The not-so-hidden risks of bank runs and fire-sales with ‘hidden-to-maturity’ accounting

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Introduction

- The years 2021–22 saw a substantial rise in banks' reliance on held-to-maturity (HtM) securities, effectively allowing them to 'hide' unrealized losses
- A tangible consequence of this build-up of balance sheet vulnerabilities is a **collapse of the Silicon Valley Bank (SVB)**
- Despite significant research efforts, bank runs still surprise in the evolving economic (monetary regime) and regulatory (accounting rules) environment, and adapting business models and practices (recognition of assets in balance sheets)
- We build a stylized **model to explain bank runs to measure vulnerabilities of banks stemming from** the bank's balance sheet composition, related to
    - banks' **financial conditions perceived by depositors**
    - reliance on **uninsured deposits**
    - *de facto* inability to hold **HtM portfolios**

Results

1. Decomposition of the bank run risk into:
    - shades of liquidity with fire sales dipping only into AfS or as far as to HtM portfolios,
    - distinguishing illiquidity and insolvency state
2. Indicator of expected funding withdrawals in equilibrium
3. Shedding light on banks' ability to hold HtM assets, i.e., commensurate with banks' business models

Contributions to literature...

- ...on bank **runs in general** (first comprehensive model of Diamond (1983), then global games of Morris & Shin (2003))
- and on **understanding specific drivers** like
  - solvency / liquidity constraints (Diamond 2012)
  - fire sales (Bindseil & Fotia 2023)
  - macro-environment (e.g., changing monetary regime, Drechsler, Savov, Schnabl & Wang (2023), Ahnert (2023))
- ...and on the **impact of accounting standards** on financial stability, i.e., use of HtM accounting in stress (Granja 2023 and Kim 2023)

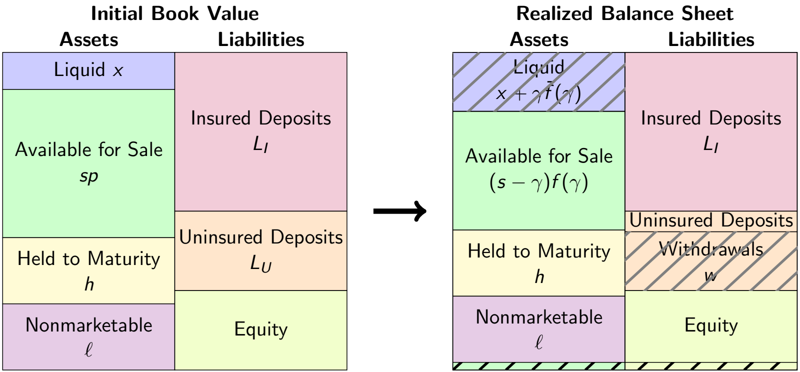

Figure: Stylized bank balance sheet represented by Initial Book Value and subject to deposit withdrawal risk where held to maturity assets need not be sold (Realized Balance Sheet). f is an inverse demand function (represents a price impact of assets sold γ). p is a market price shock to AfS (sp being a revalued AfS portfolio subject to shock p). Total assets $A := x + sp + h + l$.

Run mechanics

Assumptions:

- The uninsured investors have a maximum accepted leverage ratio $\lambda_{\max} > 1$ before withdrawals are initiated.
- The inverse demand function $f : [0, s + h] \to (0, p]$ is non-increasing with initial price $f(0) = p$, where $p \in (0, 1]$.

Leverage ratio observed by depositors ($\lambda = \lambda(w, \gamma)$) is

$$\lambda = \frac{\text{Assets}}{\text{Equity}} = \frac{A(w,\gamma)}{A(w,\gamma) - (L - w)}, \tag{1}$$

$$A(w,\gamma) = x + \gamma\bar{f}(\gamma) + [s-\gamma]^{+} f(\gamma) + [h-(\gamma-s)^{+}](\mathbb{I}_{\{\gamma\le s\}} + f(\gamma)\mathbb{I}_{\{\gamma>s\}}) + \ell - w,$$

for the given values of x, s, h, and ℓ, and $\bar{f}$ being a weighted average price function derived from f.

Equilibrium deposits withdrawals and assets sold

Bank run is a solution to a **clearing problem** that is **jointly in**

- the equilibrium amount of withdrawals w^*, and
- the equilibrium quantity sold γ^* out of the marketable securities.

Represented by **fixed points** of $\Phi : [0, L_U] \times [0, s+h] \to [0, L_U] \times [0, s+h]$ defined by $\Phi = (\Phi_w, \Phi_\gamma)$, where

$$\Phi_w(\gamma^*) = L_U \wedge \Big[\lambda_{\max} L - (\lambda_{\max} - 1)(x + \gamma^* \bar{f}(\gamma^*) + [s - \gamma^*]^+ f(\gamma^*) + [h - (\gamma - s)^+](\mathbb{I}_{\{\gamma^* \leq s\}} + f(\gamma^*)\mathbb{I}_{\{\gamma^* > s\}}) + \ell)\Big]^+ \quad (2)$$

$$\Phi_\gamma(w^*, \gamma^*) = [s + h] \wedge \frac{(w^* - x)^+}{\bar{f}(\gamma^*)}. \quad (3)$$

Here (2) enforces the depositors' maximum acceptable leverage ratio, while (3) aligns the withdrawal requests with the quantity sold

Clearing algorithm – no dipping into HtM

The minimal clearing solution $(w^{\downarrow}, \gamma^{\downarrow})$ is determined by the following algorithm:

1. **(No sales)** If either $L_U \leq x$ or $\lambda_{\max} L - (\lambda_{\max} - 1)(x + sp + h + \ell) \leq x$, then $\gamma^{\downarrow} = 0$ and $w^{\downarrow} = L_U \wedge [\lambda_{\max} L - (\lambda_{\max} - 1)(x + sp + h + \ell)]^{+}$. Else, continue to next step.
2. **(Run without re-marking HtM I)** If

   $$L - x - (1 - \tfrac{1}{\lambda_{\max}})(h + \ell) \in [(1 - \tfrac{1}{\lambda_{\max}})sp, s\bar{f}(s)], \quad \text{and}$$
   $$L_U \geq \lambda_{\max} L - (\lambda_{\max} - 1)(x + \gamma^* \bar{f}(\gamma^*) + (s - \gamma^*)f(\gamma^*) + h + \ell), \quad \text{for}$$
   $$\gamma^* \bar{f}(\gamma^*) + (1 - \tfrac{1}{\lambda_{\max}})(s - \gamma^*)f(\gamma^*) = L - x - (1 - \tfrac{1}{\lambda_{\max}})(h + \ell), \quad \gamma^* \in [0, s],$$

   then $\gamma^{\downarrow} = \gamma^*$ and $w^{\downarrow} = x + \gamma^* \bar{f}(\gamma^*) \in (x, L_U)$. Else, continue to next step.
3. **(Run without re-marking HtM II)** If $L_U \in (x, x + s\bar{f}(s)]$ and $L_I \geq (1 - \frac{1}{\lambda_{\max}})[(s - \gamma^*)f(\gamma^*) + h + \ell]$ for $\gamma^* \in [0, s]$ solving $\gamma^* \bar{f}(\gamma^*) = L_U - x$, then $\gamma^{\downarrow} = \gamma^*$ and $w^{\downarrow} = L_U$. Else, continue to next step.

Clearing algorithm – dipping into HtM or a default

4. **(Re-marking HtM I)** If

$$L - x - (1 - \tfrac{1}{\lambda_{\max}})\ell \in [s\bar{f}(s) + (1 - \tfrac{1}{\lambda_{\max}})hf(s), (s+h)\bar{f}(s+h)], \quad \text{and}$$

$$L_U \geq \lambda_{\max} L - (\lambda_{\max} - 1)(x + \gamma^* \bar{f}(\gamma^*) + (s + h - \gamma^*)f(\gamma^*) + \ell), \quad \text{for}$$

$$\gamma^* \bar{f}(\gamma^*) + (1 - \tfrac{1}{\lambda_{\max}})(s + h - \gamma^*)f(\gamma^*) = L - x - (1 - \tfrac{1}{\lambda_{\max}})\ell, \ \gamma^* \in [s, s+h],$$

then $\gamma^{\downarrow} = \gamma^*$ and $w^{\downarrow} = x + \gamma^* \bar{f}(\gamma^*) \in (x, L_U)$. Else, continue to next step.

5. **(Re-marking HtM II)** If $L_U \in (x, x + (s+h)\bar{f}(s+h)]$ and $L_I \geq (1 - \frac{1}{\lambda_{\max}})[(s + h - \gamma^*)f(\gamma^*) + \ell]$ for $\gamma^* \in [s, s+h]$ solving $\gamma^* \bar{f}(\gamma^*) = L_U - x$, then $\gamma^{\downarrow} = \gamma^*$ and $w^{\downarrow} = L_U$. Else, continue to next step.

6. **(Illiquidity)** If it gets to this final step, then $\gamma^{\downarrow} = s + h$ and depending on whether

$$\lambda_{\max} L - (\lambda_{\max} - 1)(x + (s+h)\bar{f}(s+h) + \ell) \geq L_U \quad \text{and} \quad L_U - x \geq (s+h)\bar{f}(s+h), \quad \text{or}$$

$$\lambda_{\max} L - (\lambda_{\max} - 1)(x + (s+h)\bar{f}(s+h) + \ell) < L_U \quad \text{and} \quad L \geq x + (s+h)\bar{f}(s+h) + (1 - \tfrac{1}{\lambda_{\max}})\ell,$$

we either have $w^{\downarrow} = L_U$ or $w^{\downarrow} = \lambda_{\max} L - (\lambda_{\max} - 1)(x + (s+h)\bar{f}(s+h) + \ell) \in (x, L_U)$, respectively.

SVB case – build up of balance sheet vulnerabilities

		In USD billion										*Ratio*	
		Total deposits	Other funding	Insured deposits	Capital	Total assets	Cash	AfS	HtM	Unrealised Gains/Losses (HtM)	Unrealised Gains/Losses (AfS)	Tier 1 lev. ratio	Lev. ratio implied by Unrealised Gains/Losses
2020	q1	56	8.9	5	10.1	75	8	20	10	0.8	1.6	6.4	6.0
	q2	70	7.9	5	12.1	90	10	25	10	0.8	1.6	6.4	6.2
	q3	80	6.5	5	13.5	100	12	28	12	0.8	1.6	6.4	6.3
	q4	95	8.8	5	16.2	120	13	35	15	0.8	1.6	6.4	6.5
2021	q1	110	11.7	5	18.3	140	16	30	40	0.0	0.0	6.6	7.6
	q2	130	18.3	6	21.7	170	18	25	60	0.0	0.0	6.8	7.8
	q3	152	10.0	7	23.0	185	21	25	80	-0.5	0.0	7.0	8.2
	q4	172	16.9	8	26.1	215	23	27	103	-1.0	0.0	7.2	8.6
2022	q1	181	17.3	9	26.7	225	22	27	101	-7.5	-1.5	7.4	12.7
	q2	170	20.0	10	25.0	215	20	27	98	-11.5	-2.0	7.6	18.7
	q3	162	28.5	10	24.5	215	19	27	95	-16	-3.0	7.8	39.2
	q4	160	31.0	10	24.0	215	17	27	93	-15	-3.0	8.0	35.9

Table: Balance sheet evolution of the SVB

Numbers shown from the beginning of 2020 when the dynamics of assets and liabilities started to materially change. "Lev. ratio implied by Unrealized Gains/Losses" = [Total assets]/([Capital]-[Unrealised Gains/Losses (HtM)]-[Unrealised Gains/Losses (AfS)]); "Other funding" = calibrated such that balance sheet identity is preserved and leverage ratio reported by SVB ([Tier 1 ratio]) equals to the calculated leverage ratio (i.e., [Total assets]/[Capital]), "AfS" = securities in available for sale accounting portfolios; "HtM" = securities in held-to-maturity accounting portfolios

Source: SVB financial reports and FRB (2023)

Anatomy of SVB run risk

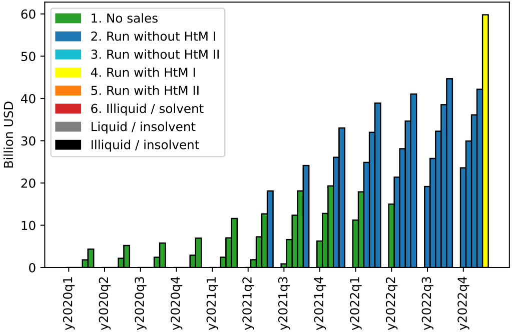

Figure: Equilibrium withdrawal of funding from SVB for various calibrations of targeted leverage ratios. For each period there is a group of bars, each of them corresponding to a leverage ratio from $\{7.0, 7.25, 7.5, 7.75, 8.0\}$. λ_{max} calibration

- Equilibrium funding withdrawals rose...
- implying runs necessitating liquidation of AfS portfolios.
- As of Q4 2022, runs following a higher leverage targeting could deprive SVB of available liquid resources (dipping into HtM)

What if unrealised losses were realised?

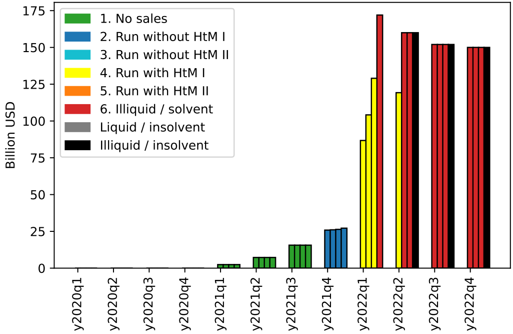

Figure: Equilibrium funding withdrawals from SVB assuming unrealised losses in AfS and HtM portfolios hit capital. For each period there is a group of bars, each of them corresponding to one parameter of the linear impact function (b) from $\{0.0001, 0.0002, 0.001, 0.002\}$.

- Considering accumulated unrealised losses, already at the beginning of 2022 financial conditions of SVB became conducive to bankruptcy
- This aligns with SVB's income outlook presented in earnings reports

HtM vs AfS trade-off

- More HtM reduced volatility of income that would be caused by MtM of assets following daily changes of market prices...
- ...but also reduces liquidity buffers used to cover funding withdrawals in distress market conditions

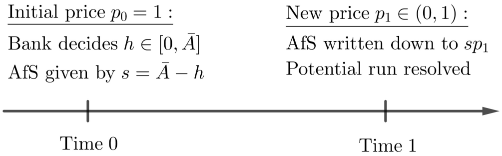

Figure: One-period model for choice of HtM. Here $\bar{A} := A - x - \ell$ are the total marketable securities (that may be designated as AfS or HtM).

- Bank decides on optimal h^*, so no selling of HtM is needed:

$$h^* = \max\{h \in [0, \bar{A}] \mid \mathrm{Asset\_sold}(p_1, \lambda_{\max}) \leq \bar{A} - h\} \tag{4}$$

Optimal HtM as an indicator of funding risk-taking

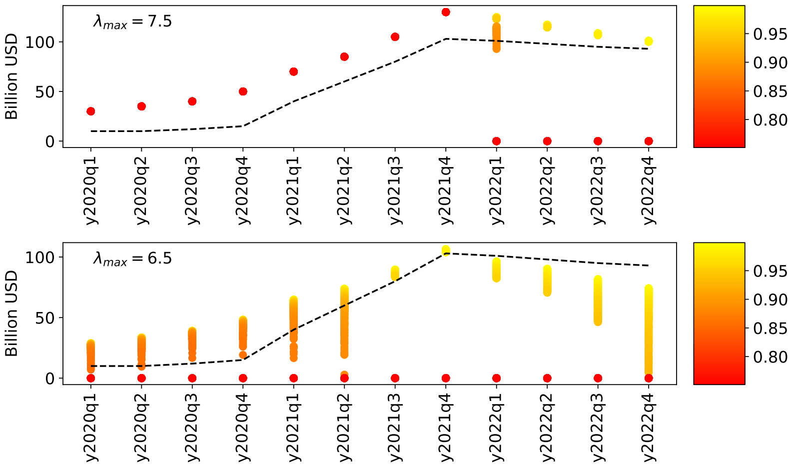

Figure: Optimized volume of HtM represented by colored circles, each of which corresponds to a price shock p_1 with values indicated in the colorbar.
The dashed black line ≡ volumes of HtM portfolios.

Conclusions

Run risk still material...

...despite regulatory efforts

Monitoring tools need...

...for balance sheet vulnerabilities, related to allocation of assets into accounting portfolios, weak funding structure, and marketability of liquidity buffers

The jury is still out on the benefits of HtM accounting

We contribute to the debate from a sustainable business model perspective, as banks should have the ability to hold HtM given their general business model (role for supervisors to ensure this)

APPENDIX

How to calibrate λ_{max}?

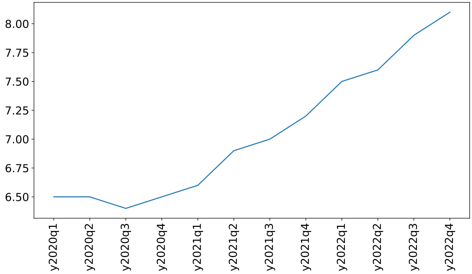

Figure: Minimum λ_{max} that, for a balance sheet of SVB with all securities held in HtM portfolio $(= s + h)$, implies no selling of securities in equilibrium to simulations

- All investors that accept the bank's leverage ratio above the value displayed in Figure would 'confidently' place money at the bank
- The level of the max acceptable λ_{max} increases, reflecting rising balance sheet vulnerabilities of the bank
- A value from the range [6.5,8] can be considered as a benchmark