The Great Escape?
A Quantitative Evaluation of the Fed’s Non-Standard Policies

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Disclaimer: This talk does not reflect the views of the NY Fed
Question

What happens if you print money (reserves) corresponding to one dollar and buy private assets for that money...

... but without changing the nominal interest rate.
  – Inflation
  – Output
  – etc

“Non-standard” open market operations
Asset Side of Fed's Balance Sheet

Oct07 Jan08 Apr08 Jul08 Oct08 Jan09 Apr09

0 0.5 1 1.5 2 2.5

Months

Trillions of $

Source: Board of Governors of the Federal Reserve System, Release H.4.1
Motivation

• What is the effect of increasing the CB balance sheet?
  – Modigliani-Miller irrelevance theorem holds without financial frictions.
  – How large is the effect with financial frictions?
What we do


- Findings:
  1. Liquidity shock in KM-model moves asset prices and investment but *not aggregate output (quantitatively).*
     - Quantitative effect of balance sheet (on output) tiny.
  2. If nominal rigidity and zero bound, the liquidity shock generates large output losses.
     - Quantitative effect of CB balance sheet possibly large (Great Escape?).

- Not a normative analysis – “crude” calibration
Model – Actors

1. Entrepreneurs: Financial frictions
2. Workers: Sticky wages
3. Capital Producers: Adjustment costs
4. Intermediate firms: Sticky prices
5. Final good producing firms: Aggregation
6. Government: Conventional (interest rate policy) and unconventional policies (credit policy).

Model – Assets

1. Equity (n): Illiquid
2. Government nominal bonds (b): Liquid
Entrepreneurs & Frictions
Stochastic ideas

Entrepreneurs

\[
\begin{cases}
\text{Saving} & \text{with prob. } 1-\chi \\
\text{Investing} & \text{with prob. } \chi
\end{cases}
\]

\[
\begin{align*}
\mathcal{K}_t & \overset{\text{i.i.d.}}{\sim} \mathcal{N}(0,1) \\
\mathcal{K}_t & \overset{\text{prob.}1-\chi}{\sim} \mathcal{N}(0,1) \\
\mathcal{K}_t & \overset{\text{prob.}1}{\sim} \mathcal{N}(0,1)
\end{align*}
\]
### Entrepreneurs & Frictions

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>nominal bonds</td>
<td>own equity issued</td>
</tr>
<tr>
<td>$b_t^{\Theta}/P_t$</td>
<td>$q_t n_t^I$</td>
</tr>
<tr>
<td>equity of other entrepreneurs</td>
<td>$q_t n_t^O$</td>
</tr>
<tr>
<td>capital stock</td>
<td>net worth</td>
</tr>
<tr>
<td>$q_t k_t^{\Theta}$</td>
<td>$q_t n_t^I = b_t^{\Theta}/P_t$</td>
</tr>
</tbody>
</table>

Where $n_t \otimes n_t^O \otimes k_t^I \otimes q_t n_t$.

Assume that $\phi_l = \phi^o = \phi$.

Then

\[
\text{Resellability constr.} \quad \text{Borrowing constr.}
\]
Entrepreneurs’ problem

$$\max E_t \Theta \log s \Theta$$

subject to

$$n_t \Theta \otimes \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta \Theta$$

$$\Theta$$

$$b_t \otimes 0$$

$$c_t \Theta p_t i_t \Theta q_t \Theta i_t \Theta \frac{b_t \Theta R_t}{P_t} \Theta$$

With probability $1-\chi$ $\rightarrow$ $i_t(e)=0$ & constraint (1) slack

With probability $\chi$ $\rightarrow$ $i_t(e)>0$ & constraint (1) binding
Workers

\[ E_t \otimes U_s \otimes h_s \bigotimes d \eta \]

\[ c_t \otimes q_t \otimes h_t \otimes b_t \otimes R_t \otimes P_t \]

\[ r_t \otimes n_t \otimes W_t \otimes h_t \otimes p_t \otimes P_t \]

\[ h_t \left[ \frac{W_t}{W_t} \right] = h_t \quad n_t \otimes 0, \quad b_t \otimes 0 \]

In equilibrium

\[ n_t \otimes 0, \quad b_t \otimes 0 \]
Three types of producers

• Capital goods producers (competitive): Source of adjustment costs. Transform consumption good into investment good for entrepreneurs at price $p_t^I$

• Intermediate good producers (monopolistic power). Calvo pricing ($\xi_p$). Rent labor from workers and capital from entrepreneurs.

• Final goods producers (competitive): Aggregate. Buy goods from intermediate goods producers and sell to consumers.
Policy Authority

• Conventional monetary policy

\[
\frac{R_t}{R} \max \theta, \phi_t \downarrow
\]

• Unconventional policy

\[
\frac{N_t^g}{K} \phi_t N_t^g \Omega_t \Gamma_t \eta_t \phi_t \Omega_t \Gamma_t 1 \leq
\]

• Government budget constraint

\[
\frac{B_t}{P_t} \phi_t q_t N_t^g \phi_t \frac{R_t B_t}{P_t} \phi_t k \phi_t q_t N_t^g \phi_t
\]

• Tax rule for government financing

\[
\phi \phi (q_t N_t^g \phi_t \frac{R_t B_t}{P_t})
\]
The intervention

• This is “open market operations” at market prices.
• Buying private paper for public debt.
• No re-salability constraints of the private sector violated.
• Only affects investment in period t through price effect.

→ Next period private sector has more “liquid” assets.
→ It is obvious that this will have an effect (boring question). Interesting question: Does it matter quantitatively?
Equilibrium and solution of the Model

• All agents maximize subject to their constraints and markets clear
• Focus on constrained steady state
  – Stock of capital is lower than in first best
  – Price of investment is strictly greater than one \( q > 1 \)
  – Workers do not save
  – Investing entrepreneurs do not hold liquid assets
  – Spectrum of interest rates

• Linearize model about steady state and solve with standard techniques
• Liquidity shock \(^t\) follows two-state Markov process (s.s. vs “crisis”)
• Explicitly take into account zero bound (Eggertsson, 2008)
The liquidity share in the data.

\[ lS_t \star \frac{B_t/Q}{B_t/P_t} \]

\[ B_t/Q \leq P_t/K_t \]
## Calibration

### Standard Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.99</td>
<td>Subjective discount factor</td>
</tr>
<tr>
<td>$\theta$</td>
<td>0.975</td>
<td>Annual depreciation</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.35</td>
<td>Capital share</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>1</td>
<td>Inverse Fisch elasticity</td>
</tr>
<tr>
<td>$\eta_p$</td>
<td>0.1</td>
<td>Steady state markup</td>
</tr>
<tr>
<td>$\eta_w$</td>
<td>0.66</td>
<td>Average duration price/wage contracts</td>
</tr>
<tr>
<td>$S$</td>
<td>3</td>
<td>Investment adjustment cost</td>
</tr>
</tbody>
</table>

### Liquidity Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta$</td>
<td>0.05</td>
<td>Doms and Dunne (1998); Cooper, Haltiwanger and Power (1999)</td>
</tr>
<tr>
<td>$L/4Y$</td>
<td>0.4</td>
<td>Average (government debt/core capital) / GDP 1952Q1:2008Q4</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.18</td>
<td>Real interest rate (2%)</td>
</tr>
</tbody>
</table>

### Zero Bound Parameters (shock duration)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$z_b$</td>
<td>0.125</td>
<td>Expected duration of zero bound</td>
</tr>
</tbody>
</table>


Calibration of $\phi$ (shock) and $\xi$ (intervention)

Two targets:
1. $\approx 24\%$ increase in measured liquidity share
2. $\approx$ $1$ trillion ($=8\%$ of GDP) increase in Fed’s assets
Calibration of $\phi$ (shock) and $\xi$ (intervention)

Two targets:

1. $\approx 20\%$ increase in measured liquidity share
2. $\approx $1 trillion (=7 percent of GDP) increaser in Fed’s assets

- Size of the shock: $\phi$ drops by -0.40
Response of Macro Variables (with intervention)
Response of Financial Variables (with intervention)

Spread Illiquid–Liquid Assets

Tobin Q

Empirical Spreads (1st P.C.)

Wilshire 5000

Log-level (2008Q2 = 0)
The effect of the intervention
The Great Escape?

Suppose expected duration of zero bound = 10 years (ZB = 1/40), then .....
Multipliers

• By how much does output increase, per dollar in intervention?
• As outcome gets worse, the effectiveness of policy becomes greater (‘divine coincident’)
• Similar result as Eggertsson (2009) and Christiano, Eichenbaum and Rebelo (2009) for government spending at the zero bound
• Important for policy making?

\[
M_{b,0} = \frac{\mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} (\hat{Y}_t^I - \hat{Y}_t^N) \right\}}{\mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \hat{N}_t^g \right\}}
\]

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Great Escape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>0.8</td>
<td>2.8</td>
</tr>
<tr>
<td>No zero bound</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Flexible Prices</td>
<td>0.009</td>
<td>0.007</td>
</tr>
</tbody>
</table>
The role of nominal frictions
The role of the zero bound

Output

Inflation

Nominal Interest Rate

Real Interest Rate

% Δ from steady state

Annualized % points

Quarters

Quarters

Annualized % points

Quarters

Annualized % points

Quarters

ZB & No Intervention  NO ZB & No Intervention
Conclusions

• What are the quantitative effects of the Fed’s non-standard policies?
• At the zero bound, interest rate policy ineffective; Fed becomes “creative”

**Quantitative results:**
– Liquidity frictions/shocks provide coherent story for financial crisis (the Holy Grail?)
– Substantial effects of Fed’s non-standard policies
– Does not imply *current* balance sheet expansion effective!

• Moving forward:
  – Theoretical foundations of resaleability constraint
    – Exogeneity of the resaleability shock, i.e., feedback from real economy and resellability.
  – Formal estimation of the model
  – The BIG question: Why has the crisis led to such a PERSISTENT weakness. ➔ Macro theory has an incomplete answer.
Path for the nominal Interest Rate