# The Tipping Point: Low Rates and Financial Stability[a,b]

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[a] Link to the paper's latest version on *www.dporcellacchia.com*.

[b] This paper represents my own views, not necessarily those of the European Central Bank or Eurosystem.

# Research question

What is the effect of low interest rates on financial stability?

**Very quick answer:**

- Excessively low rates lead to bank insolvency.
- With the right model, we can quantify the tipping-point rate.

# Literature

**Effect of low rates on bank profitability.**

- Borio, Gambacorta, and Hofmann (2017), Altavilla, Boucinha, and Peydró (2018), Claessens, Coleman, and Donnelly (2018), and Ampudia and van den Heuvel (2019).

**Effect of low rates on wider economic developments:**

1. *Credit supply.* Brunnermeier and Koby (2018) and Eggertsson et al. (2019).
2. *Risk taking.* Maddaloni and Peydró (2011), Jiménez et al. (2014), Di Maggio and Kacperczyk (2017), Martinez-Miera and Repullo (2017), and Heider, Saidi, and Schepens (2019).

**Liquidity creation and financial stability.**

- Diamond and Dybvig (1983), Allen and Gale (1998), Gertler and Kiyotaki (2015), Quadrini (2017), Segura and Suárez (2017), and Fernández-Villaverde et al. (2020).

**Franchise value of deposits.**

- Di Tella and Kurlat (2017) and Drechsler, Savov, and Schnabl (2018).

## What is the effect of low interest rates on financial stability?

**Two effects:**

- ⊕ Asset-revaluation effect.
- ⊖ Compression of net interest spread.

**Main result:** There is a tipping-point rate.

- Below tipping point, financial crisis.
- It is function of observable bank characteristics.

**Methodological contribution:** Recursive Diamond-Dybvig model.

- Clear role of bank's net interest spread for financial stability.
- Endogenous objects stable over time.

# Toy version of the model

**Framework:**

- Infinite horizon with $t = 0, 1, \ldots$.
- At time 0, the **bank** has $B$ assets and $D$ deposits outstanding.
  - Interest rate on assets is $\rho > 0$. Deposits earn deposit rate $d$.
  - *Liquidity creation*: $D > B$.
- At each date, the **depositor** withdraws all deposits with probability $\phi \in (0, 1)$.

# Bank balance sheet

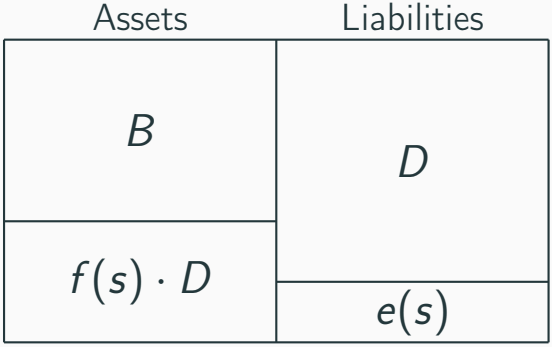
- $1+s=\frac{1+\rho}{1+d}$, *net interest spread* (NIS).

The risk-neutral valuation of bank equity $e$ is

$$e=\phi\cdot(B-D)+\phi\cdot(1-\phi)\cdot\frac{(1+\rho)\cdot B-(1+d)\cdot D}{1+\rho}+\phi\cdot(1-\phi)^2\cdot\frac{(1+\rho)^2\cdot B-(1+d)^2\cdot D}{(1+\rho)^2}+\ldots= \tag{1}$$
$$=B-[1-f(s)]\cdot D,$$

with *franchise value of deposits* (FVD)

$$f(s)=\underbrace{\frac{1-\phi}{\phi+s}}_{\substack{\text{Expected time}\\ \text{to withdrawal}}}\times\underbrace{s}_{\text{NIS}}. \tag{2}$$



# Bank behaviour & tipping point $\underline{\rho}$

Bank chooses the NIS $s$

- to set bank equity $e = 0$,
- subject to ZLB $d \geq 0 \implies s \leq \rho$.

$\rightarrow$ *Micro-foundation:*
  - Exclusive bank-depositor relationship with perfect competition ex-ante.
  - Cash as outside option for depositor.

$\rightarrow$ Easy to generalise bank behaviour to have $e > 0$.

**Target NIS $s^*$:**

$$0 = B - [1 - f(s^*)] \cdot D \tag{3}$$

$\rightarrow$ Liquidity creation $\implies s^* > 0$.

**Equilibrium NIS:**

$$s = \min \{s^*, \rho\}. \tag{4}$$

**Proposition 1:** Bank is insolvent with $e < 0$ iff $\rho < \underline{\rho}$ where $\underline{\rho} = s^*$.

# Tipping point with long-term assets 1/2

- Bank-asset duration $\tau > 0$.

$$e = B(\rho) - [1 - f(s)] \cdot D. \tag{5}$$

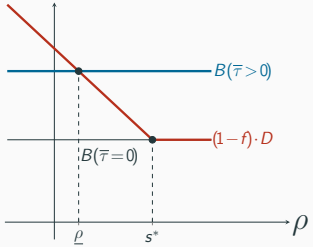
**Mechanism:**

$$\rho \downarrow \implies \begin{array}{l} 1.\ \textit{Erosion of FVD: } \rho < s^* \implies f \downarrow. \\ 2.\ \textit{Asset-revaluation effect: } B \uparrow. \end{array}$$

- Approximation for $\tau$ small enough.

$$\frac{\Delta B}{B} \cong \tau \cdot \ln(1 + d^*). \tag{6}$$

$$\frac{\Delta f}{1 - f} \cong -\frac{\partial f / \partial s}{1 - f} \cdot (\rho - s^*) \cdot \mathbb{1}_{\rho < s^*}. \tag{7}$$



# Tipping point with long-term assets, 2/2

**Proposition 2**

Consider $\tau > 0$ small enough.

The bank is insolvent with $e < 0$ iff $\rho < \underline{\rho}$ where

$$\underline{\rho} = s^* - \underbrace{\frac{\tau}{\frac{\partial f/\partial s}{1-f}}}_{\text{Effective duration gap at ZLB}} \cdot \ln(1 + d^*). \tag{8}$$

$\frac{\partial f/\partial s}{1-f}$ = interest-rate elasticity of the value of deposits once $d = 0$.

$\rightarrow$ Interpret it as the *effective duration of deposits at ZLB*.

# Quantitative analysis, 1/2

**Problem:** Find empirical counterpart for effective duration of deposits at ZLB.

**Naïve solution:** Use statutory duration of bank liabilities of 0.41 years (English, Van den Heuvel, and Zakrajšek 2018).

**Complete solution:**
*Step 1:* Find effective duration of deposits in normal times (data 1997-2007).

$$\frac{\mathrm{d}f/\mathrm{d}\rho}{1-f} = \frac{1}{1-e/B} \cdot \underbrace{\left(\tau + \frac{e}{B} \cdot \frac{\mathrm{d}e/\mathrm{d}\rho}{e}\right)}_{4Y \,+\, 9\% \cdot (-10Y)} = 3 \text{ years.} \tag{9}$$

# Quantitative analysis, 2/2

*Step 2:* Adjust for zero interest-rate pass-through at ZLB.

$$\frac{\partial f/\partial s}{1-f} = \underbrace{\frac{\mathrm{d}f/\mathrm{d}\rho}{1-f}}_{3Y} \cdot \frac{1+d^*}{1-(1+s^*)\cdot \mathrm{d}d/\mathrm{d}\rho} = 5 \text{ years} \tag{10}$$

- $\mathrm{d}d/\mathrm{d}\rho = 0.354$ (Drechsler, Savov, and Schnabl 2018).
- $d^* = 2.54\%$ in September 2007 (M2 own rate).
- $s^* = 2.64\%$ in September 2007.

**How low could Ben go?**

- What was the tipping-point rate in September 2007, as Federal Reserve started its rate cuts?

$$\underline{\rho} = \underbrace{s^*}_{2.64\%} - \underbrace{\frac{\tau}{\frac{\partial f/\partial s}{1-f}}}_{0.9} \cdot \underbrace{\ln(1+d^*)}_{2.54\%} = 0.3\%. \tag{11}$$

*Caveats:* (1) Permanent unanticipated interest-rate change, (2) No capital buffer.

# Microfoundation: recursive banking model

**Ingredients:**

1. Idiosyncratic liquidity shocks as in Diamond and Dybvig (1983) but over infinite horizon.
2. Long-term assets and storage.
3. Fundamental runs (Allen and Gale 1998).

**Results:**

- Two steady states.
  1. Good SS:
     - *Liquidity creation*: $D > B$.
     - Solvent banks: $e = 0$ with $s = s^*$.
  2. Bad SS:
     - No intermediation: $B = 0$.
     - Bankrupt banks: $e < 0$.
- Financial crisis: transition from good SS to bad SS.
  - Iff $e < 0$, economy converges to bad SS.

# Conclusion

## What is the effect of low interest rates on financial stability?

**Theoretical results.**

1. Two constrasting effects:
   - $\oplus$ Asset-revaluation effect.
   - $\ominus$ Erosion of FVD.
2. Relative strength determines the *tipping-point rate*.
   - It depends on bank's *effective duration gap at the ZLB*.

**Quantitative result:**

- Effective duration of deposits at ZLB $\cong$ 5 years.
- Asset-revaluation effect much weaker than naïve calculation suggests.

**Methodological contribution:**

- Diamond-Dybvig model features endogenous FVD.
- Recursive version suitable for quantitative analysis.

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