The Great Escape?

A Quantitative Evaluation of the Fed's Non-Standard Policies

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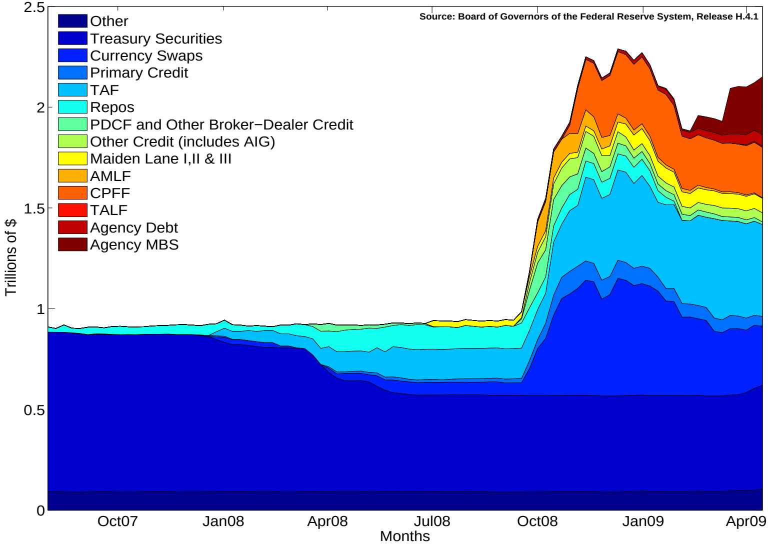
ESSIM, Tarragona (Bank of Spain); May 25, 2010

The Fed's Response to a Black Swan



Questions

- We incorporate the financial friction proposed by Kiyotaki and Moore (2008) – differences in liquidity across assets – into a DSGE model with standard real and nominal rigidities and ask:

  1. Can a KM-type liquidity shock quantitatively generate the crisis?
     - Large response of *both* macro and financial variables.

Questions

- We incorporate the financial friction proposed by Kiyotaki and Moore (2008) – differences in liquidity across assets – into a DSGE model with standard real and nominal rigidities and ask:

1. Can a KM-type liquidity shock quantitatively generate the crisis?
    - Large response of *both* macro and financial variables.
2. What is the quantitative effect of unconventional monetary policy in such a setting?
    - In an environment where standard monetary policy no longer works (the "great escape" from the liquidity trap)

KM Model – The Actors

1. Entrepreneurs $=\begin{cases}\text{Saving}\\ \text{Investing}\end{cases}$

$$k_{t+1} = \begin{cases} \lambda k_t + i_t & \text{with probability } \varkappa \\ \lambda k_t & \text{with probability } 1-\varkappa \end{cases}$$

2. Intermediate firms
3. Final good producing firms
4. Capital producing firms
5. Workers
6. Government

Entrepreneurs & Frictions

- Balance sheet:

Assets		Liabilities	
real bonds	l_{t+1}	*own* equity issued	$q_t n^I_{t+1}$
nominal bonds	b_{t+1}/P_t		
equity of *other* entrepreneurs	$q_t n^O_{t+1}$		
capital stock	$q_t k_{t+1}$	net worth	$q_t n_{t+1}$ $+l_{t+1} + b_{t+1}/P_t$

where $n_t \equiv n^O_t + (k_t - n^I_t)$.

- Income: $r^k_t n_t$

Entrepreneurs & Frictions

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- Income: $r^k_t n_t$
- Constraint:

$$n_{t+1} \geq (1-\phi_t)\lambda n_t + (1-\theta)i_t$$

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Entrepreneurs & Frictions

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where $n_t \equiv n^O_t + (k_t - n^I_t)$.

- Income: $r^k_t n_t$
- Constraint:

$$n_{t+1} \geq \underbrace{(1-\phi_t)\lambda n_t}_{\text{Resaleability Constraint}} + (1-\theta) i_t$$

Entrepreneur's problem

$$Max_{\{c_s, i_s, n_{s+1}, l_{s+1}\}_t^\infty} E_t \sum_{s=t}^{\infty} \beta^{s-t} log(c_s)$$

subject to

$$n_{t+1} - (1-\phi_t)\lambda n_t \geq (1-\theta) i_t$$

$$c_t + p_t^I i_t + q_t(n_{t+1} - i_t) + l_{t+1} + \frac{b_{t+1}}{P_t} = (r_t^k + \lambda) n_t + r_{t-1} l_t + \frac{R_{t-1} b_t}{P_t}$$

$$l_{t+1} \geq 0, \ b_{t+1} \geq 0$$

Entrepreneur's problem – Saver

$$Max_{\{c_s, i_s, n_{s+1}, l_{s+1}\}_t^\infty} E_t \sum_{s=t}^{\infty} \beta^{s-t} log(c_s)$$

subject to

$$n_{t+1} - (1-\phi_t)\lambda n_t \;\geq\; (1-\theta) i_t \;\leftarrow\; \text{not binding}$$

$$\Downarrow$$

$$c_t + q_t n_{t+1} + l_{t+1} + \frac{b_{t+1}}{P_t} \;=\; (r_t^k + q_t\lambda) n_t + r_{t-1} l_t + \frac{R_{t-1} b_t}{P_t}$$

Entrepreneur's problem – Investor

$$Max_{\{c_s, i_s, n_{s+1}, l_{s+1}\}_t^\infty} E_t \sum_{s=t}^{\infty} \beta^{s-t} log(c_s)$$

subject to

$$n_{t+1} - (1-\phi_t)\lambda n_t \geq (1-\theta) i_t \leftarrow \text{binding}$$

$$\Downarrow$$

$$c_t + q_t^R n_{t+1} + l_{t+1} + \frac{b_{t+1}}{P_t} \leq [r_t^k + (\phi_t q_t + (1-\phi_t) q_t^R)\lambda] n_t + r_{t-1} l_t + \frac{R_{t-1} b_t}{P_t}$$

where

$$q_t > 1 > q_t^R = \frac{p_t^I - \theta q_t}{1-\theta}$$

Key equilibrium conditions

$$(1-\varkappa)E_t[\frac{1}{c^s_{t+1}}\frac{r^k_{t+1}+q_{t+1}\lambda}{q_t}]+\varkappa E_t[\frac{1}{c^i_{t+1}}\frac{r^k_{t+1}+((1-\phi_{t+1})q^R_{t+1}+\phi_{t+1}q_{t+1})\lambda}{q_t}]$$

$$=$$

$$(1-\varkappa)E_t[\frac{1}{c^s_{t+1}}r_t]+\varkappa E_t[\frac{1}{c^i_{t+1}}r_t]$$

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$$=$$
$$(1-\varkappa)E_t[\frac{1}{c^s_{t+1}}r_t]+\varkappa E_t[\frac{1}{c^i_{t+1}}r_t]$$

$$(p^I_t-q_t\theta_t)I_t=\beta(\varkappa r_{t-1}L_t+(r^k_t+q_t\phi_t\lambda)\varkappa K_t)-(1-\beta)(1-\phi_t)q^R_t\lambda\varkappa K_t$$

$$\begin{aligned} r^k_t K_t &= I_t[1+S(\tfrac{I_t}{I_*})]+\tau_t \\ &+\underbrace{(1-\beta)\left\{r_{t-1}L_t+[r^k_t+(1-\varkappa+\varkappa\phi_t)q_t\lambda+\varkappa(1-\phi_t)q^R_t\lambda]K_t\right\}}_{consumption} \end{aligned}$$

Key equilibrium conditions

$$(1-\varkappa)E_t\left[\frac{1}{c^s_{t+1}}\frac{r^k_{t+1}+q_{t+1}\lambda}{q_t}\right]+\varkappa E_t\left[\frac{1}{c^i_{t+1}}\frac{r^k_{t+1}+((1-\phi_{t+1})q^R_{t+1}+\phi_{t+1}q_{t+1})\lambda}{q_t}\right]$$

$$=$$

$$(1-\varkappa)E_t\left[\frac{1}{c^s_{t+1}}r_t\right]+\varkappa E_t\left[\frac{1}{c^i_{t+1}}r_t\right]$$

$$(p^I_t-q_t\theta_t)I_t=\beta(\ \varkappa r_{t-1}L_t + (r^k_t+q_t\phi_t\lambda)\varkappa(K_t-N^g_t)\ )-(1-\beta)(1-\phi_t)q^R_t\lambda\varkappa(K_t-N^g_t)$$

$$r^k_tK_t = I_t[1+S(\tfrac{I_t}{I_*})]+\tau_t + \underbrace{(1-\beta)\left\{r_{t-1}L_t+[r^k_t+(1-\varkappa+\varkappa\phi_t)q_t\lambda+\varkappa(1-\phi_t)q^R_t\lambda](K_t-N^g_t)\right\}}_{consumption}$$

Government

- Taylor rule:

$$R_t = R_* \left(\pi_t/\pi_*\right)^{\psi_1}$$

- The government budget constraint is:

$$L_{t+1} - r_{t-1} L_t + \frac{B_{t+1} - R_{t-1} B_t}{P_t} \; = \; \tau_t,$$

- In absence of intervention: $L_{t+1} = L_*, \; B_{t+1} = 0.$

Unconventional monetary policy

- Intervention rules:

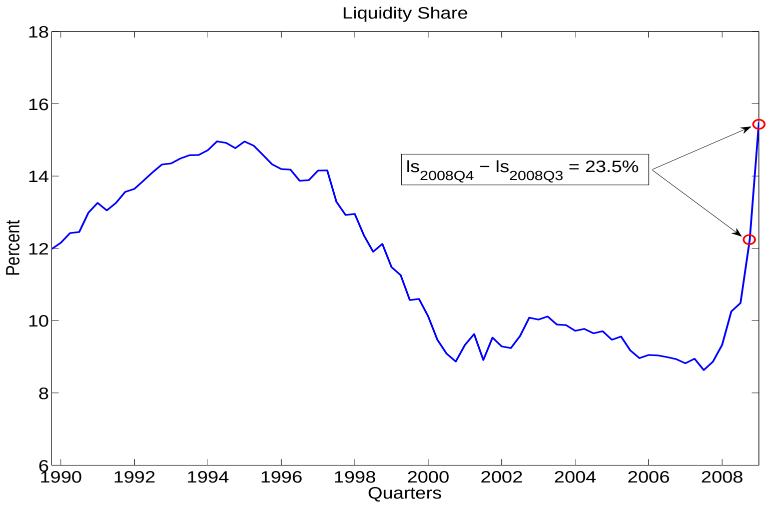
$$\tilde{N}_t^g = K_* \xi (\frac{\phi_t}{\phi_*} - 1).$$

$$q_t \; (\tilde{N}_t^g - N_t^g) = \tilde{L}_t - L_t.$$

- The government budget constraint:

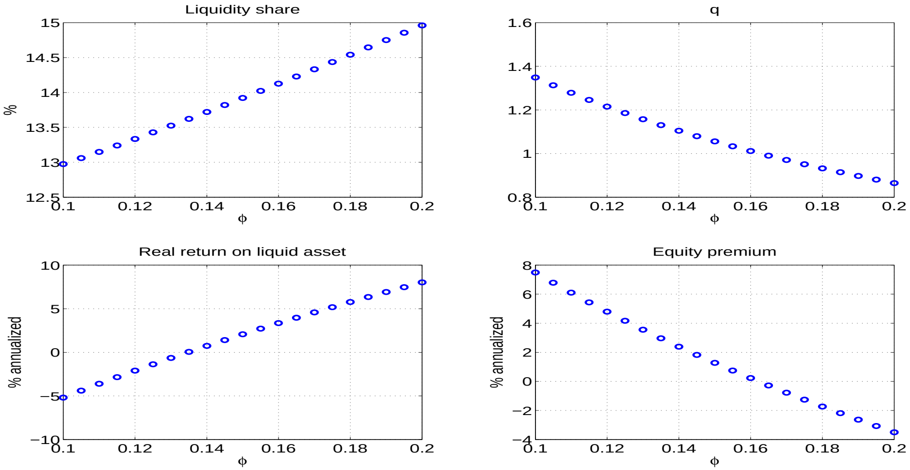
$$\tau_t = (r_t + q_t \lambda) \tilde{N}_t^g - r_{t-1} \tilde{L}_t + r_t^k \tilde{N}_t^g - q_t N_{t+1}^g + L_{t+1},$$

Liquidity Share: $\frac{L}{L+qK}$



Steady State as a Function of ϕ_*

(for $L_*/Y_* = .40$)



Calibration

- Impose $\theta = \phi = 15\%$ to obtain:
  1. steady state liquidity share of 14%
  2. real return on liquid assets of 2% (1952Q1:2008Q4)

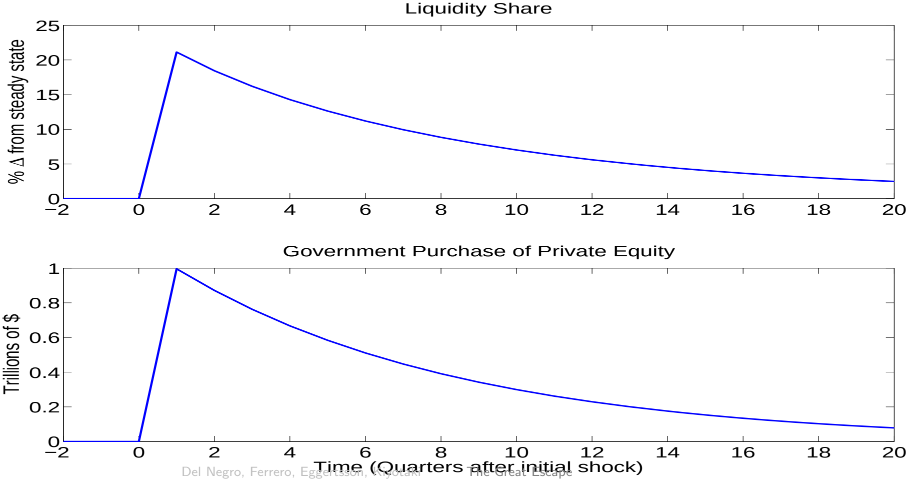
- Probability of receiving investment opportunity: $\varkappa = 6\%$

  Doms and Dunne (1998) and Cooper, Haltiwanger and Power (1999)

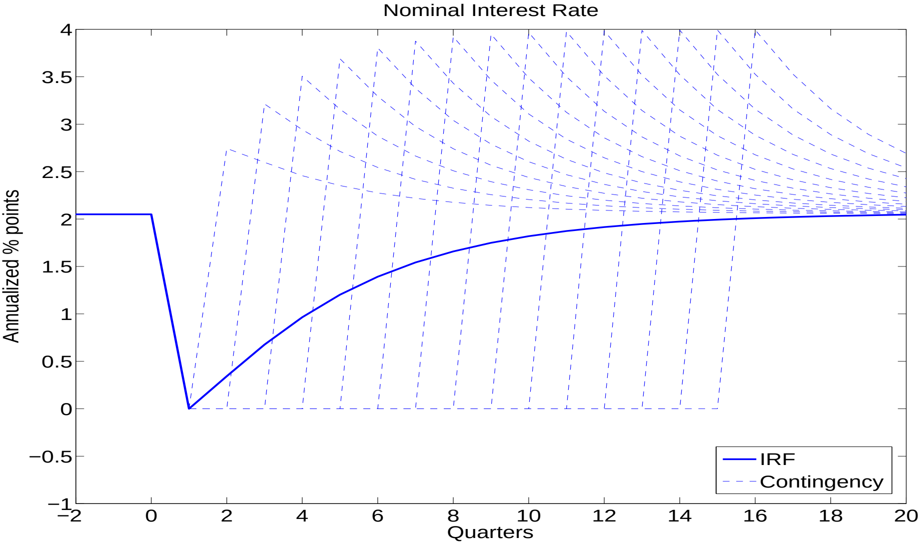
- Standard stuff:
  - Discount factor: $\beta = 0.991$
  - Depreciation rate: $\lambda = 0.975$ (Annual depreciation $= 10\%$)
  - Capital share: $\gamma = 0.33$
  - Taylor rule response to inflation: $\psi_1 = 1.5$
  - Inverse Frisch elasticity: $\nu = 1$
  - Nominal rigidities : $\zeta_p = \zeta_w = .66$
  - Investment adjustment costs: $S''(1) = 3$

Calibration of the ϕ_t Shock and the Fed's Response

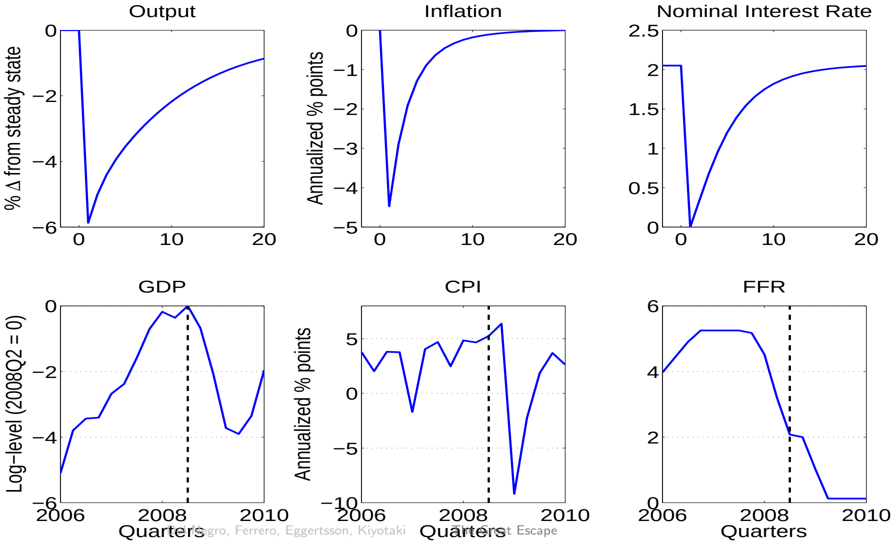
- Expected duration of the liquidity shock (Markov process):
  - 8 quarters (Baseline) , 8 years (Extreme) (Japan, Great Depression)



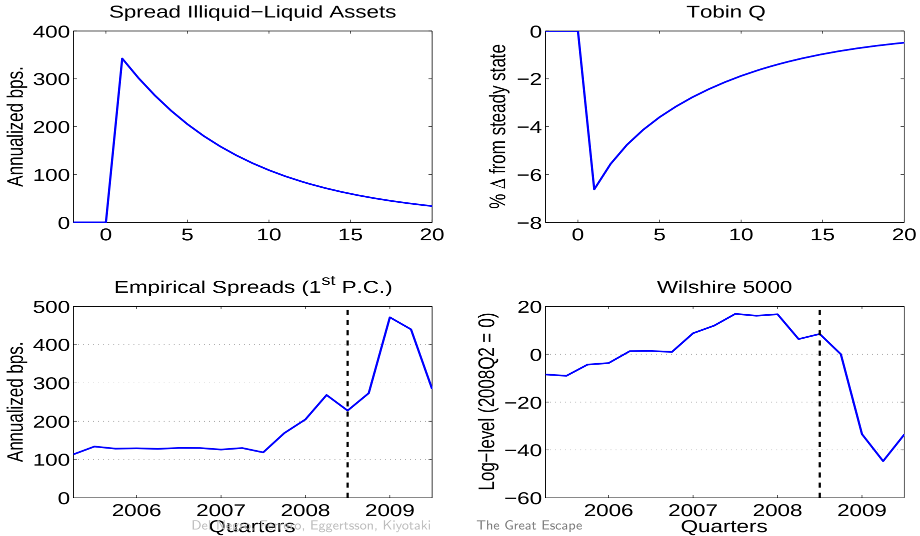
Paths for the Nominal Interest Rate



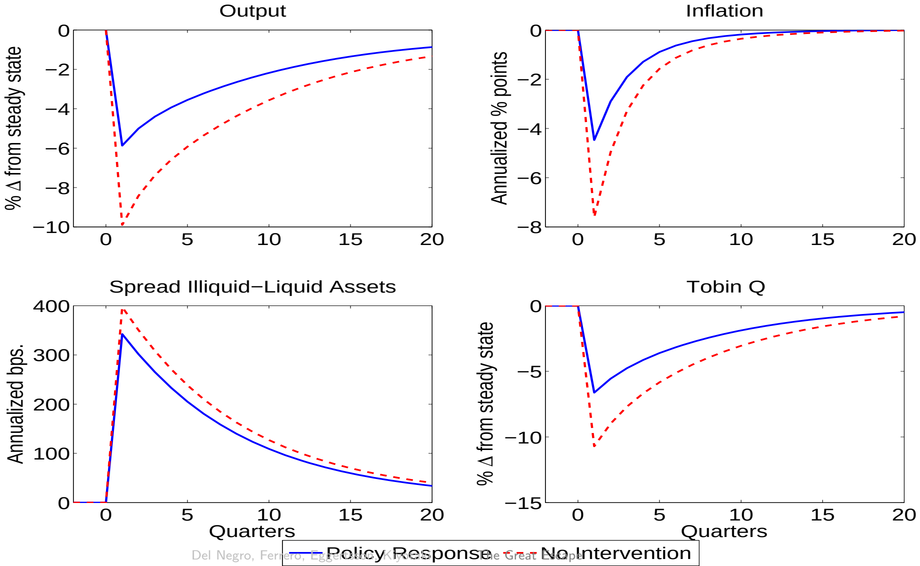
Response of Macro Variables to a liquidity shock (with intervention)



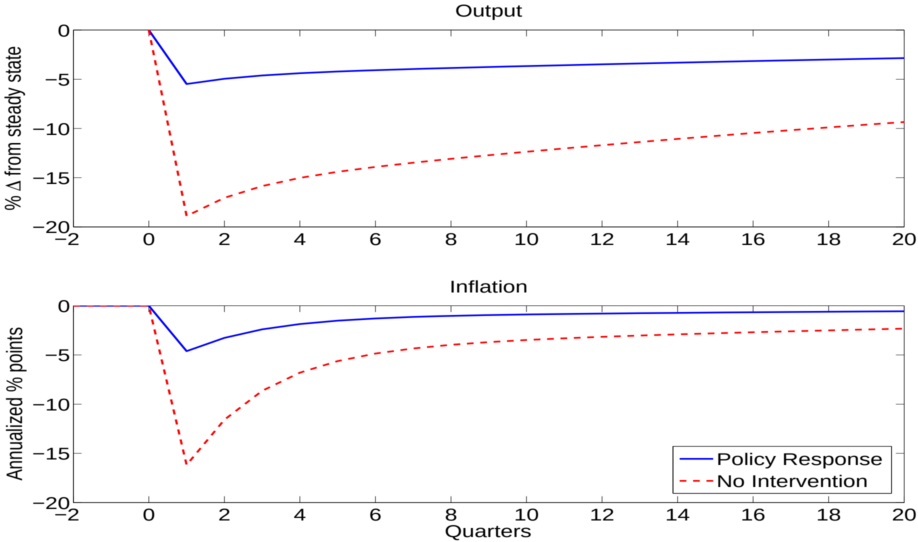
Response of Financial Variables to a liquidity shock (with intervention)



The Effect of Policy Intervention



The Great Escape?

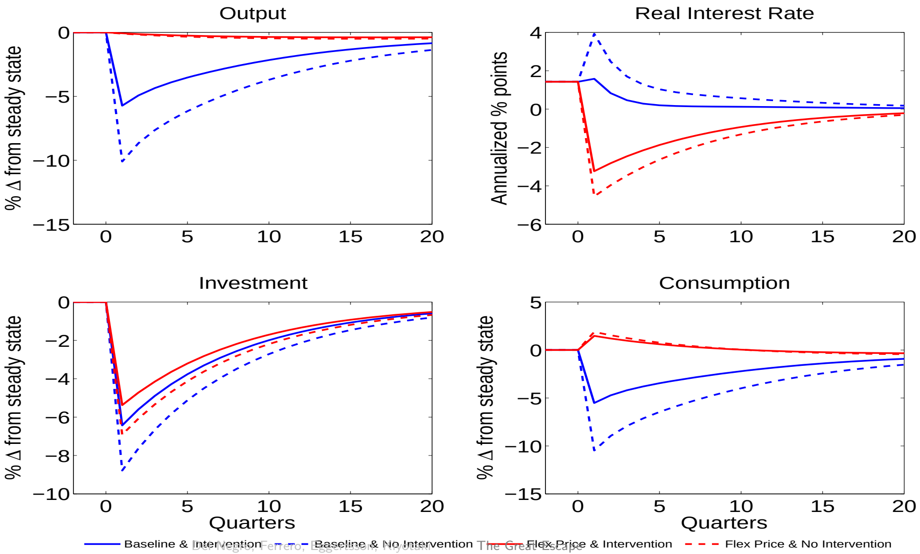


Multipliers

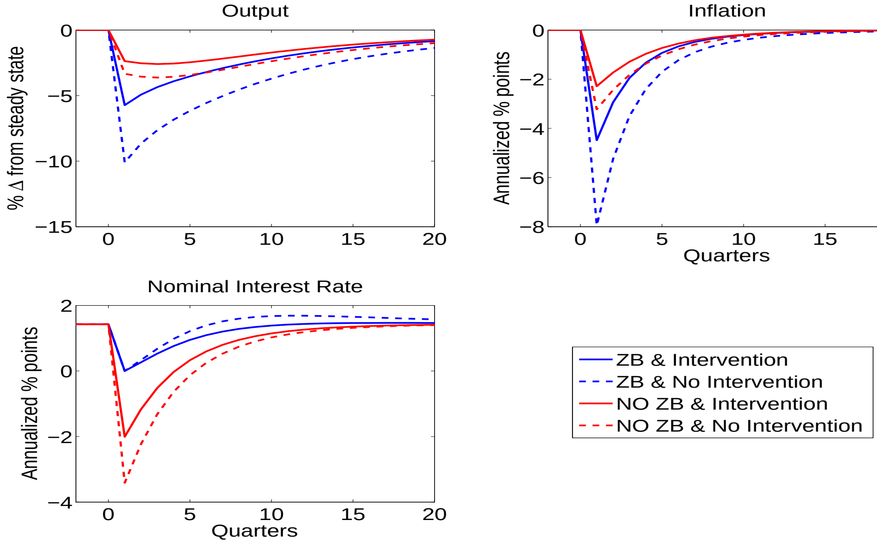
$$\frac{E_0 \sum_{t=0}^{\infty} (\hat{Y}_t^I - \hat{Y}_t^N)}{E_0 \sum_{t=0}^{\infty} \hat{N}_{t+1}^g}$$

	Baseline	Great Escape
Full model	0.643	2.240
No zero bound constraint	0.247	0.309
No nominal rigidities	0.064	0.052

The Role of the Nominal Rigidities



The Role of the Zero Bound



Conclusions

1. Liquidity shocks as in Kiyotaki-Moore model can generate quantitatively large movements in real and financial variables $\rightarrow$ can explain some features of the crisis

2. Swap of liquid for illiquid assets (unconventional policy) is effective in reducing impact on spreads and real variables

- Caveat: This is not a model for normative analysis!!!

Investment Adjustment Costs

- Capital producers:

$$max_{I_t} C(I_t) = p_t^I I_t - I_t[1 + S(\frac{I_t}{I_*})]$$

with $S(1) = S'(1) = 0, S''(1) > 0$

$$\Rightarrow p_t^I = 1 + S(\frac{I_t}{I_*}) + S'(\frac{I_t}{I_*})\frac{I_t}{I_*}$$

Sticky Prices

- Monopolistic competitors produce intermediate goods with technology:

$$y_{t(i)} = A_t k_{t(i)}^{\gamma} l_{t(i)}^{1-\gamma},$$

  subject to Calvo price rigidity (ζ_p).
- Final goods producers aggregate: $y_t = \left[\int_0^1 y_{t(i)}^{\frac{1}{1+\lambda_{f,t}}} di\right]^{1+\lambda_{f,t}}$
- Inflation determined by New-Keynesian Phillips curve

Workers

$$Max_{\{c_s', h_s', n_{s+1}', b_{s+1}', l_{s+1}'\}_t^\infty} E_t \sum_{s=t}^{\infty} \beta^{s-t} U[c_s' - \int \frac{\omega_0}{1+\nu} h_s(\omega)'^{\ 1+\nu} d\omega]$$

subject to

$$c_t' + q_t(n_{t+1}' - \lambda n_t') + l_{t+1}' - r_{t-1} l_t' + \frac{b_{t+1}' - R_{t-1} b_t'}{P_t} \leq$$
$$r_t^k n_t' + \int \frac{W_t(\omega)}{P_t} h_t'(\omega) d\omega + C(I_t) + \int \mathcal{P}(i) di + \tau_t$$

$$l_{t+1}' \geq 0, \;\; b_{t+1}' \geq 0, \;\; n_{t+1}' \geq 0$$

and to Calvo nominal rigidities (ζ_w). Differentiated labor $h_t'(w)$, packed into a composite:

$$h_t' = \left[\int_0^1 h_t'(w)^{\frac{1}{1+\lambda_w}} di \right]^{1+\lambda_w}.$$