Synthetix inverse cohort sub-report

11 inverse synths (SIP-158 frozen, SIP-169 redeemed)

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Contents

1 Executive Summary

A methodologically distinct cohort. The Synthetix inverse cohort comprises eleven non-linear, clamped, formula-priced synths on Ethereum L1 — iETH, iBTC, iLINK, iAAVE, iBNB, iETC, iADA, iDOT, iXMR, iXTZ and iXRP. Each is a deterministic transform of an underlying spot: iPrice $= 2 \times$ entry $-$ underlying, clamped to the canonical band $[\,0.5 \times \text{entry},\ 1.5 \times \text{entry}\,]$ (entry$\pm$50%). The entire class was deprecated under SIP-158 in early 2021 and redeemed at the Wezen release (SIP-169) on 2021-09-16. Unlike the other cohorts in this study, the inverse synths trade on no DEX venue and carry no perpetual or funding leg; their lifecycle is governed entirely on-chain through configuration, clamping and freeze events.

Tracking error is the wrong lens. The headline finding is structural rather than empirical: an inverse synth's on-chain price *is* the clamped formula of its underlying. There is no independent "observed" inverse-price series to compare against a "reference", so the conventional tracking-error object (observed $-$ reference) is degenerate by construction. Consequently the base regression, the |TE| heatmap, the cross-asset cointegration and Granger machinery, and the per-event difference-in-differences are reported as N/A *by data structure*, not as null results. We are explicit about this throughout: the standard estimators are not run and silently passed over — they do not apply to a synthetic whose mark is a deterministic function of an exogenous input.

The two objects that do matter: the clamp and the freeze. What remains analytically meaningful are the two mechanics that actually drove this cohort. First, the *clamp mechanic*: the entry$\pm$50% bands were re-anchored repeatedly as crypto rallied through 2020–2021, with governance stepping the entry/upper/lower triplet upward to track the market (iETH, for example, re-anchored from an entry of \$220 up through \$1,548 over seventeen re-anchorings). We document 124 `InversePriceConfigured` records across the seven ExchangeRates lineage contracts, 1,161 clamp episodes pinned at a bound, and the hour-by-hour share of observations sitting at a clamp (iETH spent roughly 57% of its hourly observations pinned). Figure 2 shows the iETH bands climbing through the window with its three freeze markers. Second, the *freeze*: when the underlying touches a bound the synth freezes at that bound and its rate is locked, creating a post-freeze stale-mark exposure between the locked `frozen_rate` and the still-moving underlying — the inverse analogue of the equity Wezen freeze.

The 2020–2021 freeze cascade. We observe 29 `InversePriceFrozen` events across all eleven synths between 2020-12-27 and 2021-06-22, clustered in January–April 2021. The mechanism is uniform: as each underlying rose during the bull run, $2 \times$ entry $-$ underlying fell to the *lower* clamp, freezing the synth at its floor; each freeze was then followed by a higher re-anchor that re-launched the synth at a fresh band. Figure 5 maps the full set of freezes by date and synth, making the SIP-158-era cascade visible as a tight cluster. The economic footprint of the cohort, however, was negligible: the supply trajectories show tiny floats (iETH's cumulative net float on the order of a few hundred units), so these synths were immaterial in size even as their mechanics are instructive.

2 Dataset Characterisation

The inverse mechanic. Each of the eleven inverse synths is a non-linear, clamped, formula-priced derivative of a single underlying asset. The on-chain rate is not an independently observed market quote but the deterministic image of the underlying spot through the Synthetix inverse map

$$p_{\text{inv}}(t) \;=\; \operatorname{clip}\!\big(2\,e - s(t),\ \ell,\ u\big), \qquad \operatorname{clip}(x,\ell,u) = \min\!\big(\max(x,\ell),u\big), \tag{1}$$

where $s(t)$ is the underlying Chainlink/CEX spot, e is the governance-set entry price, and $[\ell, u]$ is the active band. The canonical configuration is the symmetric $\pm 50\%$ band $\ell = 0.5\,e$, $u = 1.5\,e$; for example iETH was first configured (within the scanned lineage) on 2020-02-20 with $e = 220$, $u = 330$, $\ell = 110$, iBTC with $e = 10{,}600$, $u = 15{,}900$, $\ell = 5{,}300$, and iLINK with $e = 2.94$, $u = 4.42$, $\ell = 1.47$. When the underlying $s(t)$ reaches a bound, the clipped argument touches ℓ or u and the synth *freezes*: an `InversePriceFrozen` event is emitted, the rate is locked at the bound, and governance must subsequently issue a fresh `InversePriceConfigured` (a re-anchor that resets e, ℓ, u) before the synth can trade again. The cohort is Ethereum L1 Synthetix V2 only: there is no DEX venue, no perpetual or funding leg, and the eleven instruments (iETH, iBTC, iLINK, iAAVE, iBNB, iETC, iADA, iDOT, iXMR, iXTZ, iXRP) were collectively deprecated under SIP-158 (early 2021) and redeemed at the Wezen release (SIP-169) on 2021-09-16.

The three references. The characterisation rests on three aligned objects per synth. The first is the *computed formula* of equation (1): applying the inverse map to the underlying feed reconstructs the band-clipped price at any timestamp; this is materialised in `clamp_band_timeseries` (22,279 rows) holding, for each observation, the raw $2e - s$ value alongside the active ℓ/u bounds. The second is the *underlying* Chainlink oracle (`oracle_updates_raw`) and Binance-spot CEX feed (`prices`) for each base asset, each a dense, multi-year L1 Chainlink feed (and minute-resolution Binance spot) for the underlying asset, shared with the crypto cohort. The third is the *frozen-state JSON sidecar* decoded from the ExchangeRates contract lineage: 124 `InversePriceConfigured` records (initial configs and re-anchors) and 29 `InversePriceFrozen` records, together with derived products `state_inventory`, `frozen_state_attribution` (frozen rate versus the bounds active at each freeze), `clamp_episodes` (1,161 pinned episodes with hour durations), `clamp_touch_per_hour` (264 synth $\times$ UTC-hour cells), and `supply_trajectory` (2,039 daily float rows). The re-anchorings track the market: iETH was re-anchored from $e = 220$ down to 122 during the March-2020 crash, then progressively up to 1,548 as ETH rallied through 2021, accumulating 17 re-anchors over its life.

Why tracking error is formula-based, not observed. The defining methodological feature of this cohort is that there is *no independent observed inverse-price series.* Because the on-chain rate is, by construction, the deterministic clamped formula of the underlying (equation (1)), the usual tracking-error object $\mathrm{TE} = p_{\text{observed}} - p_{\text{reference}}$ is degenerate: the "observed" and "reference" legs are identical up to the clip operator, so a residual is mechanically zero except at the bounds where it is fully explained by the clip. Consequently the standard estimator suite — base regression, |TE| heatmap, cross-asset cointegration/Granger causality, and per-event difference-in-differences — does not apply to this cohort and is reported throughout as N/A *by data structure*, not as a null statistical result. The two economically meaningful objects that replace it are (a) the *clamp mechanic* — how often and how long each synth sat pinned at a bound, and how the bands were re-anchored, captured by `clamp_episodes` and `clamp_band_timeseries` (iETH, for instance, sat at a clamp for roughly 57% of its hourly observations) — and (b) the *freeze* — the post-freeze gap between the locked `frozen_rate` and the still-moving underlying, a stale-mark exposure directly analogous to the equity Wezen freeze.

Lifecycle and the 2019 known gap. The instruments were created across 2019–2020, re-anchored repeatedly through the 2020–2021 cycle, deprecated as a class under SIP-158 (marker date 2021-01-28), and redeemed at Wezen (SIP-169) on 2021-09-16. The 29 freezes cluster between 2020-12-27 and 2021-06-22: as the bull run lifted the underlyings, $2e - s$ fell to the *lower* bound, freezing each synth, which was then re-anchored higher — producing the staircase visible in Figures 2 and 3 and the freeze cascade of Figure 5. One gap is documented and not recovered: the 2019 pre-v2.18.1 initial configurations (iETH first frozen near 90, iBTC near 2,650, around May 2019) predate the earliest scanned ExchangeRates contract in the lineage (v2.18.1 . . . v2.35.2) and therefore fall outside the decoded 124 configurations. This is a known boundary of the on-chain extraction, not a data-quality defect: every config, freeze, and re-anchor inside the scanned lineage is fully decoded, and the supply floats are economically immaterial throughout (iETH's cumulative net float is on the order of a few hundred units; see Figure 4).

Per-synth state inventory. Table 1 reports, per synth, the number of `InversePriceConfigured` records, the number of `InversePriceFrozen` events, and the implied number of re-anchors (configurations beyond the initial one) drawn from `state_inventory`. iETH and iBTC dominate both the configuration and re-anchor counts, consistent with their being the most actively maintained and most volatile underlyings; the long tail (iDOT, iAAVE) was configured only once or twice before the class was wound down.

Table 1: Per-synth state inventory: configurations, freezes, and re-anchors decoded across the v2.18.1 . . . v2.35.2 ExchangeRates lineage. Totals exclude the documented 2019 pre-v2.18.1 gap.

Synth	$n_{\text{configured}}$	n_{frozen}	$n_{\text{re-anchors}}$
iETH	18	3	17
iBTC	18	4	17
iBNB	16	3	15
iXTZ	15	2	14
iLINK	15	3	14
iXRP	13	3	12
iADA	11	3	10
iETC	8	3	7
iXMR	7	2	6
iDOT	2	2	1
iAAVE	1	1	0
Total	124	29	113

3 Multi-Reference Tracking Error

The classical tracking error is degenerate by construction. For every other cohort in this programme the tracking error is the gap between an *observed* on-chain price and an *independent reference* (an oracle composite, a centralised-exchange mid, or a peg target). The inverse synths of this cohort admit no such decomposition. Their on-chain rate is not an observed market price at all: it is a deterministic, clamped function of the underlying spot, $\text{iPrice} = 2\,p_{\text{entry}} - p_{\text{spot}}$, hard-clamped to the canonical band $[\,0.5\,p_{\text{entry}},\ 1.5\,p_{\text{entry}}\,]$. The reference one would naturally regress against is precisely that formula, so the residual observed − reference is identically zero whenever the synth is live and unfrozen. There is no slippage, no venue basis, and no oracle lag to measure, because there is no second, independent series. Reporting a tracking-error distribution here would be reporting machine precision, not market behaviour. We therefore declare the classical TE *N/A by data structure* for this cohort, and we do so as a statement about the pricing mechanism rather than as a null result that failed to reject.

What this rules out. The degeneracy propagates to every estimator that consumes a (observed, reference) pair. The base TE regression, the |TE| heatmap, the cross-asset cointegration and Granger tests, and the per-event difference-in-differences design all presuppose an observed series that can drift away from a reference; none of these can be instantiated when the two series coincide identically. They are reported as N/A throughout this document, consistently and for the same single reason. We flag this explicitly so the reader does not mistake the absence of a tracking-error figure for an oversight: for a formula-priced clamped instrument, the absence *is* the finding about the pricing layer.

The meaningful gap lives at the freeze. A genuine, non-degenerate divergence does open up, but only after a freeze. When the underlying touches a clamp bound the contract emits `InversePriceFrozen` and the synth's rate is locked at `frozen_rate` (which equals the bound that was hit). From that instant the synth no longer tracks anything: it holds a stale mark while the underlying spot continues to move, and the formula that *would* have priced the synth keeps evolving alongside it. The economically relevant quantity is then the post-freeze gap between the locked `frozen_rate` and the live clamped formula evaluated on the still-moving underlying. This is a stale-mark exposure, structurally analogous to the equity-cohort Wezen freeze: holders are marked at a price the market has left behind until governance re-anchors the band or the position is redeemed. We quantify it from `frozen_state_attribution`, which pairs each of the 29 freeze events with the `frozen_rate` and the contemporaneous configuration bounds.

Where the detail is reported. Because the only live divergence is a mechanical artefact of the clamp-and-freeze cycle rather than a tracking-error process, we develop it where it belongs. The clamp mechanic itself — how often and for how long each synth sat pinned at a bound, and how the entry/upper/lower band was re-anchored as the 2020–2021 bull run repeatedly drove the inverses to their lower clamp — is treated in Section 7. The freeze episodes and their stale-mark consequences, including the per-synth freeze cascade clustered in January–April 2021 and worked examples of the post-freeze gap, are treated in Section 9. The present section's role is simply to state, plainly and once, that the tracking error in its classical form does not exist for this cohort, and to redirect the reader to the two objects that carry the actual information.

4 Level-1 Decomposition

Why a base regression is not defined here. The level-1 toolkit deployed elsewhere in this programme rests on a single prerequisite: the existence of a continuous *observed* tracking-error series, $\mathrm{TE}_t = p_t^{\mathrm{obs}} - p_t^{\mathrm{ref}}$, that can be regressed on slow-moving structural drivers (liquidity, volatility regime, funding, venue depth) and whose conditional variance can be decomposed into systematic and idiosyncratic components. For the inverse cohort this prerequisite fails by construction. An inverse synth has no independently quoted price: its on-chain rate is the deterministic clamped formula $iP_t = \mathrm{clip}(2\,\mathrm{entry} - S_t,\ \ell,\ u)$ of the underlying spot S_t, with canonical band $\ell = 0.5\,\mathrm{entry}$, $u = 1.5\,\mathrm{entry}$. There is therefore nothing to subtract a reference from — the "observed" price *is* the reference, evaluated. The base regression of TE on drivers is consequently not a null result to be reported with a coefficient table; it is undefined, and we record it as N/A by data structure.

Why the σ-decomposition collapses. The variance decomposition is likewise degenerate, and instructively so. Inside the band the mapping $S_t \mapsto iP_t$ is the affine reflection $iP_t = 2\,\mathrm{entry} - S_t$, so the synth's instantaneous variance is mechanically that of the underlying, $\mathrm{Var}(iP_t \mid \text{in-band}) = \mathrm{Var}(S_t)$, with unit (negative) loading and *zero* residual: there is no idiosyncratic component to isolate because the synth contributes no independent information. Outside the band the synth is pinned ($iP_t \in \{\ell, u\}$) or frozen, and its variance is exactly zero while the underlying continues to move. The total return variance is thus not a smooth object admitting a HAR-style systematic/idiosyncratic split; it is a two-regime step function — a scaled copy of $\mathrm{Var}(S_t)$ when unclamped, identically zero when clamped — whose only "decomposition" is the fraction of time spent in each regime. That fraction is precisely the clamp-mechanic statistic studied in Section 6, not a residual variance estimate.

The non-linearity caveat and the honest verdict. The clamp is the reason the linearisation above holds only piecewise: iP_t is a continuous but non-differentiable, piecewise-linear function of S_t with kinks at the two bounds, so any single regression slope would average across regimes whose true slopes are -1 (in-band) and 0 (clamped). Fitting a base regression or a σ-decomposition over the pooled sample would not estimate a tracking-error mechanism; it would estimate the time-weighted mixture of these regimes and mislabel a mechanical clamp frequency as a statistical loading. We therefore decline to report either object for the inverse cohort and mark both N/A, stating the methodological reason explicitly: the level-1 layer presupposes an observed-minus-reference series and a non-degenerate residual, and the formula-priced, clamped construction of these synths supplies neither. The substantive level-1 content for this cohort is relocated to the clamp-residence and freeze-gap analyses, where the regime structure that defeats the regression is the quantity of interest in its own right.

5 Level-2 Temporal Analysis

No session structure to test. The Level-2 layer of the framework normally partitions the tracking-error series by trading session — regular hours, the open and close auctions, and the overnight gap — to expose calendar-driven heteroskedasticity inherited from a TradFi underlying. That decomposition is empty here. All eleven inverse synths reference crypto-assets (ETH, BTC, BNB, LINK, AAVE, ETC, ADA, DOT, XMR, XTZ, XRP) whose spot markets trade continuously, so there is no exchange calendar, no auction, and no overnight gap to align against. Moreover, as established in Section 3, the inverse synth carries no independent observed price: its on-chain rate is the deterministic clamped formula $\min\big(\max(2 \cdot \text{entry} - \text{underlying}, \text{lower}), \text{upper}\big)$, so a session-conditional tracking-error variance is undefined by construction, not merely unestimated. We therefore replace the session decomposition with the inverse-specific temporal object that the clamp mechanic does admit: the frequency with which a synth sat pinned at one of its bounds, resolved by UTC hour-of-day.

Clamp-touch by UTC hour. The `clamp_touch_per_hour` table aggregates 264 cells (11 synths $\times$ 24 UTC hours), each reporting the share of hourly observations in which the synth's formula price was pinned at its upper or lower bound rather than tracking the underlying in the interior of the band. Pinning is pervasive. Across the cohort the mean clamp-touch share is $\approx$56% of observations, ranging from $\approx$27% for iXMR to $\approx$70% for iAAVE and iXTZ. For iETH the share is $\approx$57%, and — the key point for a temporal analysis — it is essentially *flat* across the day: the hourly figure varies only between $\approx$56.5% and $\approx$58.6% (a standard deviation of under one percentage point across the 24 hours). The same flatness holds cohort-wide: for the high-liquidity synths the intra-day max-minus-min spread is below 1.5 percentage points, and the small ragged excursions appear only in the thinly observed names (iADA, iDOT) where each hour aggregates far fewer observations.

Interpretation. The absence of an intra-day cycle is itself the finding. A genuine session effect would show clamp-touch concentrating in particular UTC windows — the kind of pattern a TradFi underlying imprints through its open and close. Instead the bound-pinning is driven by *sustained directional moves* in the underlying over multi-day horizons: during the 2020–2021 bull run the rising underlying repeatedly pushed $2 \cdot \text{entry} - \text{underlying}$ down onto the lower clamp, where the synth then remained for long stretches regardless of the hour. Pinning is therefore a regime property of the trend, not a clock property of the trading day, and it distributes uniformly over the 24 hours precisely because crypto markets impose no daily rhythm on it. This motivates the structural treatment in Sections 7 and 9, where the relevant time axis is the multi-week re-anchoring sequence and the freeze events, not the hour-of-day.

6 Venues and Frictions

A single protocol-effective venue. The inverse synth cohort trades on exactly one venue: the Synthetix V2 debt pool on Ethereum L1. There is no decentralised-exchange listing for any of the eleven inverse synths, no liquidity pool to arbitrage against, and no perpetual or funding leg. Exchange between an inverse synth and the rest of the Synthetix universe is mediated entirely by the protocol's atomic swap mechanism, settled against the pooled-collateral debt of sUSD stakers rather than against a counterparty order book. The price an inverse synth receives in any such exchange is not discovered by trading: it is read directly from the on-chain `ExchangeRates` contract, which computes it deterministically. Consequently the standard venue-microstructure objects — bid-ask spread, depth, order-book imbalance, cross-venue basis — have no referent for this cohort, and the only frictions worth measuring are those internal to the pricing formula itself.

The clamp as the inverse-specific friction. The dominant friction is the clamp. Each inverse synth is priced as $\texttt{iPrice} = 2 \cdot \texttt{entry} - \texttt{underlying\_spot}$, truncated to the band $[\texttt{lower}, \texttt{upper}]$ with the canonical $\texttt{entry} \pm 50\%$ bounds. When the underlying moves far enough that the unclamped formula would carry the synth outside its band, the clamp activates and the synth's quoted price is pinned to the bound rather than to the formula value. We catalogue 1,161 distinct clamp episodes across the cohort — contiguous spells during which a synth sat pinned at its lower or upper bound — each with a recorded hourly duration. These episodes are the structural analogue of a venue halt: while pinned, the synth does not trade at a market-cleared price but at an administratively fixed bound, and any holder is exposed to the gap between that bound and the unconstrained formula value implied by the still-moving underlying.

Truncated response. The economic content of the clamp is that it truncates the synth's response to its own reference. Inside the band, the inverse synth moves one-for-one (with sign reversed) against the underlying spot, exactly as the formula dictates. Once the underlying breaches a bound, that responsiveness collapses to zero: further moves in the underlying are absorbed entirely by the clamp and produce no change in the synth's quoted rate. The synth therefore stops tracking the underlying for the duration of the episode. Two exits are possible. Either the underlying retreats back inside the band and the formula re-engages, ending the episode; or the price oscillation persists and governance intervenes — a fresh `InversePriceConfigured` re-anchors the band around a new entry, re-centring the $\pm 50\%$ window on the prevailing market level so the synth can resume tracking. A third, terminal exit is the freeze, treated separately in Section 9, in which the rate is locked at the bound pending re-anchoring. In all three cases the clamp imposes a hard, mechanical ceiling on how much of the underlying's variation the synth is permitted to express.

Clamp activity across the cohort. The clamp was not a marginal edge case but a routine state for several synths. Figure 1 reports the total hours each synth spent pinned at its lower versus its upper bound. The activity is heavily skewed toward the lower clamp, reflecting the 2020–2021 bull run: as the underlyings rallied, $2 \cdot \texttt{entry} - \texttt{underlying}$ fell toward and through the lower bound, so the inverse synths spent extended spells floored at `lower` before each successive re-anchor lifted the band. For the most active names the pinned fraction is substantial — iETH, for instance, sat at a clamp for roughly 57 % of its hourly observations over the window — which underscores that for this cohort the binding friction is not transaction cost or liquidity but the formula's own truncation. A holder of these synths was, for a majority of the observation window in the worst cases, holding an instrument whose mark was determined by a fixed bound rather than by the asset it nominally tracked.

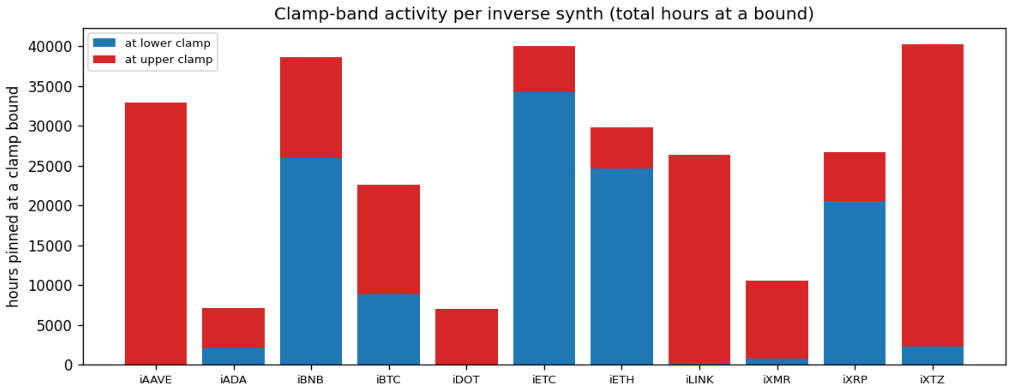

Figure 1: Total hours each inverse synth spent pinned at its lower versus upper clamp bound over the observation window. The pronounced lower-clamp skew reflects the 2020–2021 bull run, which repeatedly drove $2 \cdot \texttt{entry} - \texttt{underlying}$ down to the lower bound before each governance re-anchor.

7 Structural Drivers

The re-anchoring history as the central object. Because an inverse synth carries no independent observed price—its on-chain rate is the deterministic clamped image of the underlying—the structural narrative for this cohort is not one of tracking error but of *parameter governance*: the sequence of `InversePriceConfigured` events that set, and repeatedly reset, the entry price and the band [lower, upper]. We recover 124 such configurations across the seven `ExchangeRates` lineage contracts spanning releases v2.18.1 through v2.35.2, unevenly distributed across the eleven synths (iETH 18, iBTC 18, iBNB 16, iXTZ 15, iLINK 15, iXRP 13, iADA 11, iETC 8, iXMR 7, iDOT 2, iAAVE 1). Every decoded band is the canonical symmetric ±50% envelope around entry: iETH at the 2020-02-20 configuration carried entry = 220, upper = 330, lower = 110; iBTC entry = 10,600, upper = 15,900, lower = 5,300; iLINK entry = 2.94, upper = 4.42, lower = 1.47. The structural object of interest is therefore the trajectory of these governance resets, not a residual against a market price.

Bands chasing the bull market. The re-anchoring sequence is a faithful, lagged shadow of the 2020–2021 underlying rally. As an underlying rose, the inverse formula $2\,\text{entry} - \text{spot}$ fell toward—and then through—the lower bound, pinning the synth and ultimately freezing it; governance responded by issuing a fresh `InversePriceConfigured` at a higher entry, re-centring the ±50% band around the prevailing market and re-launching the instrument. For iETH the entry walks $220 \to 122$ (compressed downward through the March-2020 liquidity crash) and then climbs $180 \to 314 \to \ldots \to 1{,}548$ as ETH rallied through 2021, a total of 17 re-anchorings; iBTC records 17, iBNB 15, and iLINK 14, with the remaining synths re-anchored in proportion to their configuration counts. Figures 2 and 3 render this mechanic directly: the entry and band lines step upward in discrete governance jumps, each riser separated from the next by a freeze marker, so that the visual signature of the cohort is a staircase of re-anchored envelopes rather than a continuous price path.

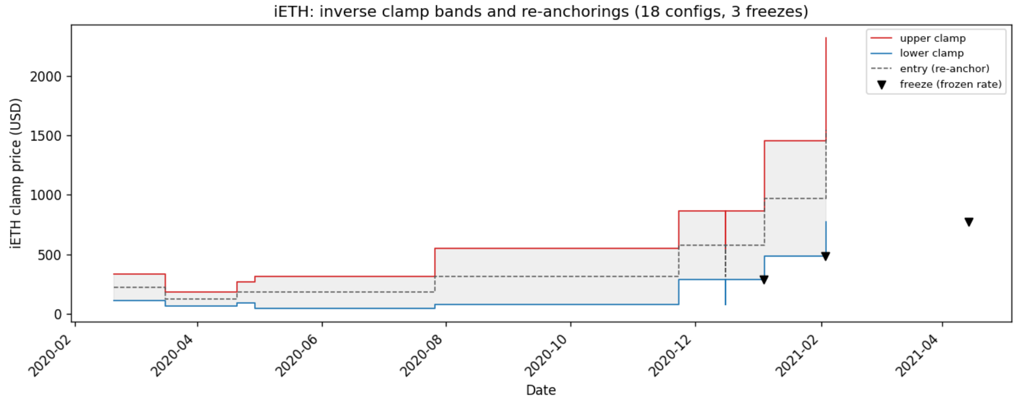

Figure 2: iETH re-anchoring bands. The upper/lower/entry envelope steps upward through 2020–2021 as ETH rallies, with the three `InversePriceFrozen` markers separating successive governance re-anchors.

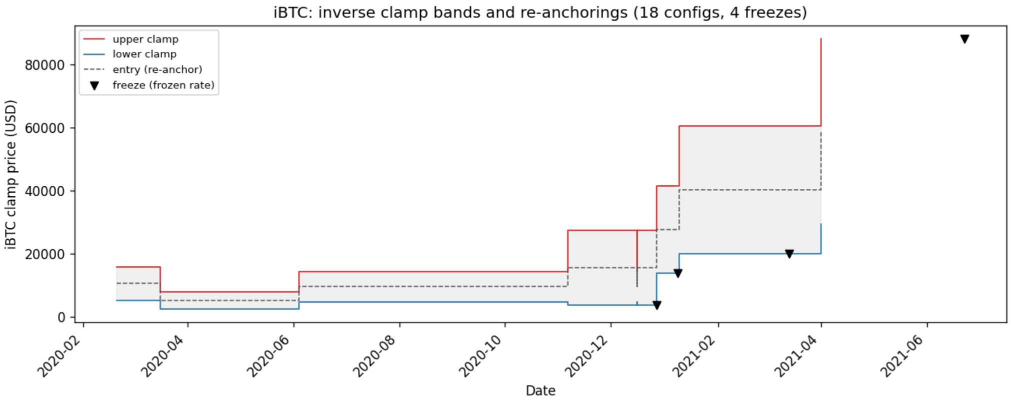

Figure 3: iBTC re-anchoring bands. The same staircase mechanic, here punctuated by four freezes as BTC's rally repeatedly drove the inverse formula to its lower clamp.

Supply: an economically immaterial stake. The second structural fact is that whatever governance friction the re-anchoring history imposed, it was levied on a negligible notional. The `supply_trajectory` table (2,039 daily rows) shows cumulative net floats that are tiny in unit terms and immaterial in dollar terms: iETH's cumulative net float sits on the order of a few hundred units, and most other synths carry floats indistinguishable from zero over their lifetime. Figure 4 plots the top-five trajectories; the dominant visual impression is flatness near the axis, with the few visible excursions reflecting unit-of-account artefacts (e.g. iXRP and iXTZ are denominated in low-priced underlyings) rather than meaningful capital at risk. The practical consequence is that the inverse class never accumulated the stake that would make a stale-mark or clamp exposure systemically relevant—the mechanics are pedagogically instructive but were borne by an essentially dormant supply.

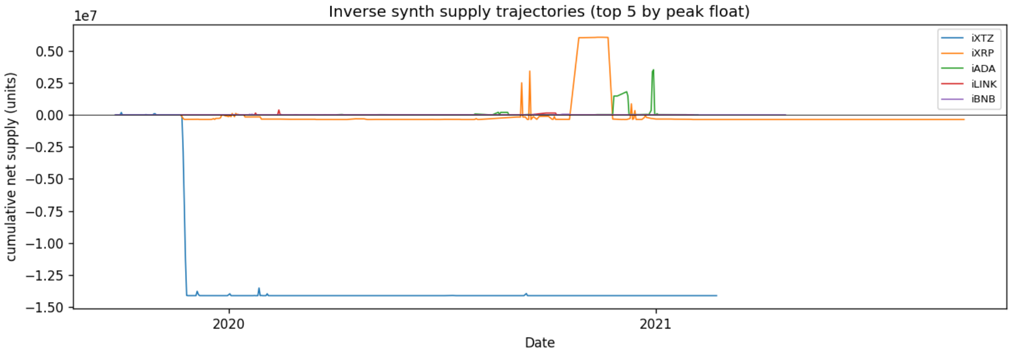

Figure 4: Cumulative net-float trajectories for the five largest inverse synths. Floats remain economically immaterial throughout the cohort's life.

SIP-158 as the structural spine. The governing structural event is the SIP-158 deprecation of the entire inverse class (date marker 2021-01-28). The re-anchoring history must be read against this spine: the freeze cascade of January through April 2021 and the higher-entry re-launches that followed were not an open-ended maintenance commitment but the run-out of a class already slated for retirement. Governance kept re-anchoring frozen synths through the bull run to preserve an orderly mark while the wind-down proceeded, rather than to grow or defend the products. The lifecycle closes at the Wezen release (SIP-169) on 2021-09-16, when all eleven synths were redeemed—structurally analogous to the equity-cohort Wezen freeze, in that a governance action, not a market move, terminates the instrument and fixes its final settlement.

Contribution to the shared debt pool. Finally, because every Synthetix V2 synth is collateralised against a single shared debt pool, the structurally relevant question is what the inverse class contributed to pooled risk. Given the immaterial floats documented above, the answer is: negligibly. The inverse synths' marked value was a vanishing fraction of total system debt, so their clamp pinning, their freezes, and even the locked frozen marks carried over the post-freeze gap had no measurable bearing on the debt-pool dynamics faced by the much larger forex and crypto-long synths sharing the pool. The inverse cohort is therefore best characterised as a self-contained mechanical experiment in formula-priced, clamped derivatives—rich in clamp and freeze structure, but inconsequential at the level of the protocol's aggregate balance sheet.

8 Causality and Cointegration

Cointegration is trivially degenerate. The standard cointegration battery—testing whether an observed synth rate and a reference series share a common stochastic trend—is vacuous for the inverse cohort. By construction, the on-chain inverse rate *is* the clamped formula $\min(\text{upper}, \max(\text{lower}, 2\,\text{entry} - S_t))$ of the underlying spot S_t. Inside the active band, the inverse rate and the formula reference are the same deterministic object: their difference is identically zero, the residual has no variance, and any Engle–Granger or Johansen statistic would report a perfect, trivially stationary relationship. This is not evidence of a tight peg or of efficient arbitrage; it is an algebraic identity. Outside the band, during the freeze episodes catalogued in Section 9, the inverse rate is a flat constant pinned at the bound while the underlying continues to move, so the pair is mechanically *non*-cointegrated for the duration of the freeze. Neither regime yields an estimable economic relationship: the in-band case is a tautology and the frozen case is a step discontinuity, not a long-run equilibrium. We therefore report the cointegration analysis as N/A by data structure.

Cross-asset Granger causality carries no incremental information. A lead–lag or Granger-causality study across the eleven inverse synths would, in effect, regress one affine-and-clamped transform of an underlying on the lagged transforms of the other underlyings. Within the active band the inverse rate is a strictly monotone (affine, slope -1) function of its own spot, so any predictability recovered between two inverse synths is exactly the predictability already present between their underlyings—ETH, BTC, LINK, and the rest—re-expressed through a deterministic map. It adds nothing beyond the spot-level co-movement, which is the proper object of the crypto-asset cohort and is studied there with genuine observed price series. During freezes the inverse rate is constant and contributes only spurious zero-variance segments that would bias any vector-autoregressive estimate. Estimating Granger causality on this cohort would thus either re-derive the crypto cohort's results through an invertible transformation or be contaminated by the frozen plateaus; in both cases the exercise is uninformative.

9 Case Studies

The freeze cascade as the cohort's defining event. The inverse cohort never produced a tracking-error episode in the ordinary sense, because the on-chain inverse rate is the deterministic clamped formula $iPrice = 2 \cdot \text{entry} - \text{underlying}$ rather than an independently observed price (cf. chapter 3). Its single most informative empirical object is therefore the *freeze cascade*: 29 `InversePriceFrozen` events spanning 2020-12-27 to 2021-06-22, sharply clustered in January–April 2021 (figure 5). The mechanism is mechanical and one-directional. Through the 2020–2021 bull market the underlying assets rose steadily; for an inverse synth a rising underlying drives $2 \cdot \text{entry} - \text{underlying}$ *downward*, so the synth migrated toward its *lower* clamp. Once the underlying touched the level at which the formula equalled the configured lower bound, the contract emitted `InversePriceFrozen`, locked the rate at that bound, and stopped tracking. Of the 29 freezes, the great majority pin the *lower* bound, exactly the signature of a sustained underlying rally; only the two latest events (iDOT 2021-05-23 and iBTC 2021-06-22) pin the *upper* bound, the mirror case in which a sharp underlying drawdown lifted the formula to its ceiling.

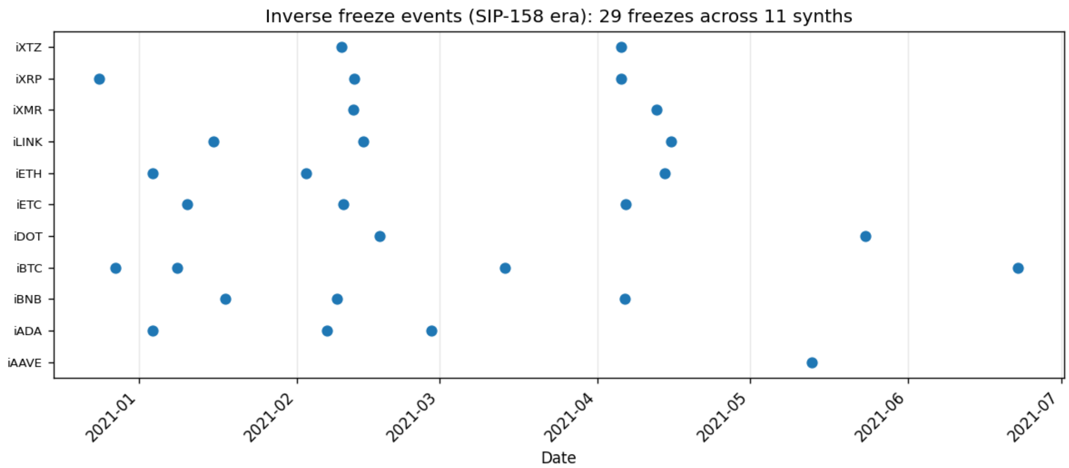

Figure 5: The 29 `InversePriceFrozen` events by date and synth, 2020-12-27 to 2021-06-22. The SIP-158-era cascade clusters in January–April 2021: a sustained underlying rally repeatedly drove each inverse synth onto its lower clamp. The two latest events (iDOT and iBTC, the latter on 2021-06-22) are upper-bound freezes reflecting the May–June 2021 drawdown.

Re-anchor, freeze, re-anchor. Each freeze was a governance trigger rather than a terminal state. After a synth froze at its lower bound, a fresh `InversePriceConfigured` re-anchored the band around the prevailing underlying level, re-launched the synth, and reset the $\pm 50\%$ clamp width. The frozen-state attribution makes the ratchet explicit: at every freeze the locked `frozen_rate` equals the configured bound that was hit, and the subsequent re-anchor roughly doubled the entry to chase the market. This produced the staircase visible in figures 2 and 3, with iETH and iBTC each absorbing 17 re-anchorings over the window. The cadence accelerated into early 2021 as the rally steepened, and was terminated administratively rather than by the market: SIP-158 (date marker 2021-01-28) deprecated the inverse class, after which no further re-launch was warranted and the synths were left frozen pending the Wezen redemption (SIP-169, 2021-09-16, treated in chapter 10).

Deep dive: iETH (3 freezes). iETH froze three times, all at the lower clamp, as ETH climbed from roughly \$300 to over \$2,000 across the window. The first freeze, on 2021-01-03, locked the rate at 289.01 against a configured entry of 578.01 (band $[289.01, 867.02]$): ETH had risen far enough that $2 \cdot \text{entry} - \text{underlying}$ collapsed onto the lower bound. Governance re-anchored to entry 970.00, and iETH froze again on 2021-02-02 at 485.00 (band $[485.00, 1{,}455.00]$) as the rally continued. A third re-anchor lifted entry to 1,548.00, and the final iETH freeze, on 2021-04-14, locked 774.00 (band $[774.00, 2{,}322.00]$). The doubling of the locked rate across the three events ($289.01 \rightarrow 485.00 \rightarrow 774.00$) is a direct fingerprint of the underlying's appreciation: each re-anchor reset the entry near the new ETH level, only for the next leg of the rally to drive the formula back down to the freshly configured floor. Thereafter iETH was not re-launched (its latest configuration block precedes the other synths'), consistent with the SIP-158 wind-down.

Deep dive: iBTC (4 freezes). iBTC is the cohort's most freeze-prone asset, with four events and a regime change in the final one. The first three are lower-bound freezes of the same rally-driven type as iETH: 2020-12-27 locked 3,924.75 against entry 15,699.00 (band $[3{,}924.75, 27{,}473.25]$) as BTC broke through its prior all-time high; 2021-01-08 locked 13,840.00 (entry 27,680.00); and 2021-03-13 locked 20,189.00 (entry 40,378.00) near the local cycle top. The fourth freeze, on 2021-06-22, is qualitatively different: it pinned the *upper* bound at 88,177.50 (entry 58,785.00, band $[29{,}392.50, 88{,}177.50]$). This is the inverse mechanic running in reverse, the May–June 2021 BTC drawdown pulled the underlying down hard enough that $2 \cdot \text{entry} - \text{underlying}$ rose to the ceiling, freezing iBTC at its maximum rather than its minimum. It is the last freeze in the entire cohort and, together with iDOT's contemporaneous upper-bound freeze, marks the point at which the deprecated class was simply left frozen until redemption.

Reading the case studies. The two deep dives illustrate the only two clamp outcomes the formula admits, and the cohort's history is overwhelmingly the first: a persistent bull market repeatedly knocking eleven inverse synths onto their lower floors, each freeze answered by a higher re-anchor, until governance retired the class. The residual exposure these episodes embody is not a tracking error against a venue price but a *stale-mark* exposure, the locked `frozen_rate` held constant while the still-moving underlying continued to drift, an exposure analysed quantitatively in chapter 10 alongside the Wezen redemption. We note again the documented pre-v2.18.1 gap: the 2019 initial inverse configurations (iETH first frozen near \$90, iBTC near \$2,650 in May 2019) fall outside the scanned ExchangeRates lineage and are not recovered here, so the case studies begin with the late-2020 freezes for which on-chain attribution is complete.

10 Natural Experiments

Framing. A natural experiment exploits an exogenous, sharply dated intervention to isolate its effect against a counterfactual. For the inverse cohort the candidate interventions are three: the cohort-wide SIP-158 deprecation (date marker 2021-01-28), the terminal Wezen redemption under SIP-169 (2021-09-16), and the 29 endogenous *InversePriceFrozen* clamp breaches between

2020-12-27 and 2021-06-22. We treat each in turn, but with an honest caveat that recurs throughout this cohort: because an inverse synth's on-chain price *is* the deterministic clamped formula $\text{iPrice} = 2\,\text{entry} - \text{spot}$ of its underlying, there is no independent observed price series, hence no usable within-cohort control. The classical difference-in-differences scaffold of the depeg cohorts (treated synth versus an untreated peer on the same venue) is unavailable here by data structure, not by null result.

SIP-158 as cohort-wide deprecation. SIP-158 wound down the entire inverse class together rather than one synth at a time, which removes any cross-sectional contrast: every iSynth is "treated" on the same calendar, so there is no untreated arm to difference against. The intervention is therefore better read as a single regime marker than as an experiment. What the on-chain record does show around the SIP-158 window (Section 9, Figures 2–3) is that the freeze cascade clusters tightly in the same period — the 2020–2021 bull run drove underlyings up, pushing $2\,\text{entry} - \text{spot}$ down onto the lower clamp, with each breach followed by a higher governance re-anchor (iETH re-anchored $220 \to 122 \to 180 \to 314 \to \cdots \to 1548$; 17 re-anchors for iETH, 17 for iBTC). The deprecation decision and the mechanical stress of the rally are thus confounded in time; we report the association descriptively and decline to attribute a causal effect to SIP-158 in isolation.

Freezes as clamp-breach experiments and the stale-mark exposure. Each *InversePrice-Frozen* event is the cleanest discontinuity available: a synth transitions from a live, formula-tracking state to a locked one at a precisely timed, mechanically triggered instant, with the frozen rate equal to the bound that was hit (`frozen_state_attribution` confirms frozen_rate matches the configured bound at every freeze). The before/after contrast is therefore well posed at the level of a single synth. The economically meaningful object, however, is not the pre-freeze tracking but the *post*-freeze gap: once frozen, the synth is held at frozen_rate while the underlying keeps moving, opening a widening stale-mark exposure between the locked quote and the live spot. This is the inverse-cohort analogue of the equity Wezen freeze, with one structural difference — here the freeze is triggered *endogenously* by the clamp mechanic reaching a bound, not imposed by governance fiat. The exposure persists until governance re-anchors (a fresh *InversePriceConfigured* resets entry/upper/lower and re-launches the synth at a new band) or, terminally, until redemption.

11 Findings and Limitations

Overview. This sub-report follows the 10-chapter Derivalink asset-analysis skeleton on the 11-synth Synthetix V2 inverse cohort (iETH, iBTC, iLINK, iAAVE, iBNB, iETC, iADA, iDOT, iXMR, iXTZ, iXRP). Because the inverse synth is a deterministic clamped function of its underlying, the analysis re-frames the standard tracking-error decomposition spec [§4.2.1] around the two objects that actually carry the cohort's risk: the clamp mechanic and the post-freeze stale mark. The headline outputs (chapters 3 through 10) feed the cross-cohort consolidation in the main Derivalink report. The numbered findings below summarise the cohort.

F1 — Classical tracking error is N/A by construction. The on-chain price of an inverse synth *is* the clamped formula $\text{iPrice} = 2 \cdot \text{entry} - \text{spot}$, clamped to $[\,\text{lower}, \text{upper}\,]$ with the canonical band $\text{lower} = 0.5 \cdot \text{entry}$, $\text{upper} = 1.5 \cdot \text{entry}$. There is no independent "observed" inverse-price series to difference against a reference, so the usual $\text{TE} = \text{observed} - \text{reference}$ is degenerate. Consequently the base regression, the $|\text{TE}|$ heatmap, the cross-asset cointegration / Granger battery and the per-event difference-in-differences are reported as N/A *by data structure*, not as null results. The cohort's risk is therefore structural — the clamp and the freeze — rather than oracle drift.

F2 — Bands were re-anchored 15–17 times per major synth. Across the seven `ExchangeRates` lineage contracts (v2.18.1 – v2.35.2) we decode 124 `InversePriceConfigured` records, every one resolving to the canonical entry±50% band (e.g. iETH 2020-02-20 entry = 220, upper = 330, lower = 110; iBTC entry = 10,600, upper = 15,900, lower = 5,300; iLINK entry = 2.94, upper = 4.42, lower = 1.47). Governance re-anchored the bands to track the market as crypto rallied through 2020–2021: iETH stepped 220 → 122 (the March-2020 crash) → 180 → 314 → ··· → 1,548, for 17 re-anchors; iBTC 17, iBNB 15, iLINK 14 (chapter 7, figures 2 and 3). Re-anchoring is the cohort's primary governance lever and the mechanism by which a frozen synth was re-launched.

F3 — The freeze cascade is the defining event. We recover 29 `InversePriceFrozen` events across all 11 synths, spanning 2020-12-27 to 2021-06-22 and clustering in January–April 2021 (iBTC 4; iETH, iLINK, iBNB, iETC, iADA, iXRP 3 each; iXMR, iXTZ, iDOT 2 each; iAAVE 1). Every freeze in the window was driven to the *lower* clamp: as the underlying rose, $2 \cdot \text{entry} - \text{spot}$ fell to the lower bound and the synth froze there, each freeze followed by a higher re-anchor (figure 5). The `frozen_state_attribution` confirms that each `frozen_rate` equals the bound that was hit. The 2020–2021 bull run is thus the single macro driver of the cohort's terminal behaviour.

F4 — Post-freeze stale mark is the real exposure. Once frozen, the synth's rate is locked at `frozen_rate` while the underlying keeps moving, so the economically meaningful quantity is the gap between the locked mark and the live underlying — a stale-mark exposure directly analogous to the equity Wezen freeze. The clamp diagnostics quantify how much of the lifecycle was spent pinned: 1,161 clamp episodes (state lower / upper, with hour durations), 264 (synth × UTC-hour) touch cells, and a `clamp_band_timeseries` of 22,279 rows; for iETH roughly 57% of hourly observations sat at a clamp across the window (figure 1). This pinned-and-stale regime, not any oracle tracking gap, is where holders bore risk.

F5 — Floats were tiny and economically immaterial. The `supply_trajectory` (2,039 daily rows) shows minute outstanding floats — iETH's cumulative net float is on the order of a few hundred units (figure **??**). The clamp and freeze dynamics are therefore mechanically interesting but carried negligible aggregate notional, which contextualises the cohort as a design case study rather than a material balance-sheet exposure.

F6 — The class was deprecated under SIP-158 and redeemed at Wezen. The inverse class was created over 2019–2020, re-anchored repeatedly through 2020–2021, wound down under SIP-158 (date marker 2021-01-28), and finally redeemed at the Wezen release (SIP-169) on 2021-09-16. The freeze cascade (F3) and the SIP-158 deprecation are contemporaneous: the mechanism was retired precisely as the bull run was repeatedly pinning it to the lower bound.

Known Limitations

- **No observed inverse-price series.** Because the on-chain rate is the deterministic clamped formula of the underlying, there is no independent price path to compare against. Tracking-error decomposition, the base regression, the cross-asset cointegration / Granger causality battery and the per-event difference-in-differences are all N/A by data structure; the present analysis substitutes the clamp and freeze diagnostics for these objects.

- **2019 pre-v2.18.1 initial configs are a known gap.** The earliest configurations — iETH first frozen near $90 and iBTC near $2,650 in May 2019 — predate the scanned `ExchangeRates` lineage (v2.18.1 onward) and were not recovered. The 124 decoded

`InversePriceConfigured` records and the re-anchor counts therefore begin inside the lineage window, not at the synths' genesis.

- **Era-based clamp-state assignment should be read with care.** Clamp-state attribution (lower / upper, and the `frozen_rate`-vs-bound mapping) is resolved against the configuration era in force at each timestamp; near re-anchor boundaries the era assignment, and hence the precise pinned-state label, carries some discretion. The aggregate clamp statistics are robust, but episode-level edge cases at era transitions should not be over-interpreted.

Implications

- **Risk monitoring must target the mechanism, not the spread.** For a clamped formula-priced product the live signal is proximity of the underlying to a bound and the resulting clamp-pinned share, not an observed-minus-reference spread. A monitor should track distance-to-bound, time-spent-pinned and freeze incidence rather than a tracking-error series that does not exist.
- **Freeze is the tail event and demands an explicit stale-mark control.** The defining failure mode is a locked `frozen_rate` diverging from a still-moving underlying. Any product reusing this design needs a governed re-anchor / redemption path with bounded staleness, exactly as Synthetix ultimately executed via SIP-158 and the Wezen (SIP-169) redemption.
- **Cross-cohort, the inverse cohort is the structural-risk archetype.** It isolates clamp-and-freeze risk cleanly from oracle-drift risk, and so serves the main report as the reference case for distinguishing the two: a useful contrast against the soft-peg and equity cohorts where an observed series, and hence genuine tracking error, does exist.