

State-Contingent Volatility Transmission between Equity Markets and Target-Date Funds

Implications for TDF Design and Systemic Risk

Huiyuang Wang¹ Lingfeng Lyu²

¹School of Economics, Nankai University ²School of Risk & Actuarial Studies and CEPAR, UNSW Sydney

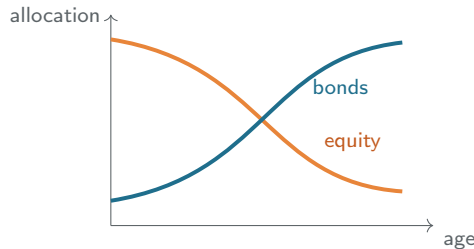
Conference / Seminar, 2026

Daily data, China vs. United States, October 2015 – October 2025

Motivation and Question

Target-date funds: a multi-trillion-dollar mechanical trader

- ▶ US TDFs manage over **\$4 trillion**: the default option (QDIA) since the Pension Protection Act 2006.
 - ▶ China launched TDFs in 2018; private-pension rollout reached **72.8 million** workers by December 2024.
 - ▶ Defining feature: a **deterministic glide path** that shifts equity into bonds as retirement nears.
- ⇒ When markets move, funds must **trade back to target**: flows that are large, predictable, and concentrated.



The glide path is fixed in advance.

The price-taker assumption

- ▶ Standard glide-path theory (Merton-style, hedging, mean–variance) treats index volatility as **exogenous** to fund rebalancing.
- ▶ But if TDF flows are large, predictable, and concentrated, they may leave a **volatility footprint** on the market they trade into.

Research question

Do TDF rebalancing flows feed back into equity-market volatility, and does this vary (i) across market states (calm vs. crisis) and (ii) across institutional environments?

Comparative design: **China** (SSE Composite) vs. **United States** (S&P 500).

What we do

1. First unified **regime-switching** analysis of TDF $\leftrightarrow$ equity volatility transmission, China vs. US.
2. **State-contingent** Granger causality: transmission is estimated *within* calm and crisis states, not as a full-sample average.
3. Draw out the **design and systemic-risk** implications, and price a regime-aware execution rule in a calibrated simulation.

Roadmap: Data $\rightarrow$ Method (GARCH $\rightarrow$ regimes $\rightarrow$ causality) $\rightarrow$ Results $\rightarrow$ Interpretation & policy.

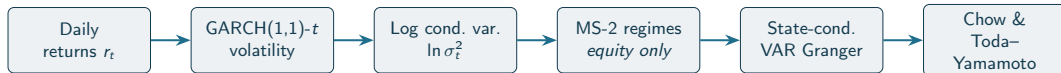
Data and Method

- ▶ Daily series, 22 Oct 2015 – 28 Oct 2025: a window spanning the 2018 trade war, the 2020 COVID shock, and 2022 monetary tightening.
- ▶ Broad equity: **SSE Composite** and **S&P 500**.
- ▶ TDFs: the 2035 / 2045 / 2055 vintages, aggregated into equal-weighted composites **CNTDF** and **USTDF**.
- ▶ Sources: WIND (China), Bloomberg (US); roughly 1,900–1,970 observations per series.

Stylised fact

Returns are **left-skewed and heavy-tailed** for both equities and TDFs: near-retirement cohorts face genuine downside, not symmetric noise.

A four-step empirical pipeline



- ▶ Log conditional variance is stationary $I(0)$ and near-symmetric: a clean input for a linear VAR.
- ▶ Regimes are identified from **equity only**: TDF variance is kept out to avoid contaminating the causality tests (endogeneity).

Identifying market regimes (MS-2)

- ▶ Two-state Markov switching on equity log-variance (Hamilton, 1989).
- ▶ State 1 = **calm** (low mean/vol); State 2 = **crisis**. Days classified by smoothed probabilities.
- ▶ Crises are **violent but brief**, and the calm state is highly persistent.

Maps cleanly onto known episodes: 2018 trade war, 2020 COVID, 2022 tightening.

	China	US
Calm mean μ_1	0.043	0.238
Crisis mean μ_2	0.543	1.178
Persistence p_{11}	0.93	0.98
Calm duration	≈ 14 d	≈ 40 d
Crisis duration	≈ 3 d	≈ 7 d

Log conditional variance; MLE via EM.

State-conditional Granger causality

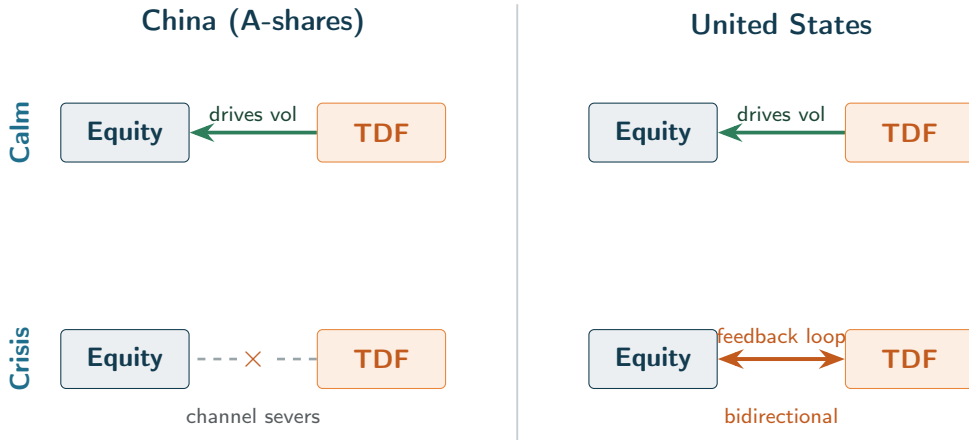
- ▶ Within each state, estimate a bivariate VAR(p) in $\{\ln \sigma_{\text{equity},t}^2, \ln \sigma_{\text{TDF},t}^2\}$.
- ▶ Wald χ^2 test on the cross-lag coefficients: does one market's *past* volatility predict the other's?

$H_0 : \varphi_{21,1} = \dots = \varphi_{21,p} = 0$ (equity does not Granger-cause TDF, and vice versa).

- ▶ Three samples: **full** / **calm** / **crisis**.
- ▶ Robustness: Chow structural breaks (Mar 2020, Jan 2022) and Toda–Yamamoto (safe under near-unit-root persistence).

Results

One channel, two crisis regimes



- ▶ In **calm markets** and the **full sample**, TDFs drive equity volatility in *both* countries; the reverse channel is insignificant.
- ▶ Under **stress**, the two markets diverge sharply: China's channel goes silent, the US channel closes into a loop.

The numbers

Direction	Full	Calm	Crisis
<i>China: SSE $\leftrightarrow$ CNTDF</i>			
CNTDF $\rightarrow$ SSE	101.97***	37.83***	5.15 (ns)
SSE $\rightarrow$ CNTDF	1.64	9.63*	0.73 (ns)
<i>US: S&P 500 $\leftrightarrow$ USTDF</i>			
USTDF $\rightarrow$ S&P	234.4***	181.4***	20.87***
S&P $\rightarrow$ USTDF	6.71	6.98	11.62**

Wald χ^2 statistics. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

China crisis: **both directions die**. US crisis: the reverse channel **lights up**.

Different shocks, different markets

	COVID-19 (Mar 2020)	Fed hikes (Jan 2022)
China (SSE → CNTDF)	stable	break**
US (USTDF → S&P)	break**	stable

China: shifts under tightening, not COVID.

±10% daily price limits truncate the variance signal in an acute crash; slow tightening lets allocation drift accumulate past the 10-day deferral window, forcing rebalancing.

US: shifts under COVID, not tightening.

Rigid glide-path mandates turn the 2020 free-fall into panicked, mechanical rebalancing that permanently reset the feedback loop.

Robustness: Toda–Yamamoto

- ▶ Augment the VAR to $p + 1$ lags, then test only the first p : inference is valid regardless of integration or cointegration.
- ▶ Across **all 12** directional tests, results agree with the baseline with **100%** qualitative agreement.

Takeaway

The asymmetric, state-dependent transmission patterns are **structural economic realities**, not artefacts of lag selection.

Interpretation, Design and Policy

Why the divergence? Institutions, not assets

China

- ▶ Managers hold **explicit discretion** to defer or suspend rebalancing (10-day restoration window).
 - ▶ $\pm 10\%$ price limits act as a **circuit breaker**.
- ⇒ Under stress the channel **severs**.

United States

- ▶ Prospectus-committed glide paths, enforced by fiduciary and peer benchmarking: **rebalance daily to target**.
 - ▶ Forced crisis trades → price impact → feeds back into own variance.
- ⇒ Under stress a **loop** closes.

Same asset class, opposite crisis behaviour: **design drives contagion**.

From evidence to design

- ▶ The loop violates the price-taker assumption: aggregate TDF rebalancing is a **pro-cyclical variance source** whose schedule is knowable in advance.
- ▶ The forward channel is *pervasive*; the loop closes *only under stress*.

A directional design principle (not a glide-path redesign)

A **regime-aware execution rule**:

- ▶ **suspend** mechanical rebalancing in the crisis state;
- ▶ **restore** the target in K tranches once the state clears;
- ▶ leave the age-based glide path otherwise untouched.

“Do not be compelled to trade in the one state where trading is most damaging and most costly.”

Does the rule pay? (calibrated Monte Carlo)

- ▶ **vs. current US practice** (daily-to-target): **+85 to +172 bps** of lifetime certainty-equivalent wealth, as crisis-cost severity λ rises from 1 to 4.
- ▶ **Decomposition:** the pure allocation effect is only $\approx +4$ bps, so almost the entire gain is **saved execution cost**, not market timing.
- ▶ **vs. a disciplined static band:** ≈ 0 . The private gain over sensible banding is negligible.

The value is systemic, not private

Any band-type rule starves the crisis loop of forced flow. The regime-aware form adds a **halved calm-state footprint** and a crisis-state flow that is **zero by construction**. $\Rightarrow$ the instrument belongs at the **regulatory default** and in **systemic monitoring**.

Policy implications

China

- ▶ Codify crisis deferral into state-contingent rebalancing rules.
- ▶ Liberalise QDII quotas to disperse rebalancing offshore.

United States

- ▶ Bring aggregate TDF rebalancing into systemic-risk monitoring.
- ▶ Treat predictable flows as pro-cyclical amplifiers, not neutral adjustments.

Cross-market

- ▶ Audit glide-path frameworks for endogenous feedback.
- ▶ Regime-contingent flexibility (UK, AU, JP, and beyond).

A shared agenda: design retirement capital to **absorb**, not **amplify**, systemic stress.

Takeaways

1. In calm markets, **TDF volatility leads equity volatility**: in both China and the US.
2. Under stress the markets split: China's channel **severs**; the US channel becomes a **feedback loop**.
3. The difference is **institutional** (discretion plus price limits vs. rigid mandates), not asset-driven.
4. A **regime-aware execution rule** captures the systemic benefit at roughly zero private cost.

Thank you

Questions and discussion welcome

Huiyuang Wang (Nankai) · Lingfeng Lyu (UNSW Sydney)