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

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Asset Pricing and Risk Management
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joint work with Agostino Capponi and Paul Glasserman
Woodford Equity Income Fund

Neil on the floor
June 19th 2014 = 100

Woodford Equity Income Fund

FTSE All-Share index

Sources: Financial Express; Datastream from Refinitiv

The Economist
The fund blocked redemptions on June 3rd.
Woodford Equity Income Fund

WEIF - Daily Fund flows

-350 -300 -250 -200 -150 -100 -50 0 50 100

Millions

The fund shrunk from £10 billion at its peak to £3.7 billion.

Woodford didn’t have enough liquid assets to meet redemptions and suspended withdrawals on June 3rd.

Withdrawals are still suspended (management fees are not...).

EU liquidity requirements failed (circumvented illegally?)
Mark Carney to a Treasury committee on June 26th:

This is a big deal. You can see something that could be systemic... These funds are built on a lie, which is that you can have daily liquidity for assets that fundamentally aren’t liquid. And that leads to an expectation of individuals that it’s not that different to having money in a bank.
Large-scale redemptions from funds could test markets’ ability to absorb asset sales, amplifying price moves, transmitting stress to other parts of the financial system, and disrupting the availability of finance in the real economy. Although to date these vulnerabilities have not created financial instability, they could do so under severe stress and are likely to become more important if more funds expand into less liquid assets.

Mutual Funds’ Share of Corporate Bond Market

Proportion of outstanding corporate bonds held in the US that are owned by mutual funds

[Graph showing the percentage of corporate bonds held by mutual funds from 1990 to 2015, with a significant increase around 2010.]
The Third Avenue Focused Credit Fund invested in low grade corporate debt.

- 2009 to mid-2014, total return $\approx 80\%$.
- 2015: portfolio losses and heavy outflows, fund shrinks from $2$ billion to $789$ million.
- December 16, 2015: the fund requests SEC approval to block further redemptions:

If the relief is not granted, and the Fund is unable to suspend redemptions, the institutional investors would likely be best positioned to take advantage of any redemption opportunity, to the detriment of those investors – most likely, retail investors – who remain in the Fund. These remaining investors would suffer a rapidly declining net asset value and an even further diminished liquidity of the Fund’s securities portfolio. The relief would help avoid such an outcome.
• When prices are falling, investors who exit a mutual fund first get out at better prices
  • The transaction costs they impose on the fund are borne by investors who stay in the fund longer

• This first-mover advantage creates a positive feedback loop between falling prices and asset sales, particularly in less liquid markets — potentially destabilizing

• Swing pricing can break the cycle, internalize transaction costs, reduce transaction costs, and enhance financial stability
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.
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.
• 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.
Feedback effect: outflow increases selling pressure, reducing fund’s NAV, leading to more outflow.

- Outflow is linear in performance:
  \[ \Delta R = - \beta \times \Delta S \]

- Asset price impact is linear:
  \[ \Delta P = \gamma \times \Delta Q \]
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.
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.
**Benchmark**: Investors hold the asset directly, without the intermediation of the mutual fund.

- Investors subject to the same financial constraints: \( \Delta Q = \beta \Delta P \).
- Sales drive down the price: \( \Delta P = \gamma \Delta Q \).

The aggregate price change is \( \Delta P_{tot} = \frac{\Delta Z}{1 - \gamma \beta} \).
Mechanics of Redemptions: First Movers

- Consider a single asset that represents the fund’s portfolio
- A proportion $\pi$ of investors in the fund are first movers
- An initial market shock $\Delta Z$ hits the asset
- The redemption procedure is:

$$\Delta R_{tot}^{fm} = -\pi \beta \Delta S_{tot},$$

(First movers redeem)

$$-\Delta Q_{tot}^{fm} \times (P_0 + \Delta Z + \gamma \Delta Q_{tot}^{fm}) = \Delta R_{tot}^{fm} \times (S_0 + \Delta Z),$$

(Fund sells asset shares)

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

(Funds’ NAV changes)
Mechanics of Redemptions: Second Movers

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

\[
\Delta S_{0}^{sm} = \Delta S_{tot}^{fm}, \quad P_{0}^{sm} = P_{0} + \Delta Z + \gamma \Delta Q_{tot}^{fm}, \quad N_{0}^{sm} = N_{0} - \Delta R_{tot}^{fm},
\]

\[
\Delta R_{n+1}^{sm} = -(1 - \pi)\beta \Delta S_{n}^{sm}, \quad \text{ (Second Movers redeem)}
\]

\[-\Delta Q_{n+1}^{sm} \times (P_{n}^{sm} + \Delta P_{n+1}^{sm}) = \Delta R_{n+1}^{sm} \times (S_{n}^{sm} + \Delta S_{n+1}^{sm}), \quad \text{ (Fund sells asset shares)}
\]

\[
\Delta S_{n+1}^{sm} = \frac{(Q_{n}^{sm} + \Delta Q_{n+1}^{sm})(P_{n}^{sm} + \Delta P_{n+1}^{sm})}{N_{n}^{sm} - \Delta R_{n+1}^{sm}} - S_{n}^{sm} \quad \text{ (Fund’s NAV changes)}
\]
Impact of First-mover advantage

Aggregate change in value of a fund share is \( \Delta S_{tot} = \sum_{n=0}^{\infty} \Delta S_{sm}^n \).

Aggregate price change of the asset is \( \Delta P_{tot} = \Delta Z + \gamma \Delta Q_{tot}^{fm} + \sum_{n=0}^{\infty} \Delta P_{sm}^n \).

Liquidity mismatch has a \textit{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 \( \Delta Z \), and both are equal to the price change of the asset in the direct ownership model.

**Proposition**

If \( \pi > 0 \), the price change depends nonlinearly on \( \Delta Z \). The nonlinearity is “increasing” in \( \gamma \).
Impact of First-mover advantage

Low $\gamma$

High $\gamma$

$-\Delta P_{\text{tot}}$

$-\Delta Z$

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Swing Pricing and Mutual Fund Runs

21 / 33
Impact of First-mover advantage

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

Proposition

There exists a critical threshold $\Delta Z^*$ for the market shock beyond which price impact and outflows lead to the fund’s failure. The critical threshold $\Delta Z^*$ is monotone in $\gamma$.
Contrast with bank deleveraging

- Following a shock to assets, a bank sells assets to restore a capital ratio
  - asset sale pushes down prices (fire sale) . . .
  - . . . which leads to a successive round of deleveraging

- The aggregate impact of deleveraging on asset prices is linear (as in Capponi and Larsson (2015)):

\[
\Delta P_{tot} = (I - S)^{-1} \Delta Z,
\]

where \( S \) is the systemicness matrix

- The presence of first movers introduces a crucial structural difference between fire sales triggered by leverage targeting and fire sales triggered by mutual fund redemptions
October 2016: SEC announces amendments to Rule 22c-1 to promote liquidity risk management in the open-end investment company industry.

From November 19, 2018, 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 costs stemming from redemption activity to the shareholders associated with that activity.

Swing pricing has been applied for over 15 years in Luxembourg and other European countries.
Swing Pricing: Our Version

Definition

The adjustment $\Delta S^{sw}$ is a swing price if the aggregate change in value of a fund share $\Delta S_{tot}$ 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

$$\Delta S^{sw} = \gamma \frac{\pi \beta \Delta Z}{1 - \beta \gamma}.$$  

Equivalently,

$$\Delta S^{sw} = -\gamma \Delta R_{fm}^{tot}.$$
Properties of Swing Pricing

- The swing price is linear in the total number of redemptions (from first movers) and the slope is determined by the illiquidity of the asset.

- Swing pricing removes the incentive to redeem immediately.

- Swing pricing doesn’t just transfer liquidation costs to redeeming investors — it reduces these costs and the first-sale impact.

- For the swing price to be effective:
  - the swing price should account for the shape of the market impact function
  - investors should be informed about a fund’s swing pricing mechanism (to reduce number of redemptions).
Swing Pricing in Practice

- Usually specified by two numbers, a threshold and a cap
  - If net outflows exceed 5% of the fund, the NAV will be swung by up to 2%
  - Also for net inflows

- Our analysis argues for a larger swing factor at larger outflows
  - Our swing price is proportional to first-mover redemptions
  - Fixed factor may be inadequate

- Threshold is typically secret
- Investors don’t know if NAV was swung (or how much) even after the fact
Swing pricing and fragility in open-end mutual funds (D. Jin, M. Kacperczyk, B. Kahraman, F. Suntheim).

- The swing pricing adjustment is larger when portfolio illiquidity is higher and during periods of market stress.
- Investors are less likely to redeem shares during market stress in funds that adopt swing pricing.
- Negative impact of outflow on fund’s performance is reduced if swing pricing is adopted.
- Funds with swing pricing attract fewer new investors.
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

\[
\Delta S_{sw}^{both} = -\gamma(\Delta R_{tot,1}^{fm} + \Delta R_{tot,2}^{fm}).
\]

- 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 $\Delta S_{loc}^{sw}$ be the NAV adjustment that makes a fund’s first movers internalize only their liquidation costs. Let $\Delta S_{glob}^{sw}$ be the swing price that offsets the effect of first movers at both funds.

**Proposition**

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

$$|\Delta S_{both}^{sw}| \leq |\Delta S_{loc}^{sw}| \leq |\Delta S_{glob}^{sw}|.$$
Operational Problems

- Difficult to estimate the liquidity of the underlying portfolio.
- Information on redemptions at other funds not readily available.
- U.S. funds usually accept orders up to 4:00pm and seek to value fund shares at approximately the same time.
- In Europe, funds may stop accepting orders at noon or 2:00pm, giving them more time to observe order flow before striking the day’s NAV.
- Some intermediaries wait until the end of the day to submit orders for multiple accounts — fund has limited intraday flow data.
- “Know your flow:” Need for funds to understand their investor base and timing of trade flows. (This need is arguably greater without swing pricing).
Transparency: The fund does not have to agree on an exact swing pricing rule with its investors. In fact, some jurisdictions explicitly recommend funds to limit the information they share with investors to avoid strategic redemptions aimed at gaming the swing pricing mechanism.

Information Sharing: Funds need to share information on their investor base to account for fire-sale externalities at other funds.
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 solution for reducing total liquidation costs.