The Great Escape? A Quantitative Evaluation of the Fed's Liquidity Facilities

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1 Background

Approach of Kiyotaki and Moore (KM2001): Real business cycles model + limited commitment

present goods

original lender $\rightleftarrows$ borrower

resell $\searrow$claim claim to future goods

new lenders

How much can the original lender enforce the borrower to repay? $\longrightarrow$ borrowing constraint

How much can new lenders enforce the borrower to repay? $\longrightarrow$ resaleability constraint

KM (2008): Run on shadow banking $\approx$ Fall in resaleability of private papers

flight to liquidity

interest-rate spread between liquid and illiquid papers expands

central bank should buy partially illiquid private papers, or lend against them

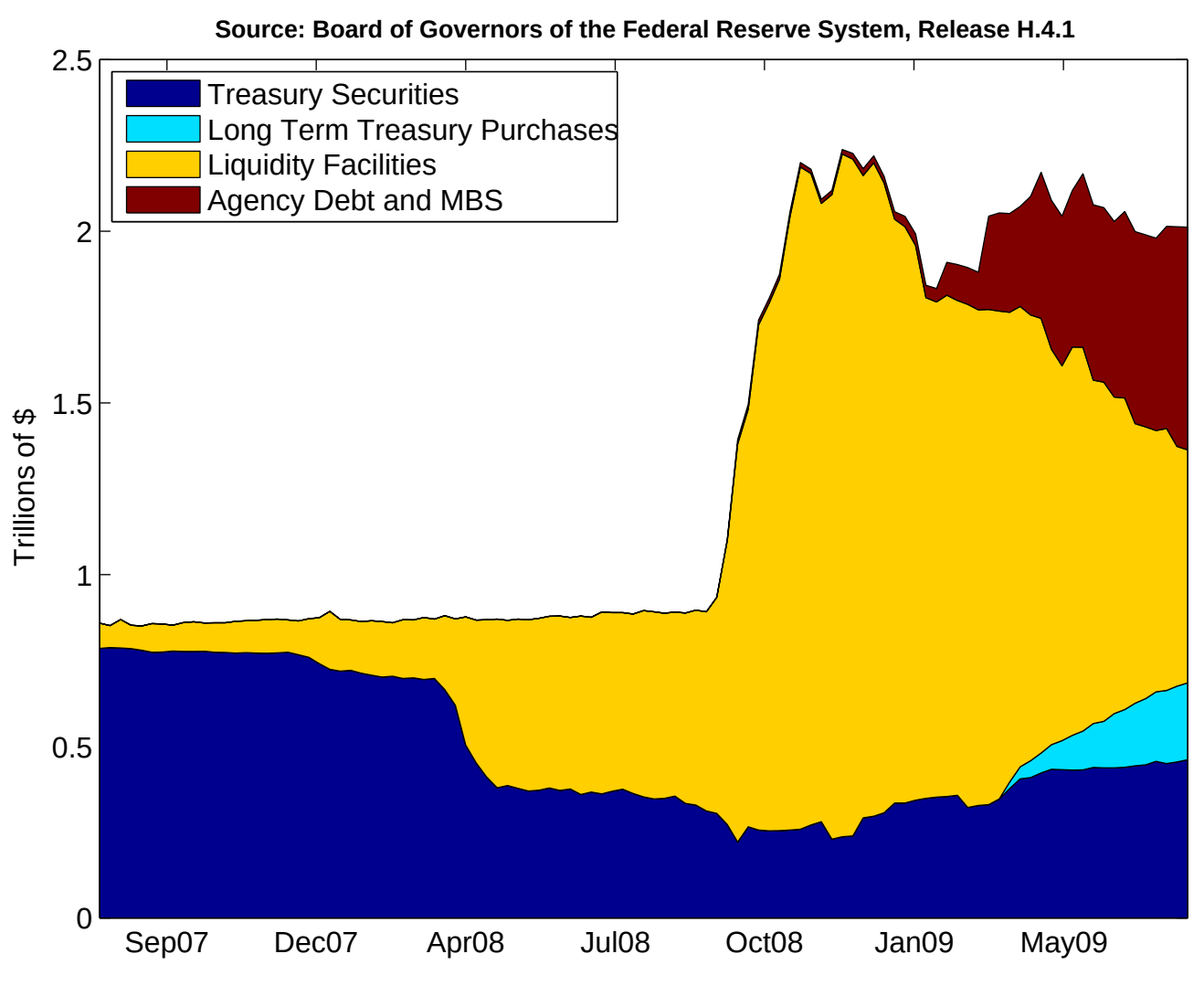
Presented KM revised at NY Fed in May 2008 $\longrightarrow$ "That is what we are doing!"

Del Negro, Eggertssson and Ferrero (DEF) start calibrating KM 2008 $\longrightarrow$ Does not work quite

Crisis deepened after Lehman collapse in September 2008

Federal Fund rate collapsed to zero in December 2008

"Reduce the spreads!": Fed purchased and lend against private papers


Source: Board of Governors of the Federal Reserve System, Release H.4.1
Treasury Securities
Long Term Treasury Purchases
Liquidity Facilities
Agency Debt and MBS
Trillions of $
2.5
2
1.5
1
0.5
0
Sep07
Dec07
Apr08
Jul08
Oct08
Jan09
May09

Joined DEF in summer 2009

introduce wage and price stickiness $\longrightarrow$ consumption and investment move together

liquid asset is treasury securities instead of money $\longrightarrow$ can adjust interest rate

nominal interest rate on treasury cannot be negative

2 Model

homogeneous output Y_t, capital K_t and treasury bills B_t with nominal gross interest rate $R_t \geq 1$ in each period

each household consists of [0,1] continuum of members, each member receives iid draw to become an entrepreneur with probability $\varkappa$, or a worker $wp.$ $1-\varkappa$

$$E_t \sum_{s=t}^{\infty} \beta^{s-t} \left[\frac{C_s^{1-\sigma}}{1-\sigma} - \frac{\omega}{1+\nu} \int_{\varkappa}^{1} H_s(j)^{1+\nu} \, dj \right],$$

investing member issues equity to finance investment

At the beginning of period

balance sheet at the start of period	
nominal bond: B_t/P_t	own equity issued: $q_t N_t^I$
equity of others: $q_t N_t^O$	
own capital stock: $q_t K_t$	net worth: $q_t N_t + B_t/P_t$

Net equity

$$N_t = N_t^O + K_t - N_t^I$$

During the period flow-of-funds of each household member j

$$C_t(j) + p_t^I I_t(j) + q_t \left[N_{t+1}(j) - I_t(j)\right] + \frac{B_{t+1}(j)}{P_t}$$

$$= \left[r_t^k + (1\text{-}\delta) q_t\right] N_t + \frac{R_{t-1} B_t}{P_t} + \frac{W_t(j)}{P_t} H_t(j) + D_t + D_t^I - \tau_t$$

Borrowing Constraint: an investing member can issue new equity at most θ fraction of his investment

Resaleability Constraint: in each period, an agent can resell at most ϕ_t fraction of his equity holdings

$$N_{t+1}(j) \geq (1-\theta) I_t(j) + (1-\phi_t)(1-\delta) N_t$$

$$B_{t+1}(j) \geq 0$$

If Tobin's q is larger than 1, $q_t > p_t^I$, entrepreneurs use all the liquidity to invest

$$I_t = \varkappa \frac{\left[r_t^k + (1-\delta)\phi_t q_t\right] N_t + \frac{R_{t-1}B_t}{P_t} + D_t + D_t^I - \tau_t}{p_t^I - \theta q_t}$$

Each worker supplies differentiated labor according to the demand, buys consumption goods and chooses portfolio

$$\begin{aligned} & C_t^{-\sigma} \\ = \; & \beta E_t C_{t+1}^{-\sigma} \left[\frac{R_t}{\pi_{t+1}} + \frac{\varkappa(q_{t+1} - p_{t+1}^I)}{p_{t+1}^I - \theta q_{t+1}} \cdot \frac{R_t}{\pi_{t+1}}\right] \\ = \; & \beta E_t C_{t+1}^{-\sigma} \cdot \\ & \left[\frac{r_{t+1}^k + (1\text{-}\delta) q_{t+1}}{q_t} + \frac{\varkappa(q_{t+1}\text{-}p_{t+1}^I)}{p_{t+1}^I - \theta q_{t+1}} \cdot \frac{r_{t+1}^k + (1\text{-}\delta)\phi_{t+1} q_{t+1}}{q_t}\right] \end{aligned}$$

At the end of period, all member get together to consume and shares the assets $C_t = \int_{\varkappa}^{1} C_t(j)\, dj$.

Final goods are produced from intermediate goods

$$Y_t = \left(\int_0^1 Y_{it}^{\frac{1}{1+\lambda_f}} di \right)^{1+\lambda_f}$$

Intermediate goods producer sets the price of its product according to Calvo rule and uses capital and labor to accommodate the demand under monopolistic competition

$$Y_{it} = A_t K_{it}^{\gamma} H_{it}^{1-\gamma}, \; Y_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\frac{1+\lambda_f}{\lambda_f}} Y_t$$

Labor union sets the wage of its differentiated labor according to Calvo rule and accommodates the demand

Capital goods producer choose its output under perfect competition

Gov't sets interest rate, purchases private paper and taxes

$$R_t = \max\left\{R\pi_t^{\psi_\pi}, 1\right\}$$

$$\frac{N_{t+1}^g}{K} = \psi_k \frac{\phi_t - \phi}{\phi}, \text{ where } \psi_k < 0$$

$$\begin{aligned} q_t N_{t+1}^g + \frac{R_{t-1}B_t}{P_t} &= \tau_t + \left[r_t^k + (1-\delta)q_t\right] N_t^g + \frac{B_{t+1}}{P_t} \\ \tau_t - \tau &= \psi_\tau \left[\frac{R_{t-1}B_t}{P_t} - \frac{RB}{P} - q_t N_t^g\right] \end{aligned}$$

Market clears

$$Y_t = C_t + \left[1 + S\left(\frac{I_t}{I}\right)\right] I_t$$

$$\begin{aligned} K_{t+1} &= (1-\delta) K_t + I_t \\ &= N_{t+1} + N_{t+1}^g \end{aligned}$$

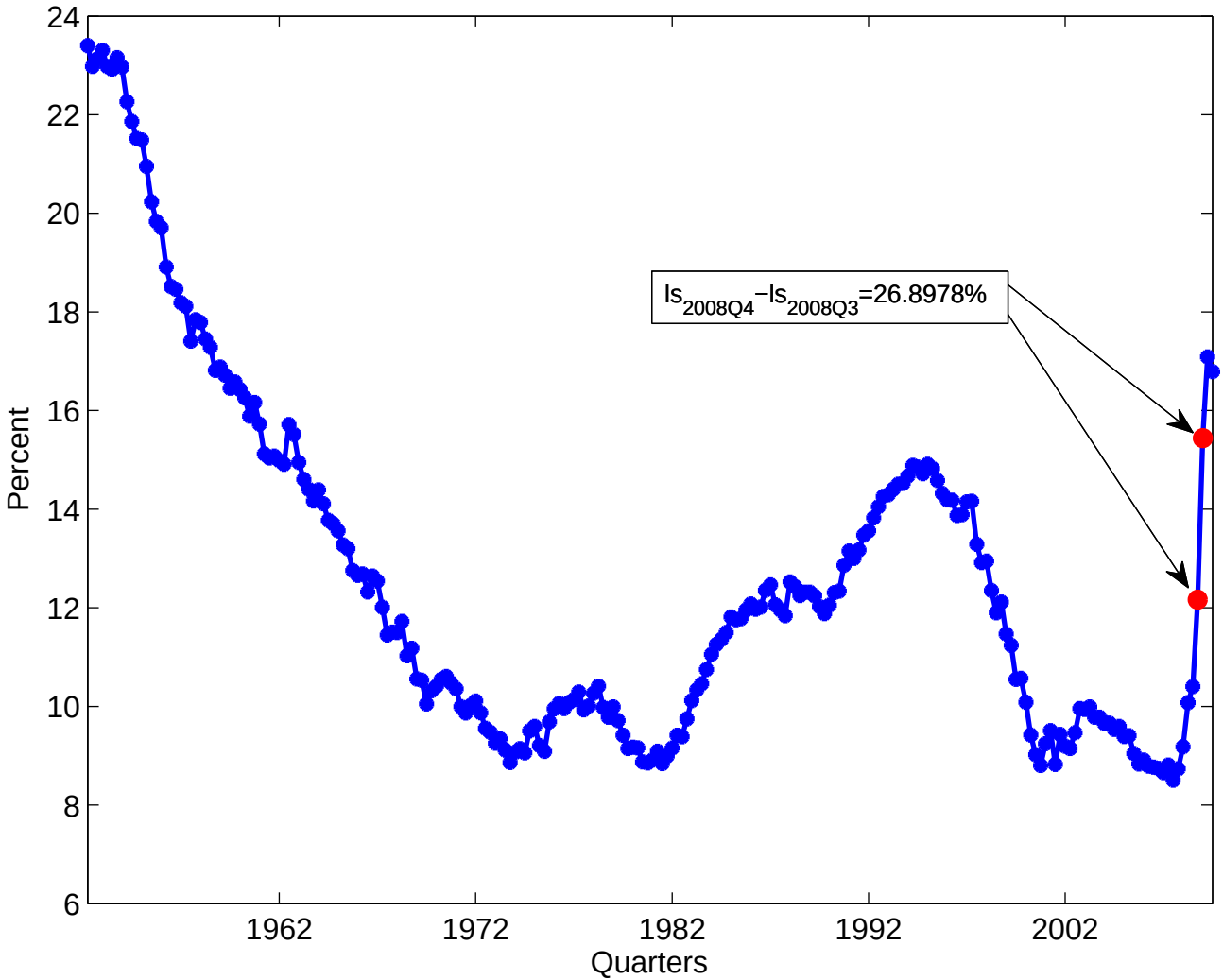
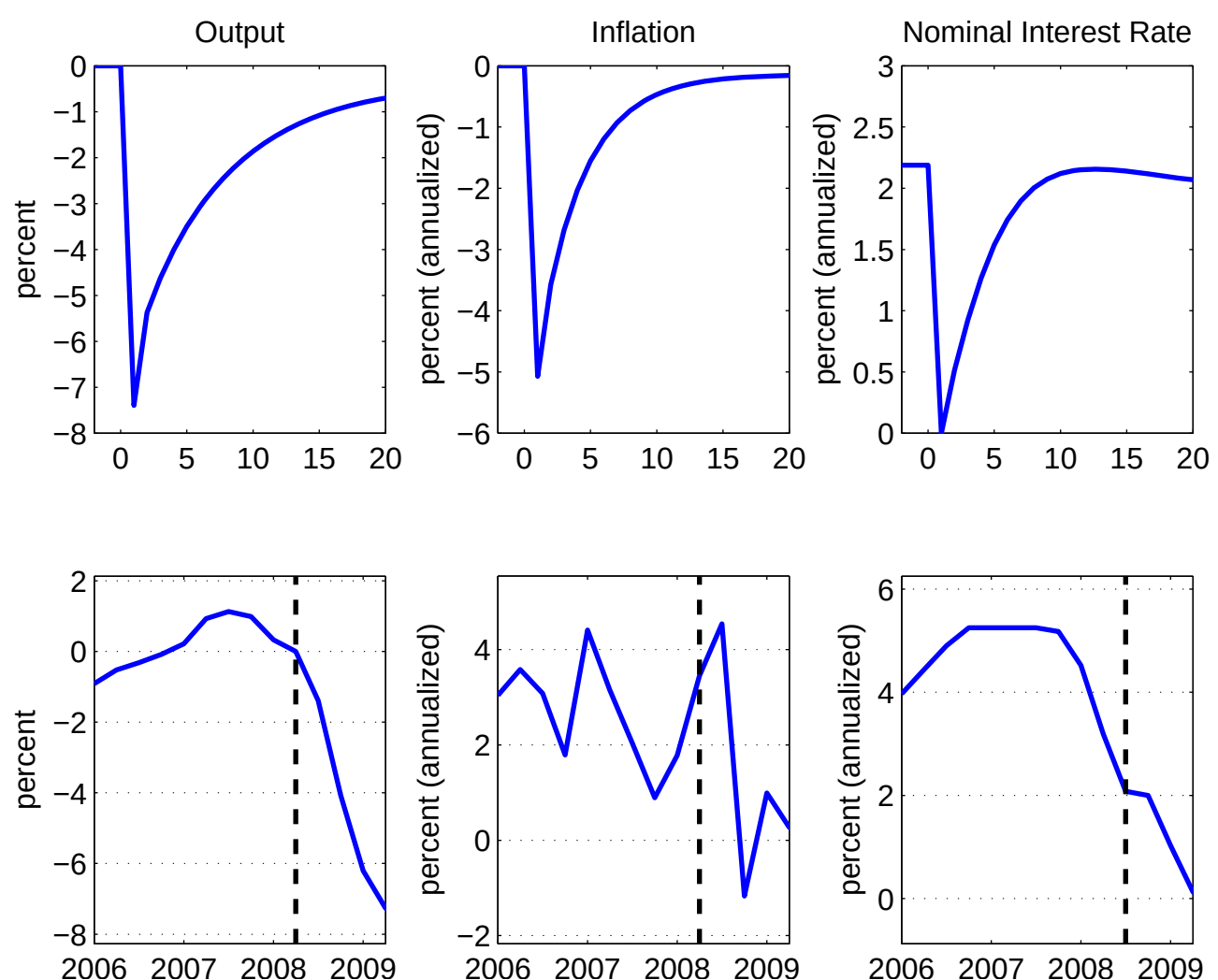
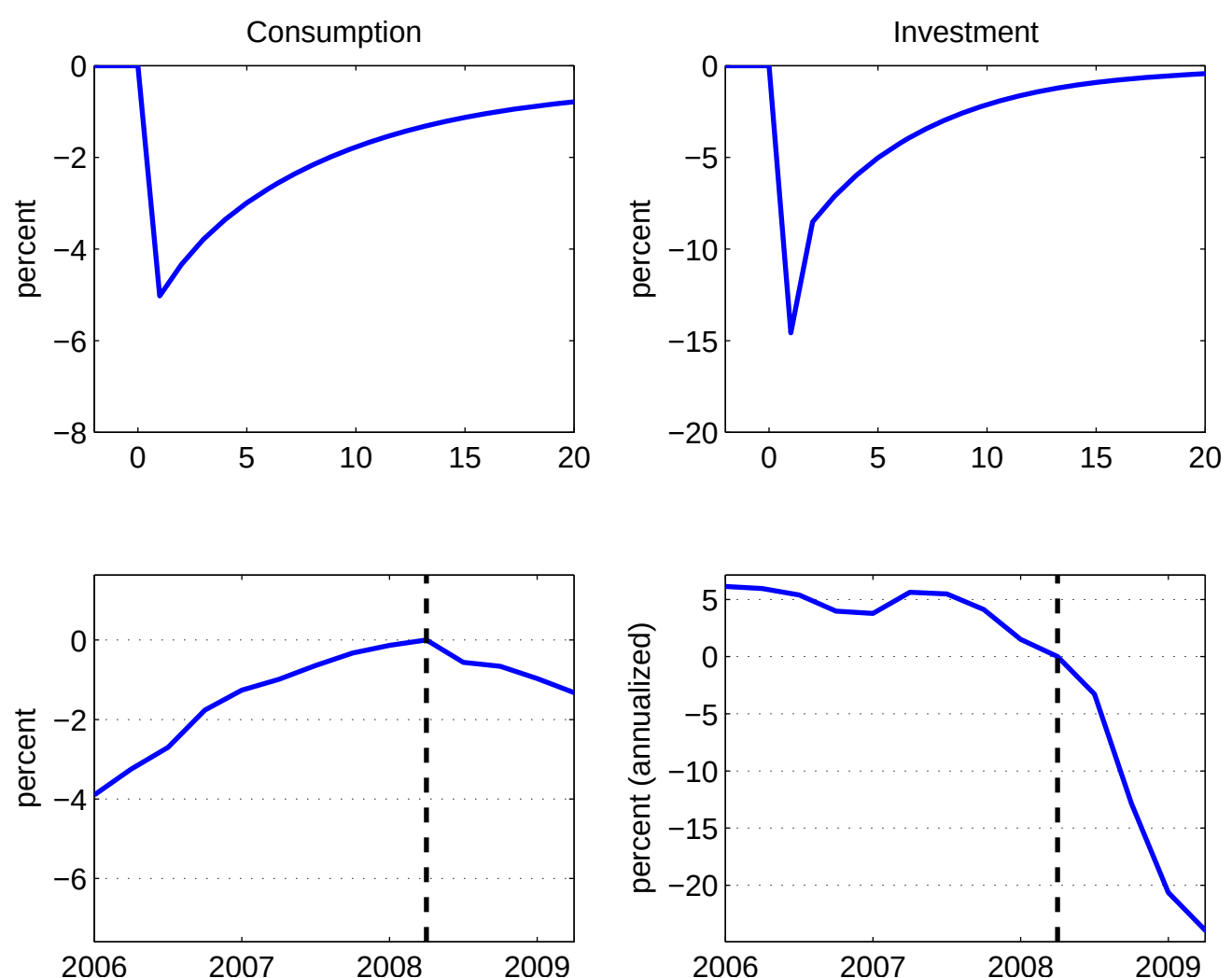
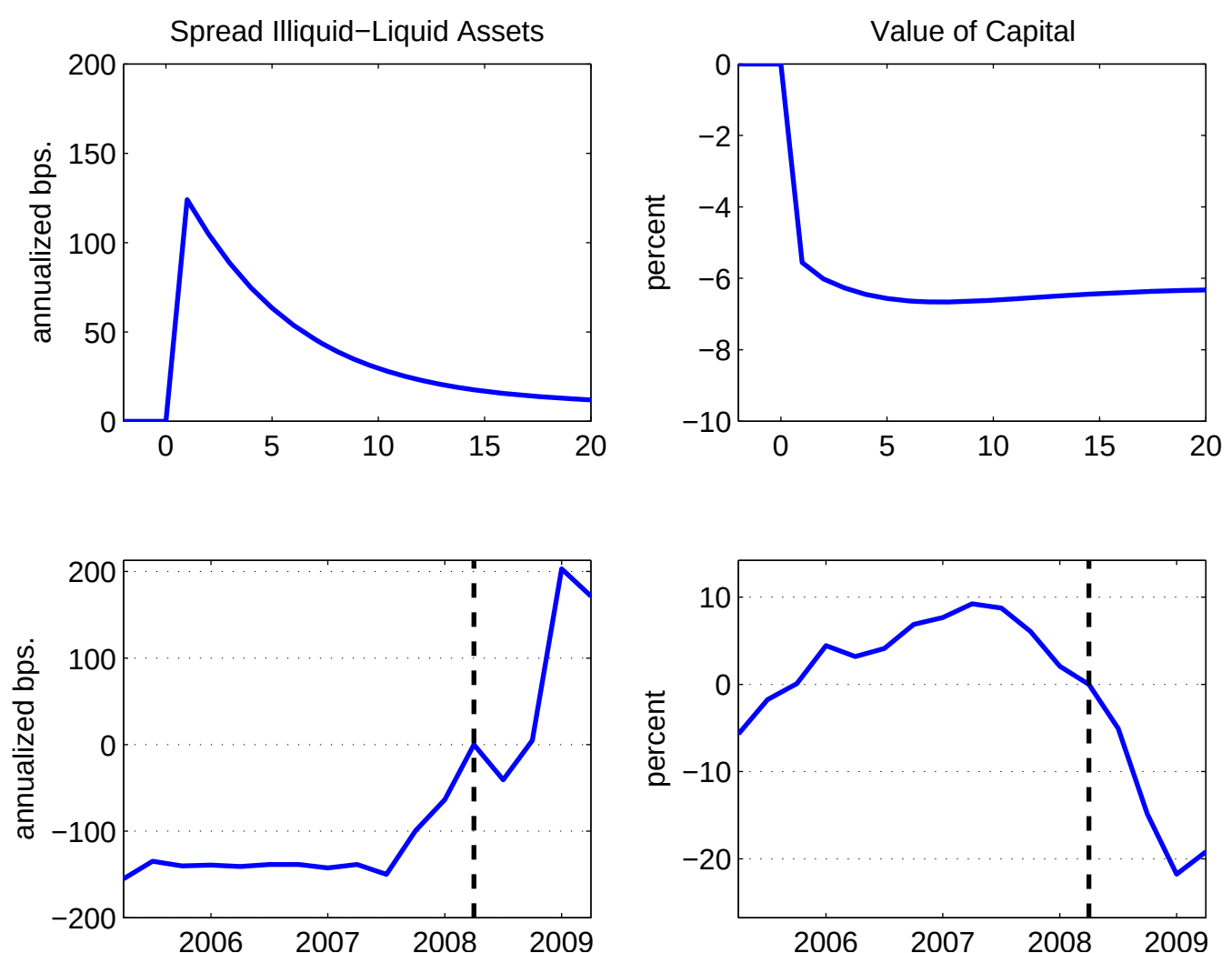

24
22
20
18
16
14
12
10
8
6
Percent
1962
1972
1982
1992
2002
Quarters
ls2008Q4−ls2008Q3=26.8978%

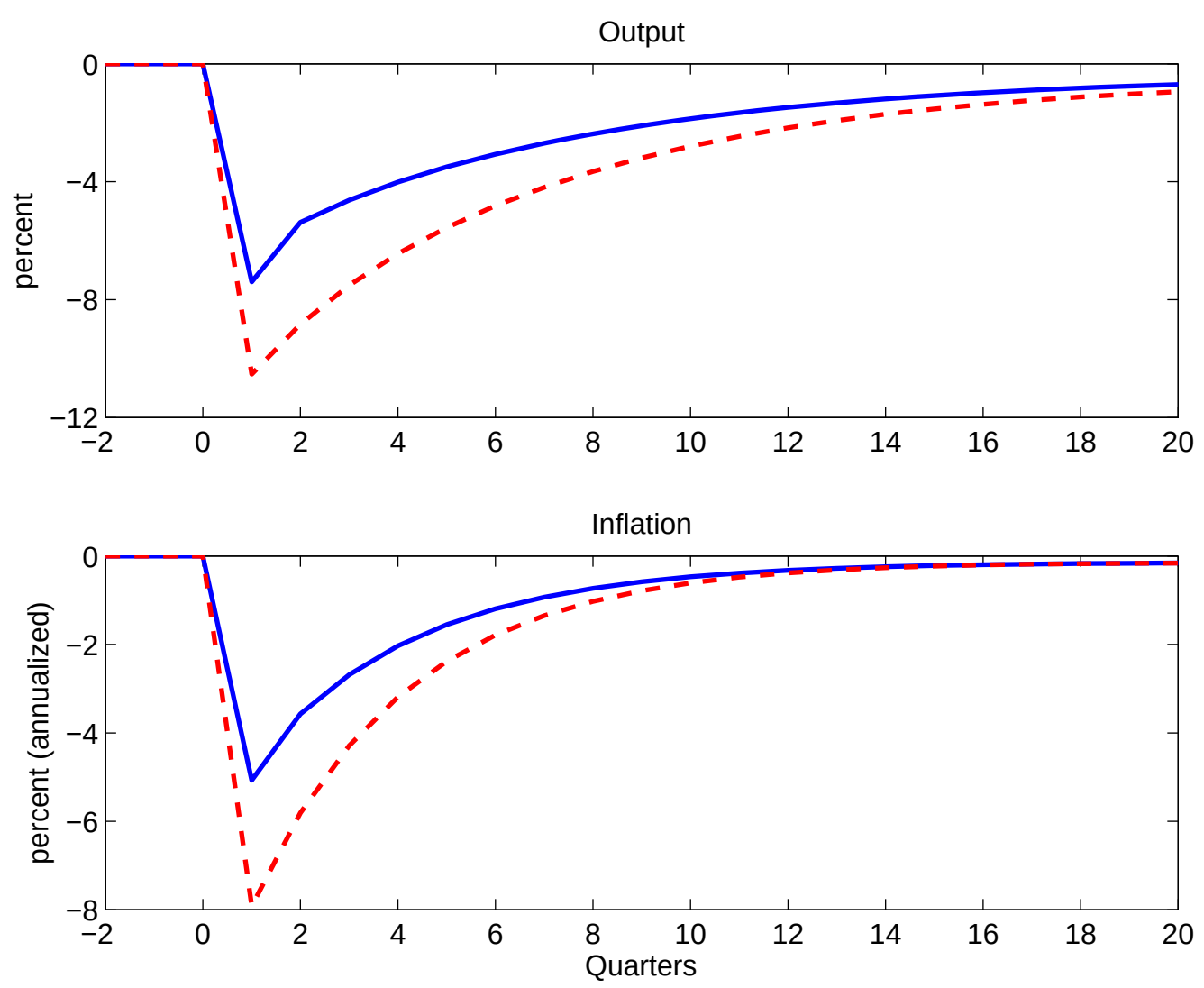
Table 1: Calibration

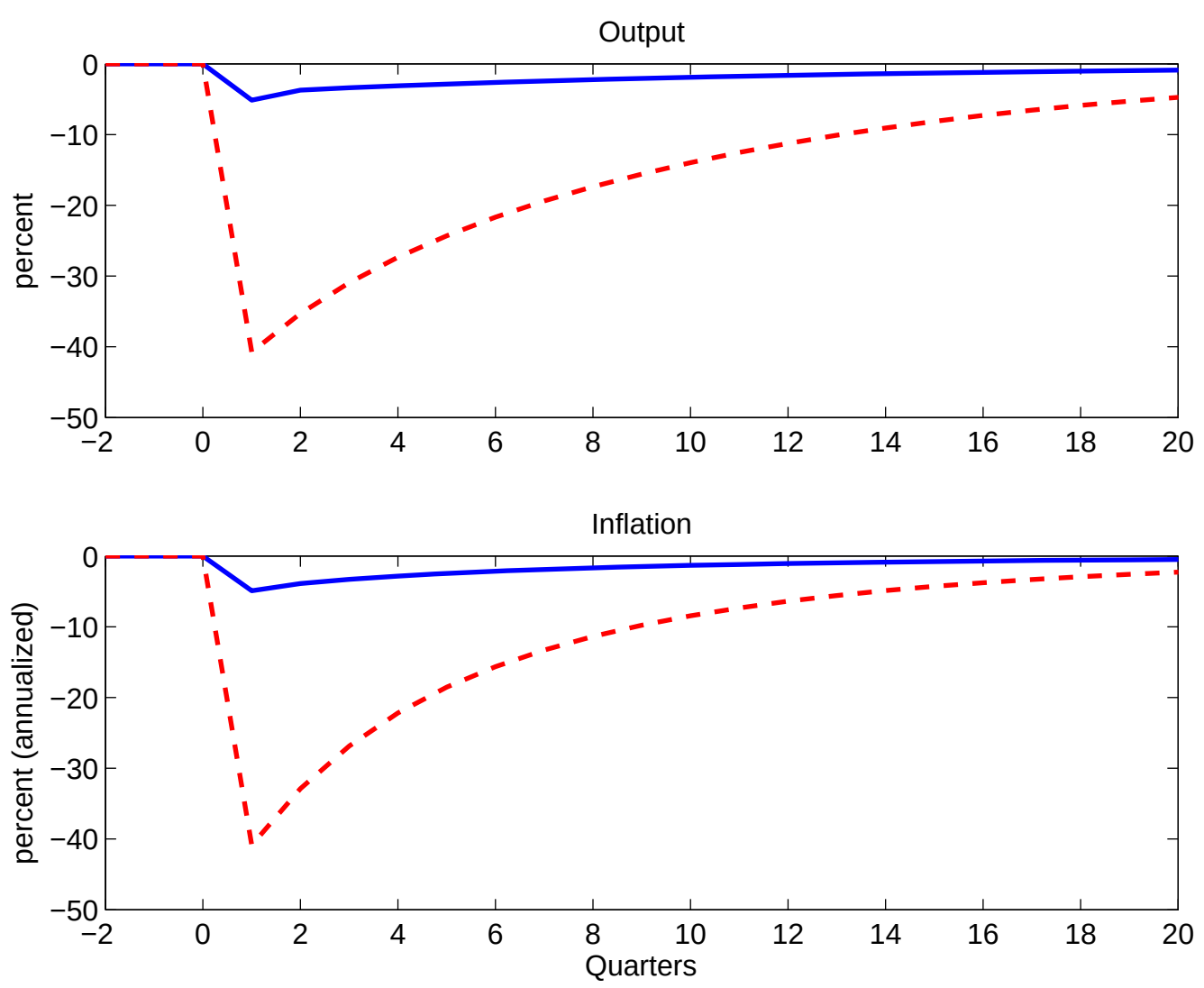
β	=	0.99		Discount factor
σ	=	1		Relative risk aversion
δ	=	0.025		Depreciation rate
γ	=	0.40		Capital share
$S''(1)$	=	1		Adjustment cost parameter
ν	=	1		Inverse Frisch elasticity
ψ	=	1.5		Taylor rule coefficient
$\zeta_p = \zeta_w$	=	0.75		Price/wage Calvo probability
$\lambda_p = \lambda_p$	=	0.1		Price/wage steady-state markup
$\varkappa$	=	0.05		Probability of investment opportunity
ϕ	=	0.19		Resaleability constraint
θ	=	0.19		Borrowing constraint
L	=	0.40		Steady-state liquidity/GDP
ξ_τ	=	0.1		Transfer rule coefficient
		Baseline	Great Escape	
$\hat{\phi}_L$	=	-0.600	-0.295	Size of the liquidity shock
ζ_{ZB}	=	0.167	0.100	Probability of exiting the crisis state
ξ_k	=	-0.063	-0.127	Government intervention coefficient

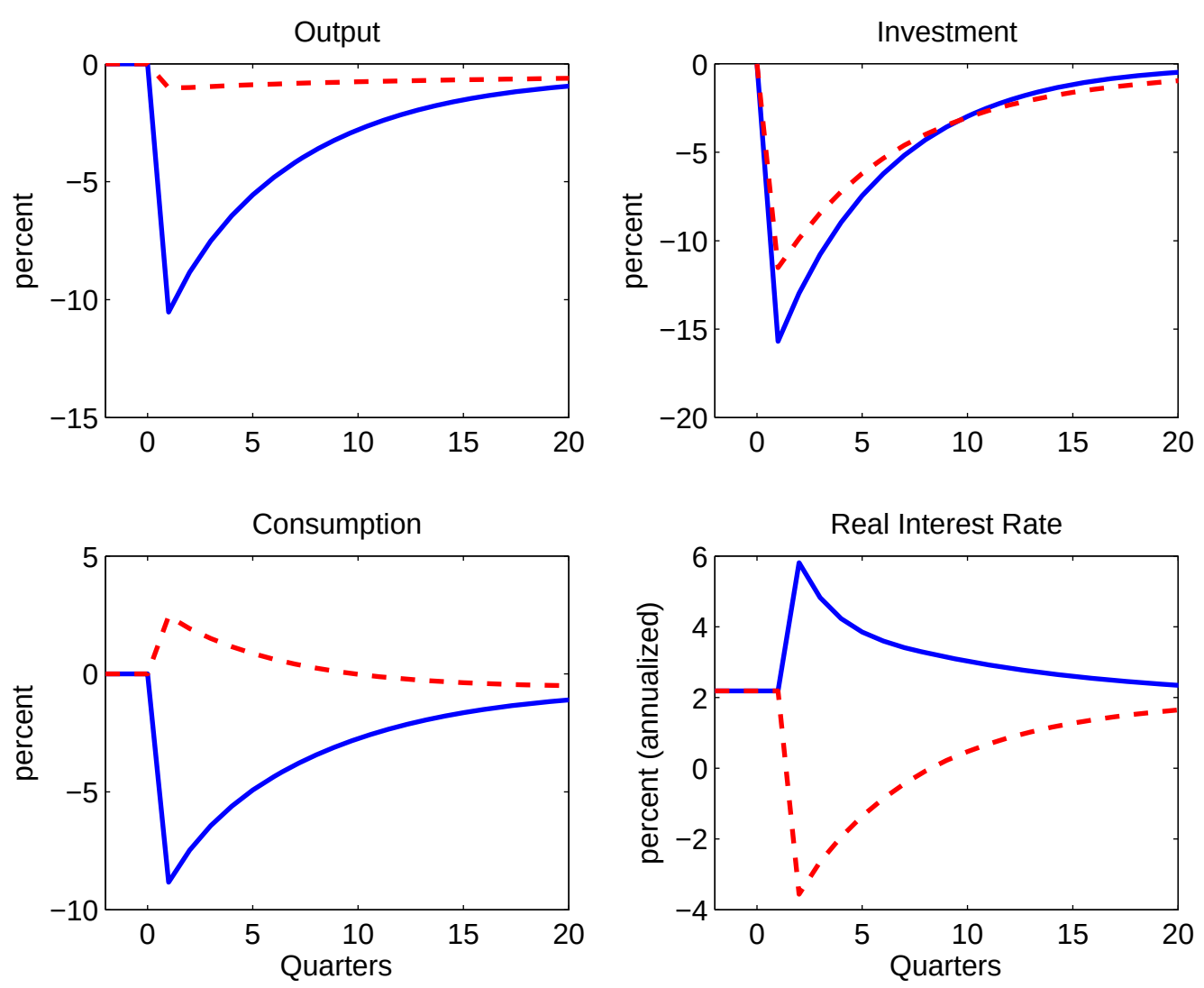

Output
Inflation
Nominal Interest Rate
percent
percent (annualized)
percent (annualized)
0
−1
−2
−3
−4
−5
−6
−7
−8
0
−1
−2
−3
−4
−5
−6
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
2
0
−2
−4
−6
−8
4
2
0
−2
6
4
2
0
2006
2007
2008
2009

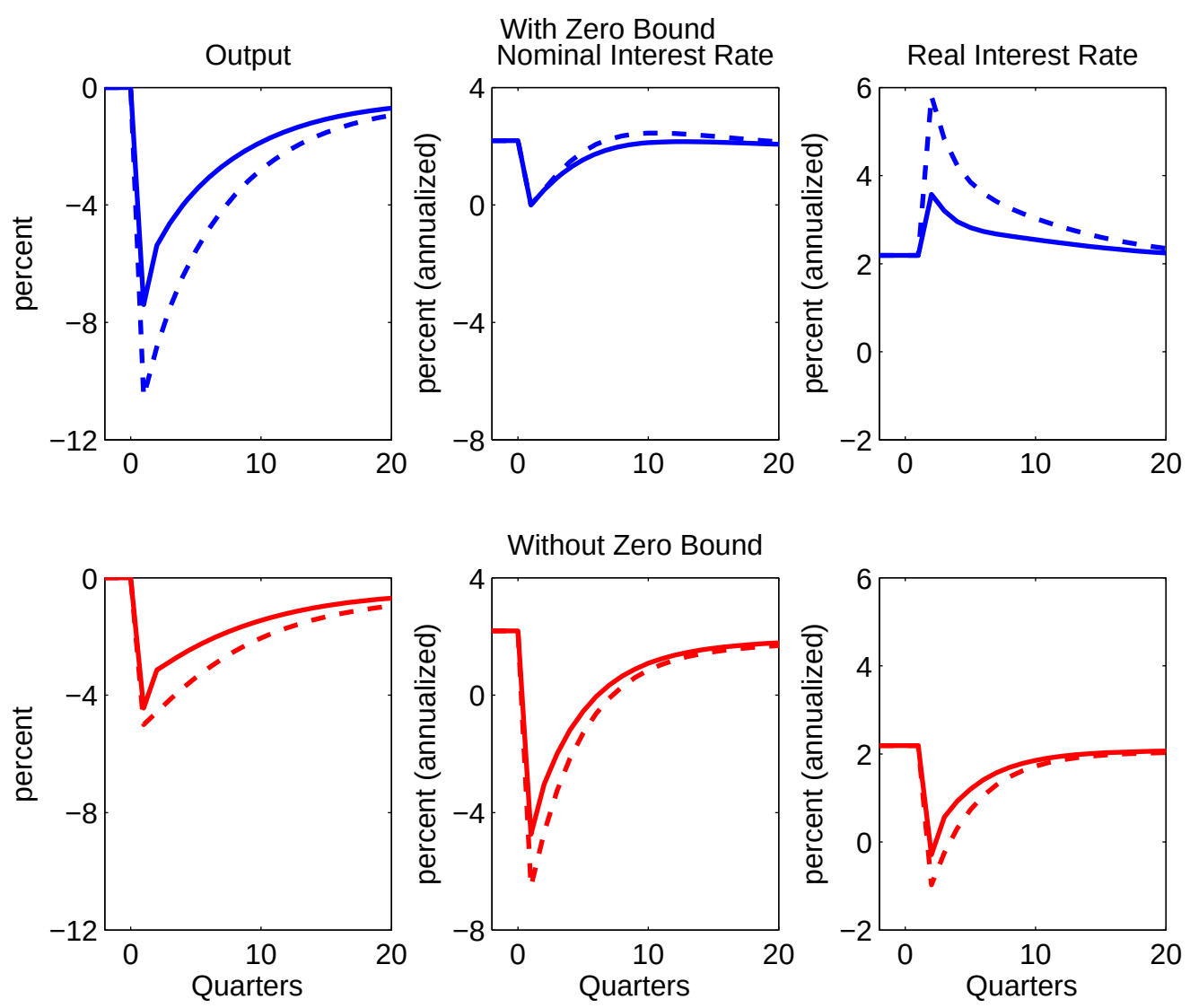

Consumption
Investment
percent
percent
0
−2
−4
−6
−8
0
−5
−10
−15
−20
0
5
10
15
20
percent
percent (annualized)
2006
2007
2008
2009


Spread Illiquid−Liquid Assets
annualized bps.
200
150
100
50
0
0
5
10
15
20
Value of Capital
percent
0
−2
−4
−6
−8
−10
0
5
10
15
20
annualized bps.
200
100
0
−100
−200
2006
2007
2008
2009
percent
10
0
−10
−20
2006
2007
2008
2009


Output
0
−4
−8
−12
percent
−2
0
2
4
6
8
10
12
14
16
18
20
Inflation
0
−2
−4
−6
−8
percent (annualized)
−2
0
2
4
6
8
10
12
14
16
18
20
Quarters


Output
percent
0
−10
−20
−30
−40
−50
−2
0
2
4
6
8
10
12
14
16
18
20
Inflation
percent (annualized)
0
−10
−20
−30
−40
−50
−2
0
2
4
6
8
10
12
14
16
18
20
Quarters


Output
Investment
Consumption
Real Interest Rate
percent
percent
percent
percent (annualized)
Quarters
Quarters
0
−5
−10
−15
−20
5
6
4
2
−2
−4
0
5
10
15
20


With Zero Bound
Output
Nominal Interest Rate
Real Interest Rate
percent
percent (annualized)
percent (annualized)
0
−4
−8
−12
4
0
−4
−8
6
4
2
0
−2
0
10
20
Without Zero Bound
percent
percent (annualized)
percent (annualized)
Quarters
Quarters
Quarters