The Great Escape?

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

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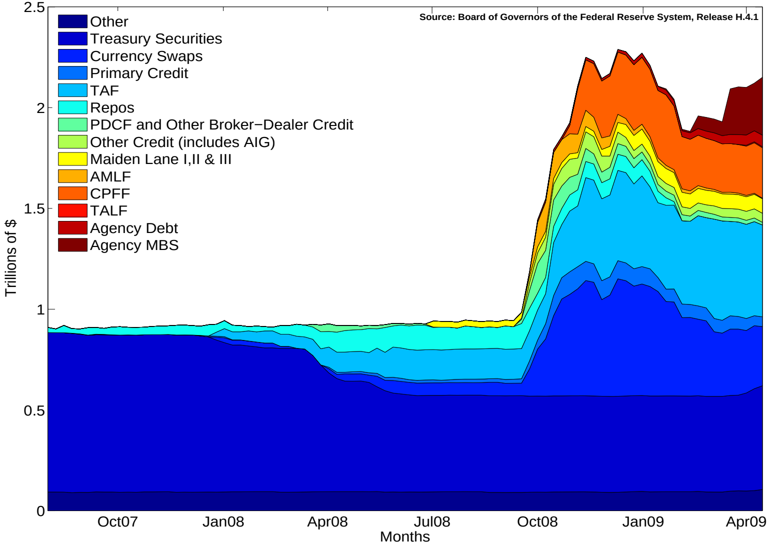
The Fed's Response to a Black Swan



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 *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 *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)

The model: KM + . . . a few more 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. Workers

3. Government

4. Intermediate firms

5. Final good producing firms

6. Capital producing firms

The model: KM + ... a few more actors ... and a few more rigidities

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2. Workers $\Rightarrow$ sticky wages
3. Government
4. Intermediate firms
5. Final good producing firms

   } $\Rightarrow$ sticky prices
6. Capital producing firms $\Rightarrow$ investment adjustment cost

Entrepreneurs & Frictions

- Balance sheet:

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

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

- Income: $r^k_t n_t$

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- Constraint:

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

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

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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

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

subject to

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

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

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

Entrepreneur's problem – Saver

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

subject to

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

$$\Downarrow$$

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

Entrepreneur's problem – Investor

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

subject to

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

$$\Downarrow$$

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

where $q_t^R = \dfrac{p_t^I - \theta q_t}{1-\theta} \Rightarrow$ if $q_* > 1$ then $q_*^R < 1 < q_*$

Key equilibrium conditions

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

$$=$$

$$(1-\varkappa)\boldsymbol{E}_t[\frac{1}{c^s_{t+1}}\frac{R_t}{\pi_{t+1}}]+\varkappa\boldsymbol{E}_t[\frac{1}{c^i_{t+1}}\frac{R_t}{\pi_{t+1}}]$$

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$$=$$

$$(1-\varkappa)\boldsymbol{E}_t\Big[\frac{1}{c^s_{t+1}}\frac{R_t}{\pi_{t+1}}\Big]+\varkappa\boldsymbol{E}_t\Big[\frac{1}{c^i_{t+1}}\frac{R_t}{\pi_{t+1}}\Big]$$

$$(p^I_t-q_t\theta_t)I_t=\beta\Big(\varkappa\frac{R_{t-1}}{\pi_t}\frac{B_t}{P_t}+(r^k_t+q_t\phi_t\lambda)\varkappa K_t\Big)-(1-\beta)(1-\phi_t)q^R_t\lambda\varkappa K_t$$

$$\begin{aligned} r^k_tK_t &= p^I_tI_t-\tau_t \\ &+\underbrace{(1-\beta)\left\{\frac{R_{t-1}}{\pi_t}\frac{B_t}{P_t}+[r^k_t+(1-\varkappa+\varkappa\phi_t)q_t\lambda+\varkappa(1-\phi_t)q^R_t\lambda]K_t\right\}}_{consumption}\end{aligned}$$

Key equilibrium conditions

$$(p_t^I - q_t\theta_t)I_t = \beta\Big(\varkappa\frac{R_{t-1}}{\pi_t}\frac{B_t}{P_t}$$

$$+ (r_t^k + q_t\phi_t\lambda)\varkappa(K_t - N_t^g) \Big) - (1-\beta)(1-\phi_t)q_t^R\lambda\varkappa(K_t - N_t^g)$$

Government

- Taylor rule:

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

- Government budget constraint:

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

- Taxes:

$$\tau_t - \tau_* = \psi_2 \left(\frac{R_{t-1}B_t}{P_t} - \frac{R_* B_*}{P_*} \right)$$

Unconventional monetary policy

- Intervention rule:

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

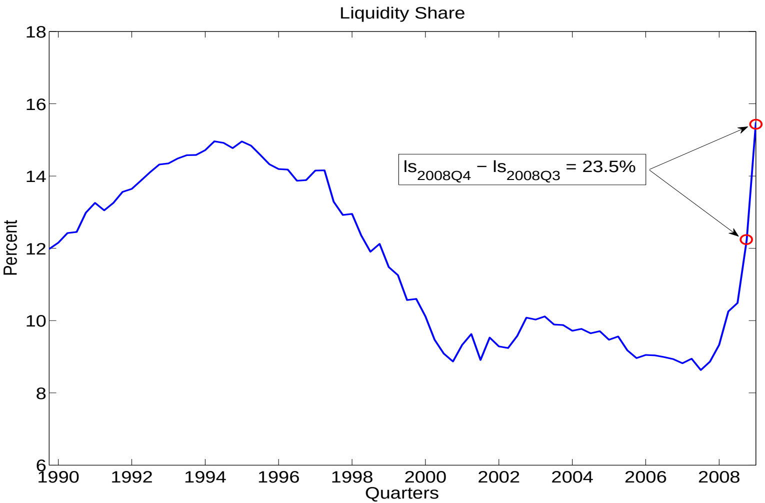
- Government budget constraint:

$$q_t N_{t+1}^g + \frac{R_{t-1} B_t}{P_t} \; = \; \tau_t + \frac{B_{t+1}}{P_t} + (r_t^k + q_t \lambda) N_t^g$$

- Taxes:

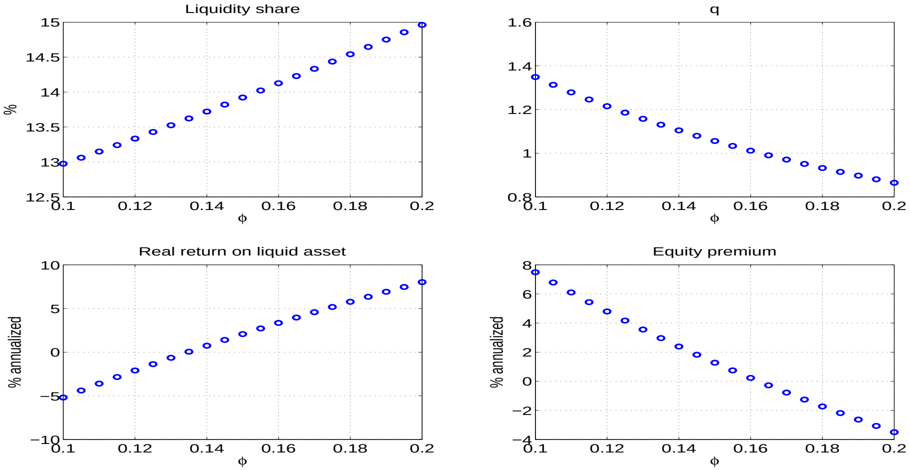
$$\tau_t - \tau_* = \psi_2 \left(\; (\frac{R_{t-1} B_t}{P_t} - \frac{R_* B_*}{P_*}) \; - \; q_t N_t^g \; \right)$$

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



Steady State as a Function of ϕ_*

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



Calibration

- Impose $\theta = \phi = 18\%$ to obtain:
  1. steady state liquidity share of 14%
  2. real return on liquid assets of 2% (1952Q1:2008Q4)

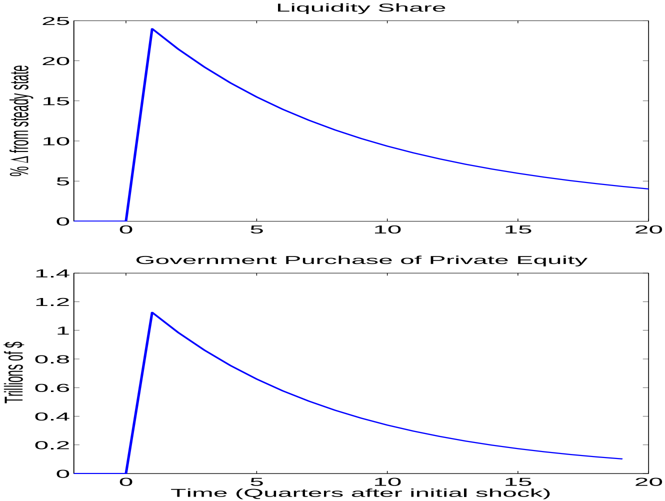
- Probability of receiving investment opportunity: $\varkappa = 5\%$

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

- Standard stuff:
  - Discount factor: $\beta = 0.99$
  - Depreciation rate: $\lambda = 0.975$ (Annual depreciation = 10%)
  - Capital share: $\gamma = 0.35$
  - 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

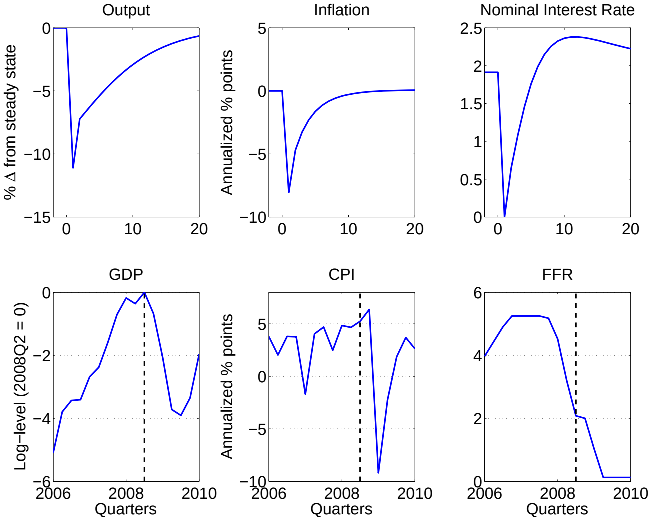
- Expected duration of the liquidity shock (Markov process):
  - 8 quarters (Baseline) , 8 years (Extreme) (Japan, Great Depression)



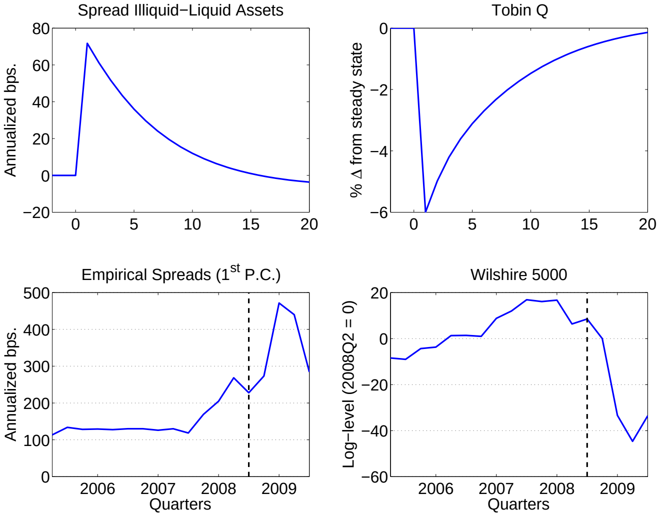
Equilibrium and solution of the Model

- All agents maximize subject to their constraints and markets clear
- Linearize model about constrained steady state and solve with standard techniques
- Liquidity shock follows two-state Markov process (s.s. vs crisis)
- Explicitly take into account zero bound (Eggertsson and Woodford, 2002)

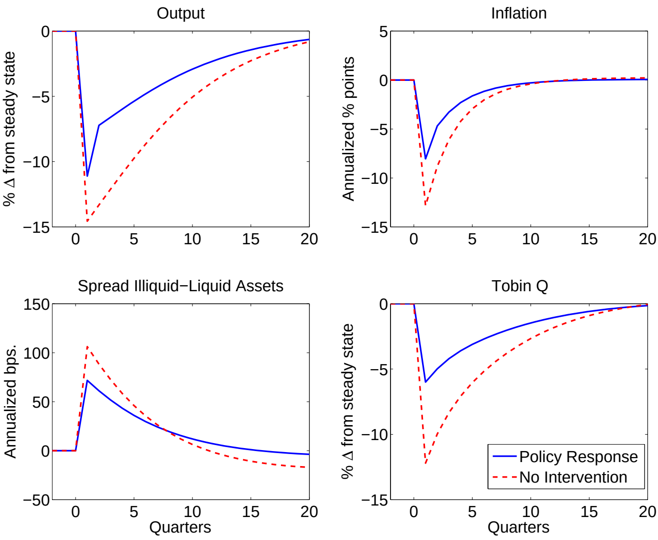
Response of Macro Variables to a liquidity shock (with intervention)



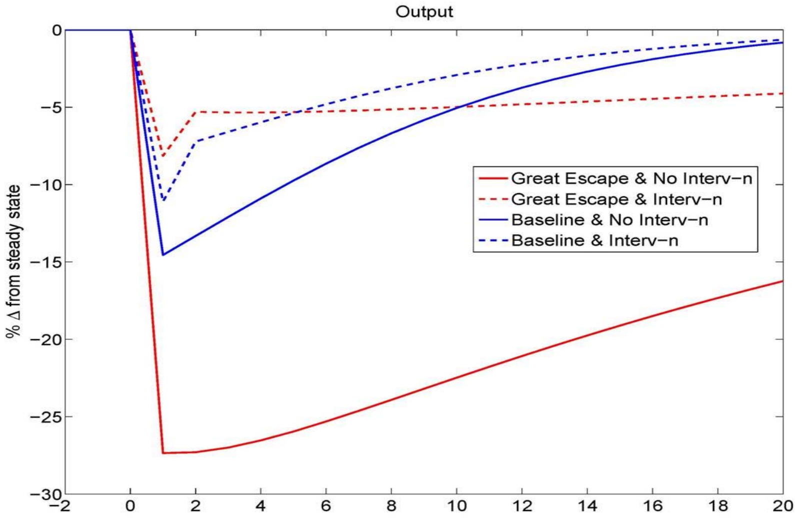
Response of Financial Variables to a liquidity shock (with intervention)



The Effect of Policy Intervention



The Great Escape?

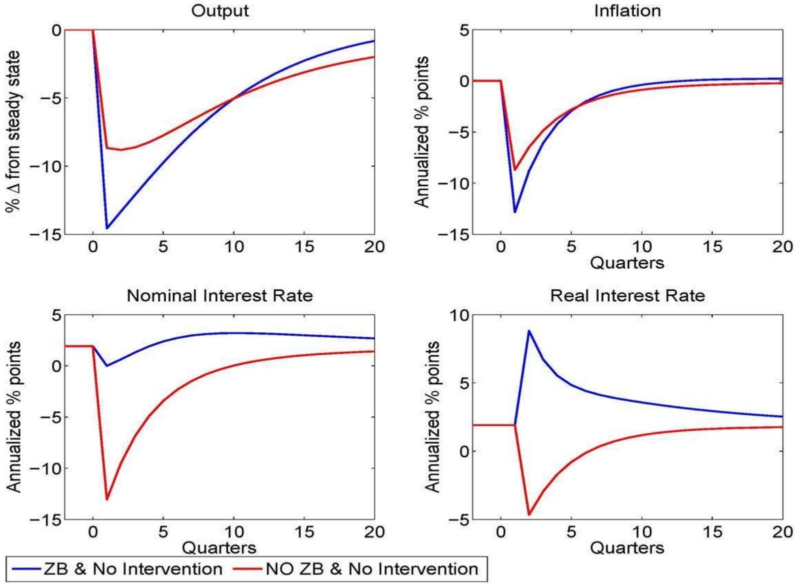


Multipliers

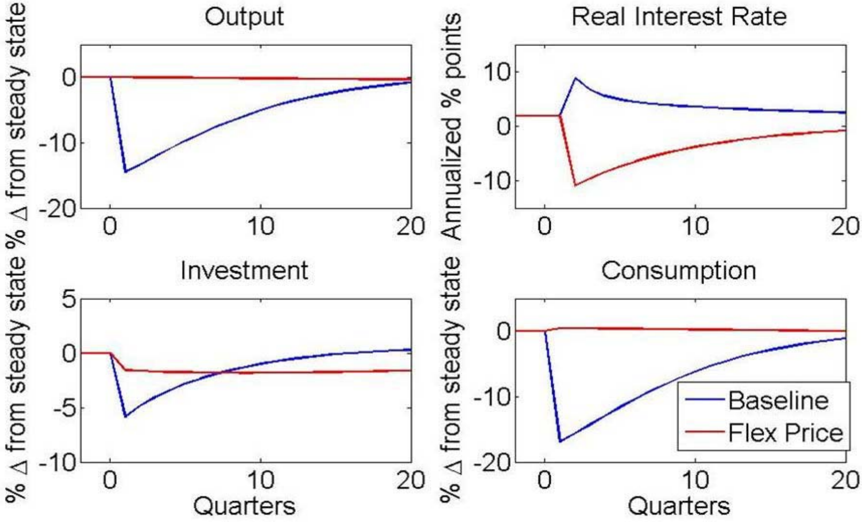
$$\frac{E_0 \sum_{t=0}^{\infty} (\hat{Y}_t^I - \hat{Y}_t^N)}{E_0 \sum_{t=0}^{\infty} \hat{N}_{t+1}^g}$$

	Baseline	Great Escape
Full model	0.8	2.8
No zero bound constraint	0.6	0.8
No nominal rigidities	0.009	0.007

The Role of the Zero Bound



The Role of the Nominal Rigidities



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
    - How much should the central bank intervene via unconventional policy?
    - "Great escape" or "Great moral hazard"?

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

Investment Adjustment Costs

- Capital producers:

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

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

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

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

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

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

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

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

Paths for the Nominal Interest Rate