Who Fire-Sells? Public Pensions as Conditional, Not Aggregate, Sellers in Drawdowns

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Abstract. As critical vehicles for public employee retirement benefits and state fiscal stability, equity-heavy public pension funds are frequently scrutinized for potentially amplifying systemic market volatility during economic drawdowns. Using a U.S. panel from 2000 to 2026, we triangulate plan-level implied active flows against Federal Reserve and Census sec- tor data and show that aggregate public pensions are net equity buyers in drawdowns: their net selling is positively correlated with the contemporaneous market return (+0.50 to +0.57 across sources) and does not predict next-quarter realized variance or VIX. That stability masks a level-of-analysis distinction. Plans simultaneously cash-flow negative and heavily allocated to illiquid alternatives cut their crisis-period buying, robustly to lagged timing and two-way fixed effects, and quantile regressions show this pressure to be a broad downward level shift across the flow distribution rather than a localized fire-sale tail. Headline funded status is an unreliable early-warning metric: underfunded plans buy more equity in crises. Accordingly, we put forward a conditional vulnerability map. At the same time, we con- tend that both macroprudential governance and public service oversight ought to shift their focus away from reliance on aggregate accounting labels and toward the monitoring of dynamic liquidity constraints. Such a reorientation is essential for safeguarding the long-term sustainability of public pension systems.

Keywords: Public pension systems, Financial stability, Institutional heterogeneity, Macro- prudential oversight · Public crisis and risk management.

1 Introduction

With several trillion dollars under management, U.S. public pension funds are responsible for securing retirement benefits for public service employees and maintaining state fiscal stability. To fulfil these commitments, they allocate substantial portions of

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their portfolios to equities and illiquid alternatives, while simultaneously bearing long-dated, contractually rigid benefit obligations. This combination of substantial scale, pro-cyclical exposure, and inflexible cash outflow schedules has repeatedly cast them as a recurring suspect in the debate over whether large institutional investors amplify market drawdowns.The mechanical intuition is simple: when public equities fall, an underfunded plan facing fixed payouts and a ballooning illiquid weight should be pushed to sell liquid equities, converting patient capital for sustainable public governance into a pro-cyclical seller precisely when markets can least absorb it.

Aggregate flow evidence rejects that intuition at the sector level, which forces the research question to shift. Rather than asking how much public pension selling amplifies volatility, we ask whether the sector amplifies volatility at all, or whether the perceived threat is an aggregate- level fallacy masking heterogeneous plan behavior, and if so, which constraints (chronic cash-flow pressure, illiquid concentration, or headline underfunding) mark the vulnerable subset.

We answer with a U.S. public pension panel spanning 2000–2026, combining plan-level implied active flows from the Public Plans Database with two independent aggregate sector series, and estimating an additive conditional-interaction model of distress against market crises. We con- tribute, first, an aggregate reframing: triangulating implied plan flows, Federal Reserve Financial Accounts (L.120), and Census Quarterly Survey of Public Pensions data, we show the sector is a net dip-buyer in drawdowns, not an amplifier. Second, a conditional vulnerability map: the stabilizing average conceals plans that are simultaneously cash-flow negative and illiquid-heavy, and these plans cut crisis-period buying as a broad negative level shift across the flow distribution rather than a localized fire-sale tail; headline funded status is the wrong trigger, since underfunded plans buy more in crises. Third, identification transparency: we recover a selling quantity without transaction data, and report that instrumenting distress with state fiscal shocks fails a confounder horse-race, so we present an associational map rather than a strained causal claim. Ultimately, mapping these plan-level constraints links portfolio choices to the stability of public pension systems and the broader financial markets they interact with.

2 Related Work, Mechanisms, and Hypotheses

Related work. Liquidity-constrained institutions sell into falling markets, and these sales have price impact that propagates shocks across holders of the same assets [5, 4]. Recent evidence on non-bank intermediaries, however, emphasizes high cross-sectional heterogeneity in liquidity management [9], suggesting a sector-wide fire-sale reflex may be the exception rather than the rule. Two strands motivate our conditioning variables. The intermediary asset pricing view holds that behavior is governed by balance-sheet constraints, so shocks to net worth or liquidity translate mechanically into asset demand [1]; the appraisal-lag literature shows that infrequently valued private assets stay marked near pre-crisis values while public markets plunge, inflating the illiquid weight and triggering rebalancing pressure [7, 3]. They highlight cash need and illiquidity, not funding ratios, as binding, contrasting reach-for-yield litera-

ture. [6, 8] predicts the opposite for underfunded plans, which we revisit in Section 5.2.

Mechanisms. Two channels predict conditional selling. Under the denominator effect, private positions are valued infrequently, so when public equities plunge the illiquid share balloons past its strategic target and a cash-constrained plan faces pressure that dampens crisis buying or tilts it toward liquid sales [7]. Under cash-flow rigidity, payouts represent rigid public service commitments; when these obligations exceed incoming revenue, public financial management mandates asset sales. Liquid equities carry the lowest realization cost precisely when the illiquid sleeve cannot be sold, which is a chronic selling gradient that drawdowns intensify [1].

Hypotheses. These mechanisms predict selling at the plan level, yet the aggregates show net buying; we resolve the tension through cross-sectional heterogeneity. **H1(aggregate stability):** The sector buys equities counter-cyclically in drawdowns and has no predictive power for next-quarter realized variance or VIX, representing an aggregate net-flow statement bounded by tight confidence intervals around zero, not a systemic price-impact claim. **H2 (conditional selling propensity):** The propensity to sell is conditional on plan-level cash-flow need and illiquid concentration, the cash-flow channel being a chronic pressure that survives within-plan variation and the illiquid channel scope-conditioned to severe drawdowns and identified primarily between plans [2].

3 Data and Variables

Triangulation. Our strategy requires the same verdict from three independent flow sources. From the Boston College CRR Public Plans Database we recover implied active flows at the plan level by removing passive price drift from year-over-year changes in dollar holdings. We triangulate these against two external sector series: the Federal Reserve Financial Accounts (Z.1, table L.120), reporting observed quarterly net equity purchases and sales of the state and local defined-benefit pension sector (105 quarters, 2000Q1–2026Q1); and the Census Quarterly Survey of Public Pensions (QSPP), giving an implied sector flow from quarter-end holdings of the top-100 systems (28 quarters, 2019Q2–2026Q1). This plan/sector and implied/observed cross-check licenses the aggregate claim in Section 5.1.

Implied active flow. The key constructed variable backs out the active buy/sell decision by removing class-level returns from holdings:

$$flow_{k,t} = w_{k,t}A_t - w_{k,t-1}A_{t-1}\left(1 + r_{k,t}\right), (negative \ = \ net\ selling) \qquad (1)$$

that is, current dollar holdings of asset class k minus the prior period's holdings carried forward at the class return $r_{k,t}$; the residual is the plan's active trade, net of passive valuation change. The regression dependent variable is the equity component of Eq. (1) over prior-period total assets, winsorized at 1/99%.

Distress predictors and sample. We use FundingGap = max(0, 1−funded ratio); CashNeed = −(contributions − benefits + investment income), so positive values denote an operating shortfall that must be funded by sales; and Illiquid, the combined

private equity, real estate, and hedge fund share. Our primary cash proxy is the lagged *net* cash need (dated $t-1$); gross payout ratios and demographic-maturity proxies ignore contributions and investment income and go null, a measurement point rather than a channel failure. Crisis is a market-drawdown indicator, with a continuous intensity dose as an alternative treatment. The estimation sample covers FY2003–2024 within a 2000–2026 market window; the headline specification uses 3,660 plan-years on 220 plans, with counts ranging from roughly 3,400 to 4,000 across specifications as lag structure and coverage vary.

4 Empirical Strategy

Our design interacts plan-level distress with a market-crisis indicator to isolate reactive selling from concurrent market noise. Rather than a single pre-multiplied composite, the main specification enters each distress channel as a separate crisis interaction:

$$Flow_{i,t} = \alpha_i + y_t + \beta_C\left(Crisis_t \times CashNeed_{i,t-1}\right) + \beta_I\left(Crisis_t \times Illiquid_{i,t}\right) + \beta_F\left(Crisis_t \times FundingGap_{i,t}\right) + \boldsymbol{Z}'_{i,t-1}\delta + \varepsilon_{i,t} \quad (2)$$

The coefficients of interest are β_C and β_I: a *negative* value means cash-constrained (respectively illiquid-heavy) plans sell more liquid equities in crisis quarters, consistent with H2. We enter the channels additively rather than as the pre-multiplied product $Crisis \times CashNeed \times Illiquid$ because that literal triple interaction is insignificant ($-0.007, t = -1.44$); the additive decomposition is both better powered and a more honest description of what identifies the effect. While cash-flow pressure is chronic, the crisis interaction tests whether drawdowns systematically intensify it.

Main effects are retained and predictors are z-scored, so coefficients are per standard deviation. Dating the mechanically simultaneous cash-need predictor at $t-1$ breaks same-year simultaneity between the flow and its own income-statement inputs; the two stock measures enter contemporaneously. Winsorizing the dependent variable matters: the untamed same-year construct inflates to a spurious $R^2 \approx 0.89$, a vivid display of the simultaneity we correct. We report four variants, including a same-year baseline, the lagged headline, a two-way (plan and year) fixed-effects variant, and a continuous crisis-intensity dose, all with standard errors clustered by plan. To locate the effect within the flow distribution rather than only at its mean, we estimate quantile regressions at $\tau \in \{0.10, \ldots, 0.90\}$ with a plan-clustered bootstrap ($B = 1000, seed\ 20260628$), and test for a threshold with a piecewise-linear knot test. Accepting a null across 105 quarters carries limited power, so we read the aggregate estimates as tight confidence intervals bounding any volatility impact rather than as proof of a zero effect.

5 Empirical Results

5.1 The Aggregate Verdict: Pensions Buy the Dip (H1)

The aggregate evidence is a stabilizer verdict, and it holds across all three sources. In the observed Fed L.120 series (105 quarters) the correlation between net selling and the contemporaneous market return is +0.57 (t = +3.84)— pensions sell into rallies and buy the dip (Fig. 1), and net selling does not predict next-quarter realized variance (-0.01, t = -0.27) or VIX (-0.02, t = -0.26). The raw contemporaneous association between selling and volatility is negative (-0.26, t = -2.33) and vanishes once the quarter's market return is controlled (+0.04, t = +0.48): the sector sells in calm, rising markets, not into crashes. The implied Census QSPP series (top-100 systems, 28 quarters) gives a correlation of +0.50, with net buying in the 2020Q1 and 2022Q2 crash quarters (-1.2% and -4.8% selling rates). Inside the plan panel the same pattern holds: the crisis main effect on implied flow is +0.020 (t = 10.8; Table 1).

Amplification would require a positive selling coefficient on future volatility, and none is found. This is an aggregate net-flow verdict evaluated against broad market indices: a sector that nets to buying can still contain a distressed subset dumping specific securities at a gross, high-frequency level, which is what Section 5.2 examines.

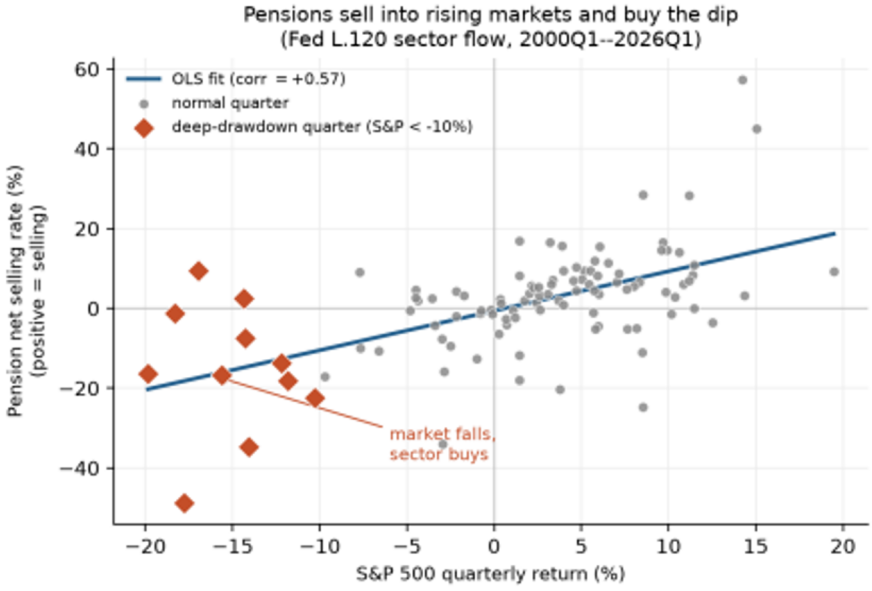


Fig. 1. Net equity selling by the state and local DB pension sector (Fed L.120) against the contemporaneous S&P 500 quarterly return, 2000Q1–2026Q1. The positive slope means the sector buys when the market falls; deep-drawdown quarters (S&P < -10%) net-buy in 9 of 11.

5.2 Conditional Sellers: A Pervasive Drag, Not a Tail (H2)

We decompose the drivers of conditional vulnerability using Eq. (2) (Table 1). At the mean, plans burdened by negative operating cash flow do sell liquid equities in crisis quarters: the CashNeed × Crisis coefficient on lagged cash need is -0.017 (t = -2.18). It is if anything stronger than its same-year counterpart, so it is not a simultaneity artifact, and it survives plan-and-year fixed effects (-0.009, t = -2.34), evidence of a within-plan channel. The average plan, by contrast, buys the dip (+0.020, t = 10.8), reproducing H1 inside the plan panel; the illiquid channel is signed the same way but weaker (-0.004, t = -1.74).

The critical question is where in the flow distribution the effect resides. A fire-sale tail of extreme sellers would concentrate the distress × crisis coefficients in the low (selling) quantiles; quantile regressions reject that reading (Fig. 2). The Illiquid × Crisis coefficient stays negative across the entire distribution (-0.002 to -0.005) and is no more negative in the low quantiles than in the middle, reflecting a level shift, not a left-tail concentration, with the bootstrap excluding zero at the median and $\tau = 0.75$. A kink test finds no threshold in either channel (illiquid LR p = 0.11; lagged cash need p = 0.90), and demeaned binned scatters show smooth, monotonic gradients rather than discrete triggers. The CashNeed × Crisis term, correctly signed and significant at the mean, is noisier across the distribution: its bootstrap band includes zero at every individual quantile. We therefore claim a robust mean effect for the cash channel and a distributional level shift for the illiquid channel, and no tail evidence for either. Distressed plans do not experience a discrete crisis- triggered blow-up; they exhibit a chronic, cross-sectional reduction in dip-buying that drawdowns intensify. This reframes the regulatory question from "which plans might fire-sell" to "how much does illiquid concentration dampen crisis-period buying across the constrained subset".

Table 1. Conditional equity-flow interactions (H2). DV: implied equity flow over prior-period assets (1/99% winsorized), negative = net selling; plan-clustered t-statistics in parentheses; predictors z-scored. Cash need is dated t in column 1 and t - 1 in columns 2–4; column 4 uses continuous drawdown intensity. *p < 0.1, **p < 0.05, ***p < 0.01.\

	(1) Baseline	(2) Lagged	(3) Two-way FE	(4) Cont . DD
Crisis / intensity	+0 .020 ***	+0 .015 ***	—	+0 .009 ***
(main)	(10 .78)	(7 .34)		(10 .76)
CashNeed × Crisis	−0 .016 *	−0 .017 **	−0 .009 **	−0 .004 *
	(−1 .81)	(−2 . 18)	(−2 .34)	(−1 .74)
Illiquid × Crisis	−0 .007 ***	−0 .004 *	−0 .004	−0 .003 ***
	(−3 .56)	(−1 .74)	(−1 .46)	(−2 .97)
FundingGap × Crisis	+0 .005 **	+0 .008 ***	+0 .006 ***	+0 .000
	(2 .37)	(3 .60)	(2 .70)	(0 .27)
Cash-need timing	t	t-1	t-1	t-1
Plan FE / Year FE	no / no	no / no	yes / yes	no / no
N / Plans	3,987 / 227	3,660 / 220	3,660 / 220	3,660 / 220
R^2	0.089	0.049	0.245	0.073

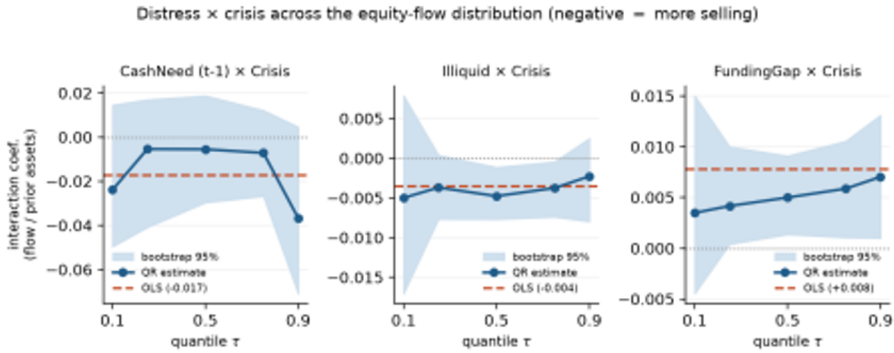


Fig. 2. Distress × crisis coefficients across the equity-flow distribution (quantile regression, plan-clustered bootstrap 95% bands; dashed line is the winsorized OLS estimate). The illiquid channel is a flat negative level shift, not a spike in the low (selling) quantiles.

The funding-gap correlate runs the wrong way. Funded status behaves opposite to the naive prediction. The FundingGap × Crisis interaction is significantly positive throughout Table 1 (+0.008, t = +3.6 lagged; +0.006, t = +2.7 under two-way fixed effects): underfunded plans buy more equity in crises, consistent with reach-for-return under a survival constraint [2, 8]. A mechanical-rebalancing reading cannot be ruled out, as underfunded plans run higher strategic equity targets, though controlling for lagged actual or strategic equity exposure interacted with Crisis leaves the coefficient unchanged (+0.007 to +0.008, t > 3.4). We decline any causal reading of this margin and treat it as a diagnostic caveat: headline funded status is a noisy, potentially misleading early-warning metric for forced selling.

6 Robustness

Excluding the extreme crises. Dropping fiscal years 2008–2009 and 2020 identifies the crisis interactions of the milder downturns that remain. The cash-flow channel not only survives but strengthens, from -0.017 (t = -2.18) to -0.028 (t = -3.54), and the positive funding-gap correlate is likewise robust (+0.008 → +0.011, t > 3). The illiquid channel, already marginal in the full sample, attenuates to a small insignificant coefficient once the deep crashes are removed, consistent with the denominator effect being most acute in severe drawdowns, and why we read that channel as scope-conditioned.

Alternative dependent variable. Replacing the price-drift-adjusted flow with the raw year- over-year change in equity weight, which serves as a noisier proxy conflating active rebalancing with passive valuation, preserves the signs (Illiquid × Crisis = -0.33 pp, t = -1.83; FundingGap × Crisis = +0.49 pp, t = +2.93).

Placebo tests. Two permutation exercises (B = 1,000, seed 20260721) probe what H2 is specific to. Permuting distress across plans within each fiscal year collapses the interactions toward zero and leaves the true estimates deep in the left tail (cash need p = 0.001; illiquid p = 0.043): the effect is specific to a plan's own position. Randomly

relabelling which fiscal years are crises does not isolate the effect (cash need p = 0.87; illiquid p = 0.70), and we report this openly. It characterises H2 rather than overturning it: the cash-flow squeeze is a chronic gradient present in normal years too, so reshuffling crisis labels cannot extinguish it. The defensible reading is cross-sectional, focusing on which plans sell, intensified by but not uniquely triggered by crisis timing.

7 Conclusion and Policy Implications

Our analysis yields two core findings that together form a coherent picture. At the aggregate level, the U.S. public pension sector stabilizes markets. It net-buys during drawdowns, and its selling does not forecast next-quarter volatility, so the amplification prior fails for the sector overall. Yet that average masks a conditional vulnerability. Plans with both negative cash flows and illiquid-asset concentration cut crisis-period purchases, appearing as a pervasive drag across flows rather than a localized fire-sale tail. Thus, systemic risk stems from specific plan-level financial constraints, not from the sector label.

These findings are subject to two important caveats. First, the assessment of aggregate sector stability is based on broad net flows and does not preclude the possibility of localized, high-frequency security selling by plans facing financial constraints. Second, we refrain from making strong causal claims. When we instrument plan distress using state tax declines, that instrument fails a con- founder horse-race against a broader set of macroeconomic controls. We therefore present our conditional map as a robust associational pattern rather than as evidence of a causal mechanism.

For public governance and macroprudential oversight, supervisory targets must shift from static accounting ratios to dynamic liquidity metrics (including operating cash-flow pressure and sensitivity to illiquid assets), evaluated via stress testing and liquidity buffers, so as to safeguard market stability and public service sustainability. Using headline funded status as the primary watchdog misdirects policy, whereas blanket restrictions impede long-term value creation without mitigating actual vulnerabilities. Future research should utilize intra-quarter transaction data to examine price impacts across constrained plans.

Disclosure of Interests

The authors have no competing interests to declare.

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