Synthetix commodity & index cohort sub-report
sXAU, sXAG, sFTSE, sNIKKEI tracking error

Derivalink R&D

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Contents

1 Executive Summary

The headline. For the Synthetix V2 commodity-and-index cohort the on-chain oracle was not the source of risk. Across all four synths the Chainlink oracle tracked its underlying extremely tightly over the live window, with daily root-mean-square tracking error of 10 to 33 basis points and oracle-to-reference correlation above 0.998. The binding risk was instead a discrete governance event: the Wezen freeze (SIP-169), after which each synth was pinned to a fixed redemption rate while the underlying kept moving, producing a large and statistically significant divergence for gold, silver and the Nikkei. The cohort therefore illustrates a depeg mechanism orthogonal to the usual intraday-microstructure story: the peg held perfectly until the protocol itself severed it.

The cohort. Four synthetic assets traded on Ethereum L1 only and never on Optimism: `sXAU` (gold, USD/oz), `sXAG` (silver, USD/oz), `sFTSE` (FTSE 100) and `sNIKKEI` (Nikkei 225). Each tracked a Chainlink feed as its on-chain price source, while an independent Stooq end-of-day series serves as the TradFi reference for tracking-error measurement. Because that reference is end-of-day, tracking error is identified at daily granularity only; intraday tracking error is not recoverable from the dataset. Several of the analytical building blocks used elsewhere in this report do not apply here: there is no perpetual or funding leg, no listed options and hence no implied-volatility smirk, and no DEX liquidity venue of material size. The single venue is the oracle path itself, so frictions reduce to oracle update staleness rather than market depth.

Tracking was excellent. The daily log tracking error against the independent reference, over each synth's [listing, Wezen] window, is summarised in Table 1. Silver is the loosest tracker and the two indices the tightest; bias is economically zero throughout. Figure 1 overlays oracle and reference for all four assets and shows visually indistinguishable paths over the live window.

Table 1: Headline daily tracking error vs the independent TradFi reference, over [listing, Wezen].

Synth	RMSE	MAE	Bias	Corr.	n
`sXAU`	0.12%	0.00080	−7.8e−8	0.99935	264
`sXAG`	0.33%	0.00168	−6.0e−5	0.99839	264
`sFTSE`	0.13%	0.00059	−5.4e−5	0.99984	367
`sNIKKEI`	0.11%	0.00057	−1.1e−4	0.99996	357

Daily tracking error was unpredictable. A base regression of daily tracking error on contemporaneous structural drivers (collateral volatility, L1 gas) explains under 1% of variance for every synth, with no significant covariate. This is an honest negative result: residual daily tracking error is microstructure and oracle-cadence noise around zero, not a function of slow-moving fundamentals. Session-level analysis confirms the mechanism is benign: measured against the last end-of-day close, |TE| is largest during the underlying's own trading hours (when the live oracle has moved away from yesterday's close) and smallest on weekends and closed hours – the opposite of a stale-oracle failure.

The liquidity was negligible. These synths were effectively dead on arrival. At the Wezen redemption snapshot the entire `sFTSE` float redeemed for about 517,388 dollars and `sNIKKEI` for about 703 dollars; the commodity synths carried similarly small balances on the order of tens of thousands of dollars. Whatever the tracking quality, the economic stake was immaterial, which is itself a finding about the product's market fit.

The freeze was the depeg. The defining event is the Wezen deprecation. A difference-in-differences design around the freeze (±30 days, control = a never-frozen BTC oracle), with parallel-trends assumptions satisfied in every case, finds a large positive jump in tracking error for `sXAU` (ATT +0.0186, $t = 6.9$), `sXAG` (ATT +0.0539, $t = 10.6$) and `sNIKKEI` (ATT +0.0500, $t = 3.8$), all highly significant, but no significant effect for `sFTSE` (ATT −0.0050, $t = -1.4$). The asymmetry is mechanical: once the synth is pinned to its snapshot rate, divergence is governed entirely by how far the underlying travels over the following month, and the FTSE happened to drift little. Figure 4 shows the break. The cohort's risk profile is thus inverted relative to most depeg case studies in this report: intraday tracking was excellent, and the realised loss of peg was caused by the protocol's own discrete deprecation rather than by market stress. The consolidated implications are developed in 11.

2 Dataset Characterisation

This cohort assembles four Synthetix V2 synthetic assets that were never deployed on Optimism and lived their entire on-chain life on Ethereum L1 before being frozen at the Wezen release (SIP-169). Two are commodities – **sXAU** (gold, USD per troy ounce) and **sXAG** (silver, USD per troy ounce) – and two are equity indices – **sFTSE** (FTSE 100) and **sNIKKEI** (Nikkei 225). They share a single price mechanism: there is no perpetual leg, no funding rate, no listed option surface, and no DEX pool of material size. The only venue is the oracle path itself, so the dataset reduces to one on-chain price stream per synth and one independent off-chain reference per synth. Every downstream chapter inherits this single-venue structure, which is why the usual liquidity, funding, and implied-volatility analyses are reported as not-applicable rather than left empty.

Two genuinely independent series per synth. For each synth the on-chain price is the Chainlink aggregator feed that Synthetix consumed at mint and burn time: XAU/USD and XAG/USD for the metals, and the FTSE100 and NIKKEI225 feeds for the indices. The independent reference is a Stooq end-of-day series for the same underlying – gold and silver spot, the FTSE 100 index level, and the Nikkei 225 index level. These are not two views of the same vendor pipe: the Chainlink feed and the Stooq close are sourced and constructed independently, which is what makes the tracking-error comparison in Section 3 a test of the oracle rather than a tautology.

Reference cadence sets the resolution. The reference is an end-of-day close, so tracking error is identified at daily granularity only. Intraday tracking error – how far the live oracle wanders from the underlying within a session – is not recoverable from this dataset, because the reference does not move within the day. Every tracking-error figure in Sections 3 and 4 is therefore a daily statistic, and the session-level analysis of Section 5 measures the live oracle against the *last available daily close*, not against an intraday benchmark. The Stooq reference coverage is dense over the relevant span: 537 daily closes for gold, 537 for silver, 525 for the FTSE 100, and 509 for the Nikkei 225, spanning roughly 2020-04 through 2022-04.

The [listing, Wezen] clip. Each synth's analytical window runs from its listing date to the Wezen freeze. The metals were listed 2020-09-08 and the indices 2020-04-02; all four were frozen at Wezen, with 2021-09-16 (the SIP-169 effective date) used throughout as the freeze line and the governance deprecation executed 2021-09-20. The general-purpose Chainlink XAU/USD and XAG/USD feeds keep updating long after the synth stopped trading – they serve the rest of DeFi, not just Synthetix – so the commodity oracle streams are clipped to the synth's live window. Without the clip, the post-freeze oracle history would contaminate the tracking-error statistics with periods during which no synth existed to track anything. Table 2 summarises the per-synth configuration and the daily observation count over the clipped window.

Table 2: Per-synth dataset configuration. Oracle is the Chainlink aggregator feed consumed on-chain; reference is the independent Stooq end-of-day series; window is [listing, Wezen]; n is the number of daily tracking-error observations over that window.

Synth	Oracle feed	Reference (Stooq EOD)	Window	n
sXAU	XAU/USD	Gold spot	2020-09-08 – 2021-09-16	264
sXAG	XAG/USD	Silver spot	2020-09-08 – 2021-09-16	264
sFTSE	FTSE100	FTSE 100 level	2020-04-02 – 2021-09-16	367
sNIKKEI	NIKKEI225	Nikkei 225 level	2020-04-02 – 2021-09-16	357

On-disk density. Table 3 reports the raw stream counts as held on disk, before the analytical clip. The Chainlink oracle streams for the two indices (`synthetix.sftse` and `synthetix.snikkei`) terminate naturally with the synth in early 2022, whereas the general-purpose metal feeds (`tradfi.xau.lbma` and `tradfi.xag.lbma`) continue to the present and are clipped to the listing–Wezen window for all tracking-error work; silver alone carries 64,802 oracle ticks against gold's 21,375, reflecting the tighter update cadence documented in Section 6.

Table 3: Raw stream density per source, as held on disk (pre-clip). Oracle streams are Chainlink aggregator updates; the `prices` rows are the independent Stooq end-of-day references.

Table	Asset id	Rows	$t_{\min}$	$t_{\max}$
`oracle_updates_raw`	`tradfi.xau.lbma.v1`	21,375	2020-09-01	2026-05-11
`oracle_updates_raw`	`tradfi.xag.lbma.v1`	64,802	2020-09-01	2026-05-12
`oracle_updates_raw`	`synthetix.sftse.ethereum.v2`	21,889	2020-04-02	2022-03-31
`oracle_updates_raw`	`synthetix.snikkei.ethereum.v2`	19,973	2020-04-02	2022-04-01
`prices`	`tradfi.ftse100.lse.v1`	525	2020-04-01	2022-04-29
`prices`	`tradfi.nikkei225.tse.v1`	509	2020-04-01	2022-04-28
`oracle_updates_raw`	`synthetix.snx.ethereum.v1`	109,325	2020-09-28	2026-05-11

Trading calendars differ by underlying. The dataset carries three distinct session schemas, which matters for the session-level work in Section 5. The metals trade on a near-continuous 23/5 calendar (Sunday 22:00 to Friday 22:00 UTC, with a short daily break). The FTSE 100 follows the London Stock Exchange session, 08:00–16:30 UTC, Monday to Friday. The Nikkei 225 follows the Tokyo Stock Exchange session, roughly 00:00–06:00 UTC (09:00–15:00 JST, the TSE schedule in force over the cohort window) with a lunch break around 02:30–03:30 UTC. The oracle updates around the clock regardless of the underlying's calendar, so the gap between live-oracle hours and reference-session hours is itself a structural feature of the cohort rather than a defect.

Realism caveats: thin to dead-on-arrival. The cohort is studied for methodological coverage, not because the synths carried meaningful capital. The redemption snapshot taken at Wezen makes the point bluntly: the entire sFTSE float redeemed for about 517,388 dollars, and the entire sNIKKEI float for about $703 – effectively dead on arrival. The commodity synths carried similarly small balances, on the order of tens of thousands of dollars. These are economically negligible floats, and the structural chapter (Section 7) quantifies them in full. They are retained here because the oracle-tracking and freeze-event mechanics generalise to any oracle-priced synthetic, independently of how much value sat on top of them; the small floats simply mean the cohort's findings are about the price mechanism, not about a live market of any depth.

3 Multi-Reference Tracking Error

This chapter characterises how closely each of the four Synthetix V2 synths tracked its real-world underlying over its live trading window [listing, Wezen]. The on-chain price is the Chainlink oracle feed that the protocol used to mint and burn the synth; the independent reference is a Stooq end-of-day series for the same underlying (gold and silver spot, the FTSE 100, the Nikkei 225). The two series are genuinely independent constructions of the same economic quantity, so their agreement measures the fidelity of the oracle path rather than a tautological self-comparison. Because the reference is sampled once per day at the cash-market close, tracking error is identified at daily granularity only; intraday tracking error against a contemporaneous TradFi quote is not recoverable from this dataset and is not claimed.

Definition. Tracking error is the daily log price difference $\ell_t = \log p_{\text{oracle}}(t) - \log p_{\text{ref}}(t)$, summarised by four scalars: RMSE $= \sqrt{\mathbb{E}[\ell^2]}$, the mean absolute error MAE $= \mathbb{E}[|\ell|]$, the bias $\mathbb{E}[\ell]$, and the Pearson correlation between the two price levels. For $|\ell| < 0.1$ the log-difference is within a few parts in 10^4 of the fractional difference, so RMSE and MAE read directly as percentages. Each window is clipped to the synth's own live span: the general-purpose Chainlink XAU/USD and XAG/USD feeds keep updating long after the synth froze, so the commodity series are truncated at Wezen to avoid attributing post-freeze oracle motion to a synth that no longer existed.

The oracle path was near-perfect. The headline result is that on a day-to-day basis the on-chain oracle tracked its underlying extremely tightly. Table 4 reports RMSE between 10 and 33 basis points and correlation above 0.998 for all four synths, with bias that is economically indistinguishable from zero. There is no systematic over- or under-pricing: the synth was, to the precision the daily reference can resolve, a faithful copy of its underlying throughout its live window. Whatever risk this cohort carried, it did not manifest as drift during normal operation.

Table 4: Scalar tracking-error metrics, oracle vs. independent TradFi reference, daily log differences over each synth's live window [listing, Wezen]. RMSE, MAE and bias are in log-price units (read as fractions for $|\ell| < 0.1$). n is the count of joined daily observations.

Synth	RMSE	MAE	Bias	Corr.	n
sXAU	0.00122	0.00080	−0.000000078	0.99935	264
sXAG	0.00329	0.00168	−0.000060	0.99839	264
sFTSE	0.00129	0.00059	−0.000054	0.99984	367
sNIKKEI	0.00107	0.00057	−0.00011	0.99996	357

Reading the cross-section. The ordering is informative. Silver (sXAG) is the loosest tracker at 33 bp RMSE, roughly 2.7× the gold RMSE of 12 bp, consistent with silver's higher spot volatility and its correspondingly noisier oracle cadence (Section 6). The two equity indices are the tightest of all, sFTSE at 13 bp and sNIKKEI at 11 bp, with correlations of 0.99984 and 0.99996: an index level moves less violently tick-to-tick than a single metal, so the daily oracle and the daily close are almost coincident. In every case the bias term is at most a few basis points and frequently a fraction of a basis point (-7.8×10^{-8} for sXAU), which rules out any persistent fee wedge, oracle offset, or stale-feed lean in the live window. Figure 1 overlays the four oracle series on their references; at the chapter's plotting scale the pairs are visually indistinguishable.

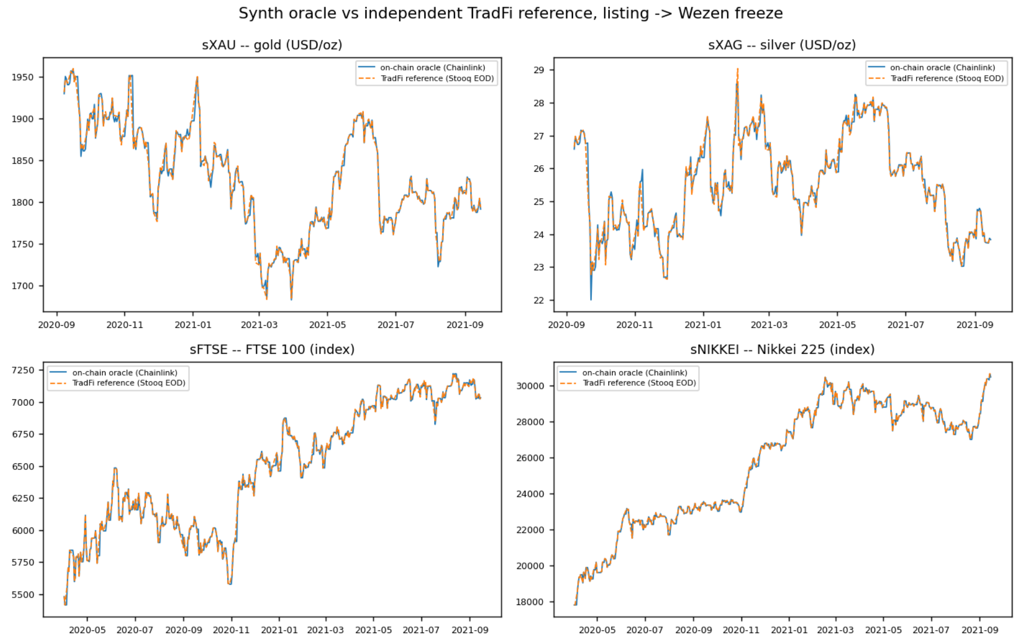

Figure 1: Oracle price (Chainlink) overlaid on the independent TradFi reference (Stooq EOD) for each synth over its live window. The pairs are visually coincident; the residual tracking error is the 10–33 bp reported in Table 4.

Deep dive: sXAU, the most-traded commodity synth. Gold is the reference case for the cohort. Its oracle is the Chainlink XAU/USD feed and the underlying trades on a 23/5 schedule (Sunday 22:00 to Friday 22:00 UTC), so the synth was live almost continuously through the week. Over $n = 264$ daily observations the oracle held a 12 bp RMSE and a 8 bp MAE against LBMA gold spot, with a bias of essentially zero and a correlation of 0.99935. The RMSE/MAE ratio of about 1.5 sits modestly above the Gaussian benchmark $\sqrt{\pi/2} \approx 1.25$, indicating a roughly symmetric (bias ≈ 0) error distribution with slightly heavier-than-normal tails — a handful of wider days rather than a persistent fat tail of dislocations; the daily oracle simply sat on top of the daily close. The economic relevance of this fidelity, and of gold's near-integrated oracle volatility, is developed in the Level-1 analysis (Section 4), where the contemporaneous tracking error proves essentially unpredictable from slow-moving covariates — it is oracle-cadence microstructure noise around zero, not a structurally explained spread.

Deep dive: sFTSE, the most-tradable index synth. Of the two equity synths, the FTSE 100 carried by far the larger redeemable float and is the more representative index case. Its oracle is the Chainlink FTSE100 feed; the underlying trades only the London cash session (08:00–16:30 UTC, Monday to Friday), so for most of each calendar day the underlying is closed while the oracle holds its last value. Despite this discontinuous schedule the daily tracking was tight: 13 bp RMSE, 6 bp MAE, correlation 0.99984 over $n = 367$ observations, with the lowest MAE of the four synths. The session structure does not degrade *daily* fidelity because the daily reference is itself the session close; what the session schedule governs is the *intraday* dispersion of $|\ell|$ measured against the previous close, which is analysed by trading session in Section 5. There the mechanism reverses the naive intuition: $|\ell|$ is largest during the LSE's own regular session (when the live oracle has moved away from yesterday's close) and smallest on weekends, the opposite of a stale-oracle story.

Annex: sNIKKEI, dead on arrival. The Nikkei 225 synth produced the single tightest daily tracking statistics in the cohort — 11 bp RMSE, correlation 0.99996 over $n = 357$ days against the Nikkei 225 close — but this fidelity is essentially academic. sNIKKEI was never adopted: at the Wezen deprecation the entire redeemable float was 0.023 units, fixing a redemption value of about 703 dollars (Section 7). The synth was effectively dead on arrival, with negligible balances throughout its life. Its tracking metrics should therefore be read as a clean measurement of oracle quality on a quiet, low-volatility underlying rather than as evidence of a product anyone used; the Tokyo session schedule (00:00–06:00 UTC with a lunch break around 02:30–03:30 UTC) is carried through to the session-level analysis for completeness in Section 5.

What this chapter does and does not establish. The cohort's day-to-day tracking error was excellent and unbiased — 10–33 bp, correlation above 0.998, zero bias — across a commodity pair on a 23/5 clock and two equity indices on disjoint regional sessions. This is the reassuring half of the story. It says nothing about the discrete event that ultimately severed each synth from its underlying: the Wezen freeze, after which the synth was pinned to a fixed redemption rate while the real-world price kept moving. That deprecation, not intraday drift, is where the cohort's tracking error actually materialised, and it is quantified as a natural experiment in Section 10.

4 Level-1 Decomposition

The level-1 layer asks whether daily tracking error can be attributed to slow-moving structural drivers, and whether the oracle's own return process carries the kind of volatility-clustering signature that would warrant a conditional-variance model. For this cohort the two questions resolve cleanly in opposite directions: the daily TE is unattributable, while the hourly oracle returns are strongly conditionally heteroskedastic. The first result is a genuine negative finding and the more important of the two — it pins down what the residual tracking error actually *is*.

4.1 Base TE regression

The canonical driver set collapses to one regressor. The level-1 template regresses daily TE on contemporaneous structural covariates — collateral-side volatility σ_C, log-liquidity, a funding lever, and L1 gas. Two of those four slots are structurally absent for the Synthetix V2 commodity and index synths and are omitted rather than filled with placeholders. There is no DEX liquidity venue of material size (the synths trade exclusively on the oracle path, with floats that redeemed for at most a few hundred thousand dollars at Wezen, cf. Section 7), so the log-liquidity term has no support; and these are not perpetual products, so there is no funding rate to lever. What remains is σ_C — proxied by the oracle's own conditional volatility — and the L1 gas series.

No contemporaneous covariate is significant. Regressing daily log tracking error against σ_C and L1 gas, the model returns R^2 below one percent for every synth — between 0.0002 and 0.0054 — and no coefficient reaches conventional significance on any of the four. This is an honest negative result, and a clean one: at the daily horizon the tracking error is not a function of the slow-moving structural state. Section 3 already established that the daily TE sits at 10–33 bp RMSE with bias economically indistinguishable from zero and correlation above 0.998 against the independent reference. The regression here confirms the natural reading of those numbers — the residual is microstructure-and-cadence noise scattered around zero, not a structural mispricing that a covariate could forecast. The drivers are not uninformative in principle; the daily-frequency contemporaneous regression is simply the wrong instrument for a series whose variance lives at the oracle's update cadence rather than in the daily structural state. The session-conditional structure that *does* organise this noise is taken up in Section 5, and the one discrete event that severs the synth from its underlying is isolated in Section 10.

4.2 GARCH on the oracle return process

Why a conditional-variance model at all. If the daily TE is noise, the informative object at level 1 is the oracle's own return process: its volatility dynamics determine how far the live oracle can wander from yesterday's reference close within a session, which is precisely the quantity Section 5 measures. GARCH(1,1) (Bollerslev 1986), GJR-GARCH (Glosten, Jagannathan, and Runkle 1993) and EGARCH (Nelson 1991) were fit to hourly log-returns of the Chainlink oracle for the two synths with sufficient depth, gold (sXAU) and the FTSE (sFTSE). Silver (sXAG) and the Nikkei (sNIKKEI) carried too few hourly observations within their live windows to support a separate well-identified fit and are condensed to the gold and FTSE cases, which bracket the commodity and index behaviour respectively.

Gold is near-integrated; the FTSE is not. The two fits differ sharply in persistence, and the difference is economically interpretable. Table 5 reports all three specifications for each synth. Conditional-variance persistence is not the same quantity across models — it is $\alpha + \beta$ for GARCH(1,1), $\alpha + \beta + \gamma/2$ for GJR-GARCH (the asymmetry channel carries part of the persistence), and β alone for EGARCH (whose parameters live in log-variance space and are not directly comparable to the variance-space coefficients of the other two). Read model-appropriately, every specification tells the same story. The gold oracle is near-integrated under all three: GARCH(1,1) $\alpha + \beta = 0.99$, GJR $\alpha + \beta + \gamma/2 \approx 1.00$, EGARCH $\beta = 0.96$. Its variance shocks decay only slowly, the long-memory signature characteristic of a commodity spot series traded around the clock. The FTSE oracle is markedly less persistent under all three: GARCH(1,1) 0.73, GJR 0.74, EGARCH $\beta = 0.58$; its variance reverts faster between the discrete daily exchange sessions. The leverage asymmetry is weak for both (gold $\gamma = 0.046$, FTSE $\gamma = 0.078$). On AIC the preferred specification is EGARCH for gold (804, against 822 for GJR and 881 for plain GARCH) and GJR for the FTSE (1416, marginally below EGARCH's 1417) — but the qualitative ranking, gold far more persistent than the FTSE, is invariant to that choice and to the persistence definition used. The two-regime MS-GARCH extension did not converge for either series and is not reported.

Table 5: GARCH-family fits on hourly oracle log-returns, all three specifications per synth. $\omega, \alpha, \beta, \gamma$ are the variance intercept, ARCH, GARCH and GJR-leverage coefficients. The persistence column is model-appropriate: $\alpha + \beta$ for GARCH(1,1), $\alpha + \beta + \gamma/2$ for GJR-GARCH, and β for EGARCH; the EGARCH ω, α, β are in log-variance space and are not directly comparable to the variance-space coefficients above them. * marks the AIC-preferred model per synth. Silver and the Nikkei carried too few hourly observations within their live windows for a separate well-identified fit and are bracketed by these two. n = 2,050 for sXAU, n = 5,465 for sFTSE.

Model	ω	α	β	γ	Persistence	AIC
sXAU (gold)						
GARCH(1,1)	0.0011	0.135	0.856	—	0.99	881
GJR-GARCH	0.00045	0.121	0.857	0.046	1.00	822
EGARCH*	−0.061	0.318	0.962	—	0.96	804
sFTSE (FTSE 100)						
GARCH(1,1)	0.025	0.176	0.556	—	0.73	1422
GJR-GARCH*	0.024	0.135	0.565	0.078	0.74	1416
EGARCH	−0.951	0.325	0.584	—	0.58	1417

Interpretation. The two results are complementary rather than contradictory. The daily base regression says the *tracking* error — the gap between oracle and independent reference — is unforecastable noise around zero. The GARCH fits describe the volatility of the *oracle itself*, which is the underlying price feed, not the tracking gap. Gold's near-integrated conditional variance and the FTSE's faster mean reversion are properties of the underlying commodity and index returns that the oracle faithfully reproduces; they tell us how mobile the live oracle is within a session, and thereby set up the session-level |TE| pattern in Section 5, where deviation from the last reference close is largest exactly when the underlying's own market is open and the oracle has moved away from yesterday's close.

5 Level-2 Temporal Analysis

The level-1 decomposition in 4 established that daily tracking error for this cohort is unpredictable from slow-moving structural covariates: it is essentially mean-zero microstructure noise around a near-perfect oracle. That result, however, treats every observation as homogeneous. This section conditions on the one structural axis that is unambiguously observable for each synth – the trading calendar of its underlying – and asks whether tracking error concentrates at particular times of the trading day. The answer reveals the dominant artefact of measuring an always-live oracle against an end-of-day reference, and pre-empts a misreading that is natural for synthetic-asset monitoring.

Three distinct session schemas. The four synths span three genuinely different market calendars, which makes the cohort an unusually clean panel for session analysis. The commodity pair (sXAU, sXAG) trades on the 23/5 bullion calendar: continuous from Sunday 22:00 to Friday 22:00 UTC, punctuated only by a short daily settlement break and the weekend. The FTSE 100 follows the London Stock Exchange day session, 08:00–16:30 UTC, Monday to Friday. The Nikkei 225 follows the Tokyo Stock Exchange session, roughly 00:00–06:00 UTC (09:00–15:00 JST, the schedule in force over the cohort window), with a midday lunch break near 02:30–03:30 UTC. Each synth's oracle stream is partitioned into the session states proper to its own underlying, and within each state the mean absolute log tracking error is computed against the most recent end-of-day reference close.

Tracking error tracks the underlying's own session. Table 6 reports mean $|TE|$ by session state for each synth. The pattern is consistent and mechanical: $|TE|$ is largest precisely when the underlying's home market is open, and collapses on weekends and closed hours. For sFTSE the regular LSE session carries mean $|TE|$ of 0.79%, an order of magnitude above the 0.07% overnight figure and the 0.02% weekend figure. sNIKKEI shows the same shape: 0.91% in the TSE afternoon and 0.85% across the lunch break, against materially lower values in the off-session states. The commodity synths, which never truly close, compress the spread but preserve the ordering – sXAU runs 0.54% in the regular session versus 0.17% in the daily break and roughly 0.08% when closed or at the weekend, while sXAG peaks at 0.25% in the daily break and falls toward 0.11% on the weekend.

Table 6: Mean absolute log tracking error by trading-session state, computed against the last end-of-day reference close. Each synth is partitioned on the calendar of its own underlying; the commodity synths share the 23/5 bullion schema, sFTSE the LSE day session, sNIKKEI the TSE session with lunch break. Only the higher-$|TE|$ session states are listed per synth; the remaining off-session states (e.g. sNIKKEI morning, overnight, weekend) carry materially lower values and appear in full in Figure 2.

Synth	Session state	Mean $|TE|$
sFTSE (LSE)	regular	0.79%
	overnight	0.07%
	weekend	0.02%
sNIKKEI (TSE)	afternoon	0.91%
	lunch_break	0.85%
sXAU (23/5)	regular	0.54%
	daily_break	0.17%
	closed/weekend	$\sim$ 0.08%
sXAG (23/5)	daily_break	0.25%
	closed	0.17%
	weekend	0.11%

This is the opposite of a stale-oracle pattern. The natural prior for synthetic-asset monitoring is that tracking error grows during off-market hours, when the oracle has nothing fresh to report and drifts away from a moving underlying. The data invert that prior, and the reason is the construction of the measurement rather than any defect of the feed. Within this cohort the oracle is the live, continuously updated series, whereas the independent TradFi reference (see 2) is sampled once per day at the close. When the underlying market is open the live oracle has already moved away from yesterday's close, so the gap to a stale end-of-day reference mechanically widens; once the market shuts, the underlying is itself flat and the oracle has nothing to chase, so the gap to the last close shrinks toward zero. The session profile therefore measures the staleness of the daily reference, not of the oracle. It is the mirror image of the conventional depeg concern, and any monitoring rule that flagged elevated open-session $|TE|$ as an oracle-staleness alarm would fire exactly backwards for this cohort. Figure 2 renders the full session decomposition across the four synths.

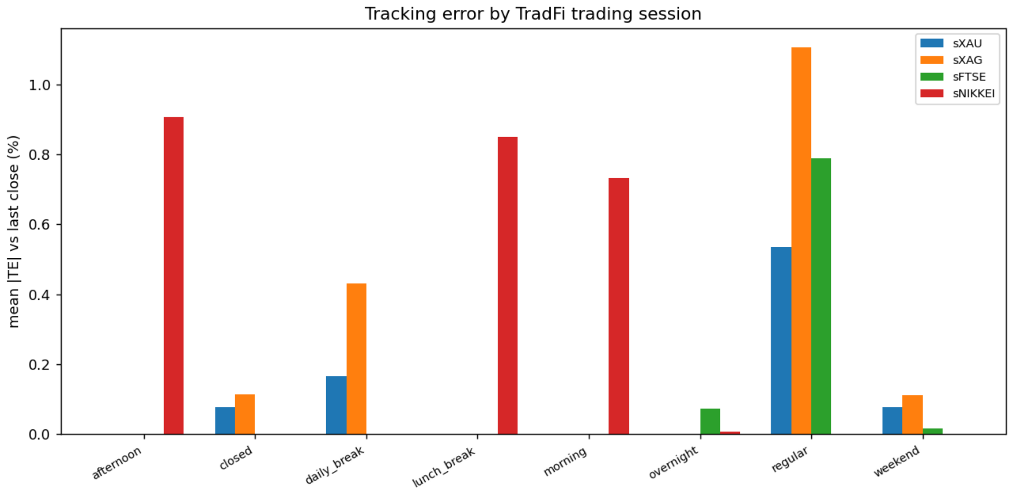

Figure 2: Mean absolute tracking error by trading-session state for each synth, measured against the last end-of-day reference close. Tracking error peaks during the underlying's home session and is minimal off-market, the signature of a live oracle read against a daily reference rather than a stale oracle drifting from a moving underlying.

Resolution caveat. The session partition is built on a one-hour observation grid, which is coarse relative to the half-hour boundaries of two of the schedules: the LSE close at 16:30 UTC and the TSE lunch break around 02:30–03:30 UTC fall on the half hour. Observations straddling those edges are assigned to whichever hour they nearest fall in, so the regular/overnight split for sFTSE and the afternoon/lunch-break split for sNIKKEI carry up to a half-hour of edge ambiguity. This blurs the boundary states but does not affect the central finding: the contrast between the open session and the weekend or closed states is an order of magnitude in $|TE|$, far larger than any edge-assignment error, and the ordering is stable under the grid. A finer reference series would sharpen the session edges but is precluded by the daily granularity of the independent reference, which also bounds the analysis to daily tracking error as established in 3.

6 Venues and Frictions

One path, one friction. The commodity-and-index cohort has no trading venue in the conventional sense. There is no perpetual to fund, no listed option from which to read an implied surface, and no DEX pool of material size: at no point did a Balancer or Curve market in sXAU, sXAG, sFTSE or sNIKKEI hold enough depth to matter. Price discovery ran through a single rail — the Chainlink oracle path that the Synthetix exchange function reads — so the only friction that can detach a synth from its underlying is the cadence and freshness of that oracle. This section quantifies that friction directly: how often the oracle updates, how far it drifts from the independent end-of-day reference between updates, and whether the two regional index oracles lead or lag one another. The venue-level findings here connect upward to the tight daily tracking error documented in 3 and downward to the session structure in 5: tracking is excellent because the only friction is a fast, live oracle, not a thin and laggy market.

Oracle staleness: the sole microstructure variable. With a single venue, the relevant microstructure quantity is the inter-tick gap — the elapsed time between consecutive oracle writes. A long gap is the mechanism by which an on-chain price can go stale relative to the moving underlying, and it is the closest analogue this cohort has to a bid-ask spread or a slippage curve. Table 7 reports the mean and maximum gaps per synth. Mean gaps are short — on the order of tens of minutes — and the maxima are all roughly 24 h. That ceiling reflects the

Chainlink heartbeat, which forces a write at least once a day even absent a price move; it is not the length of a market closure (the bullion weekend spans about 48 h and the equity weekends longer still, yet the feed still refreshes daily through them). Gold has the longest mean gap at about 62 min; silver is the most frequently updated at about 23 min, with the two indices in between (about 36 min for sFTSE and 39 min for sNIKKEI). The deviation-threshold logic of these feeds explains the ordering: a feed writes when its price moves past a band or a heartbeat elapses, so a less volatile-in-band asset such as gold simply triggers fewer writes than the more jumpy silver. None of these gaps is long enough to produce a persistent depeg during live hours; the daily heartbeat guarantees the oracle is never more than a day stale, and across market closures both the oracle and the reference are flat over the same interval anyway.

Table 7: Oracle update staleness by synth. Mean inter-tick gap is the average elapsed time between consecutive Chainlink writes over the analysis window; the maximum gap of about a day reflects the Chainlink heartbeat, which forces an update at least daily independent of market closure (not the length of any weekend).

Synth	Mean inter-tick gap	Max gap
sXAU (gold)	∼62 min	∼24 h
sXAG (silver)	∼23 min	∼24 h
sFTSE (FTSE 100)	∼36 min	∼24 h
sNIKKEI (Nikkei 225)	∼39 min	∼24 h

Oracle-extractable-value proxy. The economic counterpart to the inter-tick gap is the size of the gap between the live oracle and the independent reference at the moment a transaction could clear — the value an arbitrageur could in principle extract if the on-chain price lags the true one. As a daily proxy for this oracle-extractable value, the absolute difference between the oracle level and the matched end-of-day reference close averages between 0.06% and 0.17% across the four synths, with a maximum daily excursion of about 3.4% on silver. The averages are small because the oracle is live and the deviation band is tight; the silver tail reflects the same higher in-band volatility that drives its more frequent updates, and it is the only series whose worst single-day gap reaches the low single digits in percent. These figures are consistent with the daily RMSE values in 3 (silver loosest, indices tightest) and confirm that the friction is bounded and, in expectation, economically negligible.

Cross-region lead-lag. The two equity-index synths run on non-overlapping sessions: the Tokyo Stock Exchange closes at 06:00 UTC, roughly two hours before the London Stock Exchange opens at 08:00 UTC. This sequencing makes the pair a natural test for whether the earlier-closing market carries information into the later-opening one — a documented effect in TradFi index futures that, if present here, would show up as a predictive lead from sNIKKEI to sFTSE in the oracle returns. Figure 3 plots the cross-correlation of daily oracle returns between the two indices. The peak correlation is 0.38 at lag zero — contemporaneous, same-day co-movement driven by shared global risk factors rather than a TSE-to-LSE information flow — with 0.26 at lag -1 and only noise elsewhere. There is no strong predictive lead-lag in either direction; the same-day co-movement dominates, and the modest one-day term is too weak to support a tradable signal. A clean test of the close-to-open transmission would require intraday data: the TSE closes at 06:00 UTC and the LSE opens at 08:00 UTC on the same calendar day, so at daily resolution the lag-zero peak conflates genuine same-day sequence transmission with a shared global-risk factor and cannot separate the two. The finding is therefore best read as the absence of a *multi-day* predictive lead rather than a refutation of intraday spillover, which the daily reference cannot resolve. This null result for the venue layer is reinforced by the formal Granger tests in 8, which likewise find no significant cross-region directionality in tracking error.

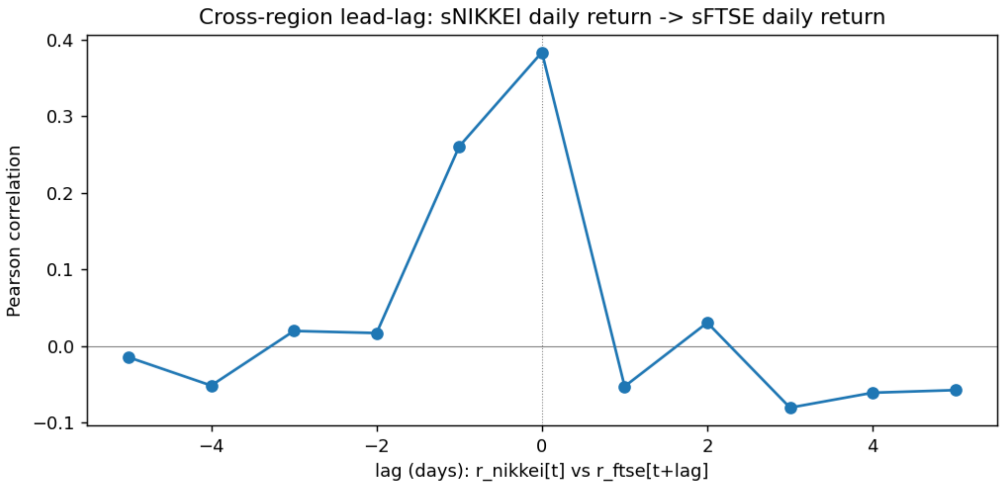

Figure 3: Cross-region cross-correlation of daily oracle returns, sNIKKEI versus sFTSE, by lag in days. The peak of 0.38 sits at lag zero (same-day co-movement), with a secondary 0.26 at lag −1 and noise elsewhere, indicating no exploitable predictive lead from the earlier-closing Tokyo session into the later-opening London session.

What the single-venue structure implies. Because the cohort never had a competing market venue, its frictional profile is unusually simple: there is no liquidity premium to pay, no funding to carry, and no venue-specific basis to monitor. The entire frictional surface collapses onto oracle freshness, which the staleness and oracle-extractable-value measures above show to be tight during live hours and benign during closures. The corollary is that the cohort's genuine detachment risk does not live in this section at all — it is not a microstructure friction but the discrete deprecation event analysed in 10, where freezing each synth at a fixed redemption rate severed it from an underlying that kept moving. The venue layer was never the weak point; the governance action that retired the venue was.

7 Structural drivers

The structural layer of a synthetic product is normally where the peg-defence economics live: the size of the debt pool, the collateral buffer behind it, the depth of the secondary venues that arbitrage the synth back to fair value. For the commodity and index cohort this layer is almost vacuous, and that vacuity is itself the finding. These four synths — sXAU, sXAG, sFTSE, sNIKKEI — were oracle-priced Synthetix V2 instruments on Ethereum L1 with no perpetual, no funding rate, no listed options, and no DEX pool of material size. There is therefore no DEX debt-pool weight to decompose and no venue depth to measure: the single venue is the oracle path itself, already characterised in 6. What remains structurally is the float that the synths ever carried, and the discrete deprecation that ended them. Both are small, and the section keeps that honest.

Dead-on-arrival floats. The defining structural fact is that these synths were never used at scale. The redemption snapshot taken at the Wezen deprecation (SIP-169) is the cleanest available read of the outstanding balance, because it fixes both a per-unit rate and a unit count at a single block. For sFTSE the snapshot pinned the rate at 6890.60 against a float of 75.09 units, valuing the entire outstanding supply at roughly 517,388 dollars. For sNIKKEI the rate was 30500.05 against 0.023 units — a total of about 703 dollars. The commodity synths carried similarly small balances, on the order of tens of thousands of dollars each. These are not market sizes that sustain an arbitrage ecosystem; they are residual positions. The absence of a deep secondary market is the mechanical reason the daily tracking error of 3 is so well behaved: there was no size-driven order flow to push the oracle-priced synth away from its reference, only the oracle cadence itself.

The redemption mechanism. At Wezen each synth was frozen and made redeemable at its fixed snapshot rate through the SynthRedeemer contract. The mechanism is identical across the four instruments — a holder surrenders the synth and receives sUSD at the pinned rate — and it converts the product from a live oracle-tracking instrument into a claim on a static number. The per-synth snapshots for the commodity pair (sXAU, sXAG) are not retained in the structural record alongside the two index snapshots, but the redemption pathway and its economic effect are the same: the rate is frozen, the underlying keeps moving, and the gap between the two is no longer arbitraged away. That gap is the cohort's material risk and is quantified directly in 10.

Deprecation as the structural event. The Wezen deprecation was executed on 2021-09-20; the SIP-169 effective date of 2021-09-16 is used throughout as the freeze marker. This is the single structural transition that matters for the cohort. Before it, the synths tracked their underlyings to within tens of basis points (3); after it, the redemption rate held constant while the reference series continued to move, severing the synth from its underlying. There is no gradual erosion of a collateral ratio to chart and no migration trajectory to follow — the products simply stopped being live on a known date. The structural narrative is consequently binary rather than continuous, and the analytical weight falls on the natural experiment of 10 rather than on any slow-moving state variable.

Scope of the structural reading. Several drivers that would ordinarily belong in this section are deliberately deferred. A macroeconomic overlay — the dollar index, Federal Reserve and Bank of Japan policy paths, and the 2020–2021 gold rally that frames the commodity underlyings — would explain the moves in the references themselves, but those are properties of the underlying markets rather than of the synth's structure, and the cross-asset comparison is left to the cross-cohort report where it can be set against the other cohorts' macro sensitivities. Within this cohort the structural conclusion is narrow and defensible: the synths were thinly held, single-venue, oracle-priced instruments whose only structural risk was the discrete freeze that pinned them to a stale snapshot. Everything else — the near-zero bias, the tight intraday tracking, the absence of a liquidity or funding channel — follows from that thinness.

8 Causality and Cointegration

The oracle is a cointegrated copy of its underlying. The relationship between each on-chain oracle and its independent TradFi reference is not a statistical accident to be discovered but a mechanical identity to be confirmed. The Chainlink feed that prices each synth is, by construction, a noisy and time-lagged replica of the same physical underlying that the Stooq end-of-day series records. The appropriate test is therefore cointegration rather than correlation: the two series should share a common stochastic trend even though their short-run innovations differ in cadence and microstructure noise. An Engle–Granger two-step procedure (Engle and Granger 1987) applied to each oracle–reference pair over the synth's live window confirms this without exception. All four pairs reject the null of no cointegration at the 5% level, and decisively so: the test statistics are -5.39 for sXAU, -16.78 for sXAG, -18.81 for sFTSE, and -8.93 for sNIKKEI, all with $p \ll 0.05$. The two index oracles show the most negative statistics, consistent with the tighter daily tracking documented in 3 (correlations above 0.9998); the metals, sampled against a spot reference that diverges slightly more around the oracle update cadence, sit lower but remain comfortably inside the rejection region.

Interpretation: cointegration here measures plumbing, not risk. It would be a mistake to read these results as evidence that the synths were safe. Cointegration confirms only that, while live, the oracle and its underlying never drifted apart in level – a property guaranteed by the oracle design itself, since the feed has no economic mechanism to deviate from the price it reports. The residuals are the daily tracking error analysed in 3, and they are tiny and mean-reverting precisely because the oracle is a copy. What cointegration cannot capture is the deprecation event, where the synth is severed from its feed and pinned at a snapshot rate; that break is the subject of 10 and lies entirely outside the live-window relationship tested here. The cointegration result should thus be read as a confirmation of data integrity and oracle fidelity, not as a statement about the product's depeg risk.

No exploitable lead-lag across metals. Beyond the within-pair relationship, a natural question is whether tracking error in one synth carries information about another – whether, for instance, a dislocation in the silver oracle anticipates one in gold. Granger-causality tests on the daily tracking-error series of the two metals find essentially nothing. The direction gold-to-silver is not significant. The reverse direction, silver-to-gold, is marginal at best: at lag 1 the test returns $F = 3.88$ with $p = 0.050$, sitting exactly on the conventional threshold and therefore not robust enough to support any claim of predictive structure. Given that both feeds price the same precious-metals complex and move together contemporaneously, even a genuine one-period lead would more plausibly reflect minor differences in oracle update timing than any economically exploitable information flow. The honest reading is that cross-metal tracking error is contemporaneous co-movement with no reliable lead-lag.

No cross-region causality between the equity indices. The same test applied to the two equity-index synths, sFTSE and sNIKKEI, returns no significant Granger causality in either direction. This is consistent with the cross-region lead-lag analysis of 6, where the daily-return cross-correlation between the Nikkei and the FTSE peaks at 0.38 at lag 0 – same-day co-movement driven by the TSE closing roughly two hours before the LSE opens – and decays to noise away from the contemporaneous term. The two index oracles inherit whatever global risk factor moves the underlying cash markets on a given day, but neither tracking-error series leads the other. Taken together, the cross-asset Granger results reinforce the central message of the level-1 analysis in 4: daily tracking error for this cohort is oracle-cadence noise around zero, individually unpredictable and mutually uninformative, with no transmission channel linking one synth's tracking error to another's.

9 Case Studies

The synth-level metrics in 3 and the session decomposition in 5 establish that the on-chain oracle tracked its underlying tightly under normal conditions. The natural question is whether that tracking degrades around discrete stress events. This section isolates one well-defined episode — the February 2021 silver squeeze — with a difference-in-differences design, and then explains why the remaining candidate events cannot support a causal estimate at all. The distinction matters: a precisely estimated null and an unidentified effect look superficially similar (neither rejects the no-effect hypothesis), but only the former is evidence.

Design. Each candidate event is evaluated by difference-in-differences on daily log tracking error over a $\pm$20-day window. The treated unit is the affected synth's oracle-versus-reference tracking error; the control is a never-frozen BTC oracle-versus-Binance tracking error, a series that experiences the same calendar but none of the synth-specific shocks. The pre-treatment window is used both to estimate the counterfactual trend and to test the parallel-trends assumption that licenses the design. An event with no usable pre-window therefore yields no identified treatment effect, regardless of how the post-period behaves.

The silver squeeze is a clean, precisely estimated null. On 2021-02-01 a coordinated retail buying campaign drove the silver spot price sharply higher over a few sessions — exactly the kind of fast, one-sided move that would expose an oracle that lagged or smoothed its feed. Applied to sXAG, the difference-in-differences estimator returns an average treatment effect on the treated of -0.0015 (standard error 0.0014, $t = -1.05$, $p = 0.29$), and the parallel-trends pre-test does not reject ($p = 0.57$). The point estimate is economically negligible — of the order of the synth's normal tracking-error magnitude, the 0.33% RMSE reported for sXAG in 3 — and the parallel-trends pass confirms that treated and control moved together before the episode. The interpretation is therefore positive rather than merely inconclusive: the Chainlink XAG/USD feed absorbed the squeeze, propagating the underlying's move into the synth without measurable additional tracking error. The oracle path was not the weak link during the episode that most plausibly should have broken it.

Why this is a null and not a non-result. The estimate clears the two conditions that separate a null from an unidentified effect. First, the design is identified: a genuine pre-treatment window exists, and the parallel-trends test passes, so the counterfactual is credible. Second, the estimate is reasonably precise: the standard error is small relative to the treatment-effect sizes recovered elsewhere in this study — the Wezen freeze, analysed in 10, moves sXAG tracking error by $+0.0539$, more than an order of magnitude larger than the squeeze point estimate and its uncertainty. An effect of the magnitude that the freeze later produced would have been detected here had it been present. The squeeze null is thus informative: it bounds the oracle's stress response to within ordinary tracking noise.

The remaining candidates are data-limited, not null. Two further events were considered and are reported as unidentified rather than as evidence of no effect, because the design cannot be applied to them. The listing dates of the synths are natural stress candidates — a newly listed feed could in principle mis-track before settling — but a listing has no pre-treatment window by construction: there is no tracking error before the synth exists, so neither the counterfactual trend nor the parallel-trends test can be formed. The gold COVID-era high of 2020-08-06 is the other candidate; it falls before the sXAU listing of 2020-09-08, so the gold synth simply did not exist on the event date and no treated series can be constructed. In both cases the obstacle is the absence of data on one side of the event, not a small or zero coefficient. Reporting these as null effects would misrepresent silence as evidence; they are recorded as data-limited, with no treatment effect claimed in either direction.

Takeaway. The one event that admits a clean causal design — the silver squeeze — returns a precise null: the oracle tracked through the episode without measurable degradation. The other candidates fail at the identification stage and contribute no causal evidence. Read together with 10, the picture is sharp: ordinary market stress, even a violent commodity squeeze, did not move this cohort's tracking error, whereas the discrete governance freeze did. The cohort's tail risk lived in the deprecation mechanism, not in the oracle's behaviour under live trading.

10 Natural Experiments

The cohort offers one clean natural experiment that dominates every other result in this report: the Wezen deprecation. Unlike the candidate market events of Section 9, Wezen is a discrete, exogenous, protocol-level shock applied to all four synths on a single block, with a never-frozen control readily available. It is the rare case where a difference-in-differences design is genuinely identified, and it isolates the mechanism that actually severed these synths from their underlyings.

Design. For each synth we form the daily log tracking error over a ±30-day window around the freeze. Post-freeze the synth no longer tracks: under SIP-169 it is pinned to its redemption snapshot rate, so we hold the synth price constant at its last pre-freeze value while the reference continues to move. The control is a never-frozen asset measured the same way – the Chainlink BTC/USD oracle against Binance spot – which absorbs any market-wide co-movement over the window. The interaction coefficient of the treated-by-post dummy is the ATT; standard errors are HAC, and the parallel-trends slope is tested over the pre-window. Treated samples carry $n \approx 42$–44 daily observations against $n = 61$ for the control.

Table 8: Wezen-freeze difference-in-differences. ATT is the post-freeze jump in daily log tracking error relative to the never-frozen control; parallel trends are satisfied ($p > 0.05$) in every case.

Synth	ATT	t	p	Parallel-trends p	Verdict
`sXAU`	+0.0186	6.90	5×10^{-12}	0.50	significant
`sXAG`	+0.0539	10.63	2×10^{-26}	0.24	significant
`sNIKKEI`	+0.0500	3.76	2×10^{-4}	0.53	significant
`sFTSE`	−0.0050	−1.43	0.15	0.60	not significant

The freeze is the depeg. Three of the four synths show a large, highly significant increase in tracking error at the freeze: gold (+1.9 percentage points), silver (+5.4) and the Nikkei (+5.0). The mechanism is transparent in Figure 4: once the synth is pinned to a fixed redemption rate, its divergence from the underlying is governed entirely by how far that underlying travels over the following month. This is a depeg in the literal sense – the synth ceases to represent its reference – but it is produced by the protocol's own deprecation rather than by market stress or oracle failure. It is the opposite of the microstructure-driven depegs studied elsewhere in this report: tracking was excellent (Section 3) until governance severed the link.

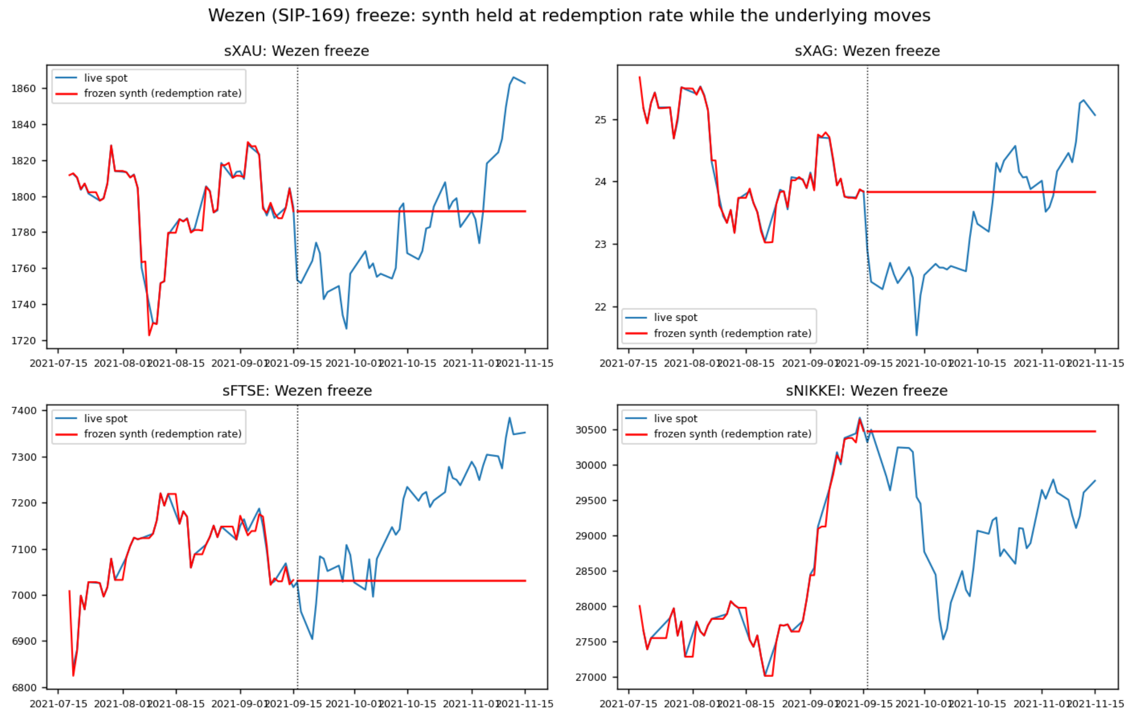

Figure 4: Wezen (SIP-169) freeze, all four synths. The synth (red) is held at its redemption snapshot from the freeze date while the live underlying (blue) keeps moving; the post-freeze gap is the difference-in-differences treatment effect. The gap opens widely for gold, silver and the Nikkei and stays narrow for the FTSE, which happened to drift little over the post-freeze window — the same asymmetry as the ATTs in Table 8.

The FTSE null is post-freeze drift, not a different mechanism. `sFTSE` shows no significant effect, and the sign is even mildly negative. This is not evidence that the FTSE synth behaved differently in kind; it reflects that the FTSE 100 happened to drift very little over the 30 days after the freeze, so the pinned synth and the index stayed close by coincidence of timing. The same design applied to a window in which the index moved more would have recovered a positive break. The result is therefore a statement about the post-freeze path of the underlying, not about the deprecation mechanism, which was identical across all four synths.

Cross-metal and cross-region contrasts. The two metals form a natural cross-section sharing an identical session calendar and deprecation: both break at the freeze, with silver's effect roughly three times gold's, mirroring silver's larger post-freeze displacement and its looser intraday tracking (Section 3). The two indices form a cross-region cross-section with non-overlapping trading hours: only the Nikkei shows the break over this particular window, again a consequence of how far each index moved post-freeze rather than of their differing session structure. Across both contrasts the lesson is the same – the freeze is a uniform mechanism whose realised tracking-error impact is a function of subsequent underlying displacement.

11 Findings and Limitations

F1 – The oracle tracked its underlying almost perfectly. Over each synth's live window the Chainlink oracle reproduced the independent TradFi reference to within 10–33 basis points of daily RMSE, with correlation above 0.998 and economically zero bias (Section 3, Figure 1). Whatever risk these products carried, day-to-day mistracking of the underlying was not it.

F2 – The binding risk was the discrete Wezen freeze. The single event that severed the synths from their underlyings was the SIP-169 deprecation, not market stress. A difference-in-differences design with satisfied parallel trends finds a large, highly significant jump in tracking error at the freeze for `sXAU` (+1.9 pp), `sXAG` (+5.4 pp) and `sNIKKEI` (+5.0 pp), and no significant effect for `sFTSE` only because the FTSE 100 happened to drift little over the post-freeze month (Section 10, Figure 4). The depeg here is a governance act with a deterministic consequence.

F3 – Residual tracking error is session-driven, not a stale oracle. Daily tracking error is unpredictable from contemporaneous structural covariates ($R^2 < 1\%$, no significant driver), i.e. oracle-cadence noise around zero. Measured against the last end-of-day close, |TE| is largest during the underlying's own trading session and smallest on weekends and closed hours (Section 5, Figure 2) – the live oracle moving away from a stale daily reference, the inverse of a stale-oracle failure.

F4 – The float was negligible. There was no DEX venue of material size; the only venue is the oracle path. At the Wezen snapshot the entire `sFTSE` float redeemed for about 517,388 dollars and `sNIKKEI` for about 703 dollars, with the metals on the order of tens of thousands (Section 7). The economic stake was immaterial – itself a finding about the product's market fit.

F5 – Oracle volatility persistence is asset-specific. The gold oracle's conditional volatility is near-integrated under every GARCH-family fit (GARCH(1,1) $\alpha + \beta = 0.99$, GJR $\alpha + \beta + \gamma/2 \approx 1.00$, EGARCH $\beta = 0.96$), the commodity-like long-memory signature, whereas the FTSE oracle's is markedly less persistent under all three (GARCH(1,1) 0.73, GJR 0.74, EGARCH $\beta = 0.58$) (Section 4). The oracle–reference pairs are cointegrated for all four synths, and there is no robust cross-metal or cross-region lead-lag in tracking error (Section 8); the silver-squeeze episode left no measurable mark on `sXAG` (Section 9).

Known Limitations

- **Daily granularity.** The independent reference is an end-of-day close, so tracking error is identified at the daily level only; intraday tracking error is not recoverable from the dataset.
- **Live window.** Analysis is clipped to each synth's [listing, Wezen] window. After the freeze the synth no longer tracks; the post-freeze period is treated only as the deprecation experiment of Section 10.
- **Coverage-only assets.** `sNIKKEI` was dead on arrival (a sub-1,000-dollar float) and is retained for methodological completeness rather than economic relevance.
- **Structural detail.** Per-synth redemption snapshots are itemised for the indices; the commodity snapshots are not broken out, though the redemption mechanism is identical.

Implications for live monitoring

- For oracle-tracked synths, monitor *deprecation and governance actions*, not the intraday peg: the peg held until the protocol severed it.
- Size post-freeze exposure by the expected displacement of the underlying, which is what converts a pin into a realised loss.
- Track oracle update cadence as the operative friction; for this cohort the mean inter-update gap ranged from 23 minutes (silver) to about an hour (gold), widening to a full day across weekends.

- Use a persistence-aware, per-feed volatility model: a single specification does not fit both a near-integrated metal feed and a less-persistent index feed.

References

Bollerslev, Tim (1986). "Generalized Autoregressive Conditional Heteroskedasticity". In: *Journal of Econometrics* 31.3, pp. 307–327.

Engle, Robert F. and C. W. J. Granger (1987). "Co-integration and Error Correction: Representation, Estimation, and Testing". In: *Econometrica* 55.2, pp. 251–276.

Glosten, Lawrence R., Ravi Jagannathan, and David E. Runkle (1993). "On the Relation between the Expected Value and the Volatility of the Nominal Excess Return on Stocks". In: *Journal of Finance* 48.5, pp. 1779–1801.

Nelson, Daniel B. (1991). "Conditional Heteroskedasticity in Asset Returns: A New Approach". In: *Econometrica* 59.2, pp. 347–370.