Liquidity Traps and Monetary Policy: Managing a Credit Crunch

FRANCISCO BUERA
UCLA

JUAN PABLO NICOLINI
Minneapolis Fed and Di Tella

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Motivation & Question

• Important economic contractions are often associated with large banking/financial crisis:
  • great depression, 1929-33
  • great recession, 2007-08

• Monetary policy (or the lack of it) is attributed a prominent role in ameliorating or exacerbating these contractions.
Motivation & Question

- Important economic contractions are often associated with large banking/financial crisis:
  - great depression, 1929-33
  - great recession, 2007-08
- Monetary policy (or the lack of it) is attributed a prominent role in ameliorating or exacerbating these contractions.
- What are the effects of alternative monetary policy during a credit crunch?
• **great depression, 1929-33:** unresponsive monetary policy, large deflation, pronounce recession, large drop in TFP, ..., nominal interest rate near zero

• **great recession, 2007-08:** large increase in government liabilities, low and stable inflation, less pronounce recession but slow recovery, large drop in investment, ..., nominal interest rate near zero
This Paper

Studies the effects of alternative monetary policies in an economy with heterogeneous producers during a credit crunch, i.e., a tightening of collateral constraints:

0. real benchmark, no government

1. unresponsive money supply

2. constant inflation target

3. distribution of welfare consequences


Preview of Results

0. real benchmark, no government
   • drop in TFP, sharp drop in the real interest rate

1. unresponsive monetary policy
   • deflation, larger drop in TFP if debts are nominal

2. constant inflation target
   • requires a large increase in money supply/government debt,
     leads to an initially less severe, but more persistent contraction

3. distribution of welfare consequences
   • winners and losers
Model Economy

- Entrepreneurs w/ heterogenous productivity, $z \sim \Psi(z)$, and workers.
- Money: cash-in-advance constraint, potential “store of value”.
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- Entrepreneurs w/ heterogenous productivity, $z \sim \Psi(z)$, and workers.


- Money: cash-in-advance constraint, potential “store of value”.

- No aggregate uncertainty, study response to unanticipated shocks.

- Flexible prices.
Entrepreneurs’ Problem

\[
\max_{\{c_t, m_{t+1}, l_t, k_{t+1}, b_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left[ \nu \log c_{1t} + (1 - \nu) \log c_{2t} \right],
\]

s.t.

\[
k_{t+1} + \frac{m_{t+1}}{p_t} + c_{1t} + c_{2t} + T_t(z) = (z_t k_t)^{1-\alpha} l_t^{\alpha} - w_t l_t + (1 + r_t) b_t + (1 - \delta) k_t + \frac{m_t}{p_t} - b_{t+1},
\]

\[-b_{t+1} \leq \theta_t k_{t+1}, \quad \theta_t \in [0, 1], \quad \text{(borrowing constraint)}\]

\[c_{1t} \leq \frac{m_t}{p_t}. \quad \text{(cash-in-advance)}\]
(Simplified) Entrepreneurs’ Problem

\[
\max \lim_{t \to \infty} \sum_{t=0}^{\infty} \beta^t \left[ \nu \log c_{1t} + (1 - \nu) \log c_{2t} \right]
\]

s.t.

\[
a_{t+1} + \frac{m_{t+1}}{p_t} + c_{1t} + c_{2t} + T_t(z) = R_t(z) a_t + \frac{m_t}{p_t},
\]

\[
k_{t+1} \leq \lambda_t a_{t+1}, \quad \lambda_t \equiv \frac{1}{1 - \theta_t} \in [1, \infty], \quad (\text{borrowing constraint})
\]

\[
c_{1,t} \leq \frac{m_t}{p_t}. \quad (\text{cash-in-advance})
\]
Gross return of net-worth solves

\[ R_t(z)a = \max_{k,b,l} (zk)^\alpha l^{1-\alpha} + (1 - \delta)k + (1 + r_t)b, \quad \text{s.t.} \]

\[ k + b = a, \quad -b \leq \theta_{t-1}k \]
**Optimal Portfolio Choice**

Gross return of net-worth

\[
R_t(z) = \begin{cases} 
\lambda_{t-1}(\varrho_t z - r_t - \delta) + 1 + r_t, & z \geq \hat{z}_t \\
1 + r_t, & z < \hat{z}_t 
\end{cases}
\]

Capital and bond demand (supply if \(b_t < 0\))

\[
k_t = \begin{cases} 
\lambda_{t-1}a_t, & z \geq \hat{z}_t \\
0, & z < \hat{z}_t 
\end{cases}, \quad b_t = \begin{cases} 
-(\lambda_{t-1} - 1)a_t, & z \geq \hat{z}_t \\
a_t, & z < \hat{z}_t 
\end{cases}
\]

where \(\varrho_t \hat{z}_t = r_t + \delta\) and \(\varrho_t \equiv \alpha \left(\frac{1 - \alpha}{w_t}\right)^{(1-\alpha)/\alpha}.\)
Workers’ Problem

\[
\max_{\{c_t, m_{t+1}, a_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t [\nu \log c_{1,t} + (1 - \nu) \log c_{2,t}]
\]

s.t.

\[
a_{t+1} + \frac{m_{t+1}}{p_t} + c_{1,t} + c_{2,t} + T_w^t = w_t + (1 + r_t)a_t + \frac{m_t}{p_t},
\]

\[a_{t+1} \geq 0,\]  
(borrowing constraint)

\[c_{1,t} \leq \frac{m_t}{p_t}.\]  
(cash-in-advance)

To derive analytical expressions we assume that for workers \(\nu = 0\) and \(a_t = 0\), but in the numerical example we treat workers and entrepreneurs symmetrically.
Government

Budget constraint

\[
\frac{M_{t+1}}{p_t} - \frac{M_t}{p_t} + B_{t+1} + \int T_t(z)\psi(dz) + T_t^W = (1 + r_t)B_t.
\]

Two alternative policies:

1. constant \( M \)

2. constant inflation target
Demographics & Mixing of Wealth

- A fraction $1 - \gamma$ of entrepreneurs (workers) die and are replaced by equal number of new entrepreneurs (workers).

- Productivity $z$ of new entrepreneurs drawn from $\Psi(z)$, iid across entrepreneurs and over time.

- Each new entrepreneur (worker) inherits the assets of a randomly drawn dying entrepreneur (worker).

- These assumptions guarantee a non-degenerated measure of net-wealth across types $\Phi_t(z)$. 
Numerical Examples

Simulate the effect of a credit crunch, i.e., an unanticipated shock to $\theta_t$, under alternative three scenarios:

0. benchmark real economy, no government

1. monetary economy, unresponsive monetary policy

2. monetary economy, constant inflation target

3. distribution of welfare consequences
debt to capital ratio, $\theta_t = 1 - 1/\lambda_t$
Numerical Examples

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Benchmark Real Economy, No Government

output

TFP

capital

real interest rate
Intuition: Bond Market

The bond market clearing condition is

\[
\int_{\hat{z}_{t+1}}^{\infty} \Phi_{t+1}(dz) = (\lambda_t - 1) \int_{\hat{z}_{t+1}}^{\infty} \Phi_{t+1}(dz) + B_{t+1}.
\]

and the marginal entrepreneur solve

\[
\alpha \left( \frac{1 - \alpha}{w_{t+1}} \right)^{(1-\alpha)/\alpha} \hat{z}_{t+1} = r_{t+1} + \delta.
\]

Given \(w_{t+1}\) and \(\Phi_{t+1}(z)\), there is a positive relationship between \(\lambda_t\) and \(r_{t+1}\).
Comparison with Exogenous TFP Shock

![Graphs showing the comparison of output, TFP, capital, and real interest rate with credit crunch and TFP shock.](image)
Numerical Examples

Simulate the effect of a credit crunch, i.e., an unanticipated shock to $\theta_t$, under alternative three scenarios:

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Monetary Economy: Unresponsive Policy

Indexed Bonds

- Output
- TFP
- Capital
- Price Level

Graphs showing the responses of output, TFP, capital, and price level over time with indexed bonds. The graphs compare real benchmark and indexed debt scenarios.
Monetary Economy: Unresponsive Policy
Indexed Bonds (cont’d)
Intuition for the Deflation

- the credit crunch generates a large drop in the real return of bonds, i.e., the real interest rate
- if the price level remains constant, excess demand for real cash balances, i.e., “store of value”
- since the supply of money is fixed, the price level must decline to clear the money market
- ... and the return of money must drop in the future, the inflation increase, so that money and bonds have the same real return
If \( (1 + r_{t+1})p_{t+1}/p_t > 0 \), then the price level at \( t \) is determined by

\[
\frac{M_{t+1}}{p_t} = \frac{\nu(1 - \beta)\beta}{1 - \nu(1 - \beta)} \left[ \int R_{t+1}(z)\Phi_{t+1}(dz) \right. \\
- \sum_{j=0}^{\infty} \int_{0}^{\infty} \frac{T_{t+j}(z)}{\prod_{s=1}^{j} R_{t+s}(z)} \Psi(dz) \left. \right].
\]

At the zero lower bound, when monetary policy is unresponsive, the sequence of price levels must satisfy

\[
p_t = (1 + r_{t+1})p_{t+1}
\]

and the money demand includes the demand for “store of value”. 
Monetary Economy: Unresponsive Policy
Nominal Bonds, Debt Deflation
Monetary Economy: Unresponsive Policy
Nominal Bonds, Debt Deflation

output

TFP

capital

price level

quarters

quarters

real bmk
indexed debt
nominal debt
Monetary Economy: Unresponsive Policy
Nominal Bonds, Interest Rates

![Graph showing real and nominal interest rates over time.](image)
Monetary Economy: Unresponsive Policy
Nominal Bonds, Explaining TFP
Numerical Examples

Simulate the effect of a credit crunch, i.e., an unanticipated shock to $\theta_t$, under alternative three scenarios:

0. benchmark real economy, no government

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Monetary Economy: Constant Inflation Target

Policy Rules

Government liabilities adjust to attain price stability

\[ B_{t+1} = \begin{cases} 
\int_{0}^{\hat{z}_{t+1}} \Phi_{t+1}(dz) \\
-(\lambda_{t+1} - 1) \int_{\hat{z}_{t+1}}^{\infty} \Phi_{t+1}(dz) & \text{if } r_{t+1} = \frac{p_t}{p_{t+1}} - 1 \\
B_t & \text{if } r_{t+1} > \frac{p_t}{p_{t+1}} - 1 
\end{cases} \]

and

\[ M_{t+1} = p_t \frac{\nu(1-\beta)\beta}{1 - \nu(1-\beta)} \left[ \int R_{t+1}(z)\Phi_{t+1}(dz) \\
- \sum_{j=0}^{\infty} \int_{0}^{\infty} \frac{T_{t+j}(z)}{\prod_{s=1}^{j} R_{t+s}(z)} \psi(dz) \right] \]
Monetary Economy: Constant Inflation Target

Policy Rules (cont’d)

1. lump-sum case:
   - pure lump-sum taxes (transfers), \( T_t(z) = T_t^W = T_t \),
   \[
   T_t = \frac{M_t - M_{t+1}}{p_t} + (1 + r_t)B_t - B_{t+1}.
   \]

2. bailout case:
   - entrepreneurs receive proceeds of new bond issues,
   \[
   \int T_t(z) \psi(dz) = \frac{M_t - M_{t+1}}{p_t} + (1 + r_t)B_t - B_{t+1}, \text{ if } B_{t+1} > B_t
   \]
   - lump-sum taxes (transfers) otherwise, \( T_t(z) = T_t^W = T_t \),
   \[
   T_t = \frac{M_t - M_{t+1}}{p_t} + (1 + r_t)B_t - B_{t+1}.
   \]
Monetary Economy: Constant Inflation Target

Lump-Sum Case

- Output
- TFP
- Capital
- Debt to GDP

- real bmk
- lump−sum
Constant Inflation Target
Lump-Sum Case (cont’d)
Intuition: Government Liabilities

- the credit crunch results in an excess demand for bonds
- to maintain price stability the government must increase the supply of “store of value”, money or bonds
- higher government liabilities imply higher future taxes
- unconstrained individuals further increase their savings, i.e., their demand for bonds, in anticipation of future taxes
Again, assuming workers are hand-to-mouth, the evolution of aggregate capital is given by

\[ K_{t+1} = \beta [\alpha Y_t + (1 - \delta)K_t] + (1 - \beta) \sum_{j=1}^{\infty} \int_0^{\infty} \frac{T_{t+j}(z)}{\prod_{s=1}^{j} R_{t+s}(z)} \psi(dz) \]

\[ -(1 - \beta) \sum_{j=1}^{\infty} \frac{\int T_{t+j}(z)\psi(dz) + T_{t+j}^{W}}{\prod_{s=1}^{j} (1 + r_{t+s})} \]
Intuition: Non-Ricardian Model

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\[ - (1 - \beta) \sum_{j=1}^{\infty} \int T_{t+j}(z) \psi(dz) \frac{1}{\prod_{s=1}^{j} (1 + r_{t+s})} \]

• productive entrepreneurs are constrained, i.e., for \( z > \hat{z}_{t+s} \),
\[ R_{t+s}(z) > 1 + r_{t+s} \]
Intuition: Non-Ricardian Model

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K_{t+1} = \beta [\alpha Y_t + (1 - \delta) K_t] + (1 - \beta) \sum_{j=1}^{\infty} \int_0^{\infty} \frac{T_{t+j}(z)}{\prod_{s=1}^{j} R_{t+s}(z)} \psi(dz)
\]

\[
-(1 - \beta) \sum_{j=1}^{\infty} \frac{\int T_{t+j}(z) \psi(dz)}{\prod_{s=1}^{j} (1 + r_{t+s})} - (1 - \beta) \sum_{j=1}^{\infty} \frac{T_{t+j}^W}{\prod_{s=1}^{j} (1 + r_{t+s})}
\]

- productive entrepreneurs are constrained, i.e., for \( z > \hat{z}_{t+s} \), \( R_{t+s}(z) > 1 + r_{t+s} \)
- transfers to workers are consumed
Monetary Economy: Constant Inflation Target

Bailout Case

[Graphs showing the effects of real benchmark, lump-sum bailout, and bailout on output, TFP, capital, and debt to GDP over 20 quarters.]
Monetary Economy: Constant Inflation Target

Bailout Case (cont’d)
Monetary Economy: Constant Inflation Target

Bailout Case, Alternative Inflation Targets

- Output
- TFP
- Capital
- Debt to GDP

Graphs showing the effects of different inflation targets on output, TFP, capital, and debt to GDP over time.
Monetary Economy: Constant Inflation Target
Bailout Case, Alternative Inflation Targets
Welfare Gains of a Credit Crunch
Welfare Gains of a Credit Crunch

Alternative Tax Schemes

- real bmk, $w^W = -0.006$
- lump-sum, $w^W = -0.013$
- bailout, $w^W = -0.02$
Welfare Gains of a Credit Crunch
Alternative Inflation Targets, Bailout Case

\[ \pi = 0.01, \quad w^W_g = -0.044 \]
\[ \pi = 0.02, \quad w^W_g = -0.02 \]
\[ \pi = 0.03, \quad w^W_g = -0.0056 \]
Conclusions

- credit contractions lead to a large drop in the return of safe assets
- money offers an alternative “store of value”, thus the zero lower bound
- what is the role of (lack of) monetary policy?
  - an unresponsive monetary policy leads to a deflation, and debt deflation and larger drop in TFP if debts are not indexed (Fisher, 1933)
  - monetary/debt policy needs to be very expansionary to stabilize prices, and output, at the cost of crowding out private investment and generating a slow recovery