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

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17 June 2021

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[a]Link to the *paper's latest version* and *slides' 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 bank stability?

Very quick answer:

- There is a cut-off rate below which low rates lead to **bank insolvency**.
- Using the model, we can quantify this **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 bank 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 bank stability?

Two effects:

- ⊕ Asset-revaluation effect.
- ⊖ Compression of interest margin.

Main result: There is a tipping-point rate.

- Below tipping point, financial crisis.
- It is function of observable bank characteristics.
- We can quantify it.

Methodological contribution: Infinite-horizon Diamond-Dybvig model.

- Deposit-franchise interpretation of the model.
- Clear role of interest margin for bank stability.

Primitives of the model

- Unit measure of infinitely-lived households with
- unit endowment at time -1.

Preferences:

- Household turns impatient with probability $\phi \in (0, 1)$.

$$E_0(\mathcal{U}) = \phi \cdot u(C_0) + (1-\phi) \cdot \phi u(C_1) + (1-\phi)^2 \cdot \phi \cdot u(C_2) + \dots \quad (1)$$

- Flow utility u has constant IES $\alpha < 1$.

Technology:

1. Productive technology K:
   - one-period net return $\rho > 0$,
   - only firms can operate.
2. Storage technology S:
   - one-period net return 0,
   - Both consumers and banks can operate.

$\to K \succ S$.

Efficiency

A **social planner** chooses $\{C_t, K_t\}$ to maximise aggregate welfare

$$\sum_{t=0}^{+\infty} (1-\phi)^t \cdot \phi \cdot u(C_t) \tag{2}$$

subject to resource constraints

$$K_t + (1-\phi)^t \cdot \phi \cdot C_t = (1+\rho) \cdot K_{t-1} \quad \text{for all } t \geq 0. \tag{3}$$

Efficiency requires

$$\frac{C_{t+1}}{C_t} = (1+\rho)^{\alpha} \quad \text{for all } t \geq 0. \tag{4}$$

- $\alpha < 1 \implies$ relatively smooth consumption pattern.

Decentralised economy

Agents:

1. Households
   - hold deposits or storage.
   - $\rightarrow$ ZLB on deposit rate.
2. Banks
   - lends to firms via long-term bonds and
   - borrows via deposits.
3. Firms
   - operate the productive technology.

Long-term bond:

- Bond issued at time $t-1$ is equivalent to γ bonds issued at t.
- Bond duration is increasing in $\gamma \in [0,1)$.

Firms

- Competitive firms
- operate productive tech and
- borrow via long-term bonds.

By arbitrage

$$Q_t = \frac{1}{1+\rho} \cdot \sum_{s=t}^{+\infty} \left(\frac{\gamma}{1+\rho} \right)^{s-t} = \frac{1}{1+\rho-\gamma}. \tag{5}$$

Withdrawal decision and bank solvency

- Focus on fundamental runs (Allen and Gale 1998).

Impatient HHs withdraw all their deposits and *patient HHs withdraw* according to

$$W_t^p = \begin{cases} 0 & \text{if bank is solvent,} \\ D_t & \text{if bank is insolvent.} \end{cases} \tag{6}$$

Bank solvency: If patient HHs do not withdraw, bank can pay at least a zero deposit rate forever.

$\rightarrow$ Withdrawing is never dominant strategy for patient HH.

$$(1 + \gamma \cdot Q_t) \cdot B_t \geq \sum_{s=t}^{+\infty} \left(\frac{1-\phi}{1+\rho} \right)^{s-t} \cdot \phi \cdot D_t \quad \text{for all } t \geq 0. \tag{7}$$

Banks

Competitive banks offer deposit contract $\{B_t, D_t\}$ that maximises

$$\sum_{t=0}^{+\infty} (1-\phi)^t \cdot \phi \cdot u(D_t) \tag{8}$$

subject to budget constraints

$$Q_t \cdot B_{t+1} + (1-\phi)^t \cdot \phi \cdot D_t = (1 + \gamma \cdot Q_t) \cdot B_t \quad \text{for all } t \geq 0, \tag{9}$$

$$Q_{-1} \cdot B_0 = 1, \tag{10}$$

and solvency constraints.

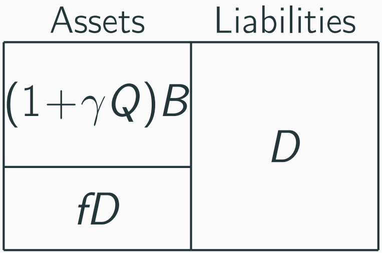
Equilibrium results:

- Solvency constraints are not binding.
- Efficient allocation.

Liquidity creation

- $1 + m_t = \frac{1+\rho}{1+d_t}$, *interest margin*.

$$\frac{(1 + \gamma \cdot Q_t) \cdot B_t}{D_t} = \frac{[1 + \gamma \cdot Q(\rho)] \cdot B^*}{D^*} < 1 \quad \text{for all } t \geq 0. \tag{11}$$

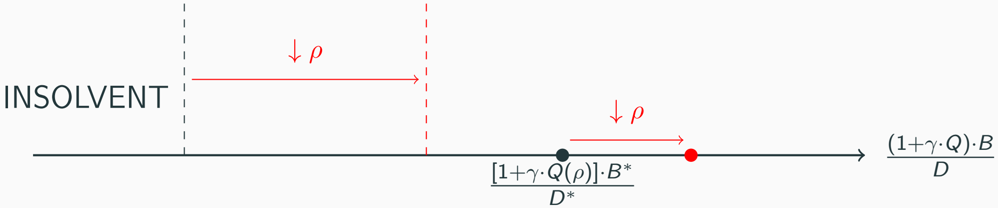


Deposit franchise:

$$m_t = m^* > 0 \quad \text{for all } t \geq 0. \tag{12}$$

$$f^* = \underbrace{\frac{1-\phi}{\phi+m^*}}_{\substack{\text{Expected time} \\ \text{to withdrawal}}} \cdot m^*. \tag{13}$$

Low rates and solvency



Consider an unanticipated and permanent fall in the interest rate ρ.

Effects:

1. Interest margin becomes thinner.
2. Revaluation effect strengthens bank balance sheet.

Tipping point with zero asset duration

Proposition 1: Consider $\gamma = 0$. There exists a unique tipping point $\underline{\rho}$ such that, if $\rho < \underline{\rho}$, then the bank is insolvent. It is given by

$$\underline{\rho} = m^*. \tag{14}$$

- No revaluation effect.
- At $\rho < \underline{\rho}$, the ZLB implies a compressed interest margin.

Tipping point with long-term assets

- $\Gamma \equiv \frac{\mathrm{d}\ln(1+\gamma\cdot Q)}{\mathrm{d}\ln(1+\rho)} = \frac{\gamma}{1+\rho-\gamma}$, *bank-asset duration.*

Proposition 2: Consider γ small enough. There exists a unique tipping point $\underline{\rho}$ such that, if $\rho < \underline{\rho}$, then the bank is insolvent. It is given by

$$\underline{\rho} = m^* - \underbrace{\frac{\Gamma}{\frac{\mathrm{d}f^*/\mathrm{d}\ln(1+m^*)}{1-f^*}}}_{\text{Effective duration gap at ZLB}} \cdot d^*. \tag{15}$$

- $\frac{\mathrm{d}f^*/\mathrm{d}\ln(1+m^*)}{1-f^*}$: $m\downarrow \implies f\downarrow$?

(Sketch of) quantitative analysis

1. Effective duration of deposits in *normal times*
    - 100bps interest-rate cut $\implies$ 10% increase in bank equity (English, Van den Heuvel, and Zakrajšek 2018).
    - Little given bank leverage and asset duration.

    $\rightarrow$ 100bps interest-rate cut $\implies$ 4% decrease in deposit franchise.

2. *ZLB correction*.
    - Adjust for absence of interest-rate pass-through.
    - Pass-through in normal times is 0.354 (Drechsler, Savov, and Schnabl 2018).

    $\rightarrow$ 100bps interest-rate cut $\implies$ 6% **decrease in deposit franchise at ZLB**.

How low could Ben go?

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

$$\underline{\rho} \; = \; m^* \; - \; \underbrace{\frac{\tau}{\frac{\partial f^* / \partial \ln(1+m)}{1-f^*}}}_{0.7} \cdot d^* \; = \; 0.7\%. \tag{16}$$

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

$\Longrightarrow$ Conservative estimate.

- Effective duration of deposits is high.
- *Naïve estimate:* Statutory duration of bank liabilities is 0.4 years $\Longrightarrow$ tipping point $= -20\%$.

Conclusion

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

Theoretical results.

1. Two opposite effects:
   - $\oplus$ Asset-revaluation effect.
   - $\ominus$ Erosion of deposit franchise.
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 is large ($\approx$ 6 years).
  - $\rightarrow$ Erosion of deposit franchise matters.

Methodological contribution: Infinite-horizon Diamond-Dybvig model.

- Deposit-franchise interpretation of the model.
- Suitable for quantitative analysis.

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