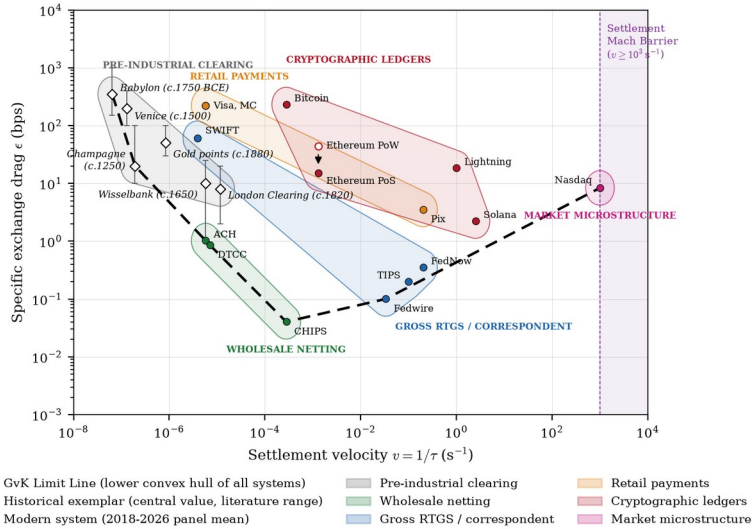
EXECUTIVE BRIEFING

Settlement speed has a price, and the policy rate sets much of it

A Gabrielli–von Kármán frontier for financial settlement systems, from Babylonian storehouses to proof-of-stake

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Modern-system figures come from a calibrated structural simulation (15 systems, 106 months, N = 1,466) benchmarked to public disclosures.



The GvK Limit Line: specific exchange drag against settlement velocity, 21 systems

Every settlement system since 1750 BCE sits on or above one cost limit line

Specific exchange drag ε adds four costs per unit of value settled: fees, risk reserves, energy and the funding cost of locked collateral. Plotted against settlement velocity, all 21 systems lie on or above a U-shaped lower boundary.

Wholesale netting forms the floor. CHIPS, ACH and DTCC define the line's lowest stretch.

Retail and proof-of-work sit far above it. Cards and Bitcoin carry one to two orders of magnitude more drag.

Beyond 10^3 settlements per second, extra speed mainly redistributes rents.

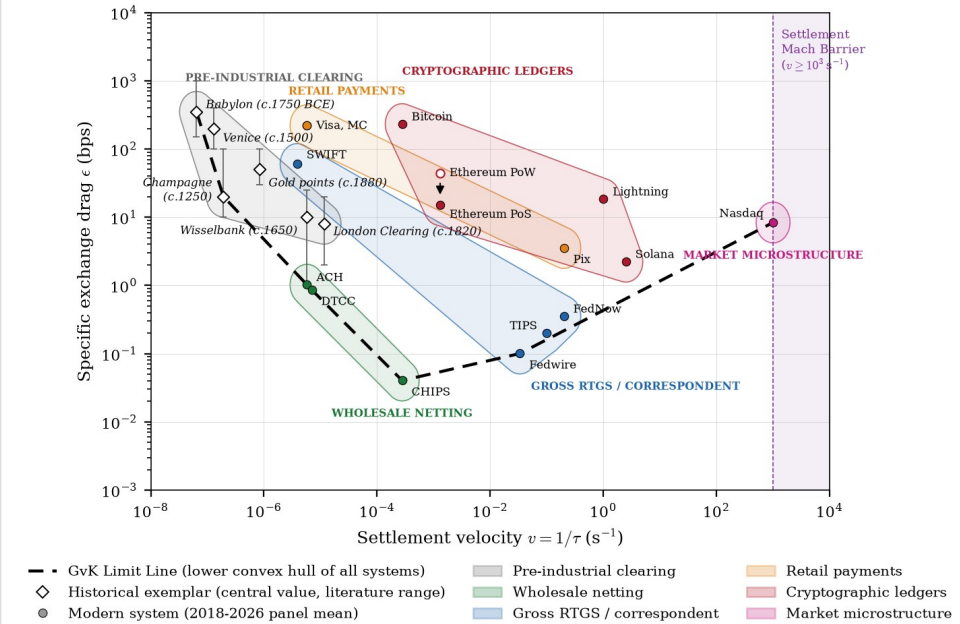


Figure 1 of the working paper. Historical exemplars show literature ranges.

Source: Bastiaanssen (2026), What Price Settlement Speed? Working paper. Modern-system values are a calibrated structural simulation, not observed data.

When SOFR rose from 0.03% to 5.41%, only capital-bound systems repriced

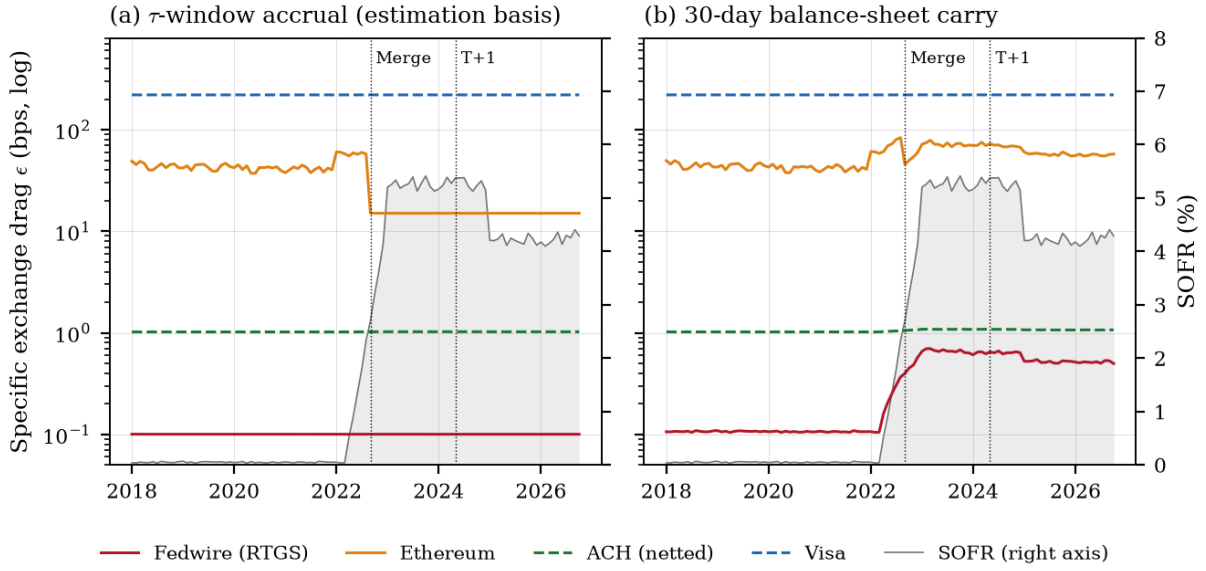


Figure 2: drag by month, 2018 to 2026, on the transaction-window (a) and balance-sheet carry (b) bases.

0.364

capital-bound rate slope in the simulation's response surface

Proposition 1: the rate elasticity of drag equals the collateral share of cost. Fedwire reprices with SOFR on the carry basis. Visa and netted ACH barely move.

Source: Bastiaanssen (2026), What Price Settlement Speed? Working paper. Modern-system values are a calibrated structural simulation, not observed data.

Netting is the floor: netted systems carry no premium above the limit line

0.00

wrapper premium of CHIPS, ACH and DTCC above the GvK limit line (Table 2)

610×

gross-to-netted drag ratio at equal speed in the calibration's response surface

The 610× ratio returns the calibration's netting assumption by construction: it shows scale, not causal proof.

Policy reading

The netting floor is the most persistent regularity in four thousand years of settlement, from Babylonian storehouses to CHIPS.

Atomic delivery-versus-payment on a shared ledger removes the netting window by design. Proposals should show how liquidity savings are preserved, for example through liquidity-saving queues or programmable netting.

Source: Bastiaanssen (2026), What Price Settlement Speed? Working paper. Modern-system values are a calibrated structural simulation, not observed data.

Faster settlement can cut per-trade collateral cost and still raise standing liquidity needs

Proposition 2: if required collateral rises with speed at an elasticity η between 0 and 1, the cost charged per settlement window falls while the balance-sheet carry rises. Both effects are real; they sit in different accounts.

T+2 to T+1, May 2024

Clearing-fund collateral ×1.35, η = 0.433

×0.675 window cost per settlement, about one third lower

+35% monthly carry cost of locked collateral

T+1 to T+0, scenario

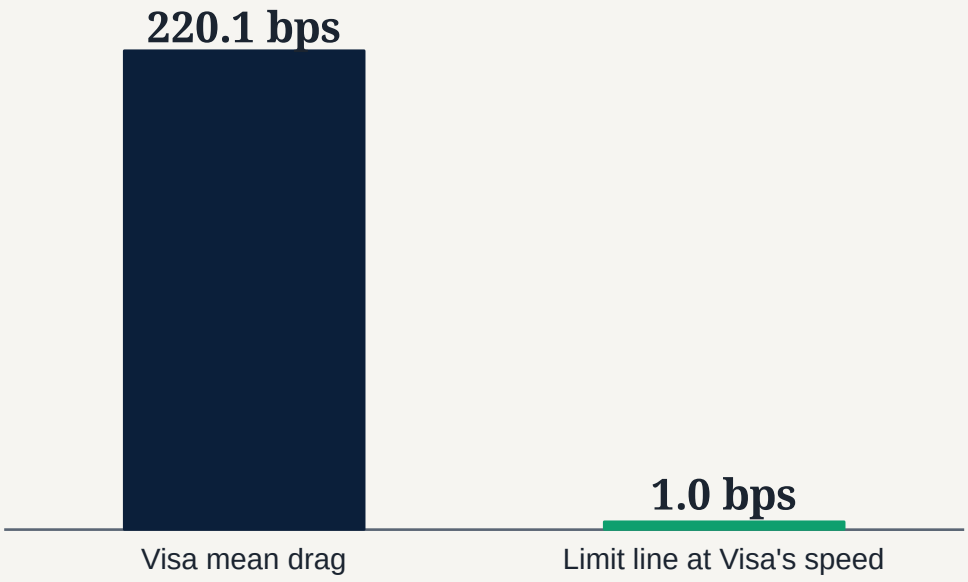
Collateral ×10 as τ falls from 1 day to 10 s, η = 0.254

×0.0012 window cost per settlement

×10 monthly carry cost of locked collateral

Source: Bastiaanssen (2026), What Price Settlement Speed? Working paper. Modern-system values are a calibrated structural simulation, not observed data.

Card networks carry a 216-fold wrapper premium above the limit line at their speed



216×

retail-class premium at card speed, π = 5.38 (Table 2); Pix, with a thinner bundle, ×16

Bundled credit float, fraud guarantees and dispute rights can only add to drag, so the limit line is an upper bound on pure settlement cost (Proposition 3). Part of interchange is a transfer, not a resource cost.

Source: Bastiaanssen (2026), What Price Settlement Speed? Working paper. Modern-system values are a calibrated structural simulation, not observed data.

The Merge moved Ethereum's security cost from the energy market to the money market

99.94%

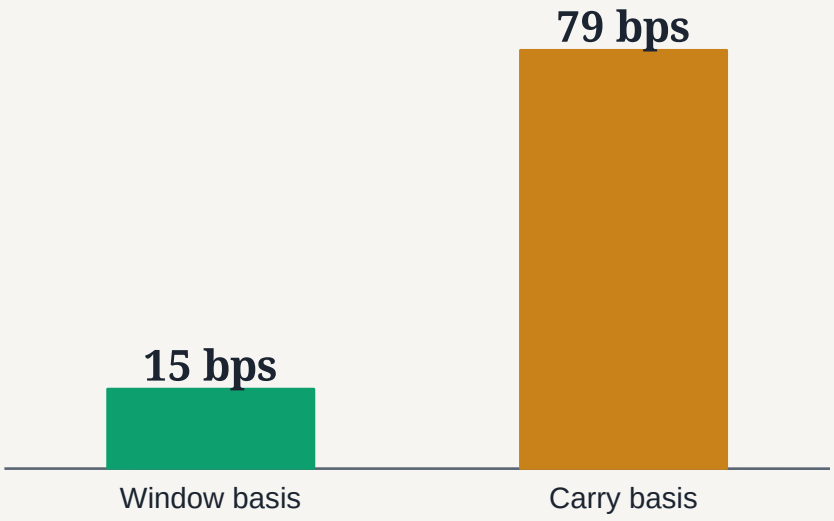
fall in Ethereum's energy cost at the Merge, September 2022

44.8 to 15.0 bps

mean drag before and after, transaction-window basis

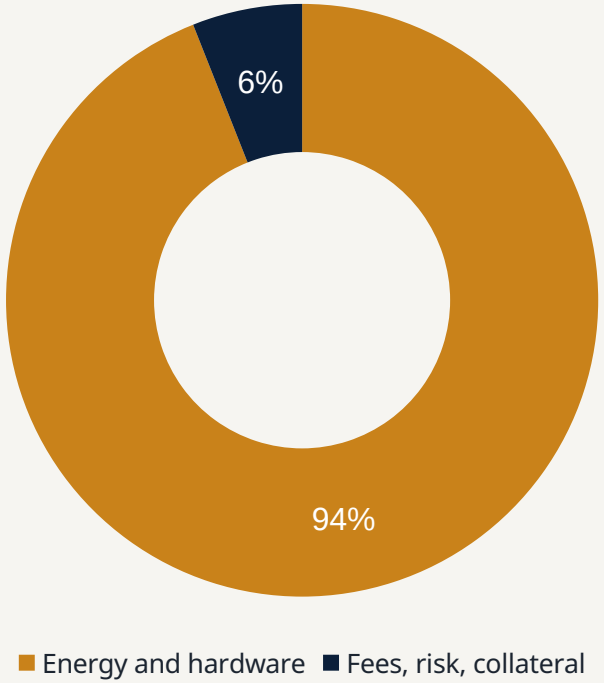
Disclosures under MiCA capture energy. A complete assessment also books the capital locked in staking and its sensitivity to the policy rate.

Ethereum drag at the 2023 rate peak, bps



Source: Bastiaanssen (2026), What Price Settlement Speed? Working paper. Modern-system values are a calibrated structural simulation, not observed data.

Bitcoin's drag of 128 to 362 bps is 94% energy, far above the limit line



128 to 362 bps

monthly drag range, 2018 to 2026, against 15.0 bps for Ethereum after the Merge

Proof-of-work buys settlement finality with electricity. By the same identity as Proposition 1, its drag moves almost one for one with the power price and barely with the policy rate.

Source: Bastiaanssen (2026), What Price Settlement Speed? Working paper. Modern-system values are a calibrated structural simulation, not observed data.

Five tests separate a genuine settlement saving from a relabelled cost before a pilot is authorised

Dimension	Typical failure in a proposal	Required GvK test
Liquidity and float	Collateral saving claimed on transaction float alone	Collateral cost on window and 30-day carry basis, with the implied η
Netting preservation	Atomic DvP removes the netting window and raises gross liquidity needs	Documented liquidity-saving queues or programmable batch netting, and their effect on locked capital
Security migration	Proof-of-stake presented as near-zero cost because energy use is small	Opportunity cost of staked capital booked next to energy and hardware
Monetary robustness	Liquidity model tested only at the pilot rate, often near zero	Drag recomputed at 0% and 5.5%; rate elasticity equals the collateral share
Latency value	Hardware cost justified by sub-millisecond finality	Above 10^3 per second, proof that drag falls, not only latency

Source: Bastiaanssen (2026), Section 6, Table 3; CPMI–IOSCO PFMI (2012). Interactive version: GvK Sandbox Scorecard.

Shared operator data turns this simulation into evidence

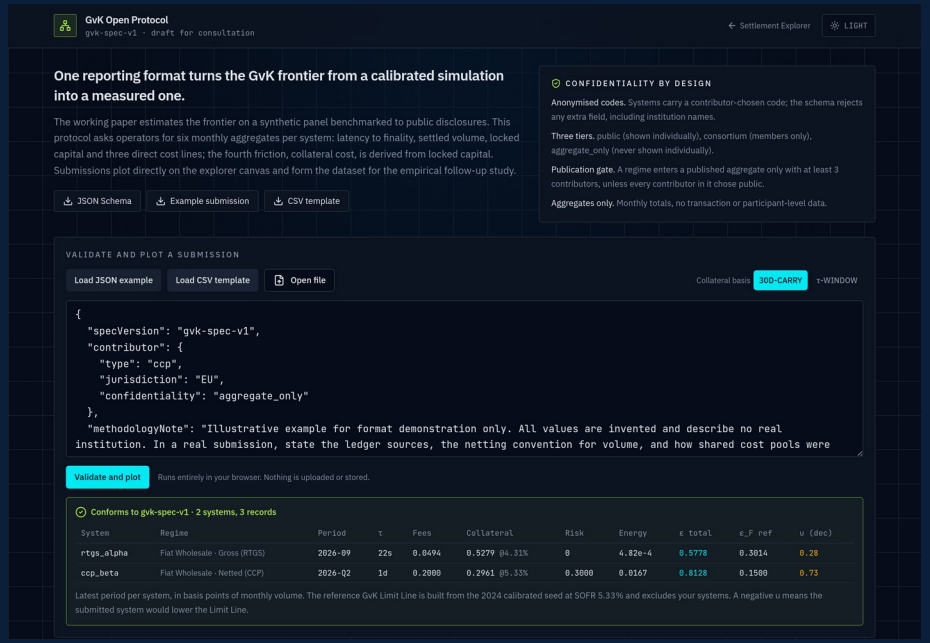
Six monthly figures per system
Speed to finality, value settled, locked capital, fees, risk and energy cost.

Anonymised by design
Contributor-chosen codes; the format rejects institution names.

Publication gate
A regime enters published totals only with at least 3 contributors.

Checked in the browser
Operators validate files locally. Nothing is uploaded.

Proposed next step: a consortium of operators and authorities contributing 2018 to 2026 data. Details at settlementfrontier.org/protocol



Protocol page with the example submission validated