Non-bank financial intermediaries and the post-crisis landscape

Swedish House of Finance Annual Conference

Hyun Song Shin*, Economic Adviser and Head of Research, BIS

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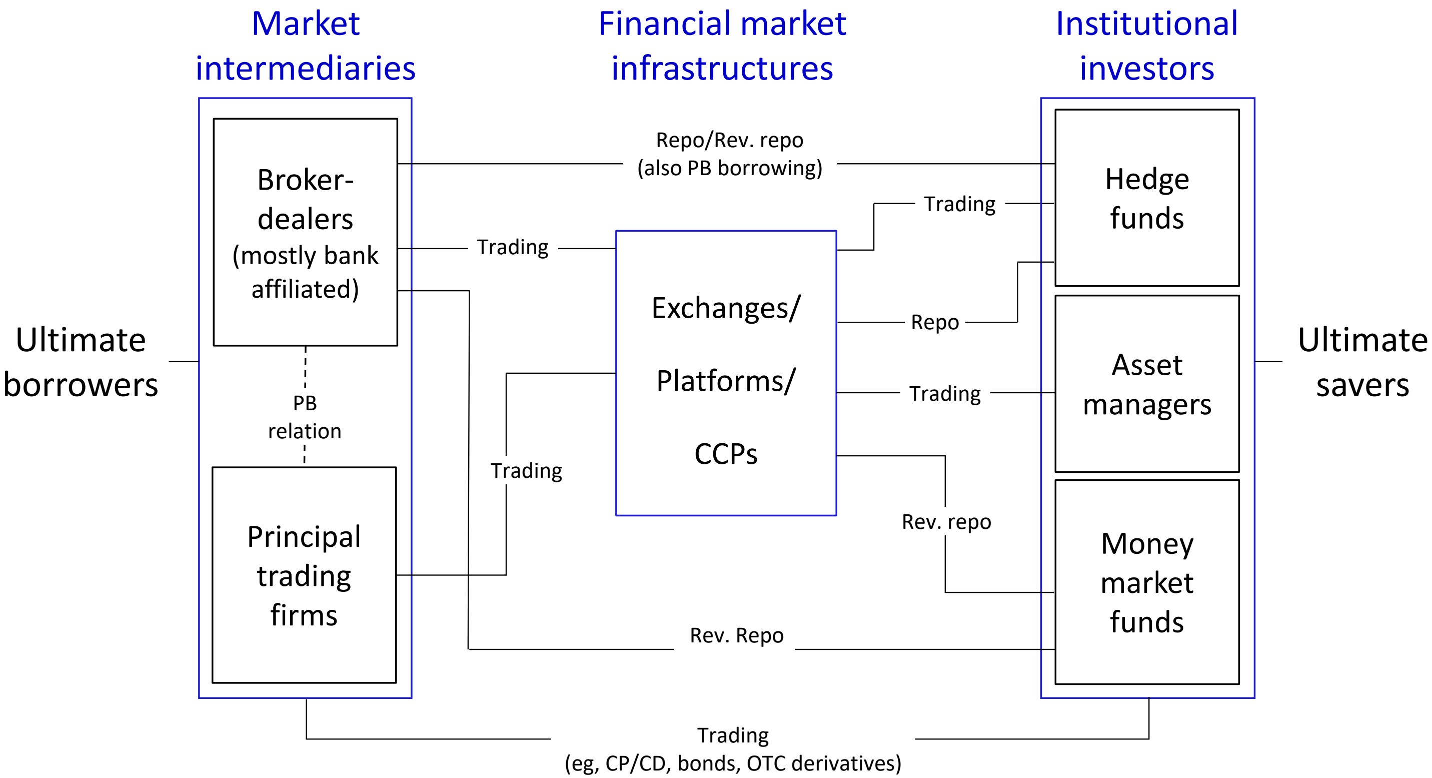
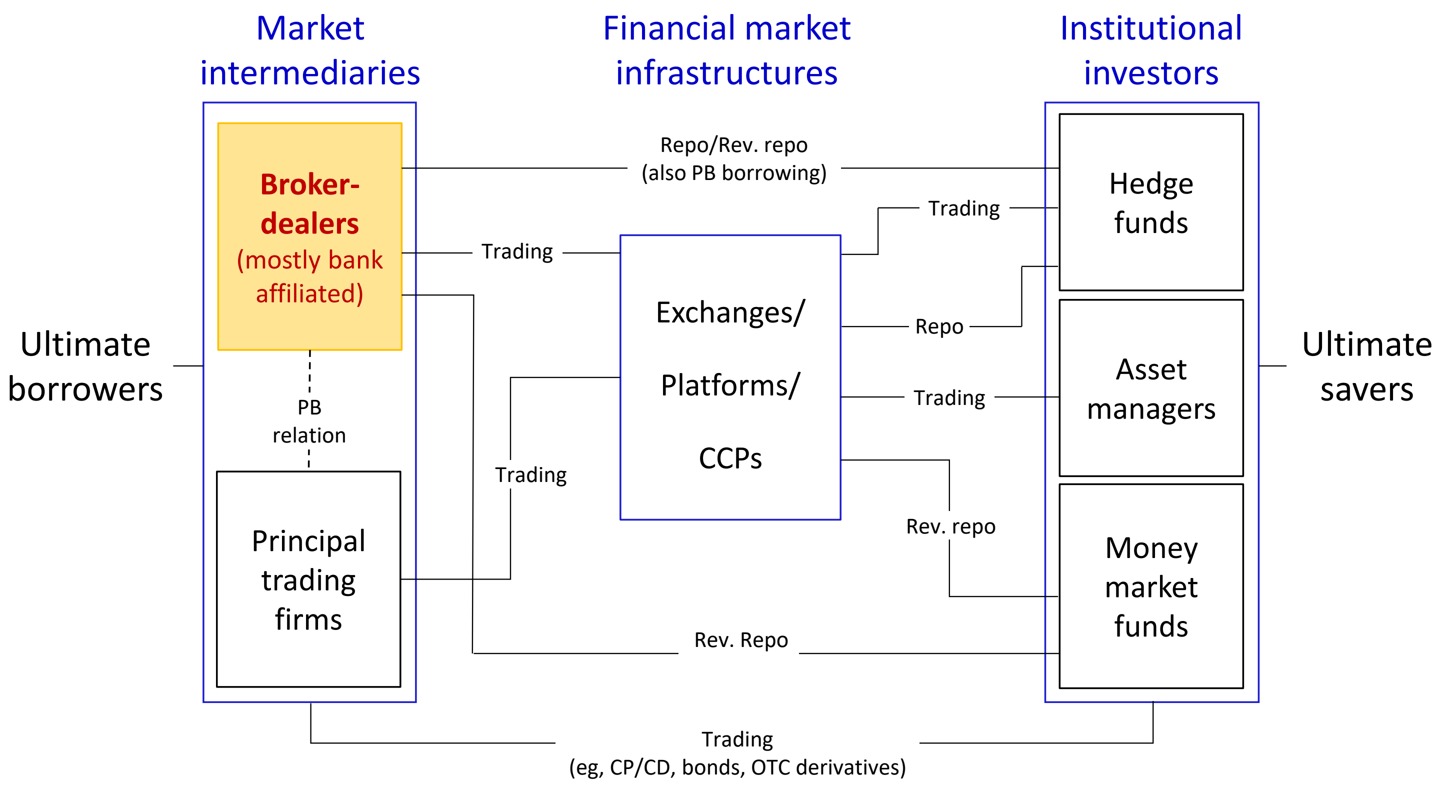
*The views expressed here are mine and not necessarily those of the Bank for International Settlements


Market
intermediaries
Financial market
infrastructures
Institutional
investors
Broker-
dealers
(mostly bank
affiliated)
Repo/Rev. repo
(also PB borrowing)
Hedge
funds
Trading
Trading
Exchanges/
Platforms/
CCPs
Repo
Ultimate
borrowers
PB
relation
Trading
Asset
managers
Ultimate
savers
Trading
Rev. repo
Principal
trading
firms
Money
market
funds
Rev. Repo
Trading
(eg, CP/CD, bonds, OTC derivatives)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Money market funds
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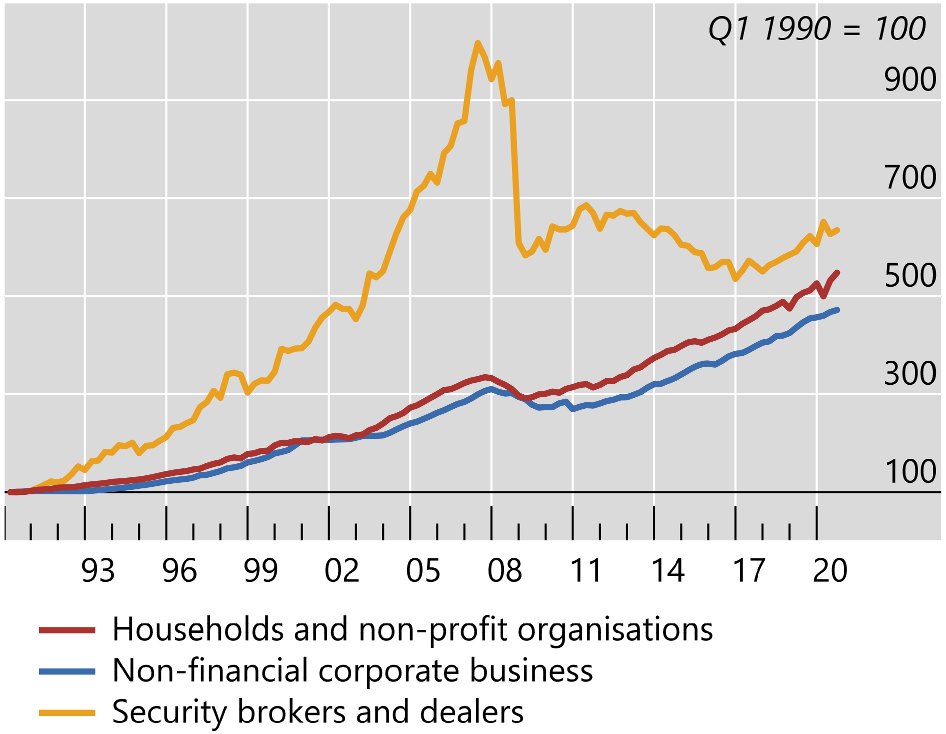
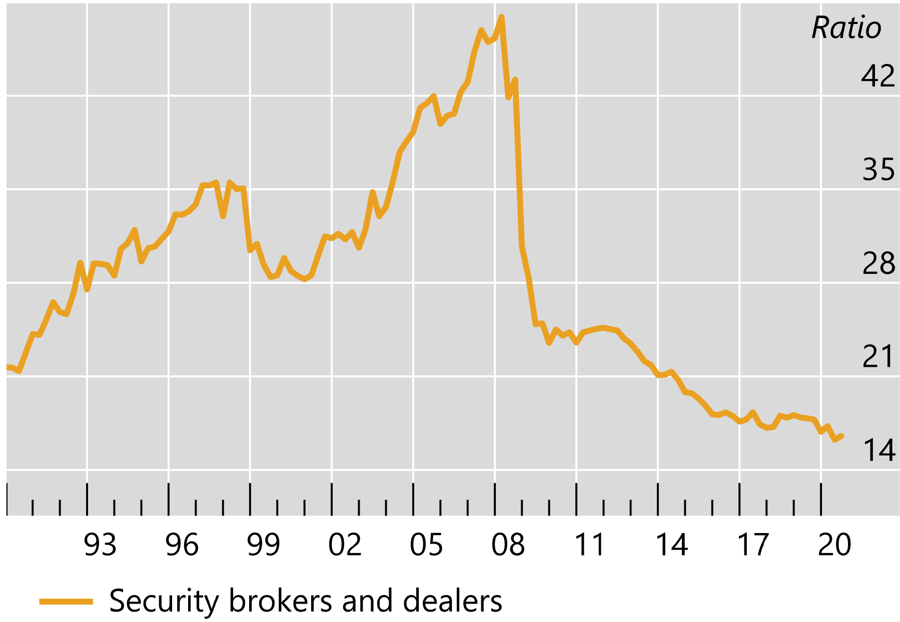
Broker-dealer balance sheets have smaller heft in the financial system post-crisis, as market-based intermediation has migrated elsewhere

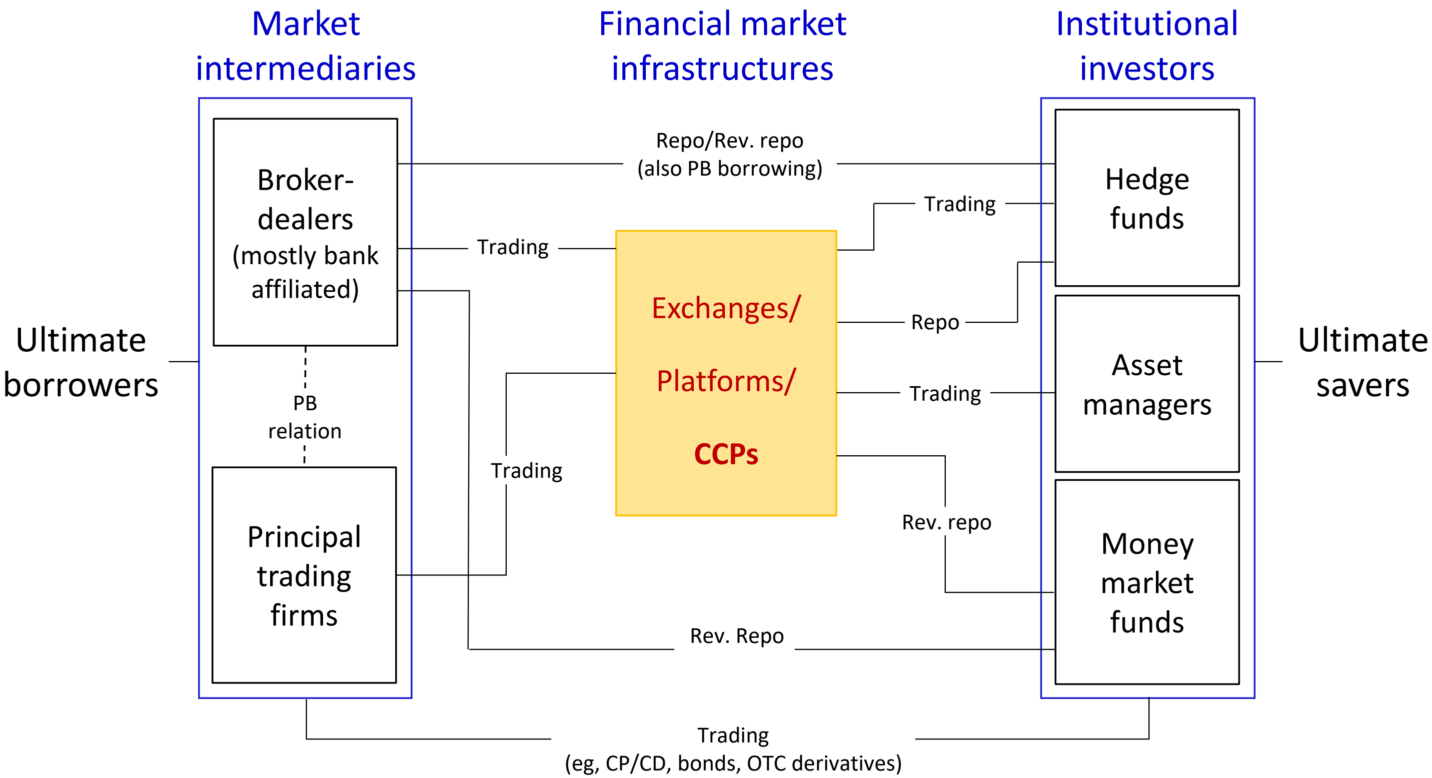
Total assets (1990Q1 = 100)



Leverage (=assets/equity)



Source: Federal Reserve, *Flow of Funds*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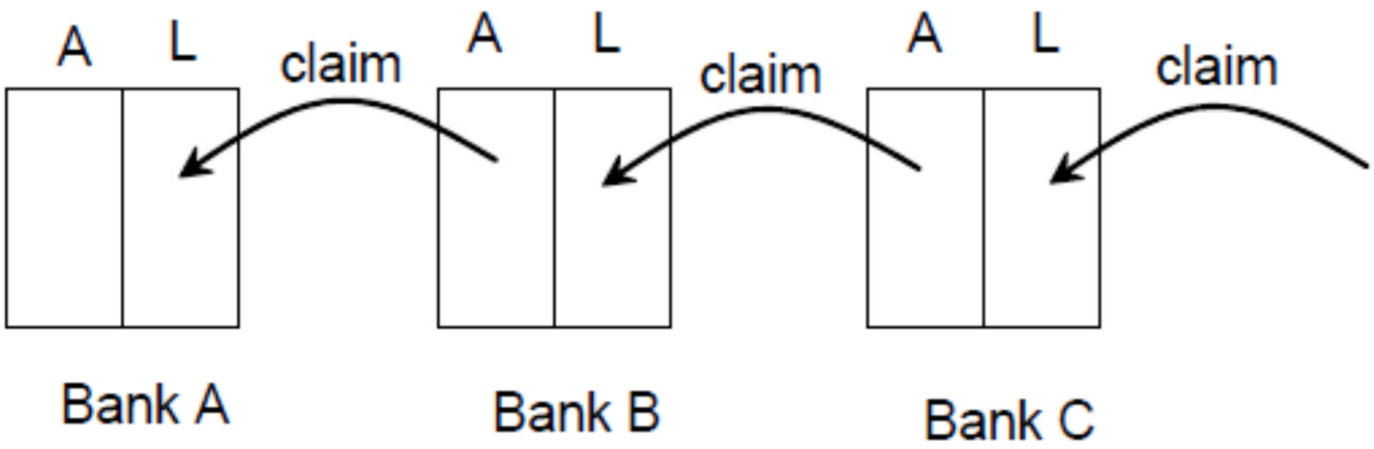
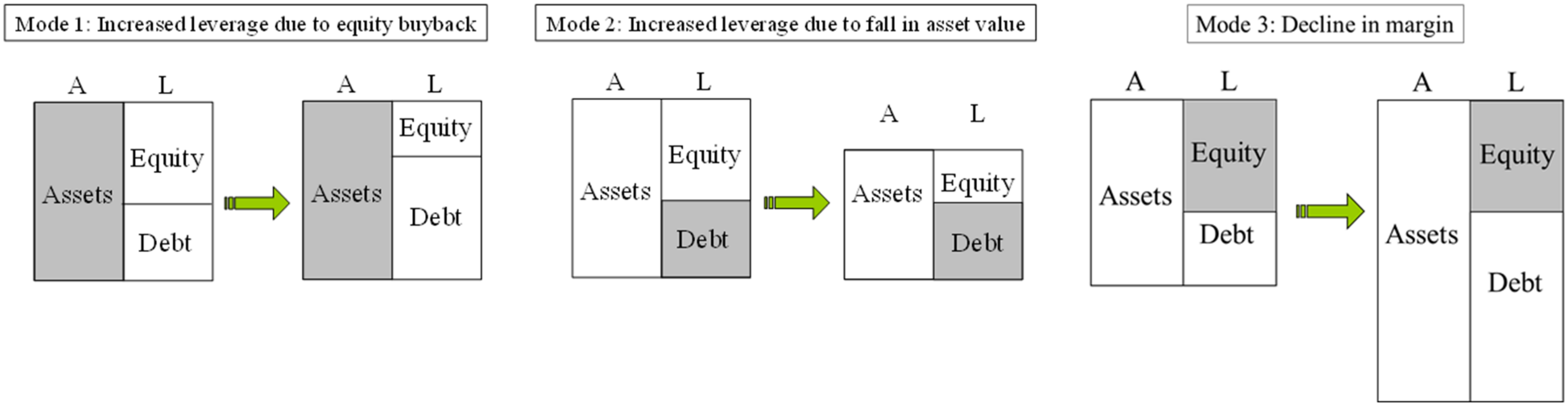
"Domino model" of cascading defaults gives an incomplete picture of systemic risk



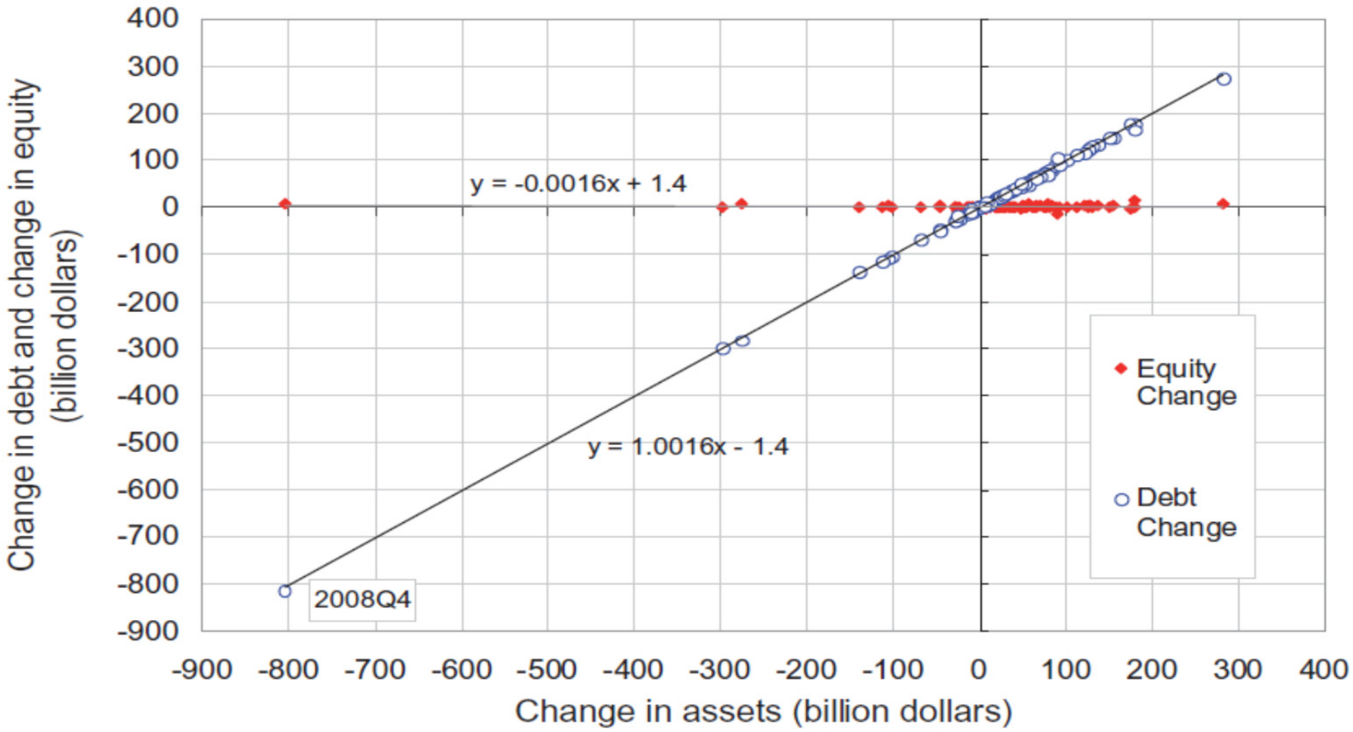
- Defaults need not figure in the propagation mechanism; deleveraging due to spike in margins / haircuts can be potent mechanism for stress propagation

Of three ways to increase leverage, the third is the relevant one for market intermediaries …



Equity buyback through a debt issue (mode 1); dividend financed by asset sale (mode 2); asset expansion due to reduced margin. Shaded area is balance sheet component held fixed.

… as illustrated by the US broker-dealer sector



- Change in assets matched dollar for dollar by change in debt, not equity

Source: Adrian and Shin (RFS, 2014), data from Federal Reserve, *Flow of Funds*

Aramonte, Schrimpf and Shin (2021)

Accounting framework for “debt capacity”

- Margins limit the use of debt financing and define debt capacity; fluctuations in margin entail fluctuations in debt capacity
- Market participant chooses portfolio $y = (y_1, \cdots, y_N)$ subject to:
$$m(y_1) + \cdots + m(y_N) \leq \kappa \leq e$$
where $m(y_i)$ is the margin on asset i and κ is *economic capital*, which is bounded by equity e
- Economic capital κ entails risk budgeting decision; like consumer choice problem over goods with expenditures $\{m(y_i)\}$ and budget κ

Aramonte, Schrimpf and Shin (2021)

Two propositions

- Debt capacity is increasing in the debt capacity of others; or "leverage enables greater leverage". Conversely, diminished debt capacity spills over to others and can propagate stress, with or without default
- Deleveraging and "dash for cash" are two sides of the same coin rather than being two distinct channels of stress propagation

Example of margins determined by Value-at-Risk constraint

Risk-neutral investor maximises expected return subject to Value-at-Risk (VaR) constraint:

$$\alpha\sigma \leq \kappa$$

where $\alpha > 0$ is a constant; σ is standard deviation of return of investor's portfolio; κ is economic capital

Denote

$$y = \begin{bmatrix} y_1 \\ \vdots \\ y_n \end{bmatrix} \qquad \mu = \begin{bmatrix} \mu_1 \\ \vdots \\ \mu_n \end{bmatrix} \qquad \text{and} \qquad \Sigma = \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1n} \\ & \ddots & \\ \sigma_{n1} & & \sigma_{nn} \end{bmatrix}$$

where y is portfolio, μ_i is the expected return on asset i; Σ is the covariance matrix of returns; σ_{ij} is the covariance of returns between asset i and asset j

Investor's portfolio choice problem is:

$$\text{Maximize}_{y} \ \mu' y \qquad \text{subject to} \quad \alpha \sqrt{y' \Sigma y} \leq \kappa$$

- Solution of Lagrange multiplier is

$$\lambda = 2\sqrt{\mu'\Sigma^{-1}\mu}$$

which is twice the n-dimensional analogue of the Sharpe ratio

- Optimal portfolio is:

$$y = \frac{\kappa}{\alpha\sqrt{\mu'\Sigma^{-1}\mu}}\Sigma^{-1}\mu$$

Position size increases in proportion to economic capital κ

Example of long-short bond portfolio

Covariance matrix is

$$\Sigma = \begin{bmatrix} z+c & c & \cdots & c \\ c & z+c & \cdots & c \\ \vdots & \vdots & \ddots & \vdots \\ c & c & \cdots & z+c \end{bmatrix}$$

where $z, c > 0$ but z is small relative to c, reflecting returns on closely correlated assets such as government bonds

As $z \to 0$, returns become perfectly correlated

Inverse takes simple form:

$$\Sigma^{-1} = \frac{1}{z^2 + ncz} \begin{bmatrix} z + (n-1)\,c & -c & \cdots & -c \\ -c & z + (n-1)\,c & \cdots & -c \\ \vdots & \vdots & \ddots & \vdots \\ -c & -c & \cdots & z + (n-1)\,c \end{bmatrix}$$

Optimal portfolio is:

$$y_i = \frac{\kappa}{\alpha\left(z^2 + ncz\right)\sqrt{\mu'\Sigma^{-1}\mu}} \left(z\mu_i + c \sum_{k \neq i} \left(\mu_i - \mu_k\right) \right)$$

As $z \longrightarrow 0$, absolute size of holdings y_i becomes large, reflecting highly leveraged long-short portfolios

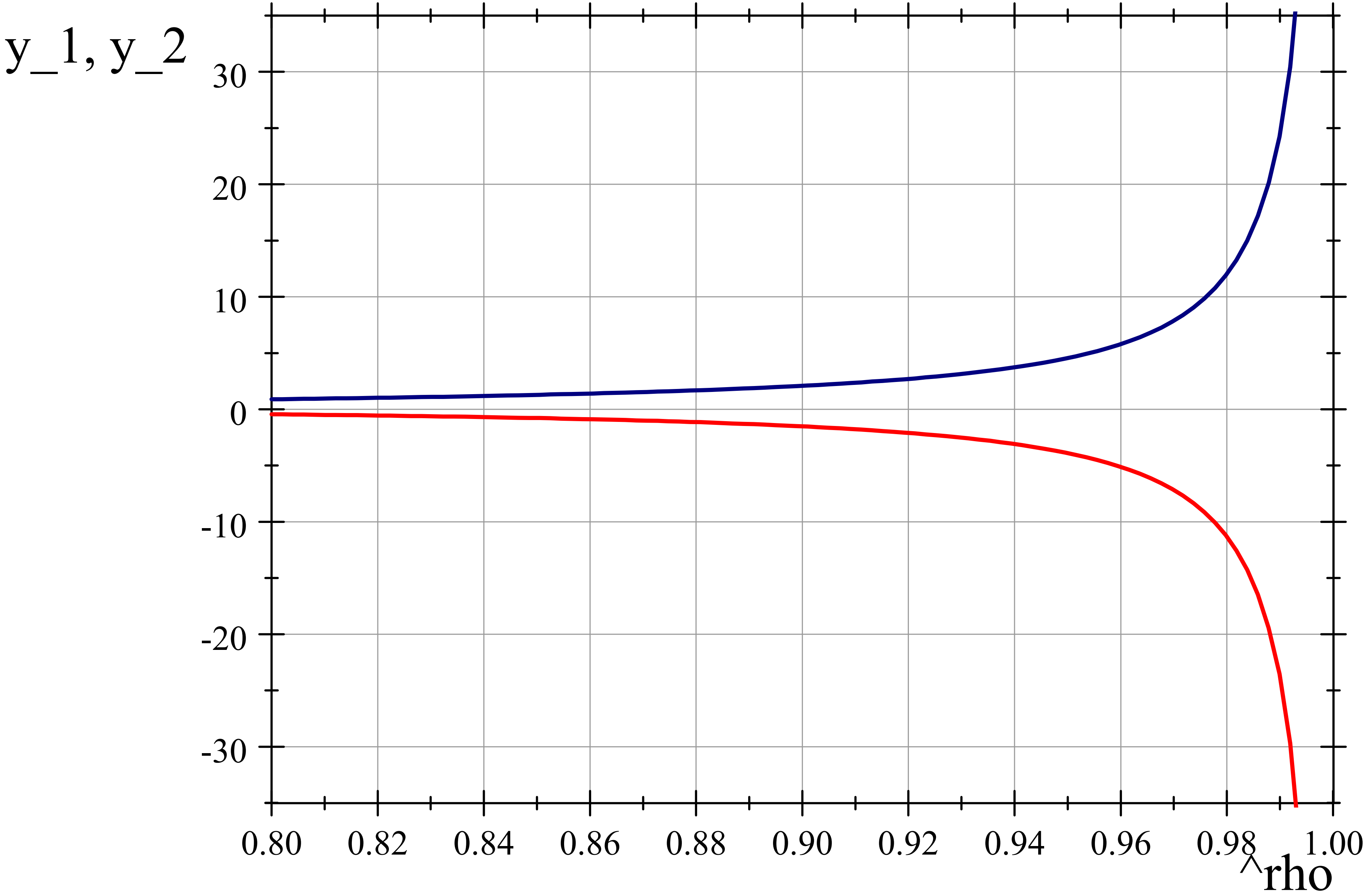
Numerical example

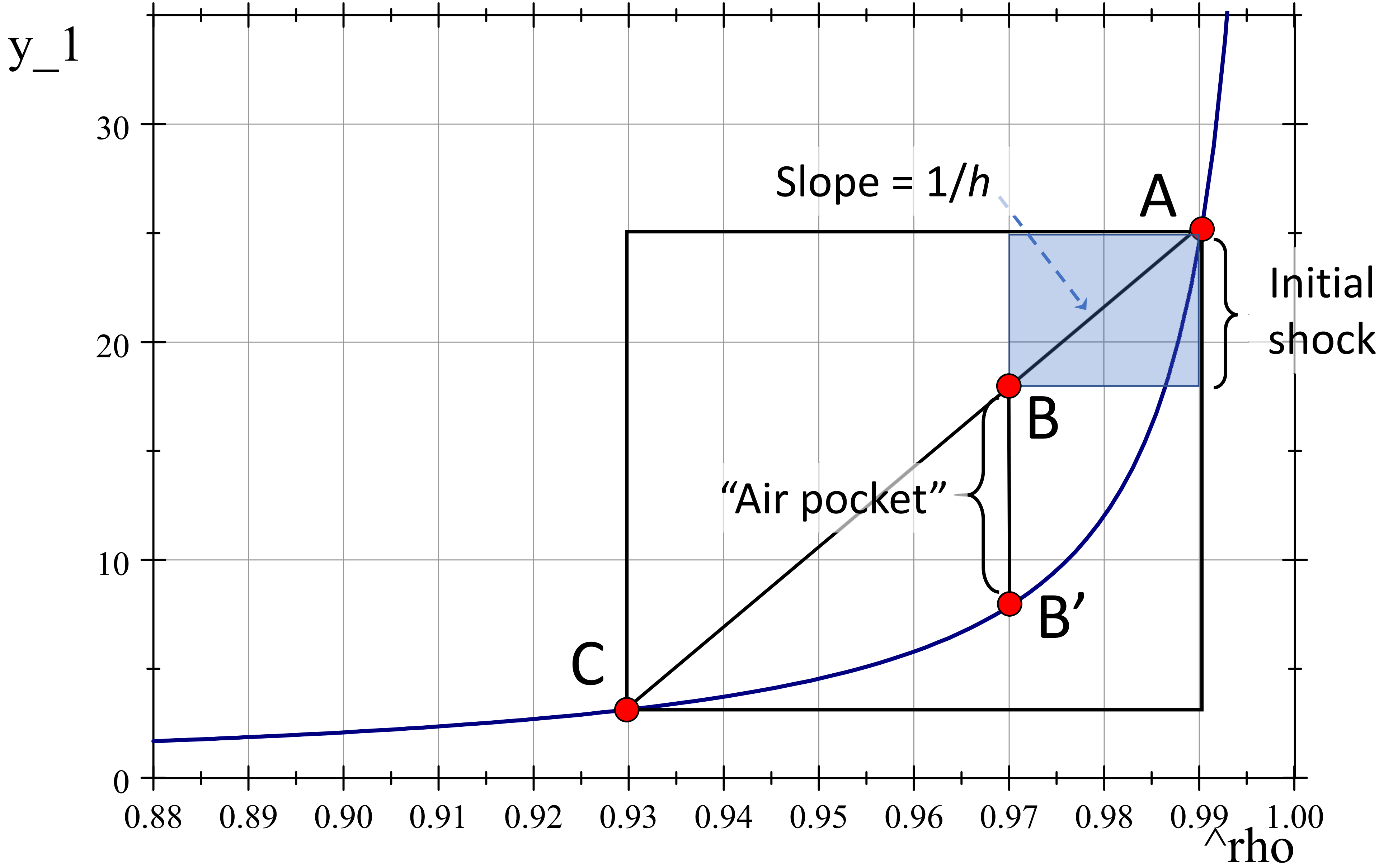
Long-short hedge fund and two bonds, with parameters:

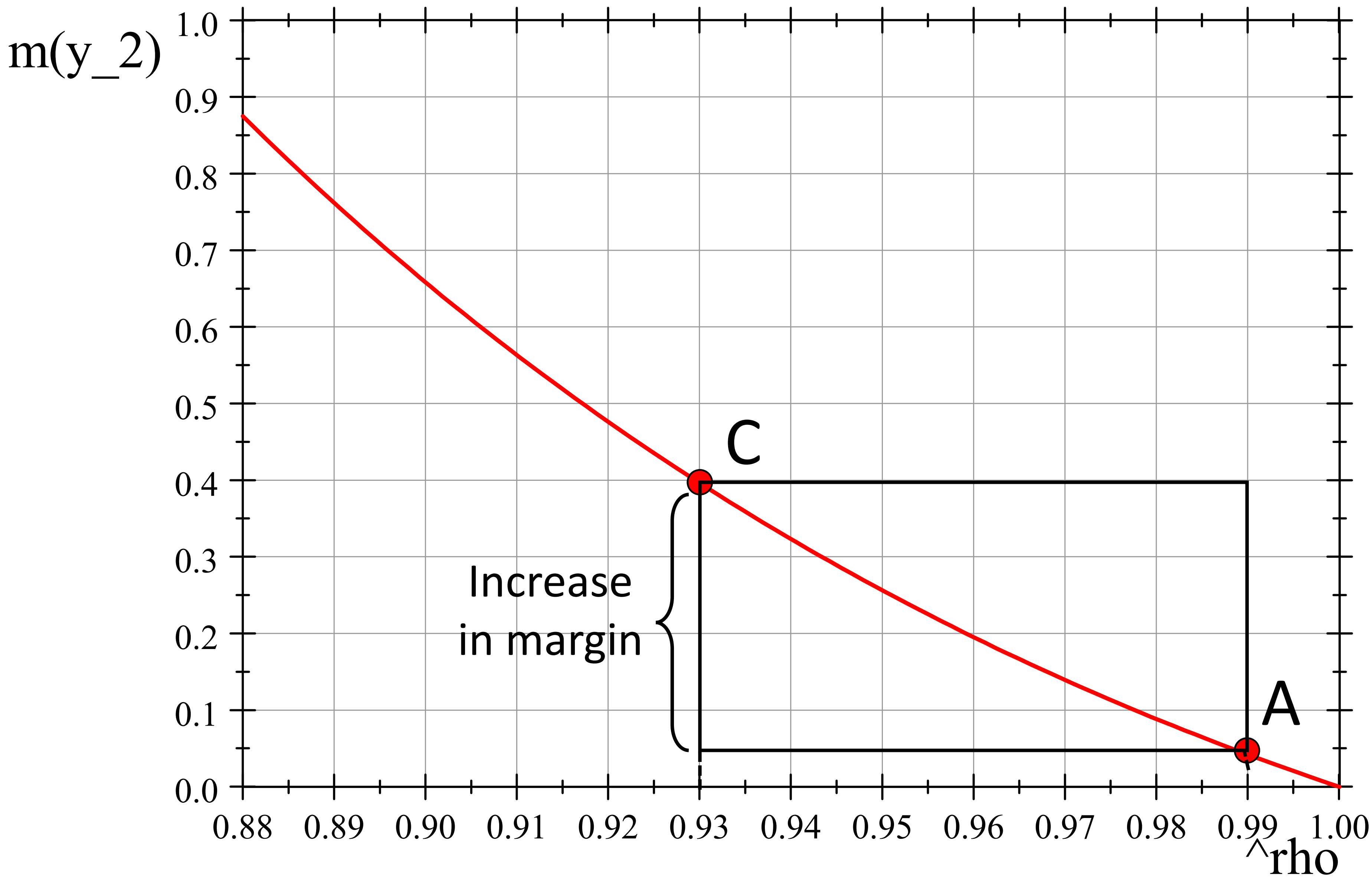
$$\kappa = 1, \mu_1 = 0.02, \mu_2 = 0.01, c = 1, \alpha = 2$$

Return correlation between the two bonds is

$$\rho = \frac{1}{1+z}$$


y_1, y_2
30
20
10
0
-10
-20
-30
0.80
0.82
0.84
0.86
0.88
0.90
0.92
0.94
0.96
0.98
1.00
^rho

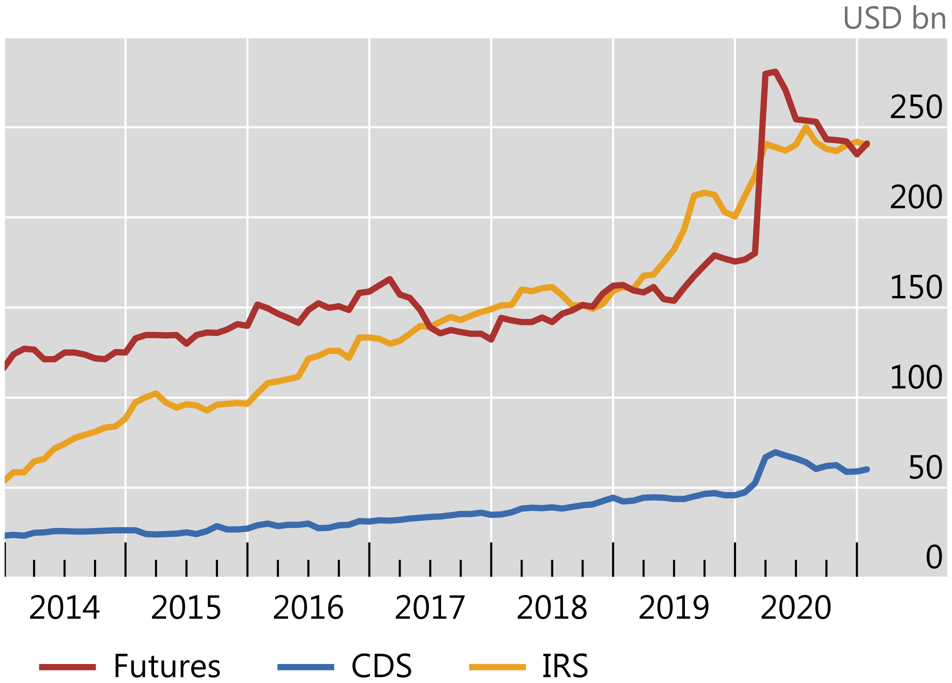

y_1
30
20
10
0
0.88
0.89
0.90
0.91
0.92
0.93
0.94
0.95
0.96
0.97
0.98
0.99
1.00
^rho
Slope = 1/h
A
Initial shock
B
"Air pocket"
B'
C



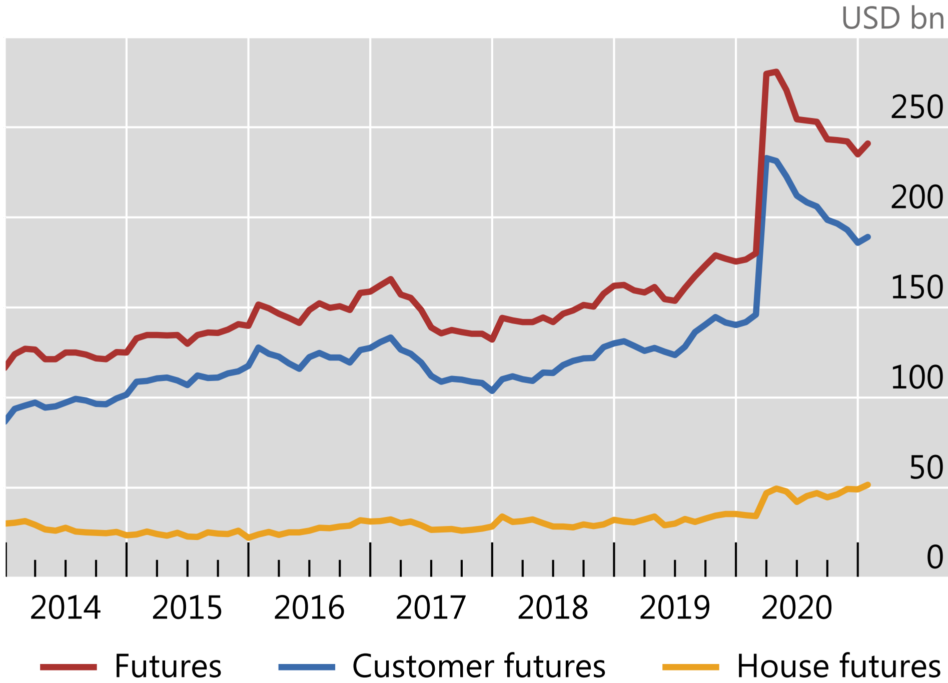
m(y_2)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
C
A
Increase
in margin
0.88
0.89
0.90
0.91
0.92
0.93
0.94
0.95
0.96
0.97
0.98
0.99
1.00
^rho

Margins on futures rose sharply in March 2020

Customer margins, by product

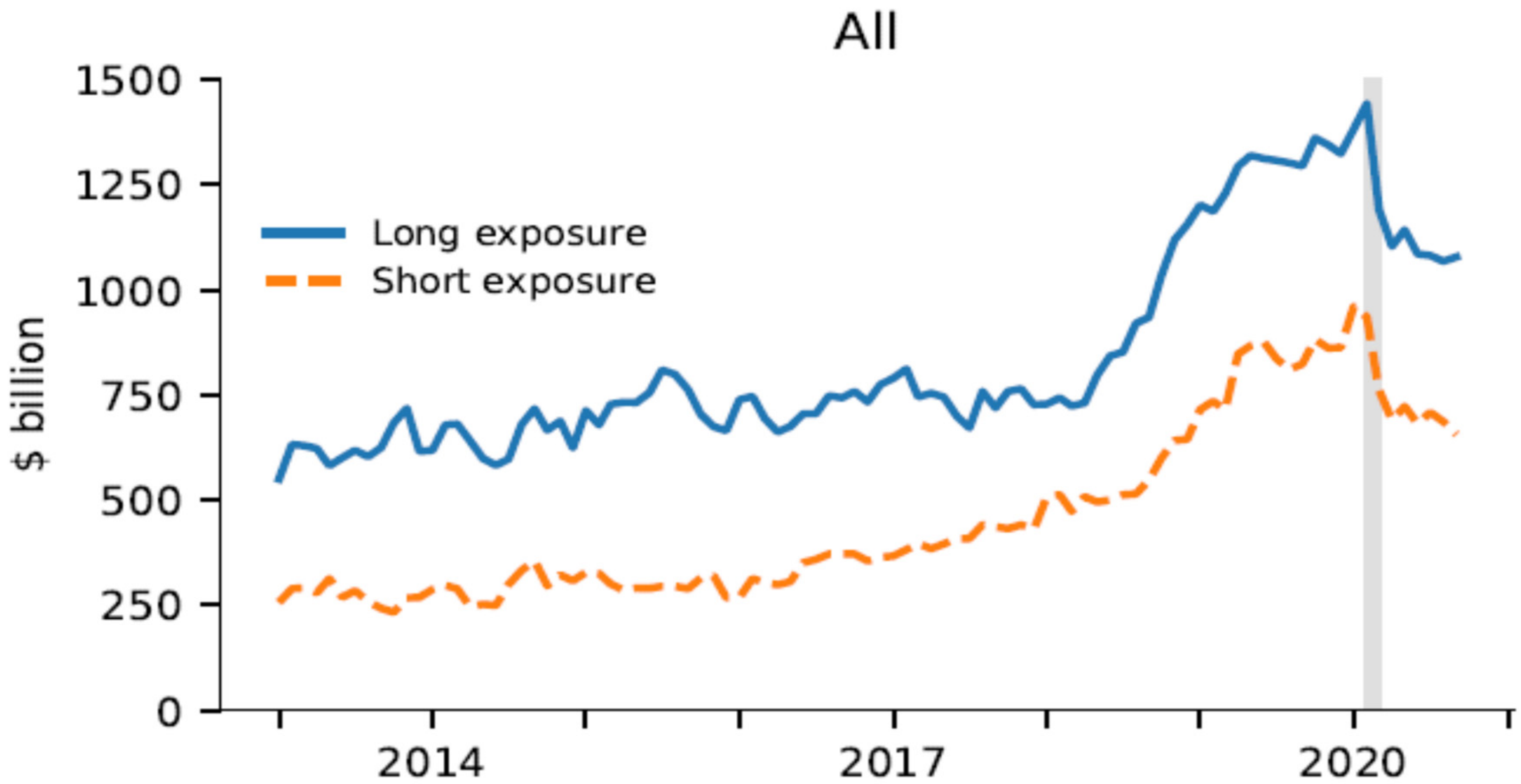


Futures margins: customer vs house



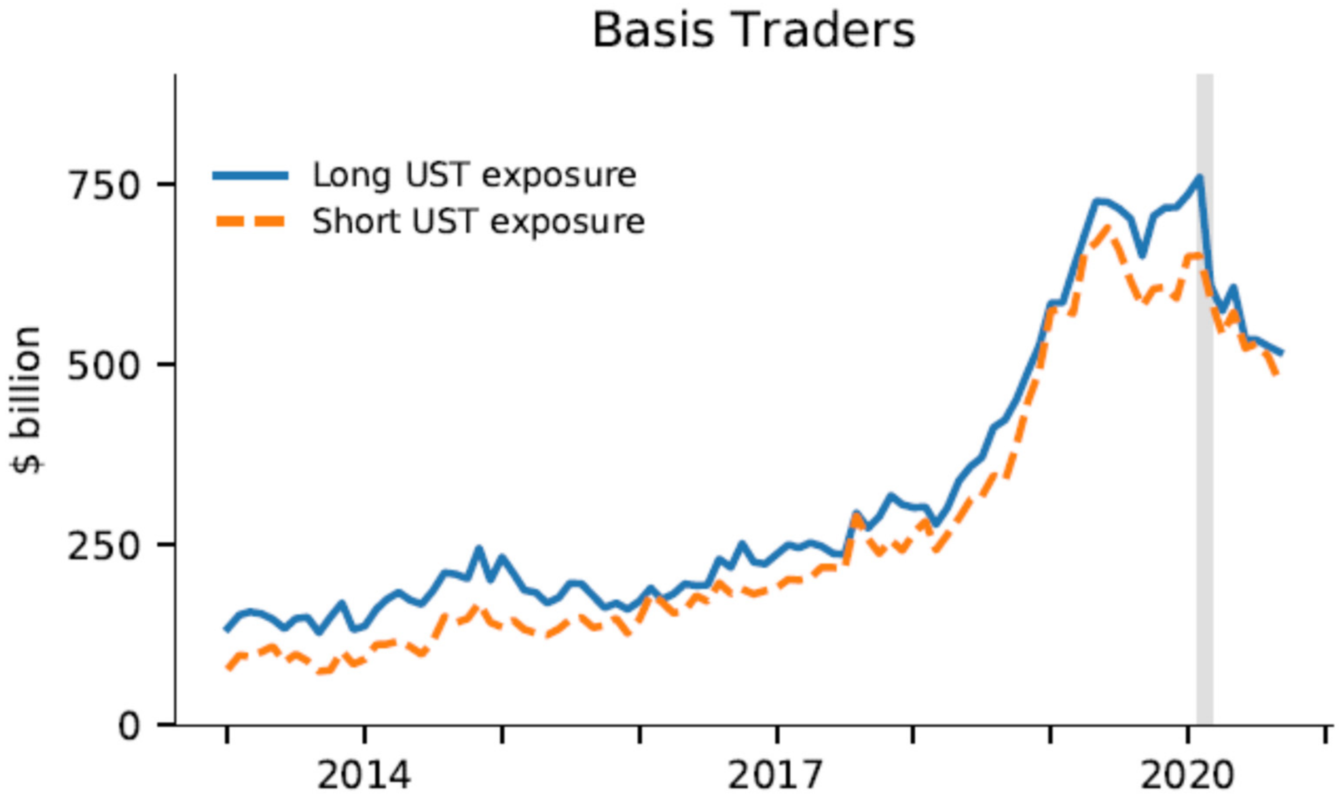
Source: CFTC.

Hedge fund US treasury exposure



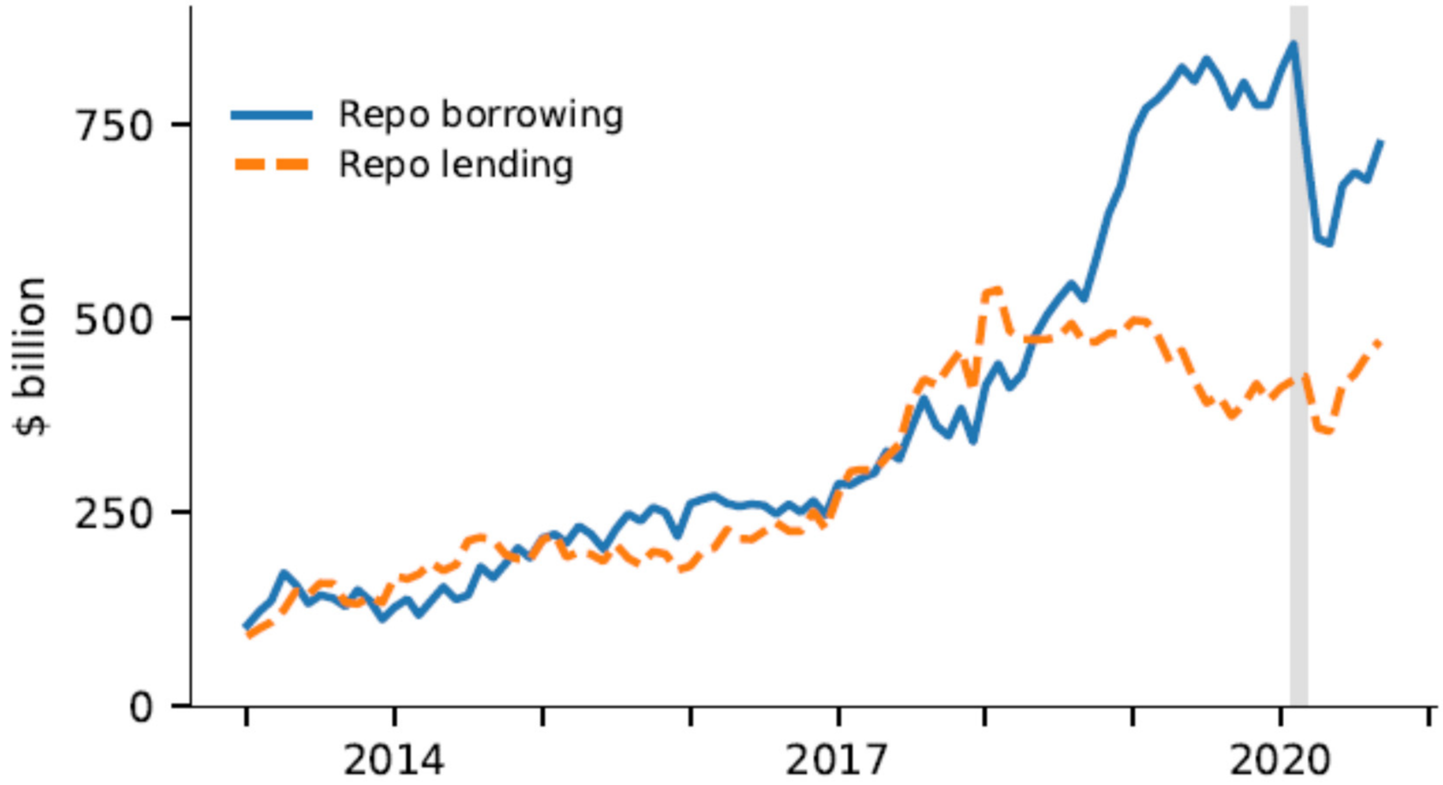
Source: Figure 1 of Kruttli, Monin, Petrasek and Watugala (2021) "Hedge fund treasury trading and funding fragility: evidence from the Covid-19 crisis https://www.federalreserve.gov/econres/feds/files/2021038pap.pdf

Cash-futures basis hedge fund US treasury exposure



Source: Figure 6 of Kruttli, Monin, Petrasek and Watugala (2021) “Hedge fund treasury trading and funding fragility: evidence from the Covid-19 crisis https://www.federalreserve.gov/econres/feds/files/2021038pap.pdf

Cash-futures basis hedge fund repo borrowing



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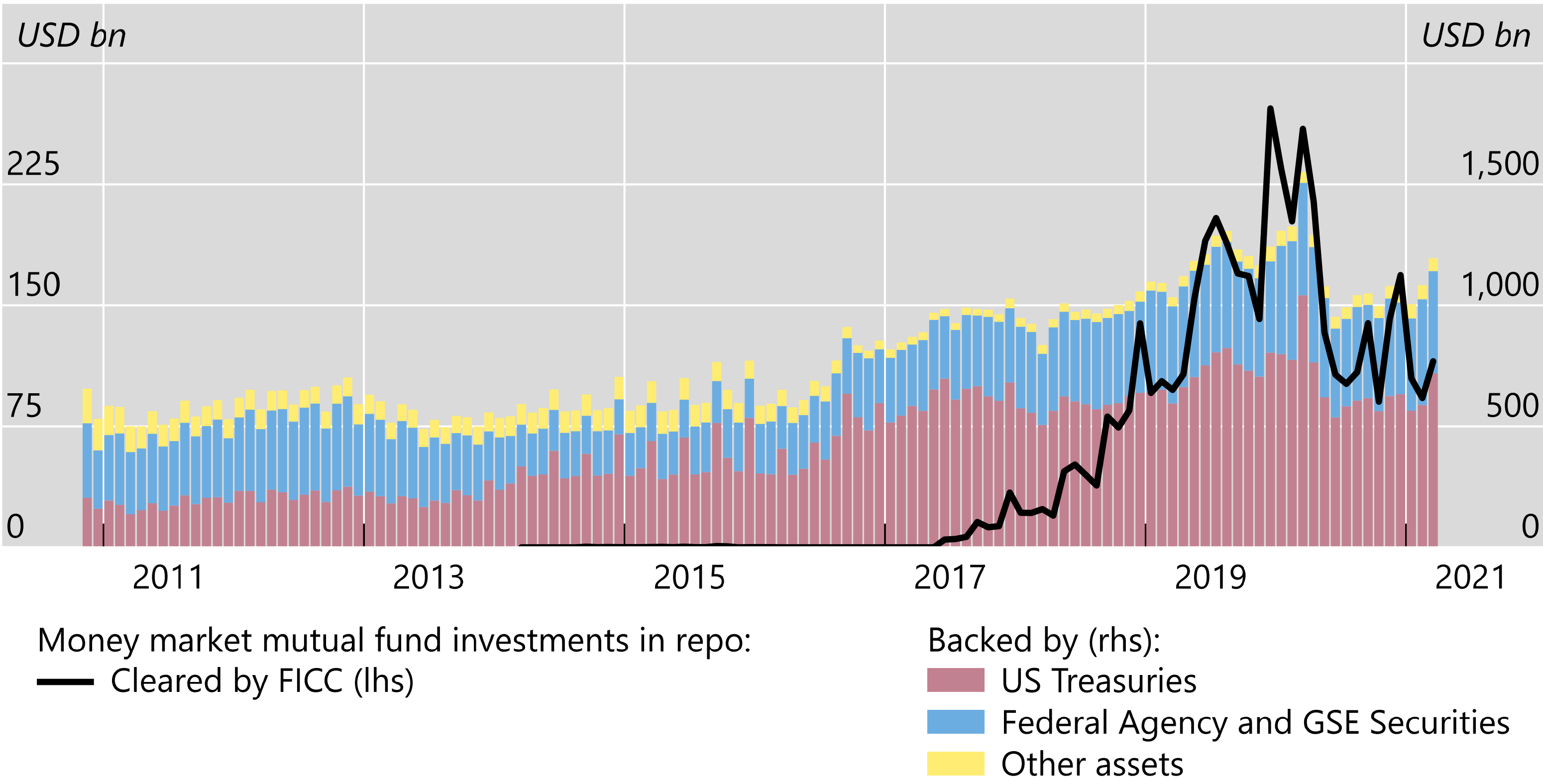
MMF investments in repo



Source: OFR, *U.S. Money Market Fund Data Release*.

Accounting framework for risk-bearing capacity

- n financial market participants ("investors", for short) indexed by $i \in \{1, \cdots, n\}$
- For i, x_i is market value of debt, e_i is market value of equity
- S outside assets (not the liabilities of any of the n investors)

$$y_1, y_2, \cdots y_S$$

Investor portfolio

- Portfolio of investor i consists of inside debt claims (n), inside equity claims (n) and outside assets (S)

$$[\underbrace{\pi_{1i}x_1, \cdots, \pi_{ni}x_n}_{\text{Inside debt claims}}; \overbrace{\rho_{1i}e_1, \cdots, \rho_{ni}e_n}^{\text{Inside equity claims}}; \underbrace{q_{1i}y_1, \cdots, q_{Si}y_S}_{\text{Outside assets}}]$$

  where π_{ji} is proportion of x_j held by investor i; analogously for ρ_{ji}, and q_{ji}
- NBFI taxonomy builds on nature of claims
  - mutual funds issue equity claims only
  - hedge funds issue both equity and debt claims, etc.

Debt capacity

- Balance sheet identity for investor i:

$$\sum_{j=1}^{n} \pi_{ji} x_j + \sum_{j=1}^{n} \rho_{ji} e_j + \sum_{j=1}^{S} q_{ji} y_j = x_i + e_i$$

- Margin constraint for investor i:

$$\sum_{j=1}^{n} \pi_{ji} x_j m(x_j) + \sum_{j=1}^{n} \rho_{ji} e_j m(e_j) + \sum_{j=1}^{S} q_{ji} y_j m(y_j) \leq \kappa_i \leq e_i$$

  where margin on asset a is $m(a)$

- Subtracting second from first, investor i's **debt capacity** is

$$\begin{aligned} x_i \quad \leq \quad & \sum_{j=1}^{n} \pi_{ji} x_j (1 - m(x_j)) + \sum_{j=1}^{n} \rho_{ji} e_j (1 - m(e_j)) \\ & + \sum_{j=1}^{S} q_{ji} y_j (1 - m(y_j)) \end{aligned}$$

Debt capacity

$$
\begin{aligned}
x_i \leq & \begin{bmatrix} x_1 & \cdots & x_n \end{bmatrix} \begin{bmatrix} 1-m(x_1) & & \\ & \ddots & \\ & & 1-m(x_n) \end{bmatrix} \begin{bmatrix} \pi_{1i} \\ \vdots \\ \pi_{ni} \end{bmatrix} \\
& + \begin{bmatrix} e_1 & \cdots & e_n \end{bmatrix} \begin{bmatrix} 1-m(e_1) & & \\ & \ddots & \\ & & 1-m(e_n) \end{bmatrix} \begin{bmatrix} \rho_{1i} \\ \vdots \\ \rho_{ni} \end{bmatrix} \\
& + \begin{bmatrix} y_1 & \cdots & y_S \end{bmatrix} \begin{bmatrix} 1-m(y_1) & & \\ & \ddots & \\ & & 1-m(y_S) \end{bmatrix} \begin{bmatrix} q_{1i} \\ \vdots \\ q_{Si} \end{bmatrix}
\end{aligned}
$$

Debt capacity

Gathering the x_i as a row vector $x = \left[\begin{array}{ccc} x_1 & \cdots & x_n \end{array}\right]$, we have:

$$x \leq x\Delta_x \Pi + e\Delta_e R + y\Delta_y Q \qquad (*)$$

where

$$\Delta_x = \left[\begin{array}{ccc} 1 - m(x_1) & & \\ & \ddots & \\ & & 1 - m(x_n) \end{array}\right], \quad \text{etc}$$

and Π is the matrix of π_{ij}, R is the matrix of ρ_{ij} and Q is the matrix of q_{ij}

Proposition 1 on recursive nature of debt capacity

$$
\begin{aligned}
x &\leq x\Delta_x\Pi + e\Delta_e R + y\Delta_y Q \\
&= \left(I + \Delta_x\Pi + (\Delta_x\Pi)^2 + (\Delta_x\Pi)^3 + \cdots\right)(e\Delta_e R + y\Delta_y Q) \\
&= (I - \Delta_x\Pi)^{-1}(e\Delta_e R + y\Delta_y Q)
\end{aligned}
$$

- Debt capacity for investor i is increasing in the debt capacity of others; "leverage enables greater leverage"
- Debt capacity rises sharply as margins on debt claims are compressed to zero
- Conversely, debt capacity falls sharply with increased margins when margins are small

Proposition 2 on "dash for cash" as flipside of margin spike

- Margin constraint for investor i is

$$\sum_{j=1}^{n} \pi_{ji} x_j m(x_j) + \sum_{j=1}^{n} \rho_{ji} e_j m(e_j) + \sum_{j=1}^{S} q_{ji} y_j m(y_j) \leq \kappa_i \leq e_i$$

- Let y be initial portfolio, $\hat{y}$ be new portfolio, and margins increase from m to $\hat{m}$ where $\hat{m} \gneq m$. From $\kappa = \hat{m}\hat{y}_+ = my_+$,

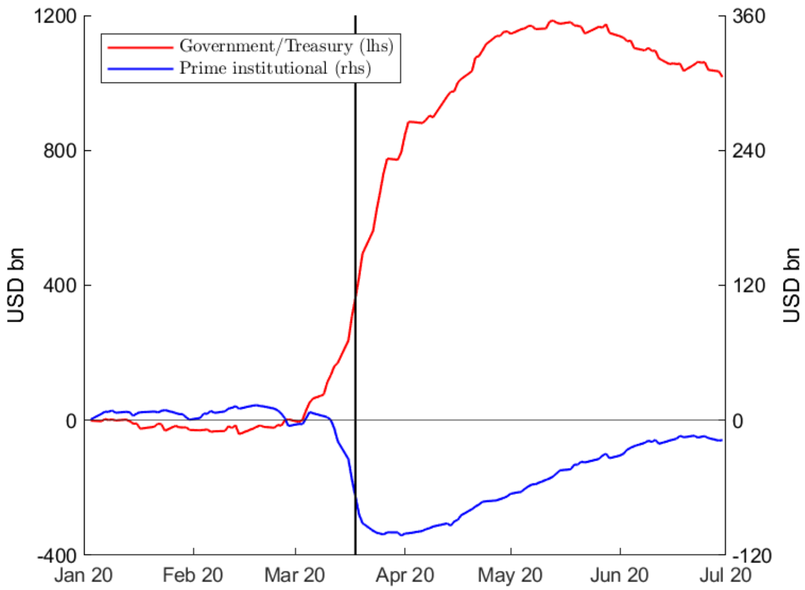
$$\underbrace{(\hat{m} - m)}_{>0} \hat{y}_+ + m\hat{y}_+ = my_+$$

$$m\hat{y}_+ < my_+$$

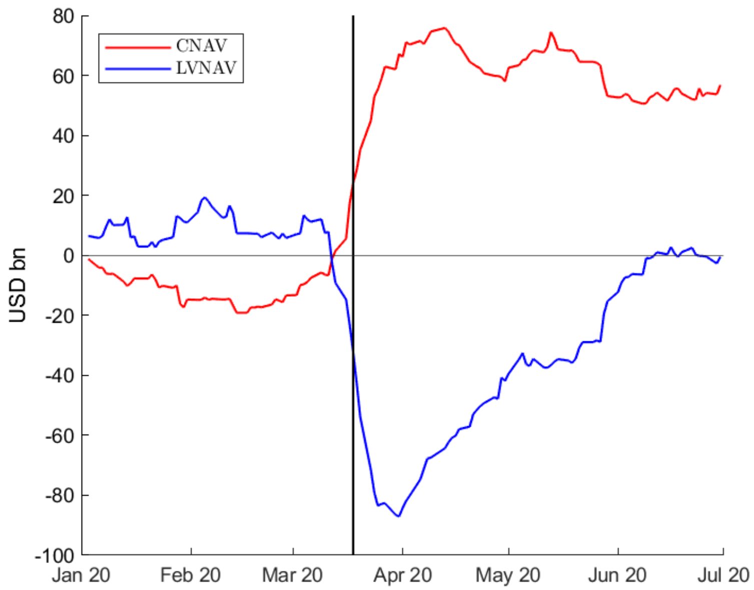
- When margins go up, investors' portfolios shift from high margin assets to low margin assets
- "Dash for cash" is the flipside of increase in margins

Govt MMFs saw inflows, prime MMFs saw outflows

Prime MMFs suffered large withdrawals



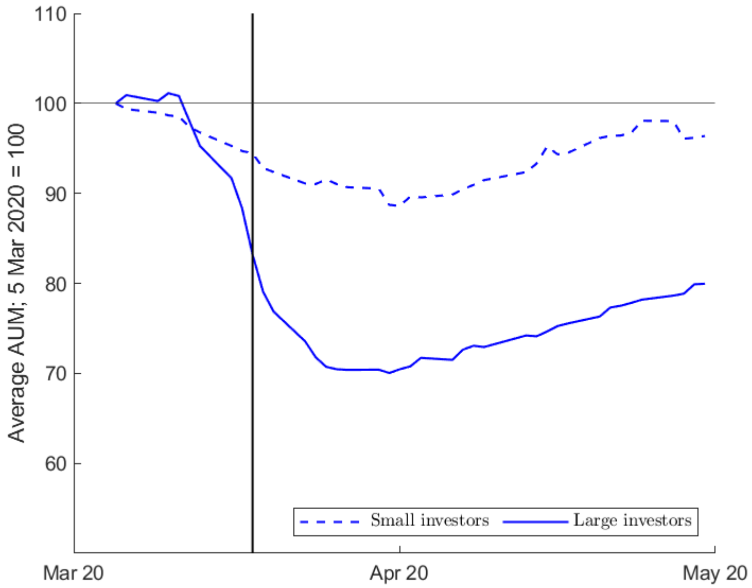
European dollar LVNAV MMFs saw large redemptions



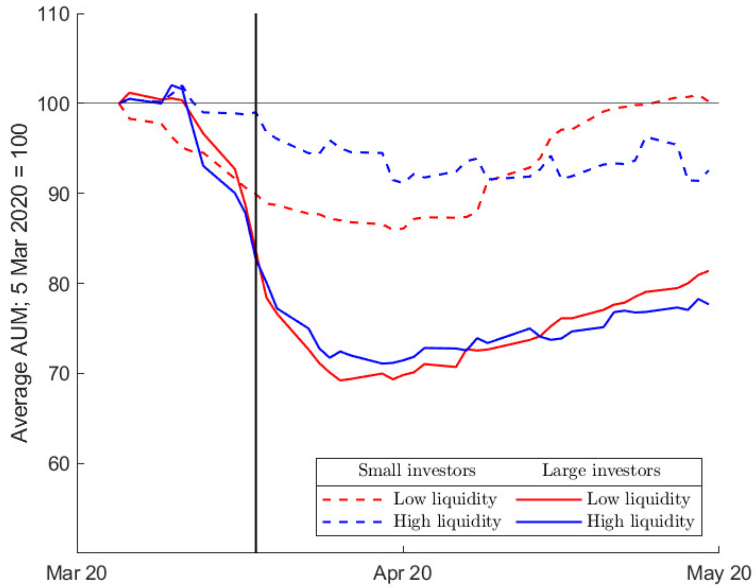
Sources: BIS Quarterly Review, March 2021.

Large investors withdrew more from prime MMFs

Large investors redeemed more…



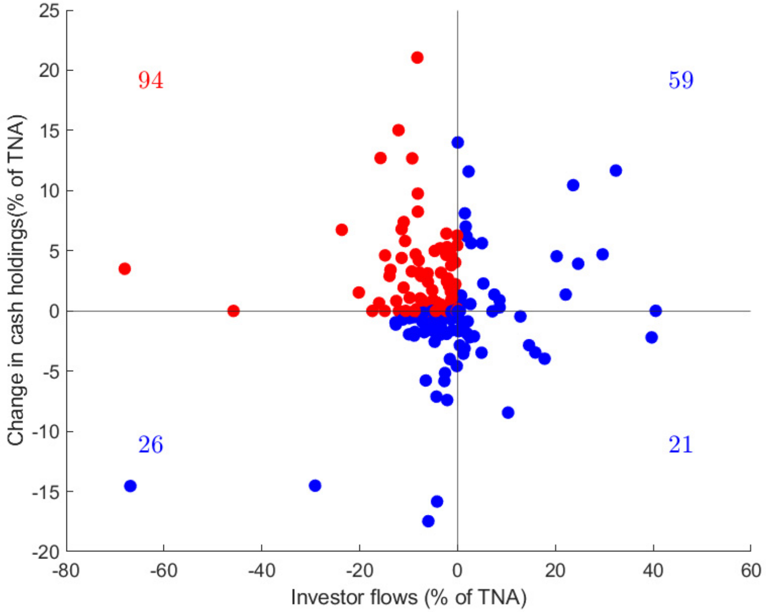
…irrespective of funds' liquidity



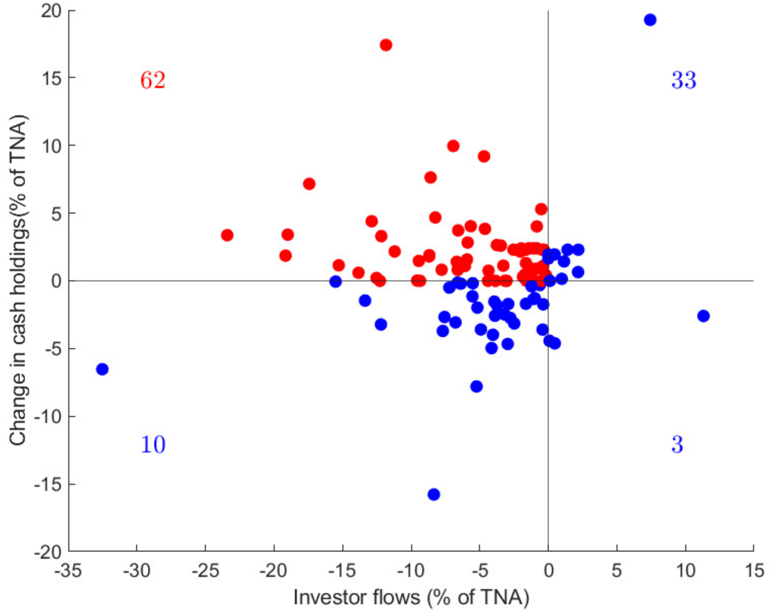
Sources: BIS Quarterly Review, March 2021.

"Dash for cash" was also seen for bond mutual funds experiencing redemptions

Global and regional AE bond funds (200)



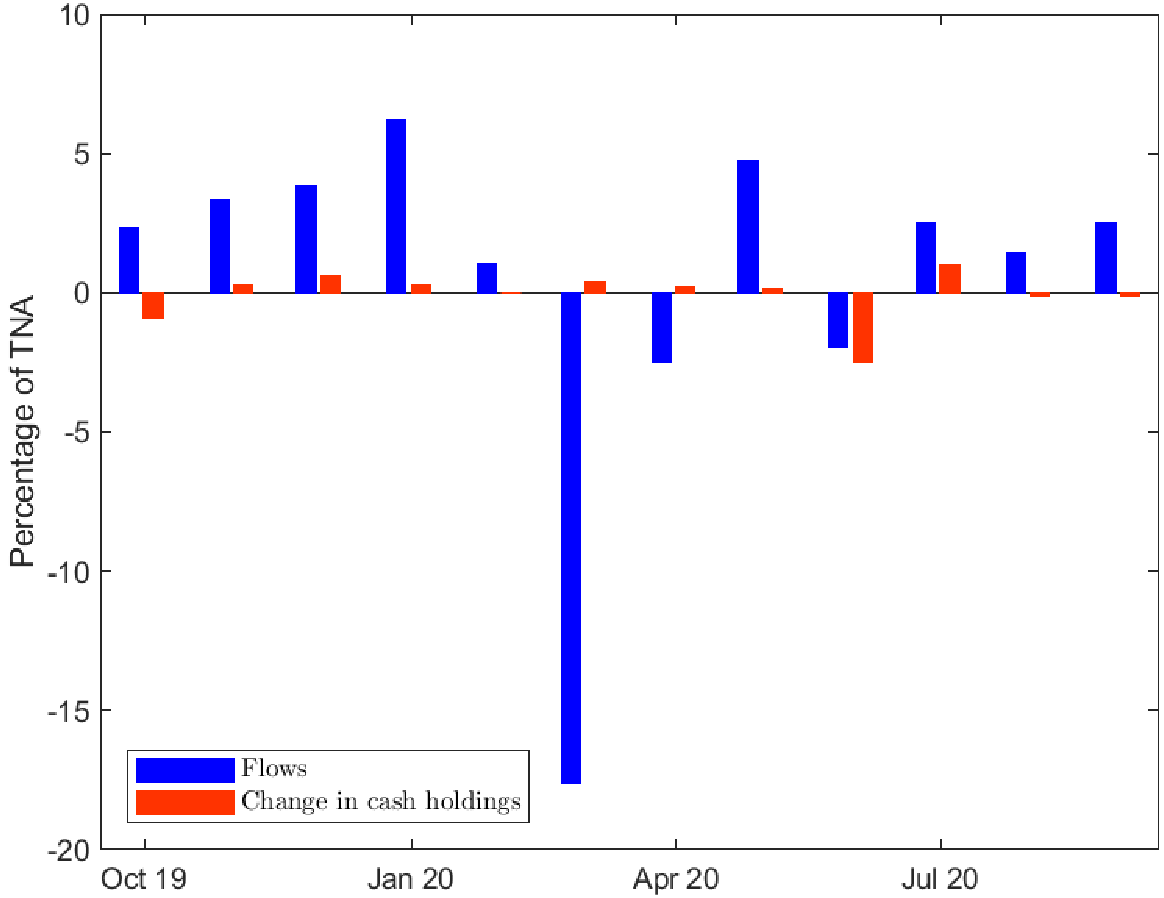
Global and regional EME bond funds (108)



TNA = total net assets. The number in brackets shows the number of funds in each category whose data on cash holdings and investor flows are available in the months of February and March 2020. The top right quadrant is when both the monthly change in cash holdings and investor flows are positive or equal to zero; the bottom right quadrant is when the change in cash holdings is negative and investor flows are positive or equal to zero; the bottom left quadrant is when both the change in cash holdings and investor flows are negative; the top right quadrant is when the change in cash holdings is positive or equal to zero and investor flows are negative.

Sources: BIS Bulletin, no 39.

Long-term US Treasury bond mutual funds saw large redemptions in March 2020

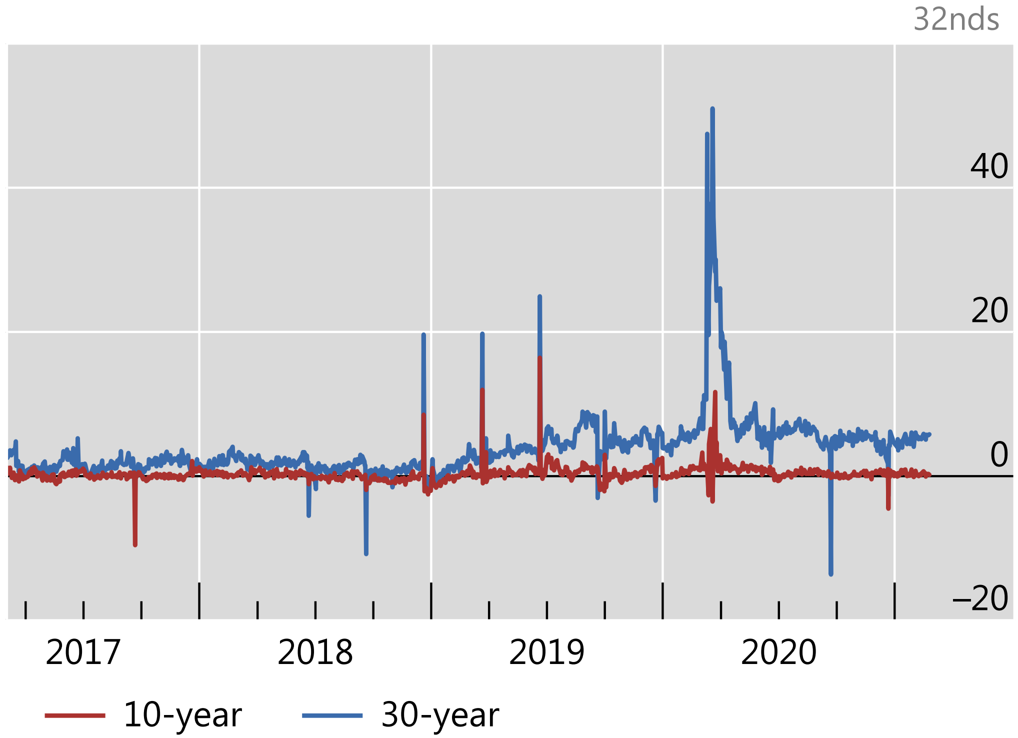


Sources: BIS Bulletin, no 39.

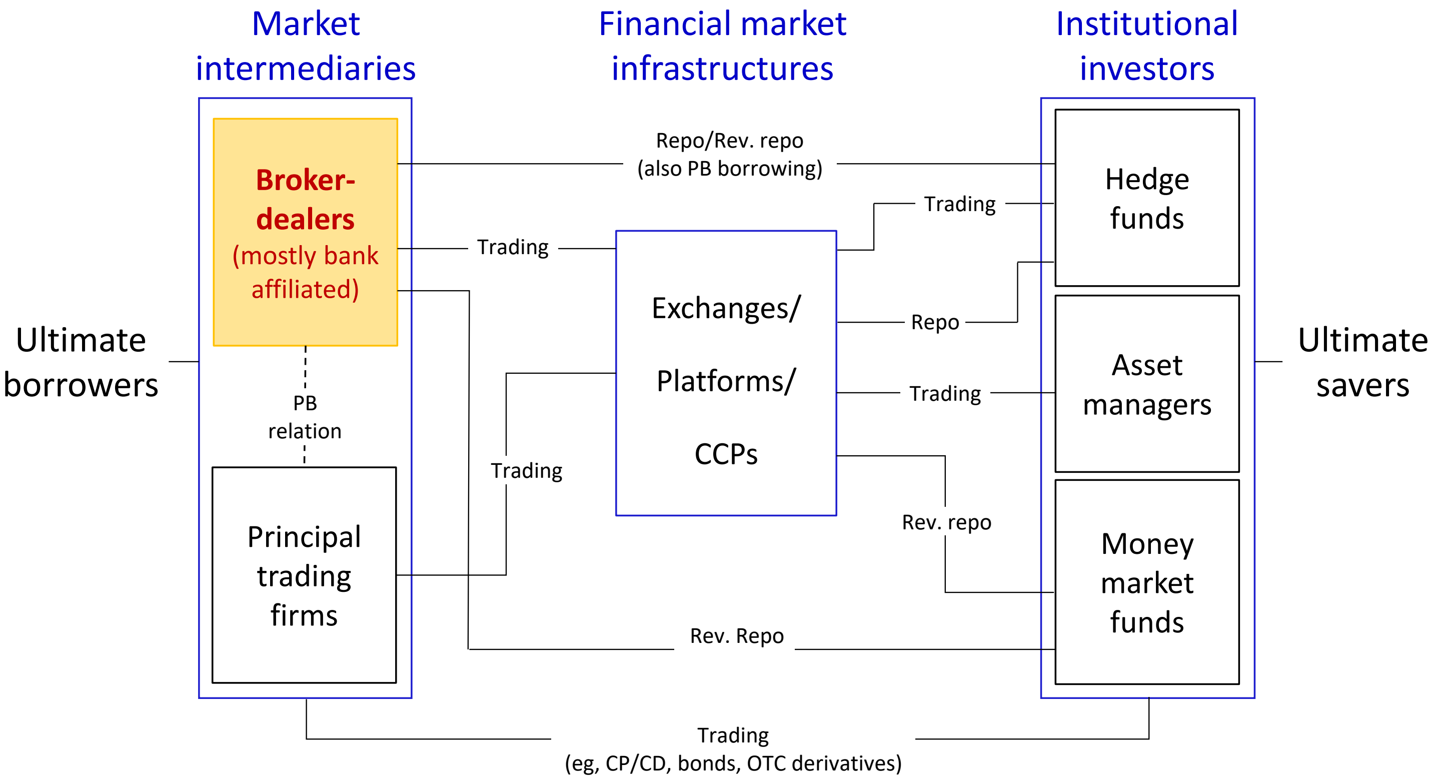
Importance of time dimension of margins

- Increase in margins after a protracted period of compressed margins will enforce lower leverage and hence smaller balance sheets of system participants
- Insolvencies exacerbate stress, but are not necessary for stress propagation; the "domino" model does not apply
- Pecuniary externalities – through prices (spreads, risk measures, etc.) are important

Spillovers through pricing channels ("pecuniary externalities") and margining may propagate stress, even when the underlying asset is default-free



- Chart shows the price difference between the futures-implied price of US treasury securities and the cheapest-to-deliver treasury, adjusted for carry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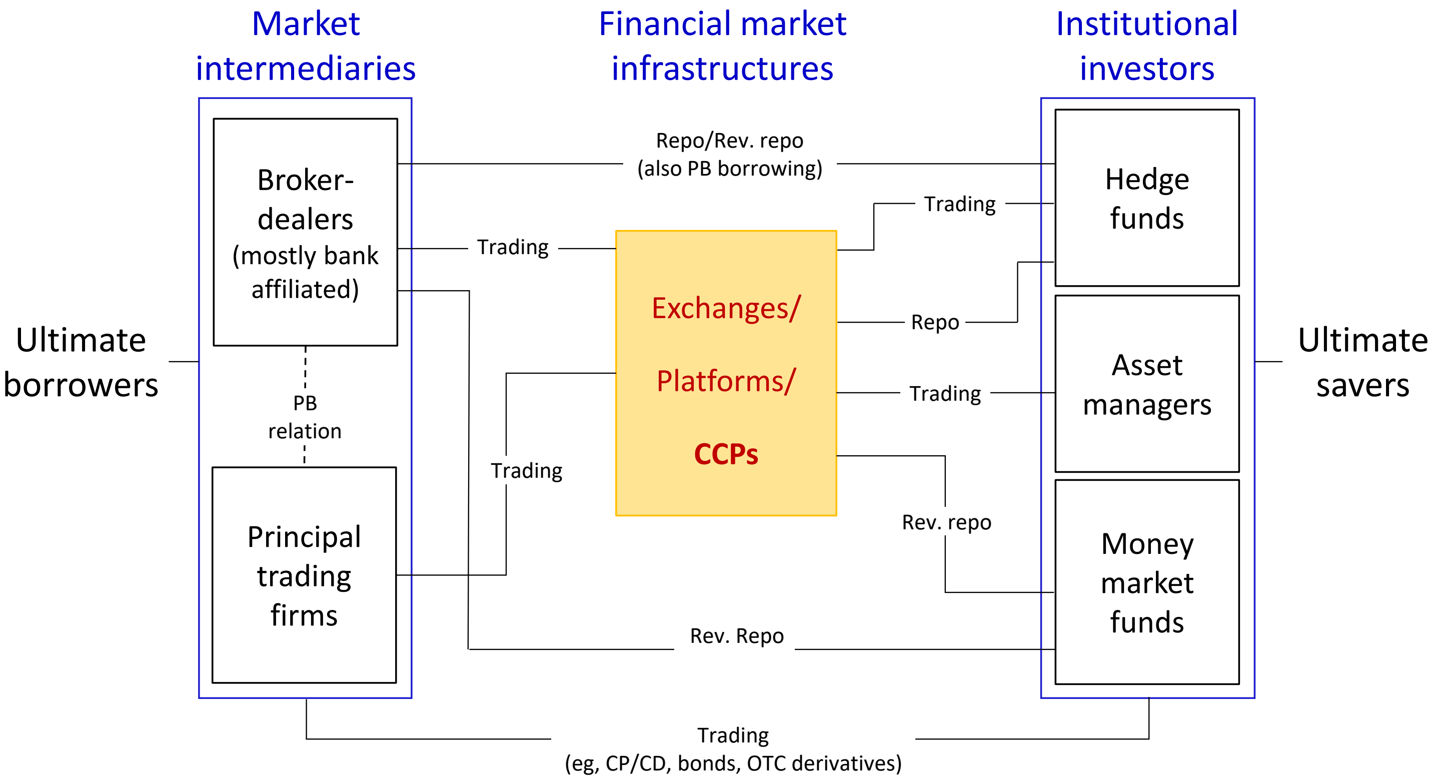

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Keeping pace with structural changes in financial markets

- Traditional intermediaries (typically part of banking groups) have ceded ground to new players (hedge funds, PTFs) and market infrastructures (CCPs, exchanges, other platforms)
- "Congruent regulation" (Metrick and Tarullo (2021)) takes on greater importance
  - Maintaining congruence in the *cross-section* so that "mix-and-match" leverage is broadly consistent with that in traditional regulated sector
  - Smoothing out the *time dimension of margins* remains central for orderly markets
- Implications for central bank market operations include how ex post interventions will affect ex ante risk capacity and the time dimension of margins and leverage