

Markets for All States of the World

Market Structure Organized by Terminal Payoff

Lauris Z.

www.lauris.xyz

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Abstract

Financial markets trade related exposures through separate contract books, regulatory regimes and clearing arrangements. A **statebook** organizes executable liquidity by terminal payoff, allowing an interval claim, for example, to trade without its own order book.

The contribution is institutional: established state-price geometry supplies a benchmark for connecting markets through matched state definitions, firm execution and offsets that survive close-out. Regulatory fragmentation shapes which routes a participant can use and what they cost to execute and finance. A finite boundary ladder spans its partition; finite option spreads bound boundary claims. Their executable corridor connects replication error and trading costs to the role of a direct market. The commercial test is whether connected execution and new claims lower the total cost of obtaining useful protection.

1. From extraction formula to venue blueprint

Borges's Funes remembers every detail. He is troubled that a dog seen from the side and the same dog seen a minute later from the front should share a name. "To think is to forget differences, generalize, make abstractions" (Borges 1964). Markets need a useful abstraction too: a way to recognize when differently named contracts pay for the same outcome.

Suppose a trader wants \$1 if an index finishes above 100 and at or below 110. A direct interval contract supplies that payment. So does buying an above-100 claim and selling an above-110 claim, provided their settlement terms match. Above 110, the payments cancel. Firm capacity in the boundary books can serve this request even when the interval book is empty.

A **statebook** is the proposed market layer that makes these connections executable. It begins with a legally specified payoff and identifies which contracts or portfolios can supply it at firm all-in price and size. A wider range of precise demands can then draw on liquidity already assembled in connected books.

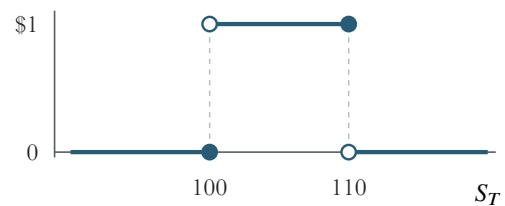
The contribution is institutional. Breeden and Litzenberger's (1978) state-price geometry supplies a benchmark for connecting exposures across contract books. Statebook asks which connections can become executable, for whom, and on what terms. Regulatory differences can restrict cross-border access or raise costs, while some separation supports financial resilience (Financial Stability Board 2019). The objective is to widen usable payoff connections while preserving those protections.

One requested payoff

$$1\{100 < S_T \leq 110\}$$

Above 100 and at or below 110.

Open point: excluded. Filled point: included.

**Existing books****Statebook compares firm alternatives**

Interval book	→	Direct	Buy the interval claim
Boundary books	→	Synthetic	Buy above-100; sell above-110 Both routes supply the same terminal payment.

Route record All-in price, firm size, residual and provenance.

Risk eligibility is tested separately; payoff equality does not grant margin credit.

Two exact alternatives are shown, subject to firm capacity and matched terms.

Other queries may return a bounded route or no firm route.

Figure 1. The statebook as an executable payoff query. A common payoff map connects separate contract books. Each firm route discloses size, cost, provenance and residual payoff. Collateral, netting, liquidation and default rules govern its risk eligibility.

Direct contracts retain a distinct role. Within a usable replication family, they earn their place by reducing the user's total cost of obtaining the exposure. Beyond the **frontier of practical replication**, they let participants trade exposures that no usable portfolio reaches. The listing question becomes where to reuse existing liquidity and where a new market is worth building.

The U.S. cases illustrate this wider design problem. Joint requests by the Commodity Futures Trading Commission (CFTC) and Securities and Exchange Commission (SEC) address definitions and cross-regime portfolio margin (CFTC and SEC 2026a, 2026b).

2. State prices before the blueprint

An Arrow security pays one unit in one state of a discrete partition. Arrow (1964) and Debreu (1959) made these claims central to equilibrium theory. Hakansson's (1976) "supershares" paid in specified return bands. Breeden and Litzenberger (1978) linked call prices to state prices; Banz and Miller (1978) estimated them. Ross (1976) developed option spanning, and Carr and Madan (1998) represented broad classes of European terminal payoffs with cash, the underlier and options.

The state-price object is still usually inferred. Exchanges list finite strikes and maturities, quotes contain spreads and occasional shape violations, and tails are missing. Researchers repair, interpolate, and extrapolate before differentiating the surface (Aït-Sahalia and Lo 1998; Buchen and Kelly 1996; Davis and Hobson 2007; Gatheral and Jacquier 2014; Figlewski 2018). Different defensible methods can fit the same quotes while assigning different prices between strikes or in the tails.

Direct contingent claims also have a trading history. Laboratory markets used Arrow-Debreu securities; macroeconomic derivatives quoted ranges for data releases; prediction and specialized markets listed event or price-boundary claims (Plott and Sunder 1988; Gürkaynak and Wolfers 2007;

Wolfers and Zitzewitz 2004). Lange and Economides (2005) developed a parimutuel mechanism for contingent claims. The CFTC's 2004 HedgeStreet designation described an intended market in cash-settled European-style binaries, and a later filing documents price-over/under event futures (CFTC 2004, 2025).

Contingent-claim prices reflect the settlement asset, collateral, market structure, wealth and risk preferences. Reading them, or option-implied state prices, as physical probabilities requires additional assumptions (Manski 2006; Wolfers and Zitzewitz 2006; Page and Clemen 2013). Kalshi range contracts provide high-frequency macroeconomic distributions with forecast content (Diercks, Katz, and Wright 2026). Their growing informativeness near resolution coexists with favorite-longshot bias and maker-taker return differences (Bürge, Deng, and Whelan 2026).

Wang et al. (2021, 2024) provide the closest execution precedent: combinatorial option markets and arbitrage-consistent payoff bounds. Statebook adds threshold and interval claims on a canonical state definition and carries their routes into portfolio risk. Provisional working papers examine related price discovery and cryptocurrency threshold-option comparisons (Keller and Tseng 2026; Portnaya 2026).

3. The fixed-maturity blueprint

That payoff map needs a precise statement before a venue can carry it anywhere. Fix a maturity T and a real-valued terminal settlement variable S_T . Let ν_T be a finite positive state-price measure for the relevant terminal claims, assume $\int s^+ \nu_T(ds) < \infty$, and let $P_T = \nu_T(\mathbb{R}) > 0$ be the settlement-asset price of a sure unit at T . Normalizing gives $Q^T = \nu_T/P_T$. For a European call with strike K ,

$$C(K, T) = \int_{\mathbb{R}} (s - K)^+ \nu_T(ds) = P_T \mathbb{E}^{Q^T} [(S_T - K)^+].$$

The representation requires a positive linear pricing functional on the stated payoff family, without requiring a unique pricing measure in an incomplete market. The later put-call-parity expression also assumes integrability of both tails. All quantities below are specific to the underlier, maturity, settlement asset, and contract definition. The notation suppresses those fields; the market cannot.

Proposition 1. The call slope prices matched boundary claims; its curvature is the state-price measure

Define strict and weak boundary values by

$$B^>(K, T) = \nu_T((K, \infty)) = P_T Q^T(S_T > K)$$

and

$$B^{\geq}(K, T) = \nu_T([K, \infty)) = P_T Q^T(S_T \geq K).$$

The exact one-sided strike derivatives are

$$-\partial_K^+ C(K, T) = B^>(K, T)$$

and

$$-\partial_K^- C(K, T) = B^{\geq}(K, T).$$

The distinction matters when the terminal variable has atoms, as a rounded or discretely published fixing may. The derivative gap is

$$-\partial_K^- C(K, T) + \partial_K^+ C(K, T) = P_T Q^T(S_T = K),$$

the price of the equality state. Strict and weak comparators can therefore define economically different claims. If a settlement variable lives on a known grid and the commercial trigger permits an equivalent boundary between grid points, that placement removes equality ambiguity. Boundary placement does not smooth the binary payoff or eliminate fixing risk.

Subject to integrability, the reverse relation is

$$C(K, T) = \int_K^\infty B^>(u, T) du.$$

Using $B^\geq$ gives the same integral because strict and weak values differ only at atoms, a Lebesgue-null set of strikes.

In distributional form,

$$d_K^2 C = v_T(dK),$$

and if Q^T has a density f^T ,

$$\frac{\partial^2 C(K, T)}{\partial K^2} = P_T f^T(K).$$

These are values under one coherent pricing functional. A venue supplies finite strikes and bid-ask quotes, so the operational comparison uses executable bounds, including the costs and constraints in section 7.

Proposition 2. Adjacent boundary claims create interval states

For ordered thresholds $K_i < K_{i+1}$, strict boundary claims give

$$\mathbf{1}\{S_T > K_i\} - \mathbf{1}\{S_T > K_{i+1}\} = \mathbf{1}\{K_i < S_T \leq K_{i+1}\}.$$

Weak boundary claims give

$$\mathbf{1}\{S_T \geq K_i\} - \mathbf{1}\{S_T \geq K_{i+1}\} = \mathbf{1}\{K_i \leq S_T < K_{i+1}\}.$$

The corresponding interval values are

$$\Pi_i^>(T) = B^>(K_i, T) - B^>(K_{i+1}, T)$$

and

$$\Pi_i^\geq(T) = B^\geq(K_i, T) - B^\geq(K_{i+1}, T).$$

A threshold is cumulative. A finite ladder and its tails create interval bins, which are Arrow-style atoms of the **finite partition**. Their prices identify interval masses; density within each bin requires additional assumptions. Threshold listings let traders address budget ceilings, covenant triggers, weather levels and other economically meaningful boundaries directly.

Proposition 3. Finite call spreads bound matched boundary claims

For $K_i < K_{i+1}$, the normalized vertical call-spread payoff satisfies

$$\mathbf{1}\{S_T > K_{i+1}\} \leq \frac{(S_T - K_i)^+ - (S_T - K_{i+1})^+}{K_{i+1} - K_i} \leq \mathbf{1}\{S_T > K_i\}.$$

No-arbitrage prices preserve the ordering:

$$B^>(K_{i+1}, T) \leq \frac{C(K_i, T) - C(K_{i+1}, T)}{K_{i+1} - K_i} \leq B^>(K_i, T).$$

The direction of the limit determines the comparator. For $h \downarrow 0$,

$$\frac{(S_T - K)^+ - (S_T - K - h)^+}{h} \longrightarrow \mathbf{1}\{S_T > K\},$$

while

$$\frac{(S_T - K + h)^+ - (S_T - K)^+}{h} \longrightarrow \mathbf{1}\{S_T \geq K\}.$$

The payoffs lie between zero and one, so dominated convergence gives the price limits. At an atom the limits differ by the equality-state value. A finite spread retains a ramp rather than a jump, leaving a residual within the interval.

Proposition 4. A finite boundary ladder spans its finite partition

Let $K_1 < \dots < K_n$, use the strict convention, and define

$$A_0 = \{S_T \leq K_1\}, \quad A_i = \{K_i < S_T \leq K_{i+1}\} \ (1 \leq i < n), \quad A_n = \{S_T > K_n\}.$$

The sure claim and the boundary claims $\mathbf{1}\{S_T > K_i\}$ generate every indicator $\mathbf{1}_{A_i}$. Any payoff g that is constant at g_i on each bin therefore has the exact representation

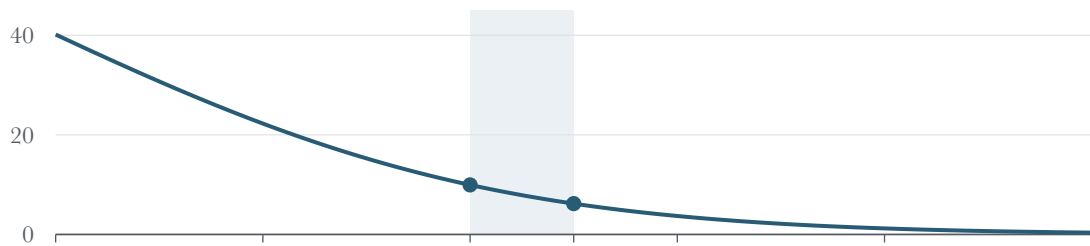
$$g(S_T) = \sum_{i=0}^n g_i \mathbf{1}_{A_i}.$$

Known finite point support permits exact pricing of every terminal payoff when the ladder separates each support point. Continuous variation within a bin has a different implication: the bin price does not determine a call or another payoff that varies inside that bin. Endpoint and tail assumptions can supply only bounds in that case.

One fixed maturity; values under one illustrative pricing measure

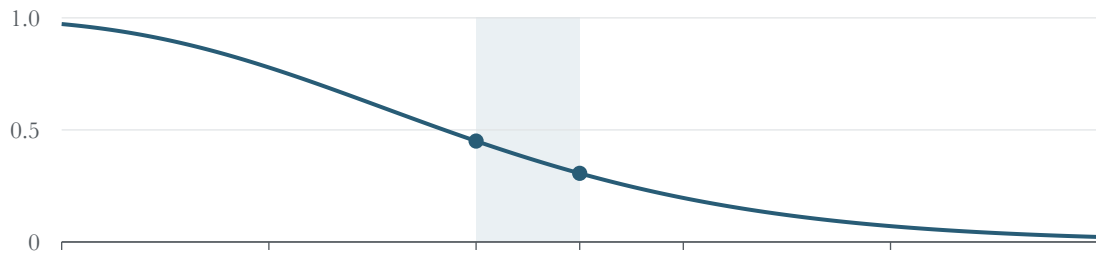
A Call value

$$C(K) = \mathbb{E}^Q[(S_T - K)^+]$$



B Strict boundary value

$$B^>(K) = -\partial_K^+ C(K)$$



C Finite interval-state price

$$\Pi_i = B^>(K_i) - B^>(K_{i+1})$$



Lognormal pricing measure: forward 100, discount 1, log-volatility 0.25.

Figure 2. From the call curve to a finite statebook. The negative right strike derivative gives strict boundary values; adjacent differences price the intervals $(K_i, K_{i+1}]$. The bars are finite-partition prices. Finite option spreads bound boundaries, and a smooth density requires additional assumptions.

Definition. The statebook

A **statebook** at maturity T is a market layer organized around one legally operative terminal state space and settlement rule. An ordered-scalar statebook admits strict or weak boundary claims, interval claims, and matched native European calls and puts into a common terminal-payoff representation. A categorical statebook uses a finite partition. It retains the registry, payoff map, routing, and risk gates but has no option-surface anchor.

The router connects limit-order books, complex books and requests for quote through the common registry and payoff map. Each registry states its partition or grid and tail treatment; ordered-scalar statebooks admit eligible sure, boundary and matched option payoffs. Routes carry provenance and residuals into the risk-eligibility test. A venue may operate many statebooks across underliers and maturities; section 4 specifies their institutional gates.

Design result. The executable payoff query

Leibniz imagined disputants settling a disagreement with *calculemus*: “Let us calculate” (Leibniz 1890, VII: 200). For specified terminal claims, the first question is calculable: what does each contract pay in every state?

Write eligible instrument j ’s payoff as $v_j(s)$ on the registered terminal-state domain, and let a portfolio x supply

$$Vx(s) = \sum_j x_j v_j(s).$$

Let $g(s)$ be the requested payoff. The equalities and inequalities below hold at every admissible s . On a finite settlement state space, the v_j form the columns of a payoff matrix. The payoff family used here is piecewise linear with registered jumps, so the check is exact at every breakpoint from both sides and in the tails; representative bin points are insufficient.

Given a participant, account, requested side, size and residual tolerance, the statebook compares firm alternatives and returns the best admissible route at its disclosed all-in price and size, classified as:

1. a direct fill in the requested claim;
2. an exact synthetic route with $Vx(s) = g(s)$ for every admissible s ;
3. one or both executable bounding portfolios: x_L satisfying $Vx_L(s) \leq g(s)$, x_U satisfying $g(s) \leq Vx_U(s)$, with each statewise residual disclosed; or
4. no firm route.

Each executable route states all-in price, reserved size, component provenance, short-position requirements and risk eligibility under section 4. Exact routes are ranked by cost at the requested size, with direct and synthetic provenance distinguished. The query leaves the matching mechanism open.

Static spanning, with a narrow domain

The option-based construction represents or approximates a broad class of European terminal payoffs on **one underlier at one maturity**. Multiple underliers, path dependence, American exercise, realized volatility and funding paths require additional state variables or instruments.

Categorical events, such as a merger closing, use a discrete partition without a strike axis. Direct trading supplies prices constrained internally by complement and partition identities. The same

registry, routing and risk gates apply. “Markets for all states” names this wider program; Breeden-Litzenberger supplies its ordered-scalar geometry.

Why the perpetual sits outside the terminal basis

If $S_T \geq 0$, then at strike zero

$$C(0, T) = P_T \mathbb{E}^{Q^T} [S_T]$$

is the fixed-maturity linear edge of the call surface. If S_T can be negative, as a rate fixing can, then $C(0, T) = P_T \mathbb{E}^{Q^T} [(S_T)^+]$. The fixed-maturity linear claim is instead related to calls and puts by

$$C(K, T) - \text{Put}(K, T) = P_T \mathbb{E}^{Q^T} [S_T - K].$$

A perpetual has no expiry and realizes funding cash flows under mark and liquidation rules before any terminal date. These fixed-maturity identities do not produce it. Section 5 explains its complementary role at venue scale.

4. Same state, or merely related?

Section 3 assumes a common S_T . A last trade and an index average can define different terminal states even under the same asset name. Matching the observation also leaves lifecycle cash flows and default treatment to be checked. Table 1 separates these tests.

Table 1. Contract and position tests

Field	Question that must be answered
Terminal state	Are both payoffs written on the same legally defined variable or partition?
Observation time or window	Do they use the same instant, fixing, auction, average, and timezone?
Maturity and finality	Do they become final at the same time and under the same correction rules?
Comparator	Do strictness, equality, precision, rounding, and tick rules match?
Settlement hierarchy	Are the primary source, fallback, disruption, and discretionary powers identical?
Settlement payment	Do payment time, unit of account, conversion, and discounting match?
Multiplier	Are payoffs normalized to the same economic unit?
Lifecycle cash flows	Do funding, variation settlement, collateral remuneration, exercise, and fees alter the position before final payment?
Legal and operational powers	Can either result be suspended, reversed, challenged, or amended differently?
Executability	For this participant and account, can each leg legally be traded and funded in the required direction and size through settlement?
Default set	Are the positions in an enforceable common netting and default-management arrangement?

State identity fixes the terminal observation; payoff identity fixes the amount due in each state. Lifecycle terms govern interim cash flows and survival to settlement. Legal netting determines which obligations can offset in default.

The CFTC's July 2026 intervention requiring fulfillment of identified Kalshi trades illustrates that external law can threaten contractual finality (CFTC 2026j). An imposed unwind of one leg could break a credited offset; the cited record does not establish that any such offset had been granted or failed.

Four necessary gates carry a payoff relation from contract to default:

1. **State identity.** The contracts use the same terminal state space, observation rule, settlement source, correction process, and finality.
2. **Payoff relation and finite-grid span.** Comparator, equality, multiplier, settlement unit, and payment terms are explicit. The eligible claims generate, bound, or approximate a stated payoff family.
3. **Execution closure.** With live component liquidity, the venue exposes a firm direct, exact synthetic, or bounded route. The record includes residual payoff, fees, size, carrying terms, and short-position requirements.
4. **Enforceable risk recognition.** The risk and default system recognizes an offset only where lifecycle, collateral, liquidation, netting, and default arrangements preserve it.

Institutional test	Result after passing
1 State identity Same observation, settlement and finality.	Compatible Payoffs can be compared.
2 Payoff relation and finite-grid span Matched terms; a specified payoff relation.	
3 Execution closure A firm route at stated all-in price and size.	<i>No firm liquidity: no firm route.</i> Executable
4 Enforceable risk recognition Offsets survive collateral, netting and close-out.	<i>If gate 4 fails: trades stay capital-separate.</i> Recognized offset

Passing one test does not establish the next. Co-location establishes none of them.

Figure 3. Four institutional gates from payoff relation to market structure. Compatibility can lack a firm route; an executable route can remain capital-separate. Co-location alone establishes neither execution nor risk recognition.

Complement and partition identities can be hard-coded. Threshold monotonicity, option convexity and call-spread bounds can be monitored across books. Cross-maturity relations additionally require carry and settlement assumptions.

A common benchmark presents a further trade-off. Matching the settlement source reduces basis and makes the payoff relation cleaner, but can also concentrate manipulation incentives. The relevant exposure is the net payout jump across all linked thresholds, intervals, and options, compared with the expected cost of moving the benchmark during its fixing window. Cash-settlement research shows why contract design, reference-market depth, and surveillance matter; the discontinuity of a binary sharpens the issue near its boundary (Kumar and Seppi 1992; Pirrong 2001; Tian 2021).

Section 9 specifies benchmark governance and surveillance responsibilities.

5. The perpetual at venue scale

Shiller (1993a, 1993b) proposed perpetual futures for risks lacking convenient spot markets or dated contracts. Modern cryptocurrency perpetuals use recurring funding and mark-price rules; their valuation depends on funding design, trading costs and collateral (Angeris et al. 2023; He et al. 2024; Ackerer, Hugonnier, and Jermann 2026).

A perpetual can concentrate directional demand across time, reduce rolling operations and provide a reference beside successive statebooks. Market makers may use it to manage delta, subject to funding, basis and liquidation risk. Cryptocurrency evidence finds price discovery and short-horizon hedging value (Alexander et al. 2020). Hyperliquid Policy Center (2026) reports that off-hours returns closely track subsequent CME reopening returns across 205 bitcoin weekends and 19 oil weekends; the commodity evidence has a shorter observation window.

These advantages depend on a hedge remaining tradable and fundable, including when reference markets are closed. Continuing flow need not supply depth at each strike. Section 7 specifies the residual risks relevant to margin credit, and section 8 compares instrument jobs across asset classes.

6. Partial implementations and the Kalshi case

Table 2 compares documented components with the four gates. Selected product sources were checked on 6 September 2026; the distributed bitcoin record retains its July cutoff. Cboe's guide describes a broker implementation using binaries and adjacent \$1 verticals, without establishing firm binary-option routing or observed depth (Cboe Global Markets 2026; Cboe Exchange 2026b, 2026c, 2026f).

Hyperliquid as an implementation comparator

Hyperliquid's HIP-3 permits builder-deployed perpetuals. By 6 September 2026, permissionless HIP-4 outcome deployment was enabled on mainnet (Hyperliquid 2026a, 2026m). The July specifications describe fully collateralized outcomes without their own leverage or liquidation, including linked questions and recurring price boundaries (Hyperliquid 2026b, 2026g-j).

The July portfolio-margin record covers eligible spot and perpetual positions and BTC/HYPE collateral access for outcomes. That is account-level collateral access, not evidence of payoff-based outcome-option offsets (Hyperliquid 2026d, 2026f, 2026k).

Table 2. Closest current component architectures

Venue and product family	Documented component	Remaining gap to the statebook standard
Cboe XSP binary and vertical complex	Live fixed-payout binaries; common strike ladder; QSB vertical eligibility; atomic option-complex execution; selected within-binary offsets	Public specifications do not establish firm binary-option routes or cross-form risk/default treatment
Kalshi predictions and perpetuals	Live co-location in Pro since 13 July; portfolio margin for perps (Kalshi 2026b, 2026c)	Predictions have separate funds protected from perp liquidation; matched options and prediction-perp offsets are not established (Kalshi 2026d)
Polymarket international	Live predictions and crypto, equity, index and commodity perps (Polymarket 2026a)	Separate U.S. platform/accounts; international site excludes U.S. residents; matched states, routes and offsets are not established (Polymarket 2026b)
Hyperliquid HIP-3 and HIP-4	Builder-deployed perpetuals; live permissionless outcome deployment; eligible portfolio-account collateral access	Matched options, dense scalar ladders and payoff-based cross-form offsets remain requirements, not findings of this comparison
United States across venues (bitcoin)	Kalshi boundaries/perps; CME dated futures/options; OCC-cleared fund options; shared benchmark family	Different terminal definitions, accounts and default sets; no consolidated executable corridor established in the reviewed record

Kalshi and the U.S. coordination problem

A passenger's journey can cross several companies' tracks. The Railway Clearing House, founded in 1842, allocated fares from such journeys among the railways (Science Museum Group n.d.). Separate operators could supply one journey through a common accounting arrangement. A distributed statebook requires comparable coordination across contracts, with firm execution and enforceable offsets as further conditions.

The distributed U.S. bitcoin case combines Kalshi boundaries and live perps, CME dated futures and futures options, and OCC-cleared fund options (Kalshi 2026a, 2026b; CME Group 2026e; SEC 2024). Together with a Treasury sure claim, these supply section 3's instrument types, though not one legally identical state.

The July contract record shows why a shared administrator is insufficient. Kalshi uses specified sixty-second real-time-index averages; CME futures use the Bitcoin Reference Rate; a spot fund's NAV uses a related rate, while its options deliver fund shares (CF Benchmarks 2026a-c; CME Group 2026g; iShares 2026; Kalshi 2026a; Options Clearing Corporation 2026; SEC 2024). Table 1's observation, comparator, deliverable and finality tests still require product redesign.

The reviewed sources establish no consolidated executable corridor or margin arrangement across these clearinghouses. Different statutes, accounts and insolvency regimes keep the positions capital-separate. CME-FICC's Treasury and interest-rate cross-margin arrangement, extended to customer accounts in April 2026, demonstrates related institutional technology for a different product set (CME Group 2026f).

7. From coherent quotes to portfolio risk

Adam Smith's village could not keep a porter employed: there was too little work for so narrow a trade. The division of labour was "limited by the extent of the market" (Smith 1776, I.3). A fine-grained contract menu faces the same participation constraint. Each added payoff needs enough business to support a useful quote.

Isolated contract books divide that business and duplicate inventory and collateral for the same state risk. Traders face legging risk, displayed depth omits executable portfolios elsewhere, and stale quotes invite latency-sensitive arbitrage.

Contract-design research makes participation and liquidity central: an established cross-hedge can beat a closer but thin contract (Carlton 1984; Duffie and Jackson 1989; Cuny 1993). Statebook applies section 3's payoff query while retaining existing priority and matching rules.

Standard strikes can retain central limit-order or complex books. Less common payoffs can use requests for quote, executable synthetic bounds, or a shared market maker. Linear programming can identify the cheapest quoted portfolio that dominates a request and the most valuable portfolio it dominates; atomic execution removes uncontrolled legging risk. Hanson (2003), Othman et al. (2013), and Heidari et al. (2018) provide adjacent market-making designs rather than a specification for this router.

An executable routing test

Route eligibility depends on the participant, account and applicable jurisdictions. A prohibited leg removes a route from the comparison. Unavailable netting can leave an executable route subject to separate collateral requirements. For an eligible route, let $a_C(K)$ and $b_C(K)$ be call ask and bid prices for the required size. For $h > 0$, the all-in purchase cost per unit of boundary notional of the upper call spread is

$$a_{\text{sub}}(K; h) = \frac{a_C(K) - b_C(K + h)}{h} + F_{\text{sub}},$$

where F_{sub} contains fees and contractually determined route charges. This is what a customer pays for an executable subhedge of $\mathbf{1}\{S_T > K\}$. Selling that spread produces the executable net bid

$$b_{\text{sub}}(K; h) = \frac{b_C(K) - a_C(K + h)}{h} - F_{\text{sub}}^{\text{sell}}.$$

The corresponding lower call spread costs

$$a_{\text{sup}}(K; h) = \frac{a_C(K - h) - b_C(K)}{h} + F_{\text{sup}}$$

and dominates $\mathbf{1}\{S_T \geq K\}$, with excess ramp payoff below the boundary. Let $\diamond \in \{>, \geq\}$ denote the selected comparator, and let $a_B^\diamond(K)$ and $b_B^\diamond(K)$ be its direct boundary ask and bid. The statewise ordering implies two immediately executable checks:

$$b_{\text{sub}}(K; h) \leq a_B^\diamond(K) \quad \text{and} \quad b_B^\diamond(K) \leq a_{\text{sup}}(K; h).$$

If the first inequality fails, buy the boundary and sell the subhedge; if the second fails, buy the superhedge and sell the boundary. Arbitrage requires atomic execution and positions carryable through settlement after financing, collateral-remuneration shortfalls, short-position costs and life-cycle cash flows. Those costs must be contractually determined or conservatively bounded for the product, account, collateral and tenor. Uncertain or unavailable carry leaves only a dominance signal.

Return to section 1's request: hypothetically, buy 80 units paying \$1 each for $100 < S_T \leq 110$. Claims share fixing, maturity, USD payment, rounding and finality. Shorting and funding are available; carrying charges are zero.

Route	Executable quotes and capacity	Fees per unit	Cost for 80 units
Direct interval	Ask \$0.27; 100 units	\$0.01	\$22.40
Strict boundary package	Buy above-100 at \$0.62 ask, 120 units; sell above-110 at \$0.38 bid, 100 units	\$0.02 total	\$20.80

The synthetic costs \$0.26 per unit, with capacity limited to 100 by the smaller leg. Atomic execution of 80 per leg saves \$1.60 with zero terminal residual. The route is unavailable to a participant prohibited from selling the above-110 claim. No margin credit is assumed.

Firm routing requires maker consent and reserved component capacity. The same resting size cannot support independent promises; slippage and maker risk limits remain binding.

Adverse selection at the boundary

A market maker facing better-informed order flow must recover the expected loss through its spread or by withdrawing size (Glosten and Milgrom 1985). That problem can become acute for a threshold claim near a scheduled fixing. A trader may have a better nowcast of the publication, faster access to benchmark inputs, or related positions whose value changes with the same result. The market maker sees an order whose information content rises precisely as the payoff becomes discontinuous.

Matched option spreads and perpetual delta hedges may reduce inventory cost, but their liquidity can deteriorate together near fixing. Quote survival therefore depends on executable hedge cost, fixing design, exposure limits and surveillance (Kumar and Seppi 1992; Pirrong 2001; Tian 2021).

Route provenance and price formation

Recorded direct-route share is the fraction of filled notional over a stated window executed directly rather than through the venue's matched synthetic route; unclassified fills are reported separately. Together with reserved-capacity records, it makes execution auditable. It does not identify information origin. Price-discovery attribution requires an econometric model or disclosed convention; route tags can inform that work (Hasbrouck 1995; Keller and Tseng 2026).

The executable corridor and strike spacing

The executable corridor describes how tightly the two route types constrain each other. At a fixed requested boundary notional, let $C(x)$ denote the call mid-price and δ_x its half-spread at strike x . The exact signed distance between the sellable subhedge and purchasable superhedge is

$$\begin{aligned}
 W(h) &= a_{\text{sup}}(K; h) - b_{\text{sub}}(K; h) \\
 &= \frac{C(K-h) - 2C(K) + C(K+h)}{h} \\
 &\quad + \frac{\delta_{K-h} + 2\delta_K + \delta_{K+h}}{h} + F_{\text{sup}} + F_{\text{sub}}^{\text{sell}}.
 \end{aligned}$$

The mid-price component has an exact payoff interpretation:

$$\frac{C(K-h) - 2C(K) + C(K+h)}{h} = \int_{\mathbb{R}} \left(1 - \frac{|s-K|}{h}\right)_+ \nu_T(ds).$$

It is the state-price value of the tent-shaped residual between the two finite-strike bounds, including any state-price mass at K . When $W(h)$ is nonnegative, it is the corridor width. Strike density alone does not determine it. If the call curve is twice differentiable near K , its state-price density is $P_T f(K)$, half-spreads are locally equal to a positive δ , and both route fees equal a locally constant F that does not vary with h , then

$$W(h) \approx hP_T f(K) + \frac{4\delta}{h} + 2F.$$

The ramp term falls as spacing narrows, but spread leverage rises because the quoted option spread is divided by h to produce one unit of boundary notional. Under these local assumptions the approximation is U-shaped and, when $P_T f(K) > 0$, is minimized at

$$h^* = 2\sqrt{\frac{\delta}{P_T f(K)}}.$$

Each option leg's quantity scales as $1/h$, so effective spreads, depth, slippage and per-contract fees generally vary with spacing. An atom at K leaves a tent value tending to $v_T(\{K\})$. Thus h^* is a local benchmark: discrete or asymmetric grids require executable-package comparisons. An unusable matched surface supplies no route bound. Corridor width alone does not determine recorded direct-route share.

Portfolio risk is a separate construction

Terminal market-risk credit applies to a legally enforceable offsetting position set. Two long portfolios with identical payoffs double exposure; the positions must offset or one representation replace the other.

Risk calculations should identify the worst portfolio loss across joint scenarios, with add-ons for unmodeled legal, operational and model risks. Table 3 distinguishes the eligible treatments and residuals. Calibration is product- and venue-specific. Initial margin, variation settlement, maintenance thresholds, liquidation, collateral haircuts, default resources and losses beyond margin require separate rules.

Table 3. Risk recognition follows the payoff relation

Relation	Eligible treatment	Residual test
Exact fixed-maturity offset	Recognize terminal market-risk offset inside one effective netting and default set	Liquidity, close-out, oracle, concentration, collateral, and operations
Finite-grid bound	Credit the bounded portfolio and preserve its worst residual	Ramp, equality state, gaps, tails, fees, and executable depth
Dynamic perpetual hedge	Grant scenario-based credit only while the hedge remains tradable and fundable	Funding, basis, jump, halt, depth, and liquidation sequence
Common-factor relation	Grant stress-tested diversification credit	Correlation breakdown, crowded exit, basis, and regime change

A naked bounded outcome may remain fully collateralized even where an exact, legally netted offset receives credit.

Scenarios should combine failure modes rather than shock them one at a time. They should test the reference below, at, and above material thresholds while shocking option shape, threshold

depth, perpetual funding and basis, oracle inputs, collateral value, settlement delay, and liquidation sequence. The set should also halt one product while another remains live.

Payoff-aware margin can reduce gross collateral while increasing complexity and wrong-way risk. Consolidation can improve or impair netting (Duffie and Zhu 2011), and funding constraints can amplify dislocations (Brunnermeier and Pedersen 2009; Gârleanu and Pedersen 2011).

8. The practical-replication frontier

The **frontier of practical replication** is the boundary beyond which a participant has no usable traded portfolio that reproduces or adequately hedges an exposure. It includes missing payoffs, weak reference markets, local basis, categorical states and barriers from size, access, collateral or operating cost. Availability includes whether a hedge can be opened or adjusted when exposure changes.

Within a usable replication family, a direct contract must lower total execution and operating cost. Beyond it, a new claim gives participants a way to trade the uncovered exposure.

New claims can change prices, participation and trading incentives, not just risk-sharing opportunities (Hart 1975; Allen and Gale 1988; Duffie and Rahi 1995). Catastrophe markets show that valuable, difficult-to-replicate risks can remain constrained by institutions and capital supply (Froot 2001).

A proposed listing should identify the residual exposure after the best existing hedge, the contract field creating the basis, likely two-sided flow, settlement governance and total hedge cost. It must also show how makers would warehouse or hedge the residual. These criteria select candidates for empirical testing.

Hegel's account of civil society begins from separate purposes: "each establishes himself and finds satisfaction by means of the others" (Hegel 1821, §182). A state-first market gives different purposes a common object. One participant wants a payment in a bad state; another accepts that liability for a premium, given its other exposures and capacity. The contract fixes what changes hands; each participant decides why to trade it.

The participant mix matters because makers must fund the residual. Demand effects on option prices depend on unhedgeable risk, while dealer entry responds to expected demand and entry cost (Gârleanu, Pedersen, and Poteshman 2009). Does a new claim attract offsetting flow or more demand in the same direction?

Entry also responds to information and joining costs. Duffie, Dworczak, and Zhu (2017) show that disclosing dealers' common cost can make customer entry responsive to gains from trade while quotes remain private. Statebook should distinguish additional users and trading from rerouted orders, allowing makers to adjust quotes and capacity. Participation gains must cover the cost of serving entrants.

A fictional small-business hedge

Prairie Freight LLC is a fictional carrier with limited treasury staff, fixed customer rates and subcontracted overflow capacity. All quantities and positions below are synthetic. Its overflow surcharge uses an initially published regional U.S. Energy Information Administration (EIA) diesel estimate. Actual carrier schedules use different national references and terms (U.S. Energy Information Administration 2026a, 2026b; FedEx 2026; United Parcel Service 2026).

Let:

- T be the specified publication and fixing date;
- S_T be the initially published regional diesel estimate named in Prairie's agreements;
- q be a fixed gallons-equivalent multiplier known when the hedge is opened;

- K_0 be Prairie's fuel budget level;
- $K_1 < \dots < K_m$ be the overflow-contract surcharge thresholds;
- H_j be the total dollar surcharge increment on a fixed committed overflow-load base, known when the hedge is opened, and payable when $S_T \geq K_j$; and
- ε_T be the signed residual from the physical purchase path, local-station prices, route, tax, stochastic volume, timing, and subcontractor basis.

The modeled exposure relative to budget is

$$L_T = q(S_T - K_0)^+ + \sum_{j=1}^m H_j \mathbf{1}\{S_T \geq K_j\} + \varepsilon_T.$$

A matched regional-index call paying $q(S_T - K_0)^+$ covers the benchmark overrun. Weak boundary claims paying $H_j \mathbf{1}\{S_T \geq K_j\}$, valued at $H_j B^{\geq}(K_j, T)$, cover the surcharge increments. Matching follows Table 1. The realized fuel bill retains ε_T ; premiums, financing, default and liquidity remain outside the terminal offsets.

Finite publication precision and contractual rounding make equality at K_j possible; strict and weak claims then differ. A newly designed agreement can place its boundary between admissible grid points if that preserves its commercial purpose. A hedge of an existing agreement cannot move the strike to simplify the mathematics.

CME specifies standard and micro NY Harbor ULSD futures and national EIA diesel futures and average-price options (CME Group 2026a-d). Specifications do not establish executable depth. Their wholesale or national monthly fixed-tax references differ from Prairie's regional, current-tax, publication-specific exposure. Size, brokerage, collateral, accounting and operating costs can add to the mismatch.

The closer hedge must justify its total cost against the best established alternative.

Table 4. Instrument jobs by asset class

Asset class	Conventional instruments and strengths	What a perpetual may add	What a bounded outcome may add	Principal residual risk
Rates	Futures, swaps and options isolate maturity and curve risk	Continuing selected-rate reference	Fixing, policy or budget-threshold payment	Tenor, curve, fixing and collateral basis
FX	Forwards, swaps and options match dated currency flows	Continuing directional exposure	Payment at a defined currency fixing	Currency, convertibility, capital controls and maturity
Commodities	Futures, spreads and options encode physical and seasonal terms	Continuing exposure with explicit reference and roll rules	Price, weather, production or budget-boundary payment	Location, grade, delivery, seasonality, roll, tax and benchmark
Credit	Bonds, CDS, tranches and options transfer spread, default and recovery risk	Continuing index with default, recovery and reconstitution rules	Defined credit-event or metric payment	Entity, obligation, trigger, recovery, maturity, series, liquidity and classification

CDX and iTraxx: institutional cousins

CDX and iTraxx standardize event-defined risk transfer across baskets of entities and obligations. They are CDS indices, not fixed-payout event contracts: premium legs, default timing, recovery, deliverables, series changes and legal classification matter (Amato and Gyntelberg 2005; Augustin et al. 2014; International Swaps and Derivatives Association 2013, 2014; S&P Dow Jones Indices 2026). Smaller units still need precise definitions, conflict controls, credible determinations and settlement; index hedges retain entity and obligation basis.

9. A lawful U.S. path

This section retains the July 2026 regulatory record; section 6 records selected September product updates. Product-specific conclusions require counsel. Appendix A maps classification questions that determine listing, execution, clearing and customer-access requirements. The June CFTC-SEC request identifies unresolved boundaries for event contracts and equity-linked perpetuals (CFTC and SEC 2026a).

Kalshi's May BTCPERP approval was product-specific. The policy statement, conversion relief and energy consultation supplied no blanket authorization or cross-product offsets (CFTC 2026b-d, 2026g). Commodity Exchange Act section 5c(c)(5)(C) and Rule 40.11 govern specified event-contract questions. The advance notice, public-interest proposal and reporting proposal had not changed the law at the July cutoff (CFTC 2026a, 2026f, 2026h).

Product review and access

Each listing must specify its underlier, payoff, observation, settlement and customer class under the applicable review process. The July CFTC advisory requires contract-specific review of settlement methodology, data sources and core-principles compliance (CFTC 2026k). Registration, intermediation, disclosure, supervision and customer eligibility must follow the product's classification.

Clearing, collateral, and customer protection

Joint margin requires compatible netting, segregation, portability, bankruptcy treatment and liquidation rules. DCO rules and the CPSS-IOSCO principles distinguish these obligations; the June cross-margin request creates no automatic entitlement across regimes (17 C.F.R. §§ 39.13-39.16, 39.18; CPSS-IOSCO 2012; CFTC and SEC 2026b). Private settlement assets add custody, redemption, sanctions and wrong-way collateral risks.

Part 190 makes the portability issue concrete. Transfers can be partial or separated by account class. The rule requires both sides, or neither, of a spread or straddle to transfer "to the extent practicable under the circumstances." Risk recognition should therefore test account compatibility and the loss if joint transfer fails (17 C.F.R. §§ 190.00, 190.07).

Benchmark and resolution governance

Price benchmarks need transparent methods, fallbacks and correction rules; categorical outcomes need objective evidence, conflict controls and auditable finality. IOSCO's principles provide a governance reference (International Organization of Securities Commissions 2013). Hyperliquid's preliminary July proposal used bonds, slashing and validator-approved templates to address deployer incentives (Hyperliquid 2026l). Challenge procedures and customer remedies remain necessary.

Surveillance and exposure controls

Surveillance must aggregate linked positions across controlled accounts and reference markets. Limits should reflect payout jumps and benchmark depth; information sharing should support detection of manipulation and liquidation feedback. The March CFTC advisory reiterates real-time monitoring duties and Rule 180.1's reach over misappropriation-based insider trading (CFTC 2026i).

Continuous operations and default management

A 24/7 market needs continuous valuation, margining, incident response and default resources, including when its benchmark, bank or reference market is closed. Extended hours do not relax registrants' operational duties (CFTC 2026e).

10. Welfare, standards, and an empirical program

Corporate hedging can protect investment when external finance is costly (Smith and Stulz 1985; Froot, Scharfstein, and Stein 1993), but collateral and organizational costs can limit its use, especially for constrained firms (Rampini, Sufi, and Viswanathan 2014; Covitz and Sharpe 2005; Banerjee et al. 2023).

Statebook's welfare case is lower total hedging cost and a more inspectable public record of state value. The relevant outcomes include usable protection, settlement integrity and customer losses. Additional listings and turnover are insufficient measures of success.

A credible U.S. route would also shape standards for contracts, benchmarks, collateral and resolution. Keeping expertise and market infrastructure within institutions that U.S. authorities can inspect gives domestic participants a role in their development. Table 5 collects the evaluation criteria.

Table 5. Statebook empirical audit

Test	Measurement	Failure condition
Payoff coverage	Share of requested size available as a direct, exact synthetic, or bounded route	The system reports theoretical relations without executable capacity or residuals
Execution	Direct-versus-synthetic all-in wedge, fill rate, size, and market impact	Fees, leg risk, or thin component books erase the expected advantage
Liquidity reuse	Reserved component capacity and simultaneous claims on the same depth	Synthetic routing double-counts inventory or merely redistributes sparse flow
Recorded direct-route share	Share of filled notional executed directly rather than through the venue's matched synthetic route, with unclassified fills reported separately	A venue-derived route is labeled direct, or unclassified fills make the share uninterpretable
State-price quality	Calibration and forecast performance against outcomes, surveys, and matched option-implied distributions	A direct contingent-claim price is interpreted as a physical probability without adjustment for risk, fees, and market structure
Risk recognition	Gross collateral, recognized offset, and stressed residual loss	Margin credit fails under basis, funding, oracle, liquidity, or close-out stress
Commercial value	Total hedge error and cost against the best established hedge	A closer state definition costs more than the basis it removes
Integrity and access	Quote survival near fixing, settlement disputes, manipulation signals, and customer outcomes	Regulated access expands turnover without durable risk transfer or adequate protection

11. Conclusion

An interval can have a market without having its own order book. That is the economic force of organizing execution around payoffs. A statebook puts existing liquidity within reach of more demands, while direct contracts serve exposures beyond practical replication. Breeden-Litzenberger supplies the ordered-state geometry. Contract design and risk institutions turn it into a usable market.

Different purposes meet in the same contract. One participant wants protection against a loss; another accepts the liability for a premium, given its other exposures. The contract fixes what changes hands. Private valuations determine whether the trade is attractive. Funding and risk capacity determine how large the trade can be.

More usable depth or lower total hedge cost must come without weakening customer outcomes, settlement integrity or protection through close-out. A lawful U.S. path should make those outcomes the standard for domestic venues and frontier designs alike. A market reaches further when a payment that once required an impractical hedge becomes available on terms both sides can sustain.

Appendix A. U.S. classification questions

Table A1. Illustrative U.S. classification map

Product family	Principal classification question	Institutional consequence
Physical-commodity price boundary, option, or perpetual	Future, option on a future, swap, or another commodity-interest form; cash settlement versus delivery; suitability of a perpetual reference	Determines the applicable listing process, execution venue, clearing arrangement, intermediation, and customer protections
Rate or FX boundary and continuing reference	Future, option, or swap; deliverability, settlement currency, and customer eligibility	Determines whether exchange trading, swap execution, clearing, or bilateral rules apply and whether retail access is available
Equity or security-linked boundary, option, or perpetual	Securities option, security future, security-based swap, mixed swap, or excluded instrument	Determines SEC-CFTC jurisdiction, permissible venue, margin regime, and coordinated or alternative compliance
Single-name, narrow-index, or broad-index credit claim	Swap, security-based swap, mixed swap, or another credit derivative	Determines regulator, clearing and execution requirements, participant eligibility, and treatment of credit events
Non-price contingency	Commodity event contract, swap or security-based swap, gaming-adjacent instrument, or another regulated claim	Raises the product-review, public-interest, evidence, state-law, resolution, and customer-protection questions specific to the event

This map preserves the July 2026 regulatory record; section 6's selected product updates do not refresh it. The table identifies classification questions, not legal conclusions. Payoff shape alone cannot collapse the resulting statutes, accounts or insolvency regimes.

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Primary product and regulatory sources

Unless otherwise stated, the original online-source access date is 13 July 2026; U.S. regulatory checks extend through 25 July, and the cross-venue bitcoin contract checks through 26 July. Selected product sources were rechecked or added on 6 September: Cboe Exchange 2026b, 2026c, 2026f; Cboe Global Markets 2026; Kalshi 2026b-d; Polymarket 2026a, 2026b; Hyperliquid 2026m. Hyperliquid 2026l records a preliminary July proposal; 2026m verifies subsequent permissionless deployment, not every proposed parameter. The remaining product and legal claims retain their stated July cutoffs. Cboe Exchange 2026a, 2026d, 2026e and Hyperliquid 2026e are retained as supporting July source records.

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