Banking, Liquidity and Bank Runs in an Infinite Horizon Economy

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Recent financial crisis

Slow run on shadow banks from Summer 2007

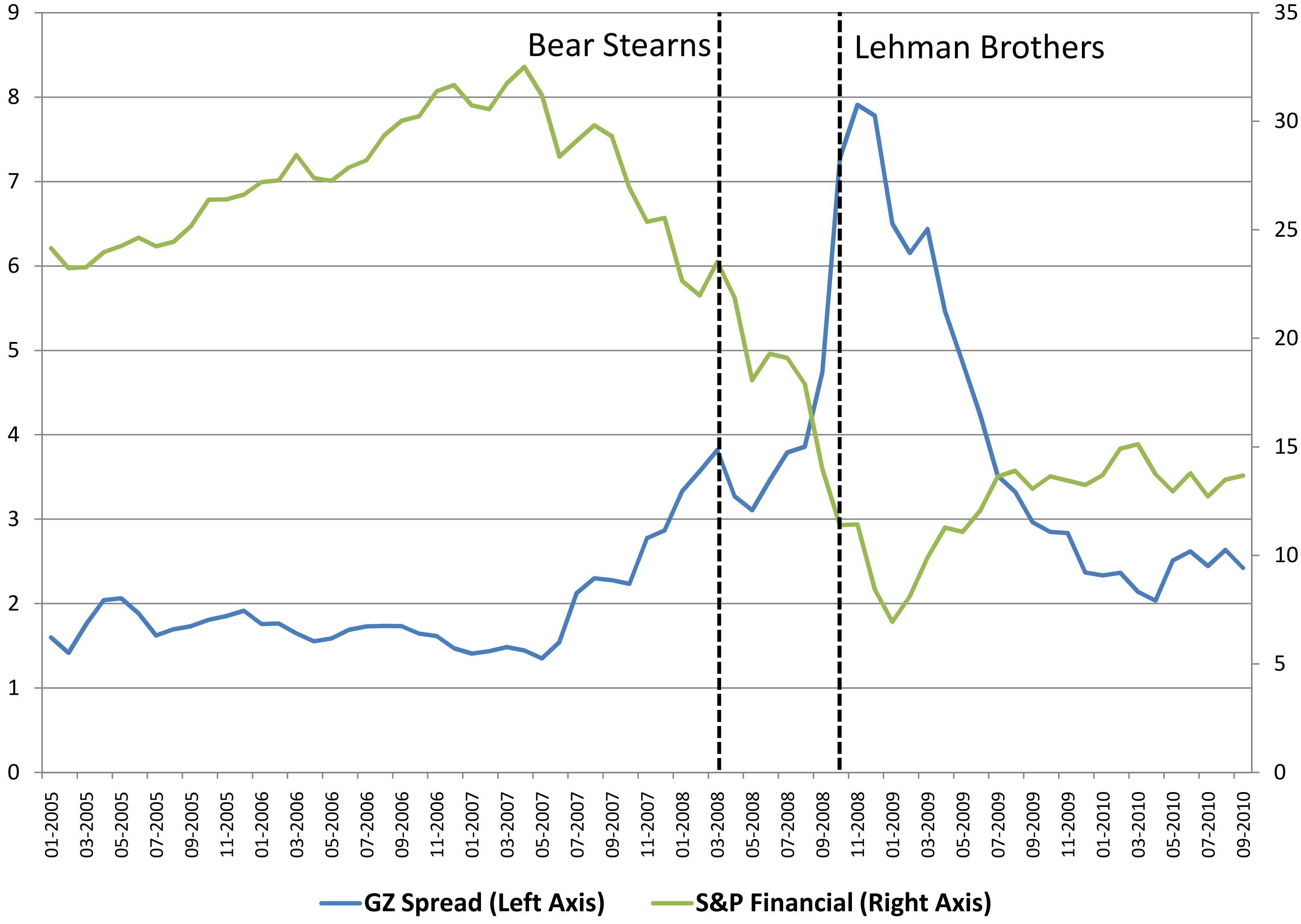
Loss in subprime loans and related assets $\longrightarrow$ Financial intermediaries loose capital $\longrightarrow$ Spreads between liquid and illiquid assets expand

Fast run after Lehmann failure in September 2008

Securitized assets market freezes

Wholesale and retail funding contracts. Asset prices fall further

"Great Recession"



Bear Stearns
Lehman Brothers
9
8
7
6
5
4
3
2
1
0
35
30
25
20
15
10
5
0
01-2005
03-2005
05-2005
07-2005
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09-2010
GZ Spread (Left Axis)
S&P Financial (Right Axis)

We develop a simple macro model of banking crisis

- Financial accelerator / Credit cycles
- Roll-over risk, or "Bank run"

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

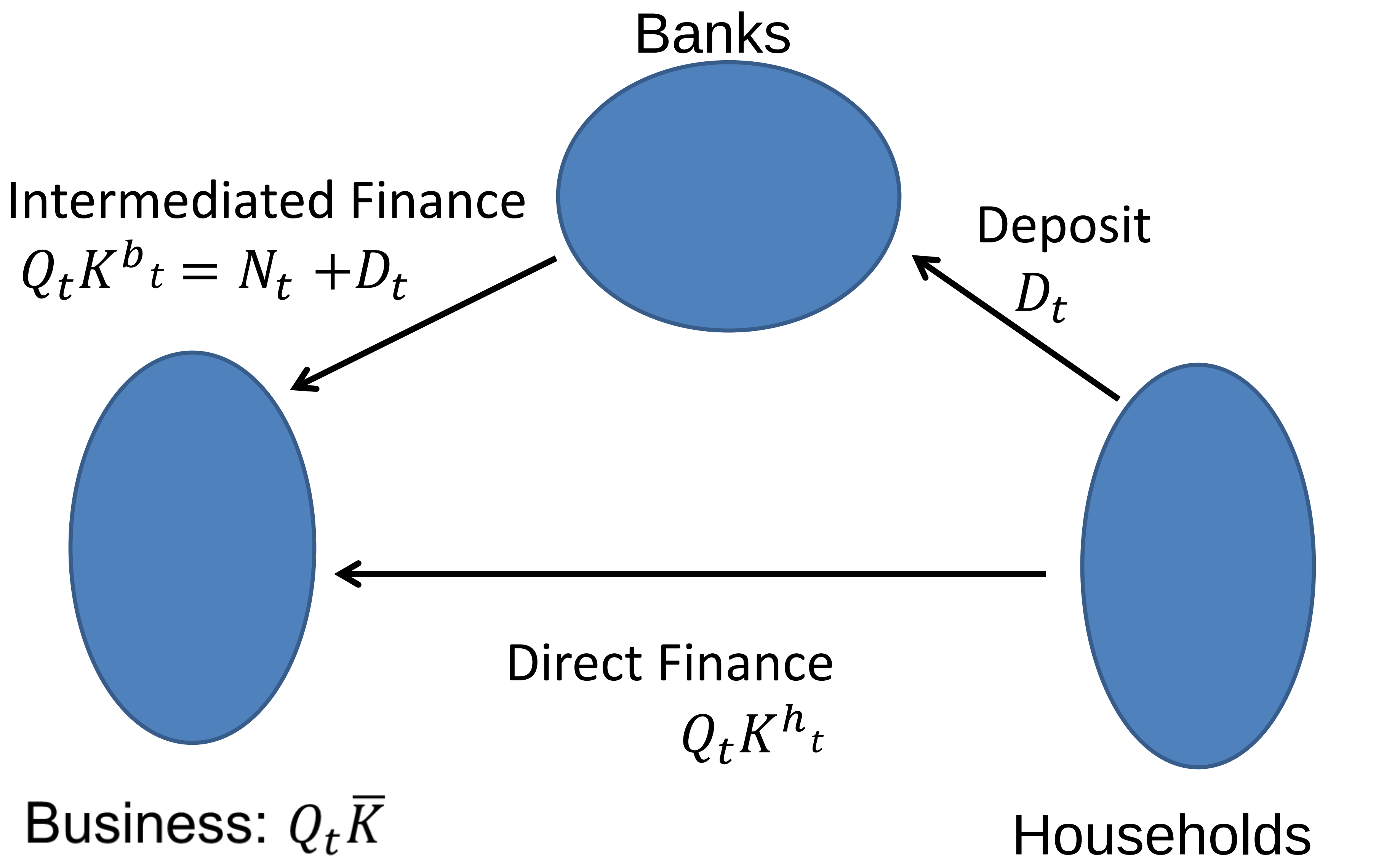
Capital is either intermediated by banks or directly held by households

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

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

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

$$f(K_t^h) = \frac{\alpha}{2}\left(K_t^h\right)^2 : \text{ management cost } \alpha > 0$$


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

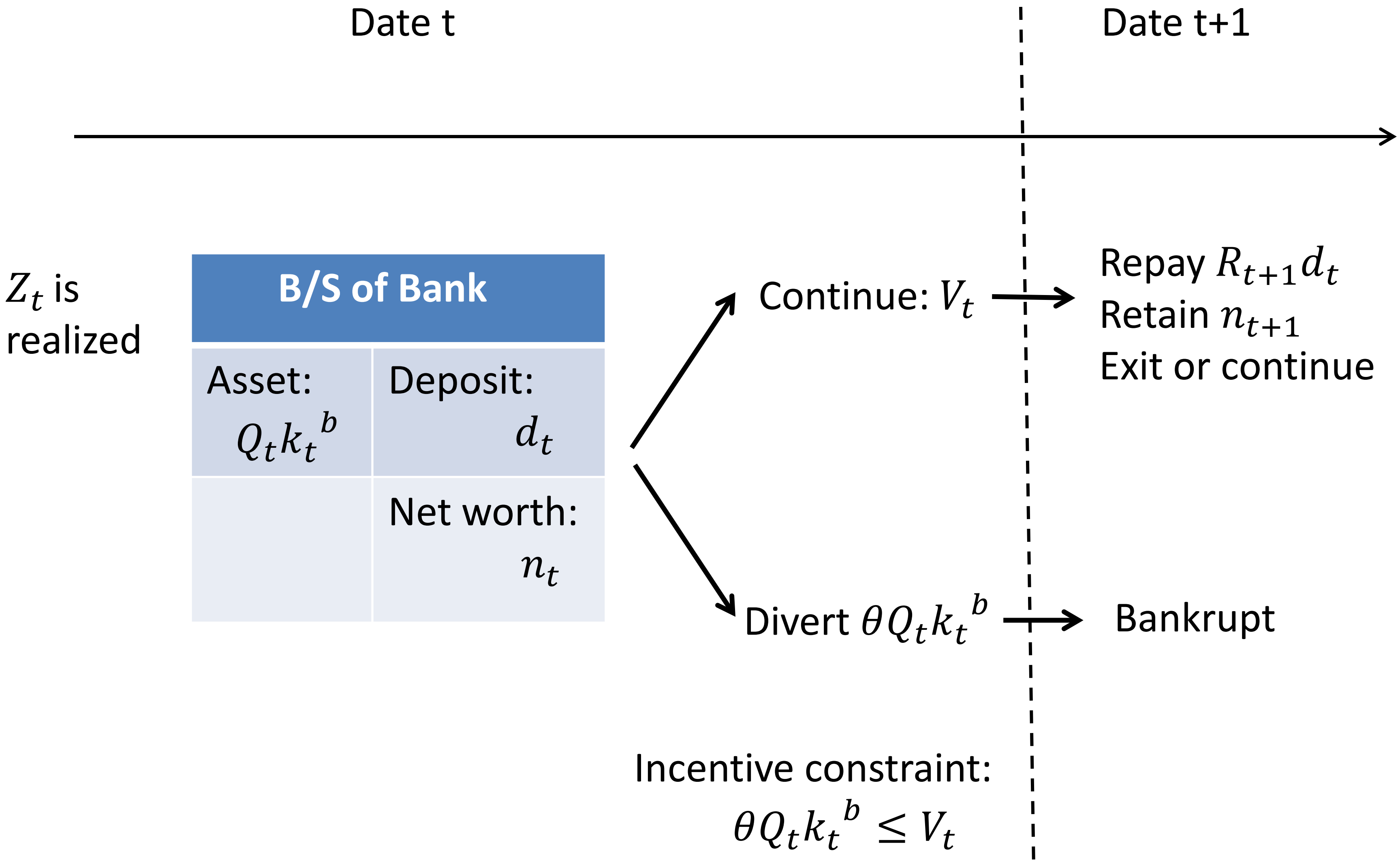
Bank balance sheet

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

Net worth n_t of surviving bankers

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

Figure 1: Timing



Bank chooses k_t^b and d_t to maximize

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

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

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

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

$$= \mu_t \phi_t + \nu_t$$

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

$$\frac{Q_t k_t^b}{n_t} = \frac{\psi_t}{\theta} = \frac{\nu_t}{\theta - \mu_t}, \text{ if } \mu_t \in (0, \theta)$$

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 :

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

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

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

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	0.19	Seizure rate
α	0.008	Household managerial cost
ρ	0.95	Serial correlation of productivity shock
Z	0.0126	Steady state productivity
ω^b	0.0011	Bankers endowment
ω^h	0.045	Household endowment

Table 2: Steady State Values

Steady State Values		
	Baseline	
K	1	
Q	1	
c_h	0.055	
c_b	0.0036	
K^h	0.31	
K^b	0.69	
ϕ	10	
R^k	1.0504	
R^h	1.0404	
R	1.0404	

FIGURE 3: A Recession in the Baseline Model; No Bank Run Case

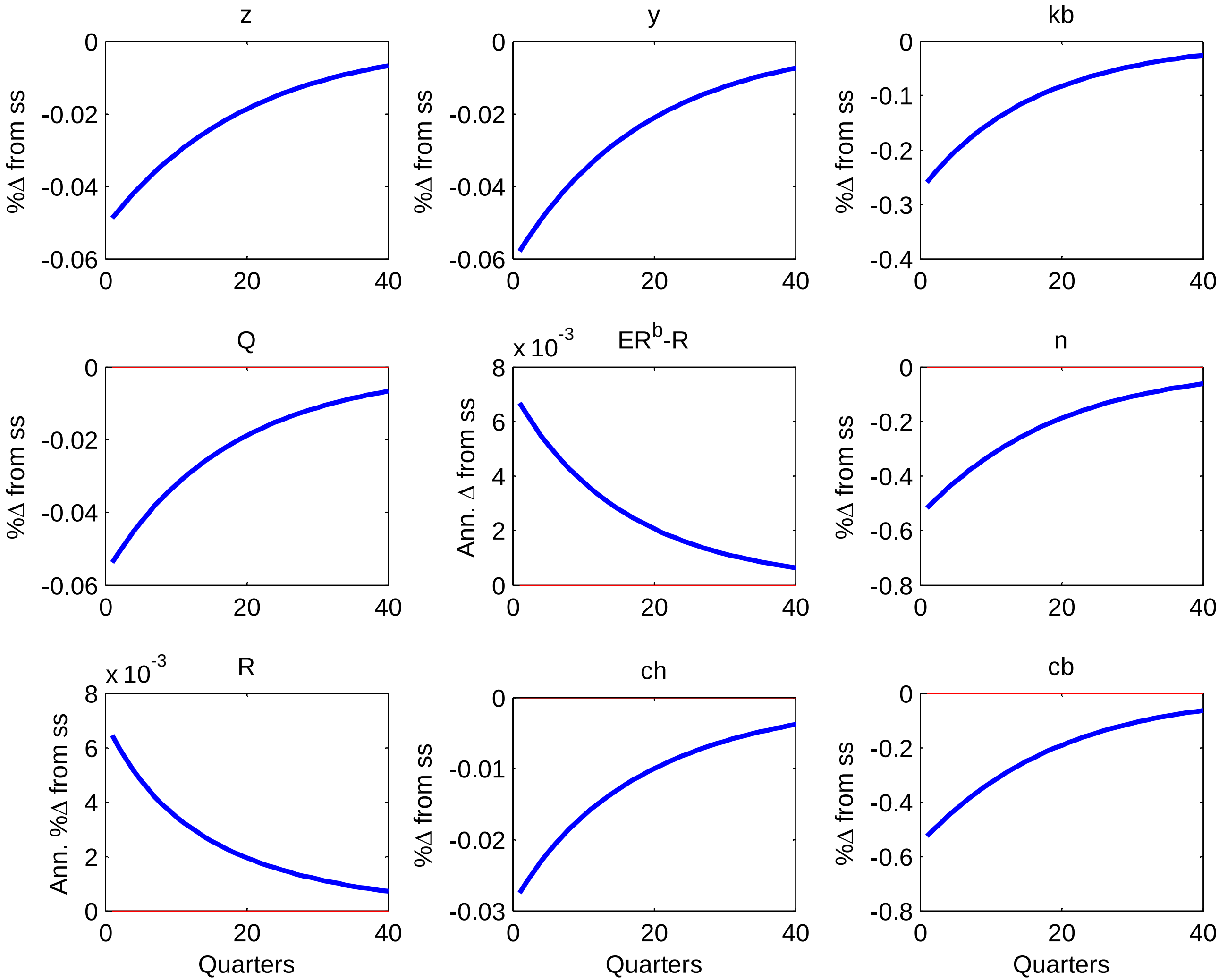
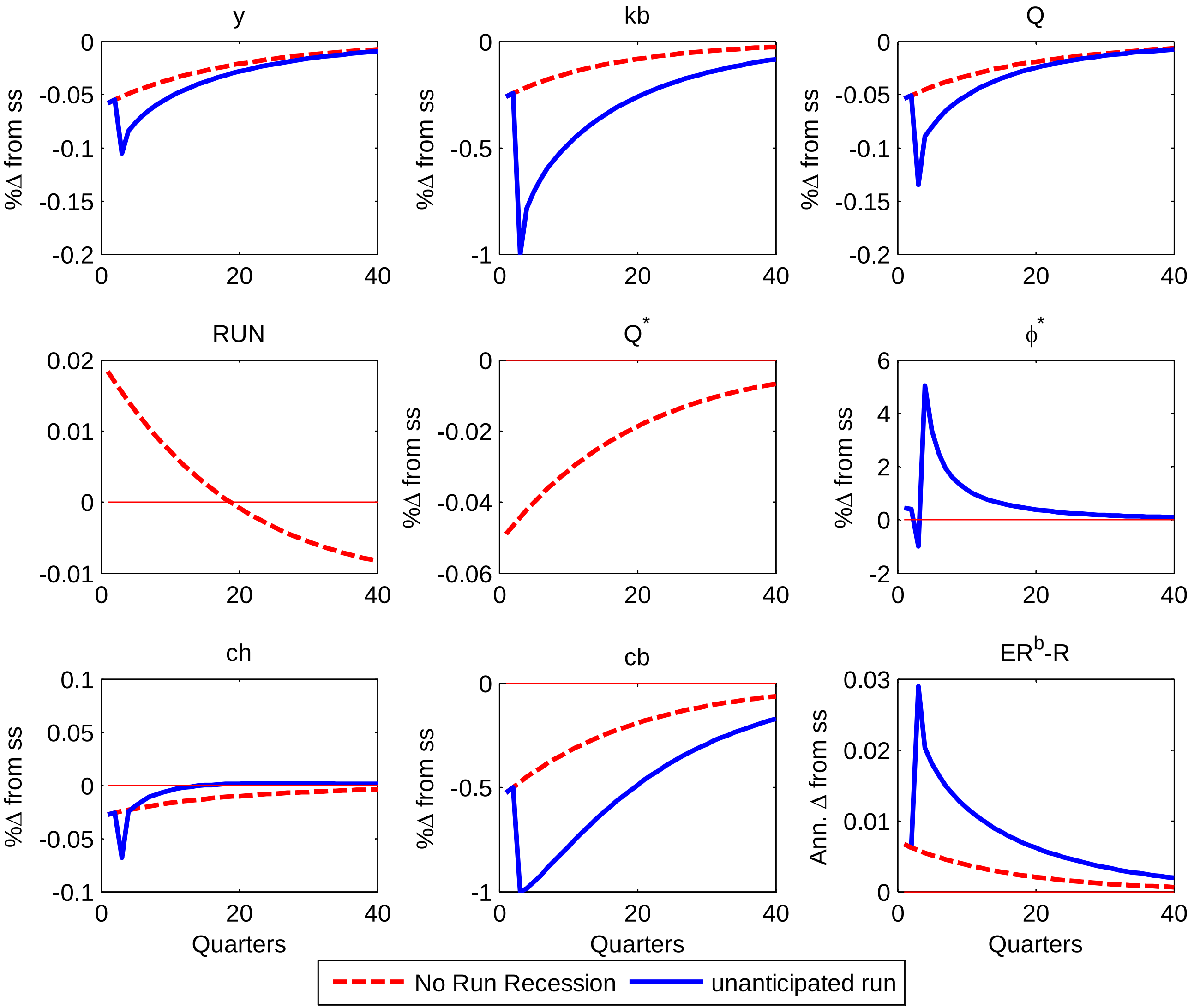


Figure 4: Ex-Post Bank Run in the Baseline Model



Extension: Anticipated Bank Runs

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

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

Household attaches the probability of bank run as

$$p_t = 1 - E_t(x_{t+1})$$

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

Figure 5: Recession with positive probability of a run

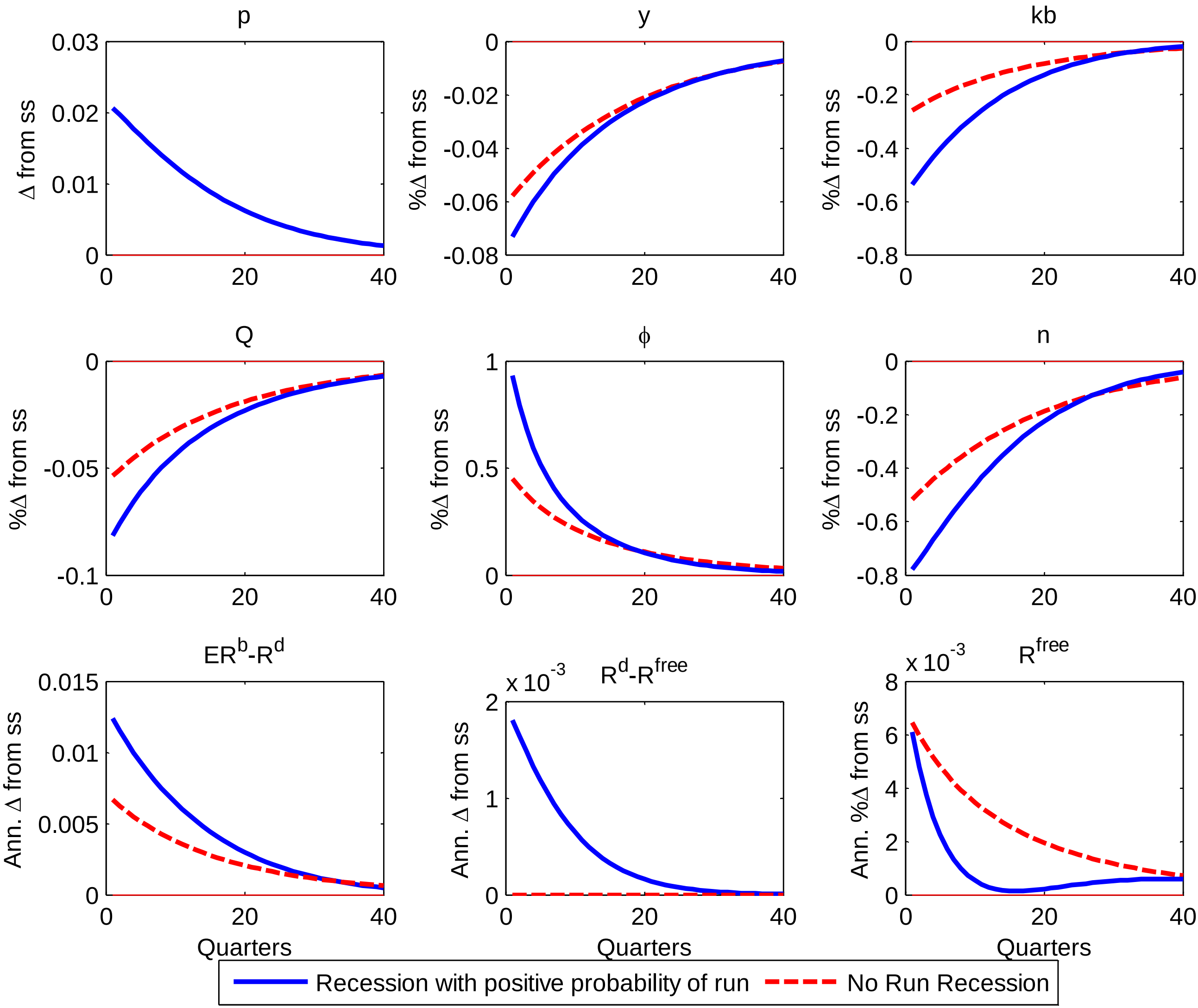
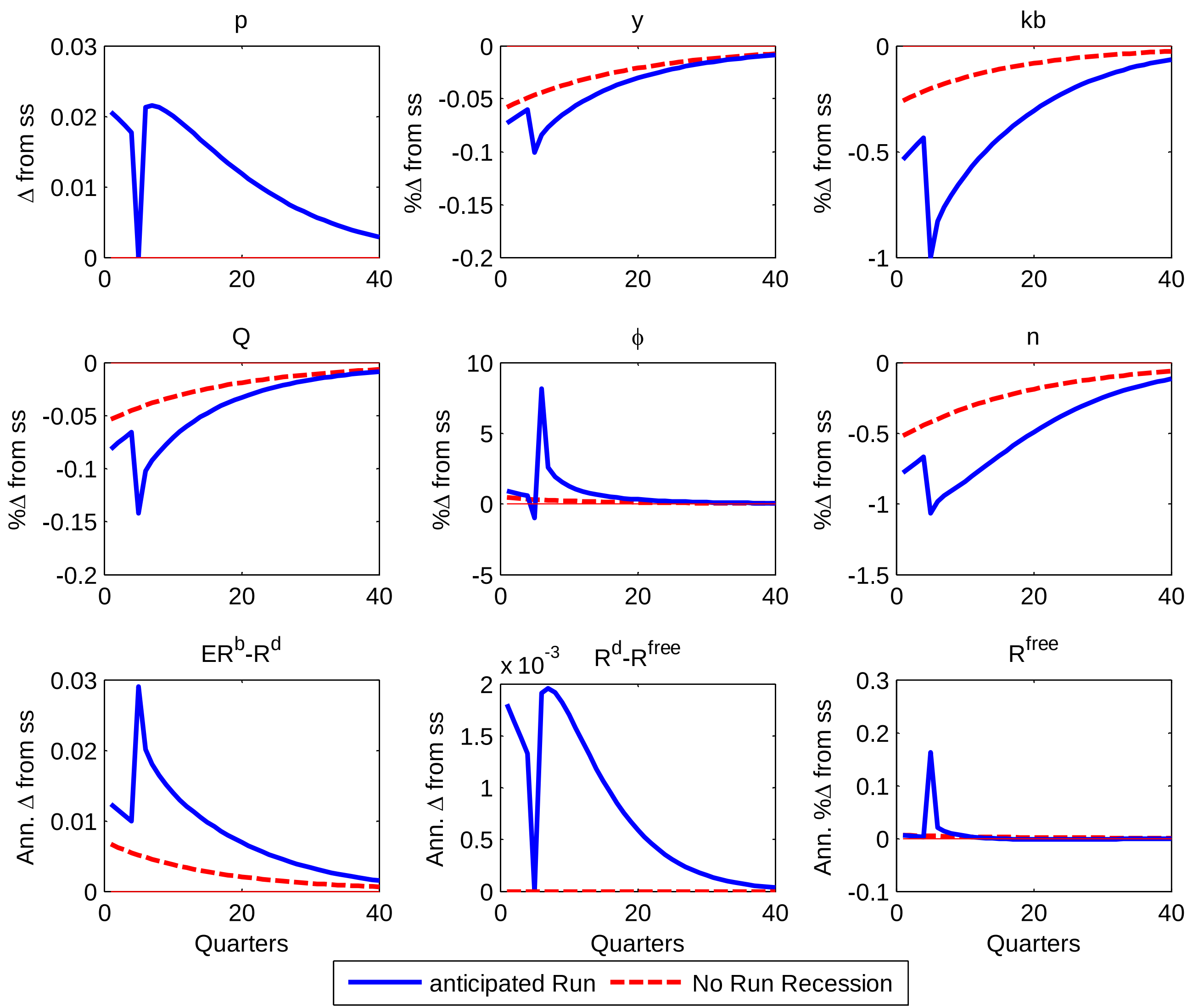
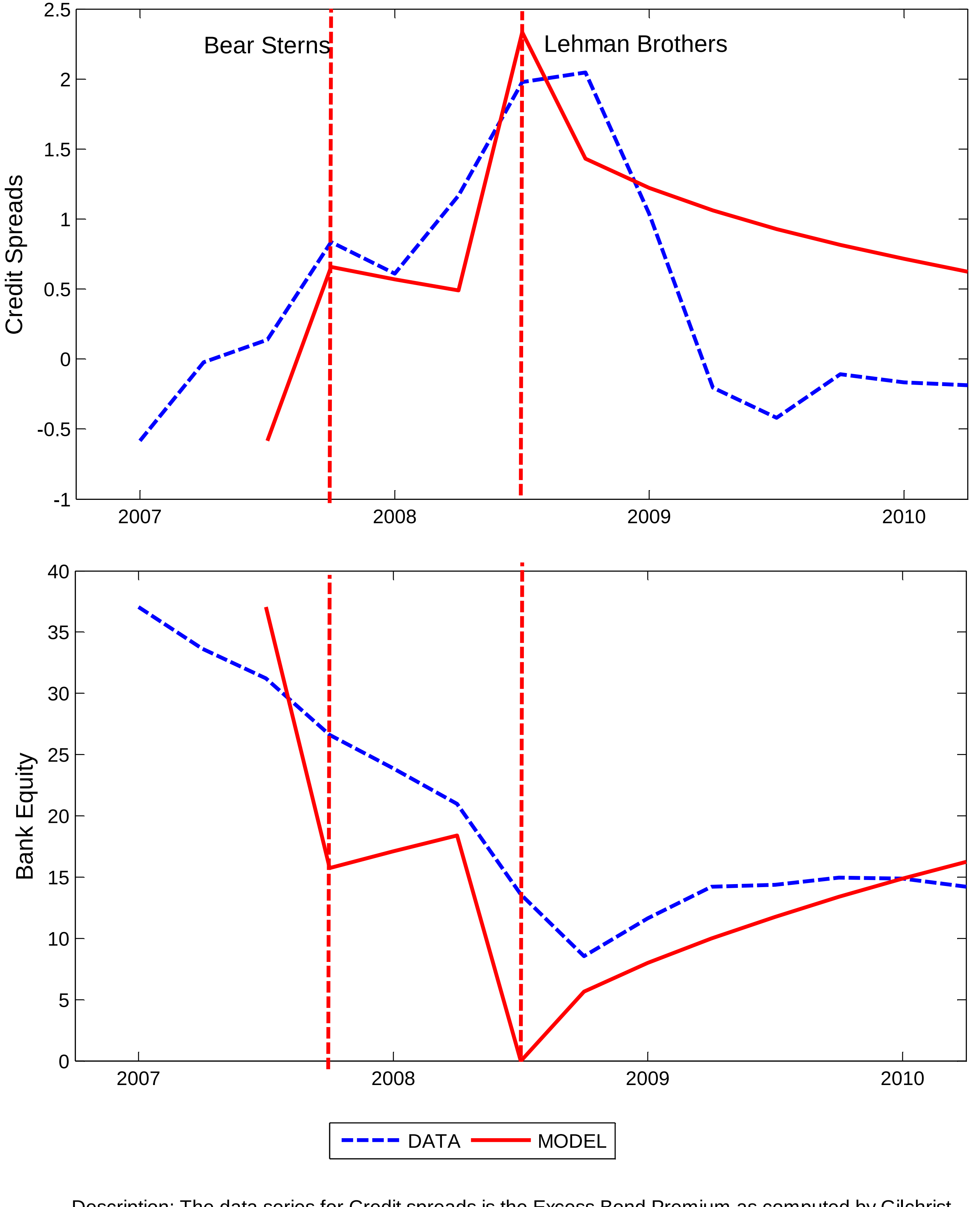


Figure 6: Recession with positive Run Probability and Ex-Post Run





Description: The data series for Credit spreads is the Excess Bond Premium as computed by Gilchrist and Zakrasjek (2012); Bank Equity is the S&P500 Financial Index. The model counterparts are the paths of $E(R^b\text{-}R^d)$ and V as depicted in Figure 6 normalized so that their steady-state values match the actual values in 2007 Q2.

Some Remarks About Policy

Deposit insurance makes depositors careless $\longrightarrow$ Bank will divert the assets

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

May reduce the likelihood of run

But increase the leverage multiple ex ante and the financial accelerator