Idea: Study liquidity regulation in a model where it serves to deter bank runs.

Observation: There is no run equilibrium when the bank has sufficient resources at t=1 to cover both fundamental withdrawals + run withdrawals.

But the bank gets to pick its mix of liquid assets and illiquid assets.

- So when does a profit maximizing bank choose to have sufficient resources at t=1 to rule out existence of a run equilibrium?
- If the bank doesn’t choose to have sufficient resources to rule out a run how can we best regulate it to do so?
When do profit maximizing banks *choose* to have sufficient resources at $t=1$ to rule out existence of a run equilibrium?

- Assume the bank observes all parameters before picking its asset mix, notably fundamental withdrawals $t_s$ and potential run withdrawals $\Delta$.
- It’s always profit maximizing for the bank to fully satisfy fundamental demand out of liquid assets, i.e. $\alpha \geq \frac{t_s r_1}{R_1}$.

- **Proposition 1:** For some parameters it is possible for the bank to deter runs even if it picks the liquid asset share $\alpha^{AIC} = \frac{t_s r_1}{R_1}$ that only covers fundamental withdrawals.
  For these parameters the bank picks $\alpha = \alpha^{AIC}$ and there is no run equilibrium.
The parameter condition:

The bank is solvent having picked $\alpha = \alpha^{AIC}$, even if $\Delta$ of depositors were to run.

- Solvency means that equity holders would have sufficient resources to:
  Pay at $t=1$: $f_1 r_1 = (t_s + \Delta)r_1$ out of liquid assets + liquidated illiquid assets
  Pay at $t=2$: $(1-f_1)r_2$ at $t=2$ out of illiquid assets proceeds.

\[
\left(1 - \alpha\right) - \frac{(f_1 r_1 - \alpha R_1)}{\theta R_2} R_2 - (1 - f_1)r_2 \geq 0 \text{ with } f_1 = (t_s + \Delta) \text{ and } \alpha = \alpha^{AIC}.
\]

Whether this holds depends on $t_s, \Delta, \theta, r_1, r_2, R_1, R_2$

- Example: $t_s=0$

Then $\alpha^{AIC} = 0$ and runs can be deterred even with no liquid assets if:

\[
\left(1 - \frac{\Delta r_1}{\theta R_2}\right) R_2 - (1 - \Delta)r_2 \geq 0 \iff R_2 - r_2 + \Delta \left( r_2 - \frac{r_1}{\theta} \right) \geq 0
\]

So, more wholesale funding makes it less likely that runs are automatically deterred by a profit maximizing bank.
What if the parameter condition doesn’t hold?

- Proposition 2: With full information a bank (or a regulator) seeking to deter runs will choose $\alpha_s = \max\{\alpha_s^{AIC}, \alpha_s^{stable}\}$

$\alpha_s^{stable}$ is the smallest value of alpha that ensures solvency at $t=1$ with both fundamental and run withdrawals

$$\left( (1 - \alpha) - \frac{(f_1 r_1 - \alpha R_1)}{\theta R_2} \right) R_2 - (1 - f_1) r_2 = 0 \text{ with } f_1 = (t_s + \Delta)$$

When the parameter condition doesn’t hold, then $\alpha_s^{stable} > \alpha_s^{AIC}$ meaning that the bank must hold more liquidity than the fundamental demand in order to deter runs.

- Notice: Proposition 2 didn’t answer the question of what a profit maximizing bank will do when the parameter condition doesn’t hold.
Summary on when there is a role for regulation:

<table>
<thead>
<tr>
<th>Parameter cond. holds</th>
<th>Parameter cond. doesn’t hold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depositors see $\alpha$</td>
<td>No (A)</td>
</tr>
<tr>
<td>Depositors don’t see $\alpha$</td>
<td>No (B)</td>
</tr>
</tbody>
</table>

- (A), (B): Depositors know the condition holds and that the bank will pick this $\alpha$ in its own best interest. Doesn’t matter whether depositors can observe $\alpha$. No regulation needed.

- (C): Unclear from paper, more below.

- (D): Here we do need regulation. If depositors cannot verify that the bank in fact picked $\alpha^{stable}$, then $\alpha^{stable}$ doesn’t deter runs and then the bank wouldn’t pick it.
What are some possible regulations that will work in ruling out a run equilibrium?

• Mandate a value of $\alpha$: Similar to NSFR.

  This works well if the mandated value can be bank-specific:
  - If the regulator can observe $\alpha$ and $t_s$, then mandate $\alpha^*_s = \max\{\alpha^{ALC}_s, \alpha^{stable}_s\}$
  - Efficient in that in a run there is no unused liquidity.

  Works less well if the mandated value cannot be bank-specific:
  - Suppose the regulator can observe $\alpha$, but only knows the distribution of $t_s$.
    Then the mandated $\alpha^*_s = \max\{\alpha^{ALC}_s, \alpha^{stable}_s\}$ must be the one that rules out runs for the highest possible $t_s$, call that $\bar{t}$.
  - Inefficient in that for most banks hold more liquidity than they need in a run.

  **Mechanism design:** If the regulator is sufficiently powerful (in terms of punishments for lying), it can make the bank reveal $t_s$ truthfully and thus make the mandated value bank-specific.
• Mandate how much liquidity must be held after \( t=1 \) withdrawals: Similar to LCR.

Mandate safe assets of \( \rho(1 - f_1) \) at \( t=1 \) after withdrawals (which may include run withdrawals).

It’s always profit maximizing for the bank to fully satisfy fundamental demand plus liquidity requirement out of liquid assets, i.e. \( \alpha_s \geq \frac{tsr_1 + \rho(1-t_s)}{R_1} \).

**Prop 3.** If there is a value of \( \rho_s \) such that the bank is solvent even with a run, when holding only enough liquid assets to cover fundamental withdrawals plus the liquidity requirement, then the regulator can mandate this \( \rho \) and deter runs. If it exists, this \( \rho_s \) solves

\[
\left( (1 - \alpha_s) - \frac{(fr_1 + \rho_s(1-f_1) - \alpha_s R_1)}{\theta R_2} \right) R_2 - (1 - f_1)(r_2 - \rho_s R_1) = 0
\]

with \( \alpha_s = \frac{tsr_1 + \rho(1-t_s)}{R_1} \), \( f_1 = (t_s + \Delta) \).

Notice that unless \( (t_s + \Delta)=1 \), there’s unused liquidity even in a run.
Comparing LCR ($\rho$) to NSFR ($\alpha$):

If the regulator can observe $\alpha$ and $t_s$ then it’s generally better to regulate $\alpha$ since this ensures no unused liquidity in a run and thus more illiquid investment upfront.

In the limit case with $f_1 = (t_s + \Delta) = 1$ is regulating $\rho$ as efficient as regulating $\alpha$: Then all liquidity is released in a run and $\rho_s$ leads to $\alpha = \alpha_s^{stable}$.

$\alpha_s^{stable}$ solves: 

$$
\left( (1 - \alpha) - \frac{(f_1 r_1 - \alpha R_1)}{\theta R_2} \right) R_2 - (1 - f_1) r_2 = 0 \text{ with } f_1 = 1
$$

$\rho_s$ solves: 

$$
\left( (1 - \alpha_s) - \frac{(f_1 r_1 + \rho_s (1-f_1) - \alpha_s R_1)}{\theta R_2} \right) R_2 - (1 - f_1) (r_2 - \rho_s R_1) = 0
$$

with $\alpha_s = \frac{t_s r_1 + \rho (1-t_s)}{R_1}$ and $f_1 = 1$
If the regulator cannot observe $\alpha$ and $t_s$ then it may be better to regulate $\rho$:

- Each approach must rule out runs for the highest possible $t_s$, $\bar{t}$.

- Consider the case with $f_1 = (\bar{t} + \Delta)=1$. Here it’s clearly better to regulate $\rho$:

For a bank with $t_s = \bar{t}$ the two approaches are equivalent as we saw above. Imposing $\alpha^{stable}$ or $\bar{\rho}$ leads to identical values of $\alpha$.

But for any bank with $t_s < \bar{t}$ imposing $\bar{\rho}$ leads to lower $\alpha$ than imposing $\alpha^{stable}$:

$$\alpha_s = \frac{t_s r_1 + \bar{\rho} (1-t_s)}{R_1},$$

with the bank’s own $t_s$, not with $\bar{t}$.

When regulating $\rho$, the bank gets to use information about its own $t_s$ to economize on liquid asset holdings.
Comment 1. Give more guidance on whether we actually need regulation when the parameter condition doesn’t hold. Link to global games literature?

Proposition 2 didn’t answer the question of what a profit maximizing bank will do when the parameter condition doesn’t hold.

- With full information (depositors observe $\alpha$): Unclear which $\alpha$ the bank picks.

  Could pick $\alpha^{AIC}$ in which case profits are random:
  - If run: Zero
  - If no run:

    $$(1 - \alpha^{AIC})R_2 - (1 - t_s)r_2$$

  Could pick $\alpha^{stable}$ in which case profits are known (there’s no run):

    $$(1 - \alpha^{stable})R_2 + (\alpha^{stable}R_1 - t_s r_1)R_1 - (1 - t_s)r_2$$

  Without assigning probabilities to the run vs. no-run equilibrium, we cannot tell what the bank will in fact prefer.
• How do we make progress on this?

Some papers (e.g. Ennis and Keister (2006)) simply assume a fixed probability of a run if a run is possible. That doesn’t seem meaningful. Where does the probability come from? Shouldn’t it depend on parameters?

Others (e.g. Goldstein and Pauzner (2005), Vives (2014)) take a global games approach: The idea is to make fundamentals stochastic and give people private information about fundamentals.

- Each person is assumed to run if he thinks the probability that this is advantageous is above some fixed value γ
- Those with sufficiently bad private signals run, but as the variance of the private signal goes to zero everyone does the same thing – for fundamentals below some cutoff everyone runs.
• I’d like to hear the authors’ take on the global games approach:

  o What is optimal liquidity regulation in that framework?
    \( (\alpha \text{ then affects fundamentals}) \)

  o Or maybe they don’t think that approach is meaningful?
    Perhaps because of the argument made by Hellwig, Mukherji and Tsyvinski (2006) that once you allow for inference from market prices, multiple equilibria re-emerge?

  o Currently the paper just says that Vives (2014) didn’t study the need for regulation.
Comment 2. We really don’t know $\theta$ (drives the liquidation payoff $\theta R_2$)

Lots of discussion of who knows $\alpha$ and who knows $t_s$ in the paper.

Equally big issue: No one knows $\theta$, perhaps not even the bank.

$\theta$ depends on whether the bank is:

a) Recalling loans causing liquidating capital (firms, houses). Then $\theta<<1$.

b) Selling loans against capital to someone else. Then $\theta$ depends on:
   - Whether buyer can collect as much cash from the borrower
   - How much cash is on the side lines ready to buy
   - Whether the run is only on one bank or the whole banking sector
If we don’t know $\theta$, it’s **hard to assess whether we need regulation** (the proposition 1 parameter condition) and **what optimal regulation is**.

- How does a profit-maximizing bank react to uncertainty about $\theta$?
- Are we supposed to make the bank solvent even for the worst possible $\theta$? Then there will be very little lending.

If $\theta = 0$ and $(t_s + \Delta) = 1$, then $\alpha_s^{stable} = \frac{r_1}{R_1}$ which is close to 1.

More analysis of this issue would be useful.

**Similar comments apply to $\Delta$:**

We really don’t know $\Delta$ with any precision, and again the bank may not even know it.
Comment 3. The bank’s funding cost should depend on whether it rules out runs

In the model:

• The bank borrows at a low rate ($r_1 < R_1$) regardless of whether it’s run proof.
• Even if it’s not run-proof, it gets funding below the Treasury rate.

In reality:

• The bank’s asset mix ($\alpha$) affects its funding cost: $r_1$ should depend on $\alpha$ and in particular on whether $\alpha$ deters runs and, if not, how large losses deposits incur in a run.
• And emerging evidence suggest that investors are willing to pay a premium for extremely safe investments.
• Accounting for this makes it more likely that we don’t need regulation.
• Even if we do, optimal regulation should account for the value created from regulation increasing the supply of completely safe assets.
Comment 4. Is it meaningful to study optimal regulation in a model where there are no benefits from non-sleepy short-term funding?

\( \alpha^\text{stable} \) is increasing in \( \Delta \).

- \( \Delta \) is the amount of non-sleepy short-term funding.
- The fact that these investors pay attention and may suddenly run due to a sunspot makes it look like we should be happy to regulate them away, or regulate them into providing longer-term financing.

In reality, non-sleepy short-term investors serve a purpose: More money-like (i.e. completely riskless) claims can be created at \( t=0 \) if you have non-sleepy investors.
Hanson, Shleifer, Stein and Vishny (2014) model how a bank can create money-like (i.e. completely safe) claims by either:

- Attracting **sleeping investors** by **constraining the deposit intake**:
  If the bank has enough equity financing, deposits are safe even if depositors don’t pay attention. Depositors can be sleepy and all withdraw at t=2.

- Having **non-sleepy short-term investors who ensure liquidation at t=1 if bad news arrive**. That avoids potential losses at t=2 had funding been renewed.

Assume:
- The worst possible asset value at t=1 is not as low as the worst possible value at t=2
- The liquidation cost at t=1 is sufficiently small

Then: More money-like claims can be created at t=0 if you have non-sleepy investors.

- In equilibrium the mix of “traditional banking” (rely sleepy investors) and “shadow banking” (rely on non-sleeping investors) **equilibrates** via the liquidation cost being increasing in the amount of shadow banking.
In this model, the liquidations at $t=1$ serve the purpose of keeping deposits riskless. It’s **not profit maximizing to issue more deposits than you can pay off in liquidation.**

The Hanson et al paper is not about regulation.

- In their framework there is likely still too much shadow banking (wholesale funding) because each shadow bank doesn’t internalize its effect on the fire sale externality.

- Would be interesting to think about optimal liquidity regulation in that framework.
Comment 5. Intermediation chains

There’s a stabilizing -- but investment reducing -- effect of liquidity regulation which is not in the model:

- The model has no intermediation chains. If you allow for those, liquidity regulation will make chains costly unless you consider interbank claims riskless.

Example: Suppose you mandate 50% liquid assets against deposits.

You have one bank with $100 in deposits:
- $50 of riskless assets are mandated.
- $50 can be lent out to firms/households.

But what if the bank has few good prospects and lends out the $50 to another bank:

Then the borrowing bank has $50 in short-term funding and another $25 of riskless assets are mandated unless interbank claims are considered riskless. Now there’s only $25 to be lent out.

Treatment of interbank claims (and other chains) in liquidity requirements are thus a central issue for how much stability they generate.
Comment 6. Optimal liquidity regulation will depend on other policies

Monetary policy rate:

Would be interesting to study the impact of monetary policy on run risk and optimal liquidity regulation within the current model. There are several effects.

1) The lower the short rate, the more demand deposits people want: $M/P = L(y,r)$. They substitute demand deposits for time and savings deposits. That makes the financial sector less run-proof: Increases $\Delta$ and $t_s$.

2) Lower short rates compress spreads and lower bank profitability (Drechsler, Savov and Schnabl (2015)). That again makes the financial sector less run-proof (via $r_1$, $r_2$, $R_1$, $R_2$).

So, will optimal liquidity regulation tighten $\alpha_s^{stable}$ when rates are low? This constrains loan supply in bad times to ensure financial stability....
Treasury supply, possibly Treasury maturity structure:

Treasury supply strongly crowds out financial sector short-term debt backed by illiquid lending (Krishnamurthy and Vissing-Jorgensen (2015)):

- Increased Treasury supply makes banking less fun (compresses spreads). The financial sector by itself cuts back on risk → Less need for regulation.