A macroeconomic model of liquidity crises

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Financial crisis of 2007-2009

- shortage of liquidity in various markets:
  - repo (repurchase agreement) market:
    - Gorton and Metrick (2009), Lucas and Stokey (2011), etc.
  - commercial paper:
    - Arteta, Carey, Correa, and Kotter (2010), Covitz, Liang, and Suarez (2009), Kacperczyk and Schnabl (2010), etc.
- a “systemic event” in the sense that the financial intermediary sector became insolvent as a whole (Gorton and Metrick, 2009).
- triggered the Great Recession.
- Arellano, Bai and Kehoe (2012):
  - The decline in output in the recent recession is mostly accounted for by the deterioration in the labor wedge (not by the decline in the TFP).
What we do in this paper

- develop a model that captures key features of liquidity crises, i.e.,
  - sudden evaporation of the supply of short-term funds;
  - sharp increase in the short-term interest rates;
  - worsening of the labor wedge;
  - disproportionate decline in the economic activity.
- consider two polar cases:
  - fundamental crises;
  - self-fulfilling (or sunspot) crisis.
- policy trade-off:
  - Guaranteeing bank deposits reduces the likelihood of self-fulfilling crises but raises that of fundamental crises.
Key assumption: Limited commitment

- Firms cannot commit to pay for the factors of production (labor and capital).
- This assumption makes liquidity essential in the production process.
  - Owners of the factors of production demand to get paid before output is produced.
  - Firms obtain short-term loans from banks for the advance payments to their factors.
- A crisis occurs whenever firms fail to obtain enough liquidity.
- In particular, it worsens the labor wedge, and hence reduces output.
  - Firms cannot commit to pay MPL to workers.
  - Without advance payments, the equilibrium wage rate indeed becomes far smaller than the MPL.
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Examples

- Self-fulfilling crises
- Fundamental crises

Model economy

Equilibrium in the sunspot shock economy

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Production

- A depositor ($D$), a bank ($B$), and a firm ($F$).
- $50 = \text{existing debt of } B \text{ and } F$.

\[ \begin{align*}
   D & \xrightarrow{50} B & B & \xrightarrow{50} F
\end{align*} \]

- Production:
  - If $F$ obtains short-term loans (liquidity) of 10 in the current period, it produces 70.

\[ \begin{align*}
   D & \xrightarrow{50} B \xrightarrow{10} F & F & \xrightarrow{70}
\end{align*} \]

- Otherwise, $F$ can produce only 30.

\[ \begin{align*}
   D & \xrightarrow{50} B \xrightarrow{0} F & F & \xrightarrow{30}
\end{align*} \]
Normal equilibrium

- $R^F$ and $R^B =$ interest rates on short-term loans and deposits:

\[
\begin{align*}
D &\xrightarrow{50+10} 50+R^B10 \\
B &\xleftarrow{50+R^B10} 50+R^B10 \\
F &\xrightarrow{50+R^F10} 70 - (50 + R^F10)
\end{align*}
\]

- Equilibrium interest rates:

\[
R^B = R^F = 1.
\]

- $D$ and $B$: break-even, and $F$: profit of 10.

\[
\begin{align*}
D &\xrightarrow{60} 60 \\
B &\xleftarrow{60} 60 \\
F &\xrightarrow{60} 70 - 60 = 10
\end{align*}
\]
Crisis equilibrium

- Liquidity (10) is not provided.
- $B$ and $F$ default, and $D$ loses 20.

\[
\begin{align*}
D & \xrightarrow{50} B \xleftarrow{30} F \\
\end{align*}
\]

\[
F : 30 < 50
\]

- $\xi^F$ and $\xi^B =$ recovery rates of loans and deposits:

\[
\xi^B = \xi^F = \frac{30}{50}.
\]
Crisis equilibrium

- A crisis occurs as an equilibrium with the following interest rates:
  \[ R^B = \frac{1}{\xi^B} = \frac{5}{3}, \quad \text{and} \quad R^F = \frac{1}{\xi^F} R^B = \frac{25}{9}. \]

- Under these rates, \( F \) defaults.
  \[
  \pi^F = \begin{cases} 
  70 - 50 - R^F 10 = -7.778 < 0, & \text{if } F \text{ borrows 10,} \\
  30 - 50 < 0, & \text{otherwise.}
  \end{cases}
  \]

- \( B \) defaults as well:
  \[
  \pi^B = \begin{cases} 
  \xi^F (50 + R^F 10) - (50 + R^B 10) = -20 < 0, & \text{if } B \text{ lends 10,} \\
  \xi^F 50 - 50 = -20 < 0, & \text{otherwise.}
  \end{cases}
  \]

- \( D \) is indifferent: \( \xi^B R^B = 1 \).
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Productivity shock

- A bad productivity shock arrives so that
  - Even with a short-term loan of 10, $F$ can only produce 50, rather than 70:
    \[
    D \xrightarrow{50} B \xrightarrow{10} F \xrightarrow{50} 50
    \]
  - Without it, $F$ can produce only 30, just as before.
    \[
    D \xrightarrow{50} B \xrightarrow{0} F \xrightarrow{50} 30
    \]
Fundamental crisis

- For any short-term rate of loans, $R^F \geq 1$, $F$ would go default:

$$\pi^F = 50 - (50 + 10 \cdot R^F) < 0,$$

and thus $F$ necessarily goes bankrupt and no short-term loans are supplied.

- Again, the failure of $F$ makes $B$ default as well:

$$\pi^B = 30 - 50 < 0.$$

- Short-term rates:

$$R^B = \frac{1}{\xi^B} = \frac{5}{3},$$

$$R^F = \frac{1}{\xi^F} R^B = \frac{25}{9}.$$
Households

- Infinitely-lived, representative household.
  - consumes, saves, and supplies labor.

- Overlapping generations of 2-period lived firms:
  - 1st period: borrow from banks to purchase capital;
  - 2nd period: borrow from banks to hire labor, and produce output.

- Overlapping generations of 2-period lived banks:
  - 1st period: collect deposits, obtain equity, and make loans to firms;
  - 2nd period: collect deposits, make loans to firms, receive payments from firms, and repay depositors and equity holders.

- Frictions:
  - Wages must be paid before output is produced;
  - Banks are subject to the moral hazard constraint as in Gertler and Karadi (2011).
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Self-fulfilling crisis

- States of nature
  - $\Omega = \{n, b\}, \Omega^n = \{n\}, \text{and } \Omega^b = \{b\}$.
  - $\Pr(s_t = n) = 1 - \varepsilon$, and $\Pr(s_t = b) = \varepsilon$.

- When $s_t = b$,
  - both firms and banks are expected to go bankrupt;
  - the recovery rates of loans and deposits are expected to become $\xi^F$ and $\xi^B$, respectively;
  - the short-term interest rates rises to $R^B_t = \frac{1}{\xi^B}$ and $R^F_t = \frac{1}{\xi^F \xi^B}$;
  - with these rates, firms and banks indeed go default;
  - no liquidity is supplied;
  - the labor wedge rises;
  - output is depressed.
Equilibrium in the fundamental shock economy

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Equilibrium in the fundamental shock economy

Fundamental crisis

- States of nature
  - $A(s_t) = s_t$.
  - $\Omega = [0, +\infty)$, $\Omega^b = [0, s)$, and $\Omega^n = [s, +\infty)$.
- Threshold value $s$ is defined by the firm’s break-even condition:
  $$A(s)l(s)^{1-\alpha} + q(s) - R^F(s)w(s)l(s) - R^L(s_-)q(s_-) = 0,$$
  where $s_- = \text{state in the previous period}$.
- When $s_t < s$,
  - The productivity is so low that firms go bankrupt;
  - It causes banks to default;
  - The short-term rates go up to $R^B_t = \frac{1}{\xi^B}$ and $R^F_t = \frac{1}{\xi^F \xi^B}$;
  - no liquidity is supplied;
  - the labor wedge rises;
  - market activity is depressed.
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Deposit guarantee policy

- Consider the following policy:
  - The government gives subsidy to banks if and only if $s \in \Omega^b$.
  - The amount of the subsidy is determined in such a way that in equilibrium $\tilde{\xi}^B(s) = 1$ for both $s \in \Omega^n$ and $s \in \Omega^b$, and the return on the bank equity is zero when $s \in \Omega^b$.
  - Firms do not receive any subsidy. They go bankrupt when $s \in \Omega^b$.
  - The fund for the subsidy is raised by lump-sum taxes on households.
- The government saves bank depositors, but not firms or bank-equity holders.
Intervention in the sunspot shock economy

- The deposit guarantee policy reduces the likelihood of the self-fulfilling crisis.
- Intuition:
  - Bank deposits are free from default: $\xi_t^B = R_t^B = 1$.
  - Only firms suffer from the debt-overhang problem.
Policy intervention

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figures/policy干预.png}
\caption{Graph showing the impact of policy intervention on liquidity crises.}
\end{figure}

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Policy intervention

Intervention in the fundamental shock economy

- The deposit guarantee policy increases the frequency of fundamental crises.
- Example (Table 1): The probability of a fundamental crisis is 0.01 under laissez-faire, and 0.02 under the deposit guarantee policy.
- Intuition:
  - The expected return to bank deposits goes up because $\xi^B(s) = 1$ even when $s \in \Omega^b$.
  - The higher return on deposits tends to reduce the supply of bank equity.
  - Shortage in bank equity tightens the moral hazard constraint and increases the short-term interest rate, $R^F(s)$.
  - Higher $R^F(s)$ squeezes the profit of firms, leading to an increase in $s$. 
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Summary

- We have provided a simple macroeconomic framework for liquidity crises, where
  - the supply of liquidity evaporates suddenly;
  - the short-term interest rates rise sharply;
  - the labor wedge increases; and
  - the economic activity is depressed.

- Key assumption:
  - Firms cannot commit to pay to owners of the factors of production.
  - This makes liquidity essential in the production process.

- A crisis can be either self-fulfilling or fundamental.

- Guaranteeing bank deposits reduces the possibility of self-fulfilling crises, but raises that of fundamental crises.