Swing Pricing for Mutual Funds: Breaking the Feedback Loop Between Fire Sales and Fund Runs

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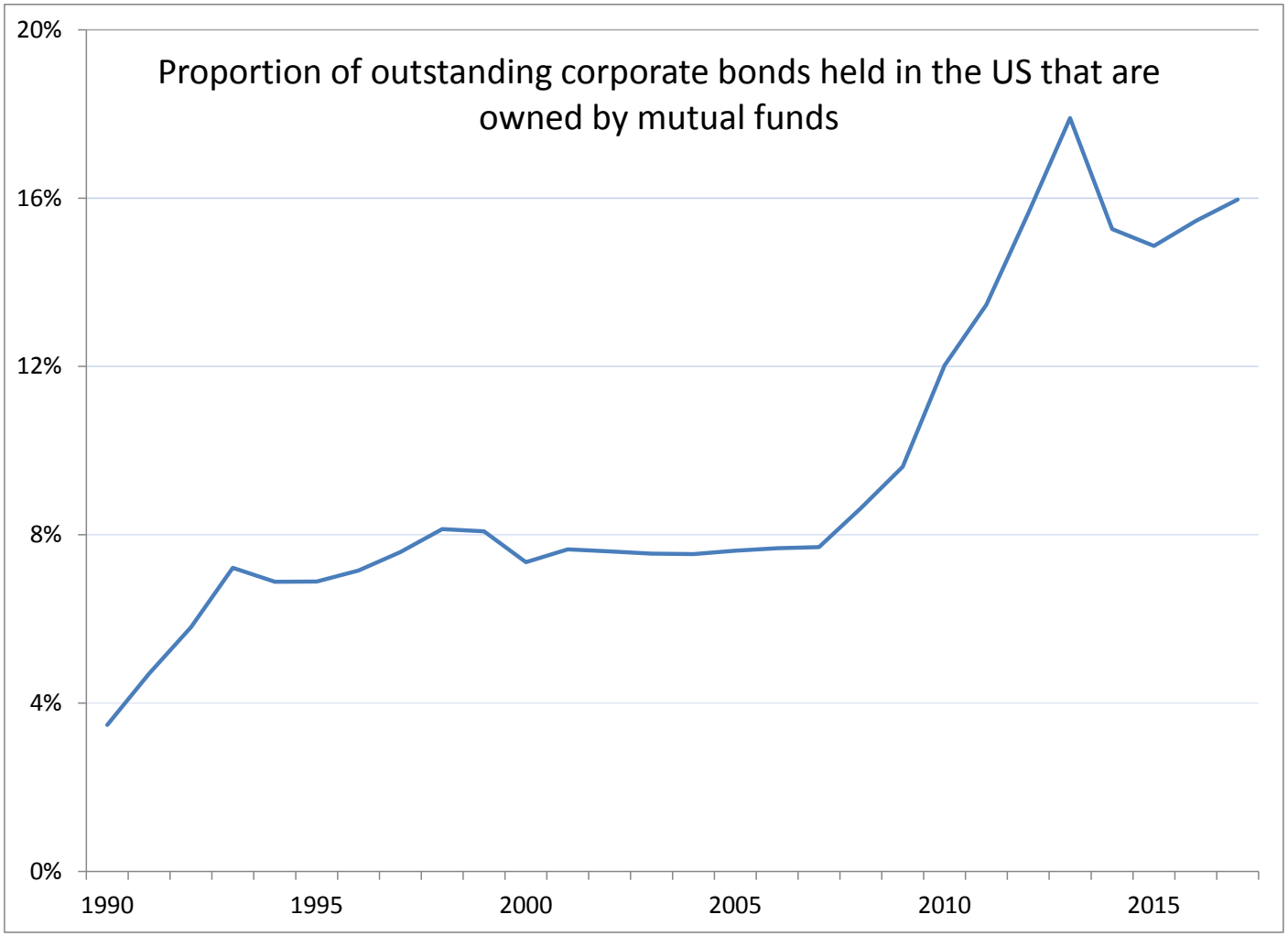
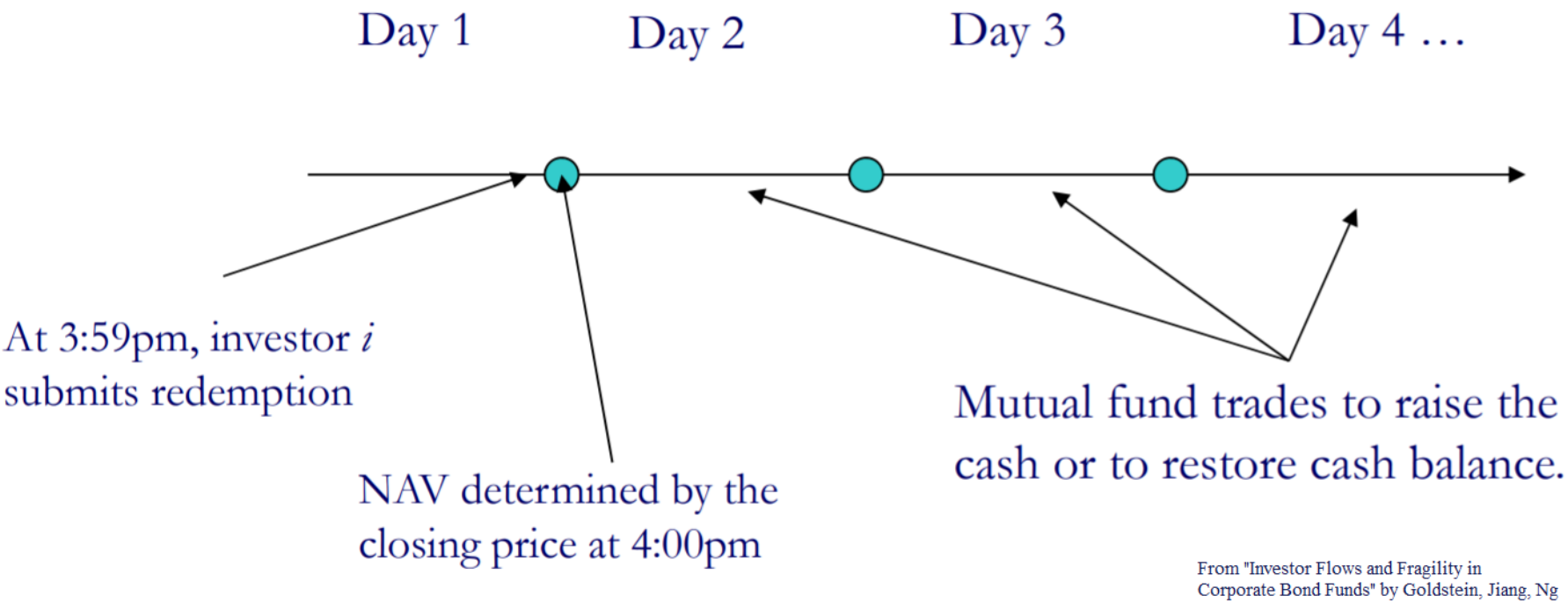
joint work with Agostino Capponi and Paul Glasserman

Mutual Funds' Share of Corporate Bond Market



Institutional Structure of Open-end Mutual Funds



From "Investor Flows and Fragility in Corporate Bond Funds" by Goldstein, Jiang, Ng

- The fund is obliged to repay investors at the first NAV determined after the submission of the redemption order.
- It may take several days to liquidate enough assets to raise the required amount of cash.

Institutional Structure of Open-end Mutual Funds

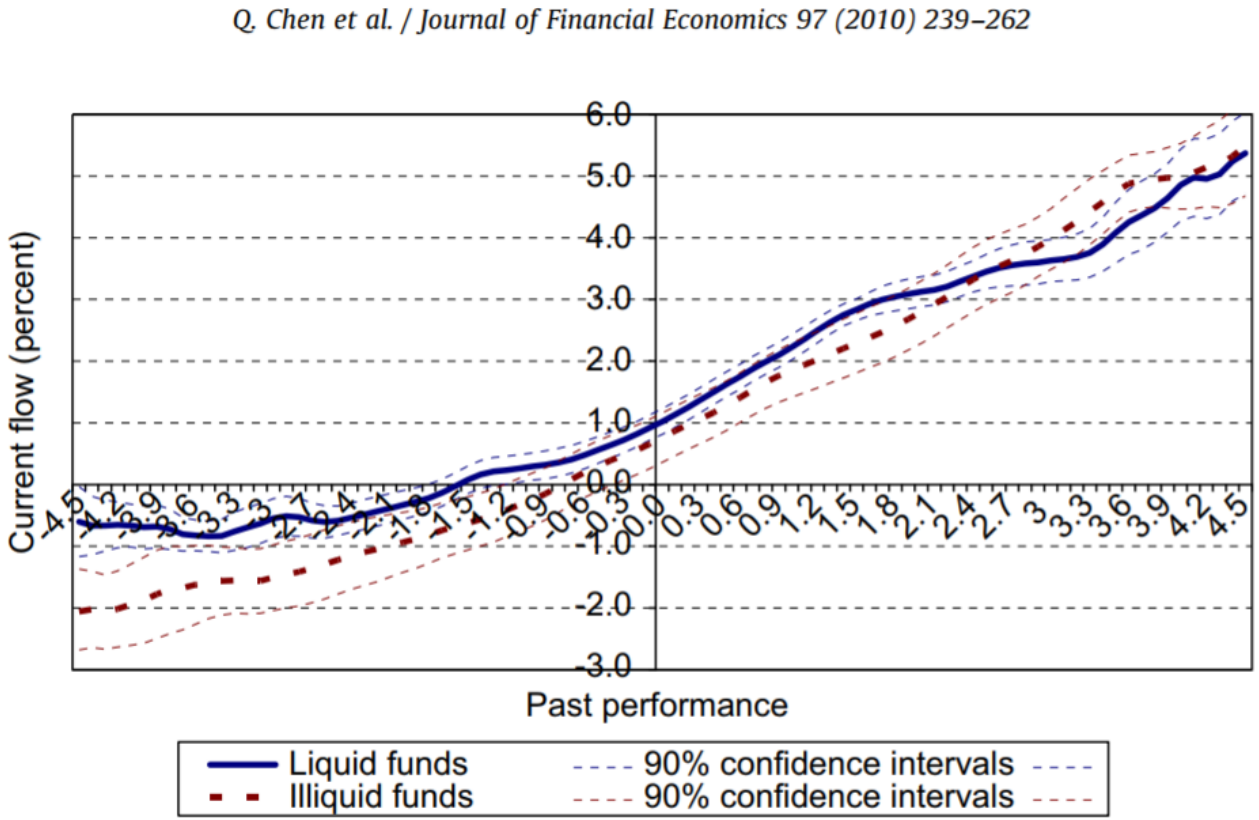
Liquidity Mismatch

Funds offer same-day liquidity to their investors (redeemed shares are paid at the end-of-day net asset value), but the assets they hold may not be as easy to sell on short notice and funds may be forced to sell assets at reduced prices in subsequent days.

First-mover Advantage

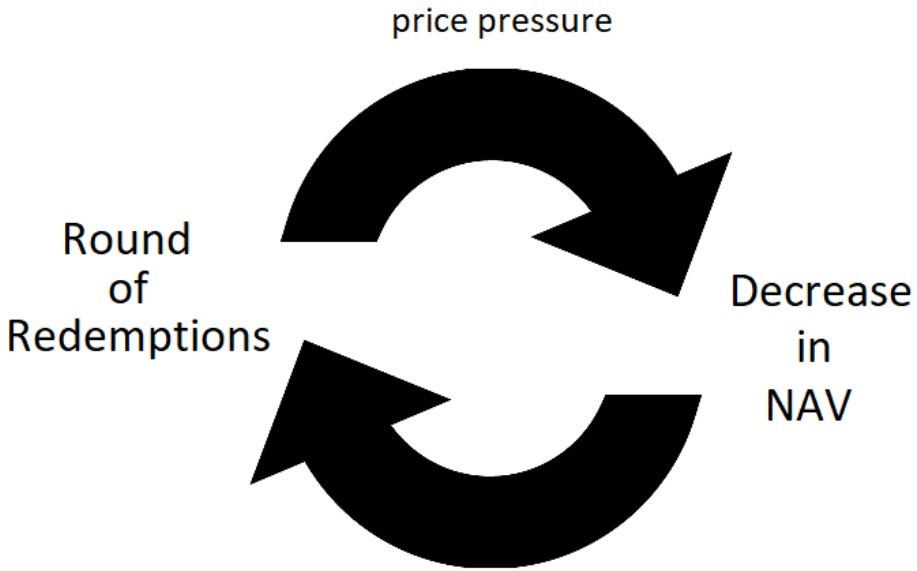
The liquidity mismatch creates an incentive for investors to redeem their shares early, because they anticipate that the cost of other investors' redemptions will be reflected in the future NAV of the fund.

Empirical Observations



- Conditional on low past performance, funds that hold illiquid assets experience more outflows than funds that hold liquid assets.
- The impact of outflows on fund returns is larger for illiquid funds.

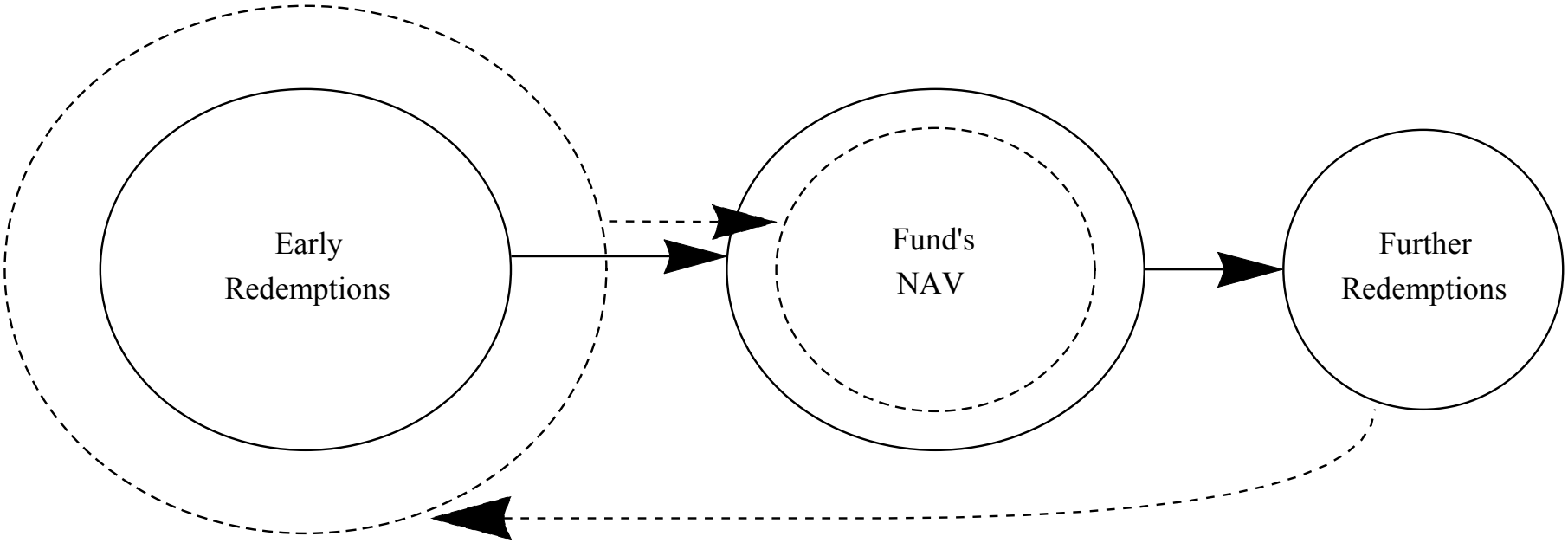
Model Description



Feedback effect: outflow increases selling pressure, reducing fund's NAV, leading to more outflow.

- Outflow is linear in performance: $\underbrace{\Delta R}_{\text{redemptions}} = - \underbrace{\beta}_{\text{sensitivity}} \times \underbrace{\Delta S}_{\text{fund's performance}}$
- Asset price impact is linear: $\underbrace{\Delta P}_{\text{price change}} = \underbrace{\gamma}_{\text{illiquidity}} \times \underbrace{\Delta Q}_{\text{traded assets}}$

Model Description



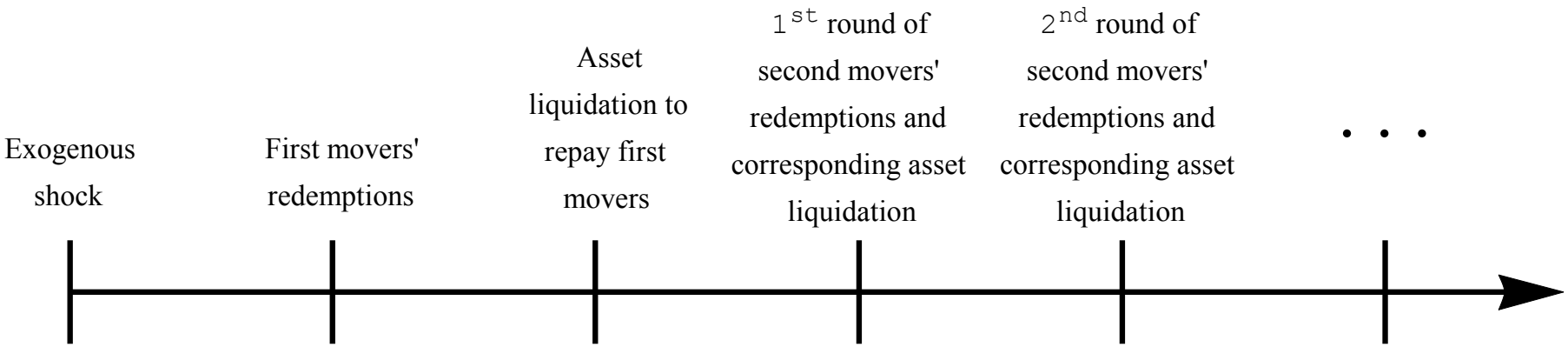
- Alert investors (*first movers*) anticipate the feedback effect. Instead of waiting and redeeming when the fund effectively hits their performance threshold (at a lower NAV), they redeem immediately (at a higher NAV).

Price impact and liquidity mismatch provide an incentive to front run.

Model Description

Redeeming investors are either *first movers* (who exploit the liquidity mismatch) or *second movers* (who don't exploit the liquidity mismatch)

- Forward-looking vs. Mechanical.
- Fast vs. Slow.



Mechanics of Redemptions: First Movers

- Consider a single asset that represents the fund's portfolio
- A proportion π of investors in the fund are first movers
- An initial market shock ΔZ hits the asset
- The redemption procedure is:

$$\Delta R_{tot}^{fm} = -\pi\beta\Delta S_{tot}, \qquad \text{(First movers redeem)}$$

$$-\Delta Q_{tot}^{fm} \times (P_0 + \Delta Z + \gamma\Delta Q_{tot}^{fm}) = \Delta R_{tot}^{fm} \times (S_0 + \Delta Z), \qquad \text{(Fund sells asset shares)}$$

$$\Delta S_{tot}^{fm} = \frac{(Q_0 + \Delta Q_{tot}^{fm}) \times (P_0 + \Delta Z + \gamma\Delta Q_{tot}^{fm})}{N_0 - \Delta R_{tot}^{fm}} - S_0 \qquad \text{(Funds' NAV changes)}$$

Mechanics of Redemptions: Second Movers

- Second movers start redeeming after all first movers' redemptions
- Their redemption behavior may be described as:

$$\Delta S_0^{sm} = \Delta S_{tot}^{fm}, \quad P_0^{sm} = P_0 + \Delta Z + \gamma \Delta Q_{tot}^{fm}, \quad N_0^{sm} = N_0 - \Delta R_{tot}^{fm},$$

$$\Delta R_{n+1}^{sm} = -(1-\pi)\beta \Delta S_n^{sm}, \qquad \text{(Second Movers redeem)}$$

$$-\Delta Q_{n+1}^{sm} \times (P_n^{sm} + \Delta P_{n+1}^{sm}) = \Delta R_{n+1}^{sm} \times (S_n^{sm} + \Delta S_{n+1}^{sm}),$$

(Fund sells asset shares)

$$\Delta S_{n+1}^{sm} = \frac{(Q_n^{sm} + \Delta Q_{n+1}^{sm})(P_n^{sm} + \Delta P_{n+1}^{sm})}{N_n^{sm} - \Delta R_{n+1}^{sm}} - S_n^{sm}$$

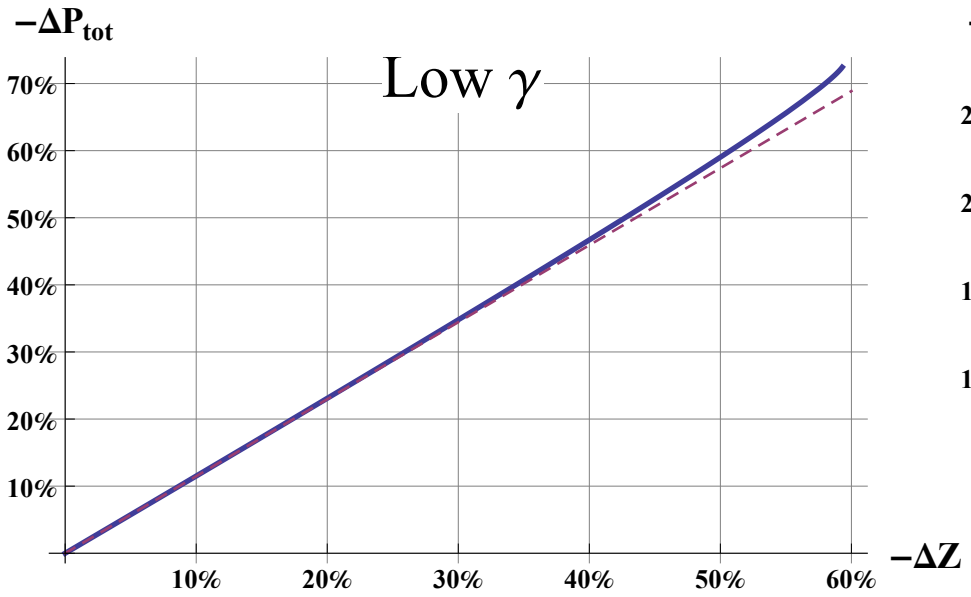
(Fund's NAV changes)

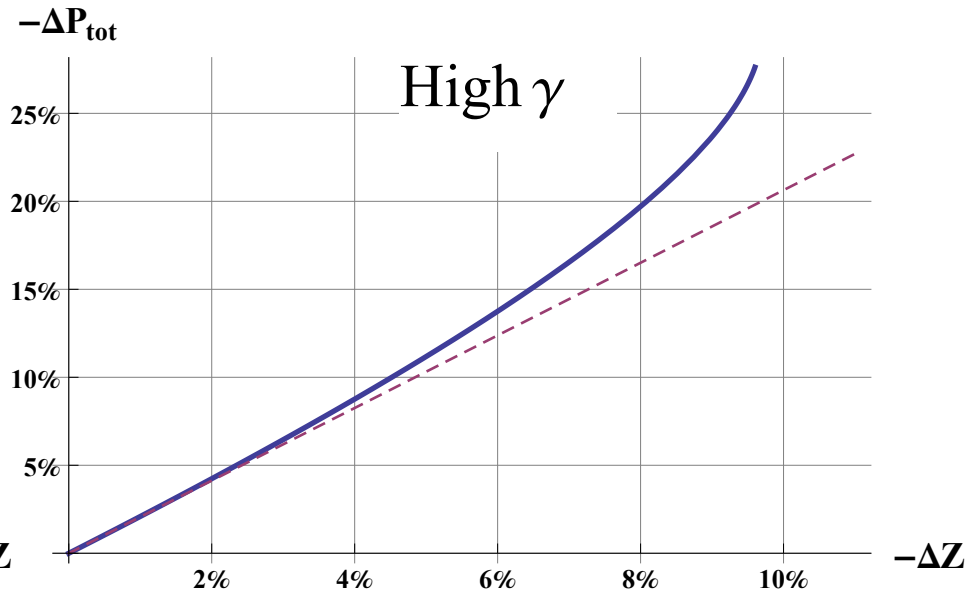
Results

Aggregate change in value of a fund share is $\Delta S_{tot} = \sum_{n=0}^{\infty} \Delta S_n^{sm}$.
Aggregate price change of the asset is $\Delta P_{tot} = \Delta Z + \gamma \Delta Q_{tot}^{fm} + \sum_{n=0}^{\infty} \Delta P_n^{sm}$.
Liquidity mismatch has a *nonlinear* impact on asset price and value of a fund share.

Proposition

If $\pi = 0$, changes in the price of the asset and in the value of a fund share depend linearly on ΔZ.
If $\pi > 0$, the dependence is nonlinear. The nonlinearity is "increasing" in γ.



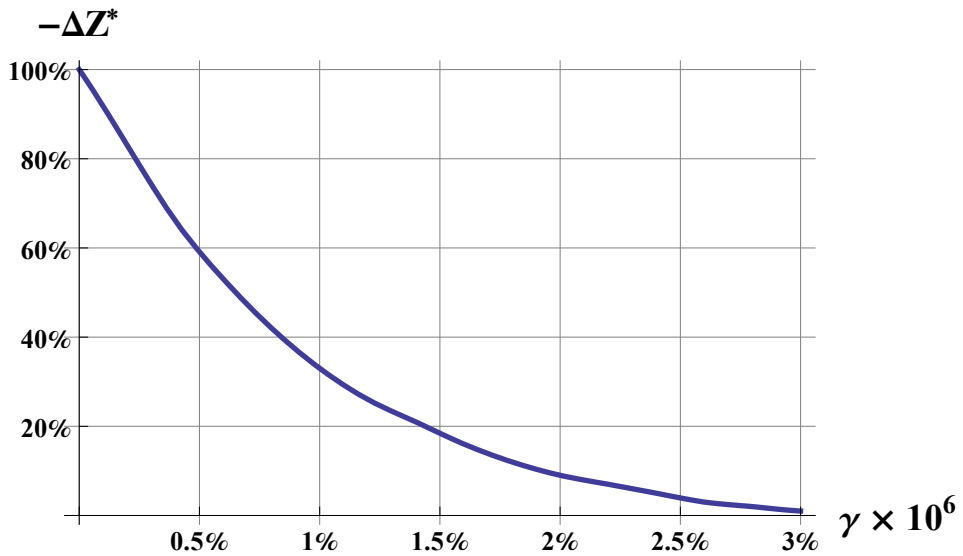


Results

The first-mover advantage may lead to the fund's failure.

Proposition

There exists a critical threshold ΔZ^* for the market shock beyond which price impact and outflows lead to the fund's failure. The critical threshold ΔZ^* is monotone in γ.



Swing Pricing

From November 19, 2018, U.S. open-end funds are allowed to use *swing pricing*: funds will be allowed to adjust ("swing") their net asset value per share to effectively pass on the asset liquidation costs to the redeeming investors.

Definition

The adjustment ΔS^{sw} is a swing price if the aggregate change in value of a fund share ΔS_{tot} is equal to the change in value of a fund share in the absence of first movers (that is, with $\pi = 0$).

Proposition

The swing price is

$$\Delta S^{sw} = -\gamma \Delta R^{fm}_{tot}.$$

Swing Pricing

Swing pricing not only transfers the asset liquidation cost from the fund to the redeeming investors, but also – and more importantly – significantly reduces this cost!

For the swing price to be effective:

- the swing price should account for the shape of the market impact function (marginal price impact increases as a function of order size);
- investors should be informed about a fund's swing pricing mechanism (to reduce number of redemptions).

Multiple Funds

The reinforcing feedback mechanism, and hence the first-mover advantage, is exacerbated if multiple funds have overlapping portfolios.

$$\Delta P_{tot} \approx \Delta Z + (\text{Impact from Fund 1}) + (\text{Impact from Fund 2}) + (\text{Cross-impact}).$$

Proposition

Assume both funds apply swing pricing. The swing price is

$$\Delta S^{sw}_{both} = -\gamma(\Delta R^{fm}_{tot,1} + \Delta R^{fm}_{tot,2}).$$

- Swing pricing should also account for the externalities imposed by first movers of the other fund.
- A fund's swing price is lower if the other fund also applies swing pricing.

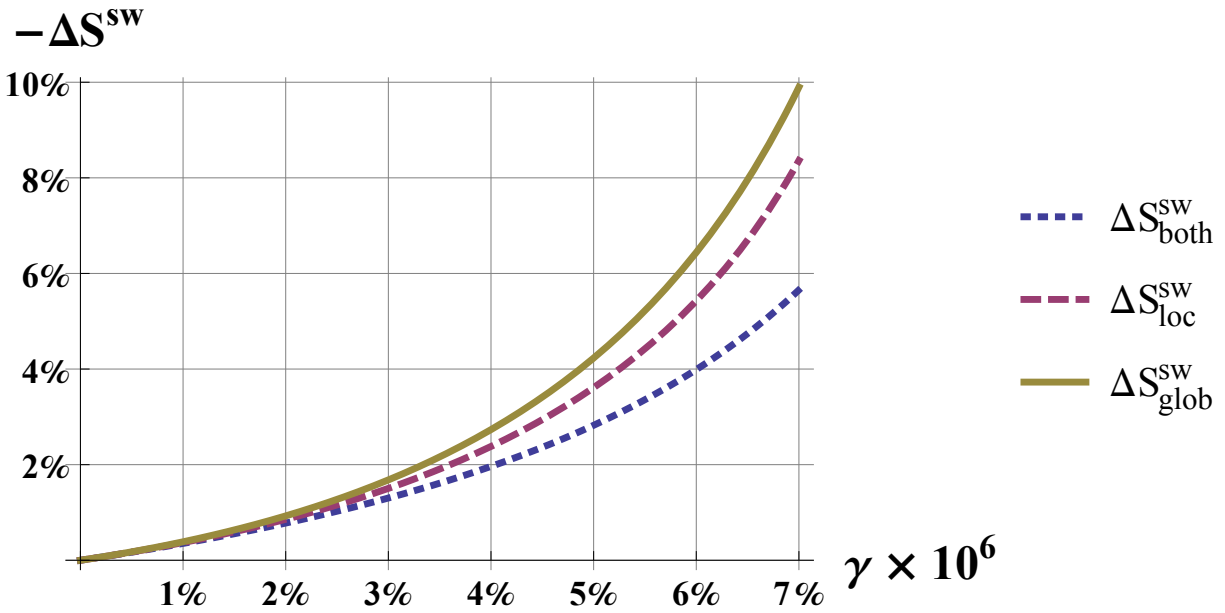
Cooperative Swing Price

Let ΔS^{sw}_{loc} be the NAV adjustment that makes a fund's first movers internalize only their liquidation costs. Let ΔS^{sw}_{glob} be the swing price that offsets the effect of first movers at both funds.

Proposition

Suppose $\pi_1, \pi_2 > 0$*, and only fund 2 applies swing pricing. We have*

$$|\Delta S^{sw}_{both}| \leq |\Delta S^{sw}_{loc}| \leq |\Delta S^{sw}_{glob}|.$$



Conclusions

- There exists a critical threshold for the market shock beyond which the liquidation costs are no longer sustainable and the fund fails to repay shares at the promised NAV.
- Swing pricing transfers the cost of liquidation from the fund to the redeeming investors, and – importantly – *reduces* this cost by removing the first-mover advantage.
- The presence of multiple funds holding the same portfolio exacerbates fire sales losses, and therefore increases the benefit of swing pricing.
- Cooperative swing pricing is the most efficient adjustment in reducing total liquidation costs.