Banking, Liquidity and Bank Runs in an Infinite Horizon Economy

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Recent financial crisis started in summer 2007

Despite of many attempts, DSGE models with financial friction forecasted no deep recession until fall 2008

After 2008Q4, models with financial friction predict deeper recession than the models without

To explain financial crisis, we need "bank run" or "sudden stop"

Liquidity mismatch opens up the possibility of run $\longrightarrow$

Inefficient liquidation of assets, loss of intermediation, and deep recession

We develop a simple macro model of banking crisis

- Financial accelerator / Credit cycles
- Banks runs

Macroeconomic conditions affect whether runs are feasible

- Bank leverage ratio
- Liquidation prices

An increase in the likelihood of run contracts the economy severely

Basic Model

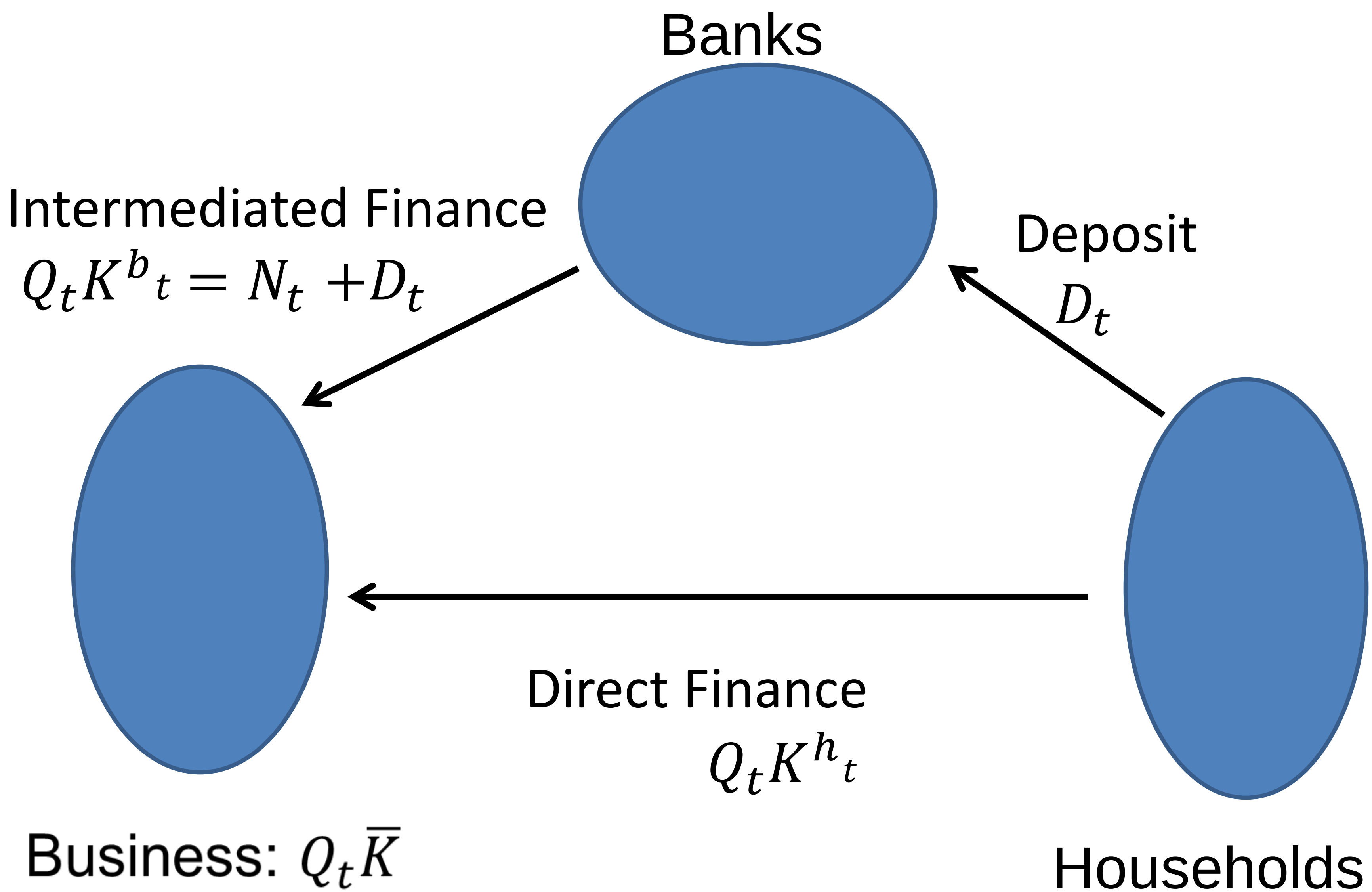
Capital is either intermediated by banks or directly held by households

$$K_t^b + K_t^h = \overline{K}$$

$$\begin{array}{c} \textit{date t} \\ \left. K_t^b \text{ capital} \right\} \end{array} \longrightarrow \begin{array}{c} \textit{date t+1} \\ \left\{ \begin{array}{c} K_t^b \text{ capital} \\ Z_{t+1} K_t^b \text{ output} \end{array} \right. \end{array}$$

$$\begin{array}{c} \textit{date t} \\ \left. \begin{array}{c} K_t^h \text{ capital} \\ f(K_t^h) \text{ goods} \end{array} \right\} \end{array} \longrightarrow \begin{array}{c} \textit{date t+1} \\ \left\{ \begin{array}{c} K_t^b \text{ capital} \\ Z_{t+1} K_t^b \text{ output} \end{array} \right. \end{array}$$

$$f(K_t^h) : \text{ management cost } f' > 0, \;\; f'' \geq 0$$


Banks
Intermediated Finance
$Q_t K^b{}_t = N_t + D_t$
Deposit
D_t
Direct Finance
$Q_t K^h{}_t$
Business: $Q_t \overline{K}$
Households

Deposit contract

Short term

Promised rate of return $\overline{R}_{t+1}$ is non-contingent

With run, the returns is the minimum of $\overline{R}_{t+1}$ and total realized bank assets per deposit

In Basic Model, bank run is unanticipated $\longrightarrow$

Realized return: $R_{t+1} = \overline{R}_{t+1}$: Promised return

Households maximize

$$U_t = E_t\left(\sum_{i=0}^{\infty} \beta^i \ln C_{t+i}^h\right)$$

subject to:

$$C_t^h + D_t + Q_t K_t^h + f(K_t^h) = Z_t W^h + R_t D_{t-1} + (Z_t + Q_t) K_{t-1}^h$$

$\longrightarrow$

$$1 = E_t\left(\Lambda_{t,t+1}\right) R_{t+1}$$

$$1 = E_t\left(\Lambda_{t,t+1} \frac{Z_{t+1} + Q_{t+1}}{Q_t + f'(K_t^h)}\right)$$

$$\Lambda_{t,t+1} = \beta \frac{C_t}{C_{t+1}}$$

Many bankers

Each has an i.i.d. survival probability of σ

Banker consumes wealth upon exit: $c_t^b = n_t$

Preferences are linear in "terminal" consumption

$$V_t = E_t\left[\sum_{i=1}^{\infty} \beta^i \sigma^{i-1}(1-\sigma)c_{t+i}^b\right]$$

Each exiting banker replaced by a new banker with an endowment $w^b = n_t$

Bank balance sheet

$$Q_t k_t^b = d_t + n_t$$

Net worth n_t of surviving bankers

$$n_t = (Z_t + Q_t)k_{t-1}^b - R_t d_{t-1}$$

Agency Problem:

After the banker raises funds, it may divert a fraction of θ of loans at the end of period t

If the banker does not repay its debt in period $t+1$, the creditors shut the bank down

Incentive constraint

$$\theta Q_t k_t^b \leq V_t$$

Bank chooses k_t^b and d_t to maximize

$$V_t = \beta E_t[(1-\sigma)n_{t+1} + \sigma V_{t+1}]$$

subject to $\theta Q_t k_t^b \leq V_t \Leftrightarrow$

Bank chooses "leverage multiplier" $\phi_t = \frac{Q_t k_t^b}{n_t}$ to maximize

$$\frac{V_t}{n_t} = \psi_t = \beta E_t \left\{ (1 - \sigma + \sigma \psi_{t+1}) \frac{n_{t+1}}{n_t} \right\}$$

$$= \beta E_t \left\{ (1 - \sigma + \sigma \psi_{t+1}) \left[\phi_t \left(\frac{Q_{t+1} + Z_{t+1}}{Q_t} - R_{t+1} \right) + R_{t+1} \right] \right\}$$

subject to $\theta \phi_t \leq \psi_t$

Aggregate leverage constraint

$$Q_t K_t^b = \phi_t N_t$$

Aggregate net worth

$$N_t = \sigma \left[\left(Z_t + Q_t \right) K_{t-1}^b - R_t D_{t-1} \right] + (1 - \sigma) w^b$$

Goods market

$$\begin{aligned} & C_t^h + (1 - \sigma) \left[\left(Z_t + Q_t \right) K_{t-1}^b - R_t D_{t-1} \right] + f(K_t^h) \\ = \ & Z_t \overline{K} + Z_t W^h + (1 - \sigma) w^b \end{aligned}$$

Bank Runs

Ex ante, zero probability of a run

If depositors do not roll over the deposits ("run"), the bank sells its capital to households who are less efficient in managing capital

In addition to an equilibrium without run, bank run equilibrium exists if:

$$\left(Z_t + Q_t^*\right) K_{t-1}^b < R_t D_{t-1}$$

$Q_t^* \equiv$ the liquidation price of the bank's assets

After a bank run at t :

$$K_t^h = \overline{K},$$

$$N_{t+1} = (1 - \sigma) w^b$$

$$N_s = \sigma \left[(Z_s + Q_s) K_{s-1}^b - R_s D_{s-1} \right] + (1 - \sigma) w^b, \ \forall \ s \geq t+2$$

Household condition for direct capital holding $\longrightarrow$

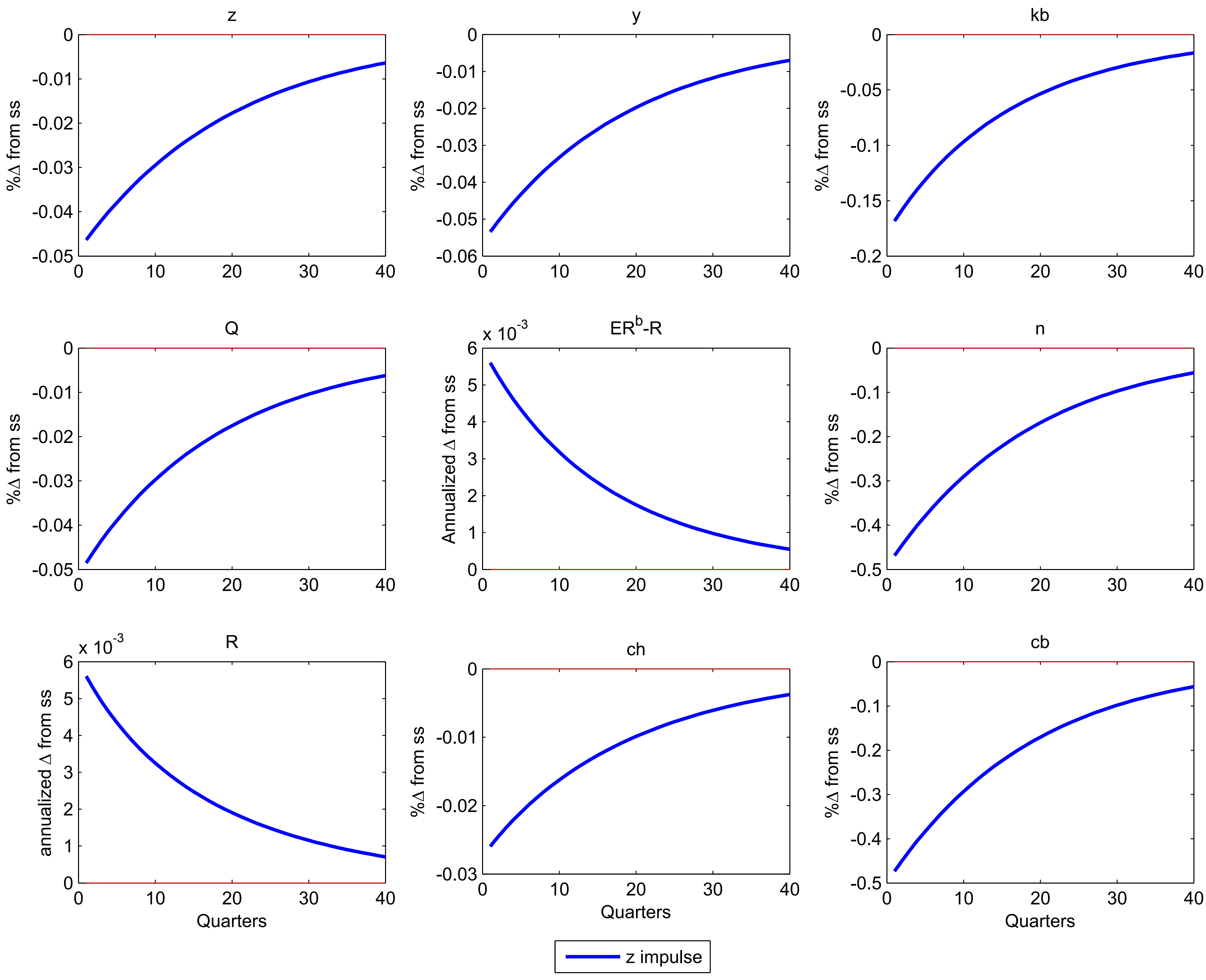
$$Q_t^* = E_t \left\{ \sum_{i=1}^{\infty} \Lambda_{t,t+i} [Z_{t+i} - f'(K_{t+i}^h)] \right\} - f'(\overline{K})$$

Table 1: Parameters

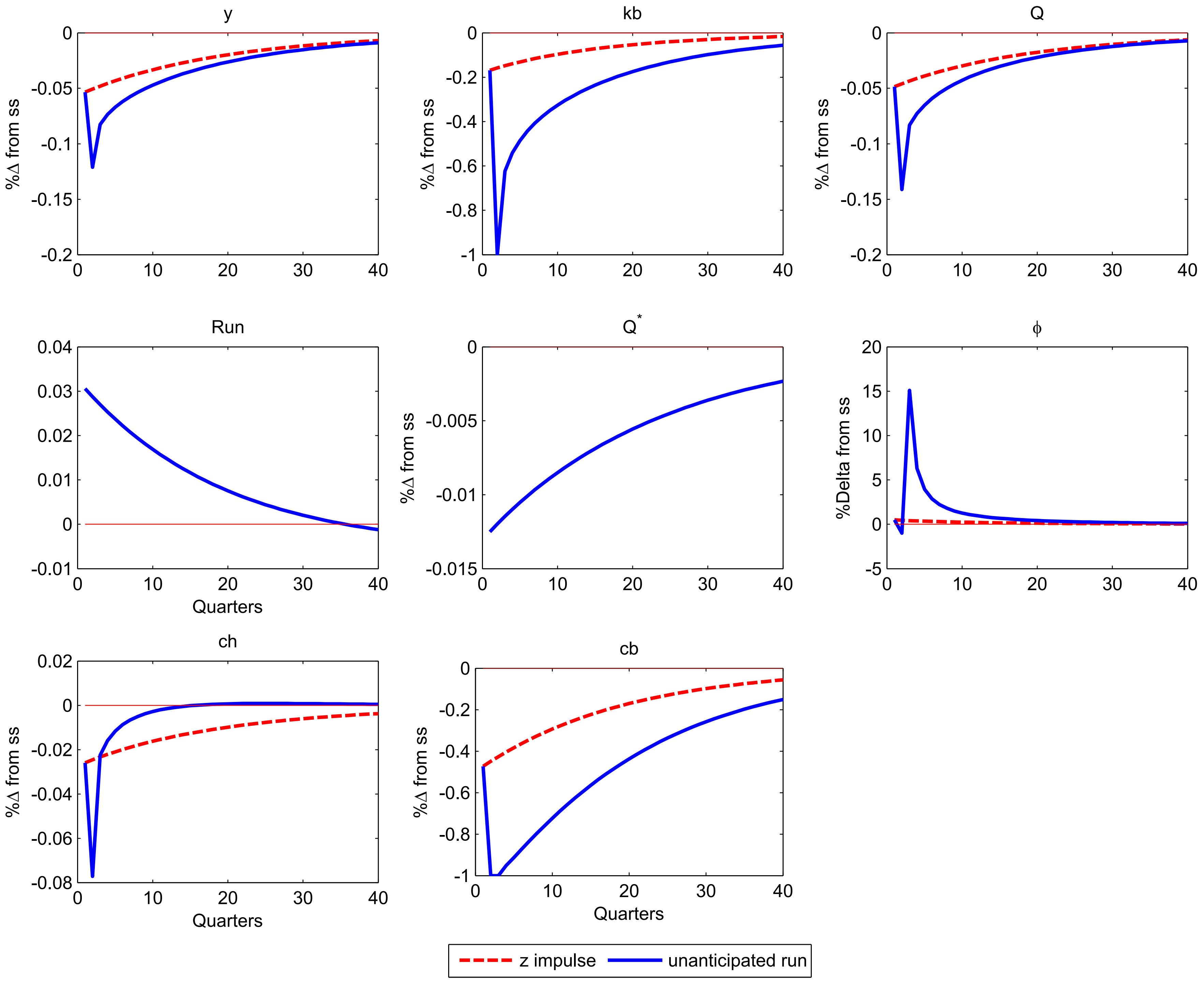
Baseline Model		
β	0.99	Discount rate
σ	0.95	Bankers survival probability
θ	0.2501	Seizure rate
α	0.01	Household managerial cost
ρ	0.95	Serial correlation of productivity shock
Z	0.0132	Steady state productivity
W^b	0.0007	Bankers endowment
W^h	0.045	Household endowment
$\bar{p}$	1	Endogenous Run Probability Parameter
δ	1	Endogenous Run Probability Parameter

Table 2: Steady State Values

Steady State Values	
	Baseline
K	1
Q	1
C^h	0.0549
C^b	0.0036
K^h	0.3094
K^b	0.6906
ϕ	10
R^b	1.0529
R^h	1.0404
R	1.0404



z
y
kb
Q
x 10^-3
ER^b-R
n
x 10^-3
R
ch
cb
%Δ from ss
Annualized Δ from ss
annualized Δ from ss
Quarters
z impulse


y
kb
Q
Run
Q*
ϕ
ch
cb
%∆ from ss
%Delta from ss
Quarters
z impulse
unanticipated run

Extension: Anticipated Bank Runs

$$\text{Deposit returns } R_{t+1} = \begin{cases} \overline{R}_{t+1} \text{ if no bank run} \\ x_{t+1}\overline{R}_{t+1} \text{ if bank run} \end{cases}$$

$$x_{t+1} = \frac{\left(Q^*_{t+1} + Z_{t+1}\right) K^b_t}{\overline{R}_{t+1} D_t}$$

Household attaches the probability of bank run as

$$p_t = 1 - E_t\left[Min\left(1, x_{t+1}\right)\right]$$

FONC for deposits is

$$1 = \overline{R}_{t+1}[(1 - p_t)E_t\left(\Lambda_{t,t+1}\right) + p_t E_t(\Lambda^*_{t,t+1} x_{t+1})]$$

Bank's leverage $\phi_t = \frac{Q_t k_t^b}{n_t}$ maximizes

$$\frac{V_t}{n_t} = \psi_t =$$

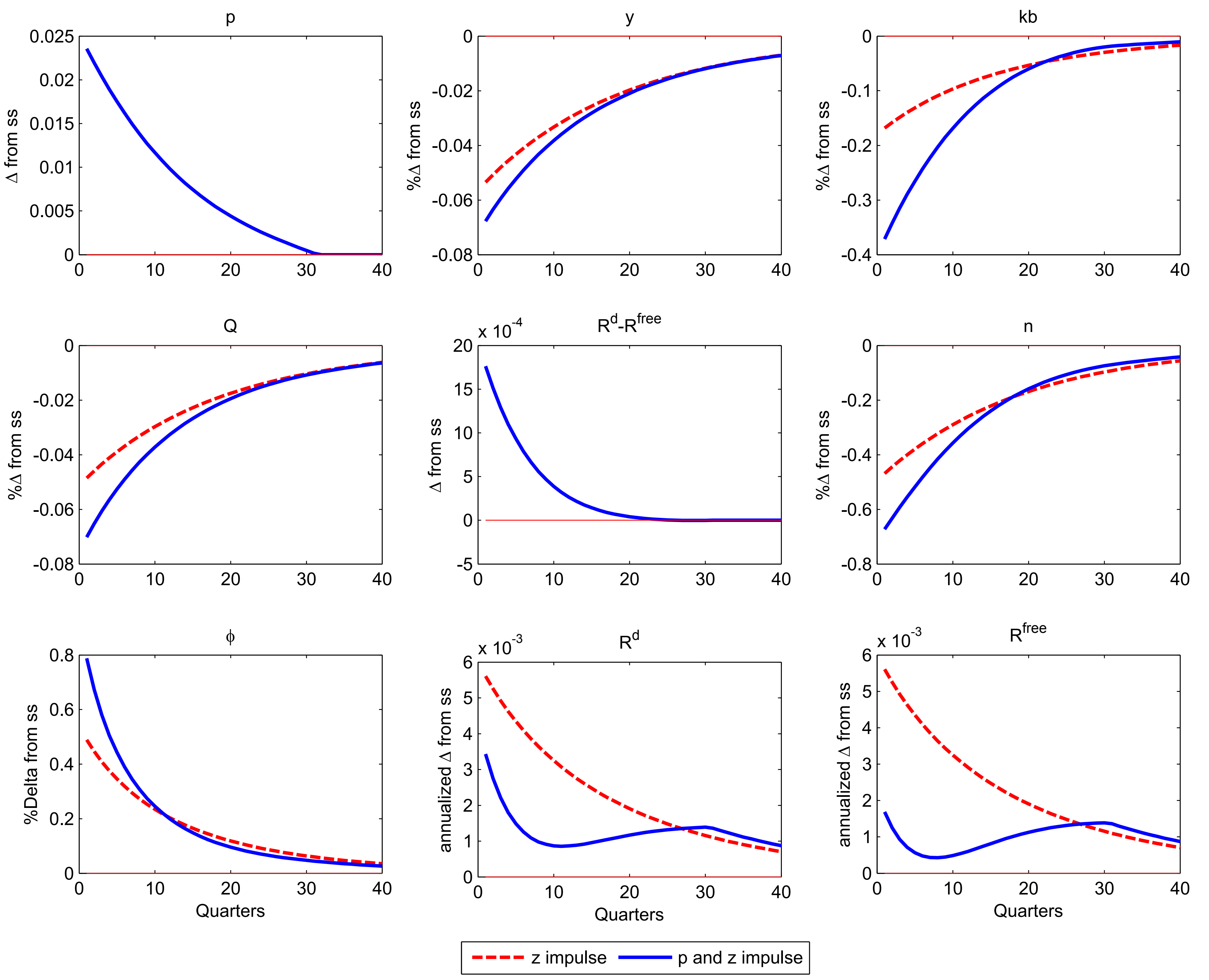
$$\beta(1-p_t)E_t\left\{(1\text{-}\sigma+\sigma\psi_{t+1})\left[\phi_t\left(\frac{Q_{t+1}+Z_{t+1}}{Q_t}-\overline{R}_{t+1}\right)+\overline{R}_{t+1}\right]\right\}$$

subject to $\theta\phi_t \leq \psi_t$.

An increase in likelihood of run is contractionary in two ways

leverage ϕ_t declines when the franchise value falls

N_{t+1} decreases even without run since $\overline{R}_{t+1}$ increases



p
Δ from ss
y
%Δ from ss
kb
%Δ from ss
Q
%Δ from ss
x 10^-4
R^d-R^free
Δ from ss
n
%Δ from ss
ϕ
%Delta from ss
Quarters
x 10^-3
R^d
annualized Δ from ss
Quarters
x 10^-3
R^free
annualized Δ from ss
Quarters
z impulse
p and z impulse

Some Remarks About Policy

Deposit insurance can eliminate bank run equilibrium

But may have moral hazard of risk-taking, particularly by investment banks

Capital requirement reduces bank risk-taking and likelihood of bank run

Can increase intermediation cost if capital is costly to raise

Lender-of-last resort stabilizes liquidation price and reduces likelihood of bank run

Can purchase or lend against a good quality securities e.g. AMBS