily ETF volume shocks ($t$ = 0.24).

# Who sets the price of equity risk in crypto?

- **Who gets the reward?** Whoever holds the coins that move most with stocks.
  - Before 2024: these were mostly people who invest only in crypto, not stock investors. On average, the most stock-sensitive coins returned 3.90 percentage points more per month than the least stock-sensitive ones.
  - After 2023: the same coins returned 5.67 points less per month; the largest coins did better as ETF money came in.

- **Why is it different from the stock market?** The price of a risk is set by the people who actually trade the asset.
  - Stock investors, who hold many assets, would ask only 0.09% a month for this risk.
  - Before 2024: few stock investors owned crypto, so crypto-only investors set the price (segmentation).
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# Concluding remarks

- **Crypto has become a levered bet on the stock market.**
- **Before 2024:** coins most exposed to stock-market risk earn 3.90% more per month ($t$ = 2.56), against 0.09% at stock-market prices: leaning toward segmentation.
- **After 2023:** the relation reverses, −5.67% per month ($t$ = −2.33); stock-market prices rejected ($p < 0.001$). Returns shift toward the largest coins, which new investors reach through ETFs; the shift began in late 2021.
- **Lesson:** moving with stocks does affect crypto returns, but crypto investors are not paid for it the way stock investors are. The reward depends on who owns crypto and how they buy it.
- **For crypto research:** check Yahoo prices against CoinMarketCap (some tickers switch to another coin), and measure crypto returns on stock-market trading days.

Thank you!