Wholesale Banking and Bank Runs in Macroeconomic Modelling of Financial Crises

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A key feature of the recent crisis is banking crisis

Slow run on shadow banks from Summer 2007, followed by fast run after Lehman failure in Fall 2008

Spreads rose and investments fell

Wholesale funding by financial intermediaries expanded significantly before the crisis

What are the driving forces?

Efficiency gain?

Possibility of run in wholesale funding market?

Why should we care about run?

Retail	Private Depository Institutions
Sector	Money Market Mutual Funds
	Mutual Funds
Wholesale	$Originate$: Financing Companies
Sector	Real Estate Investment Trusts
	$Securitize$: Government Sponsored Enterprises
	Security Brokers Dealers
	ABS Issuers
	$Hold$: GSE Mortgage Pools
	Funding Companies
	Holding Companies

Figure 2: Wholesale Intermediation

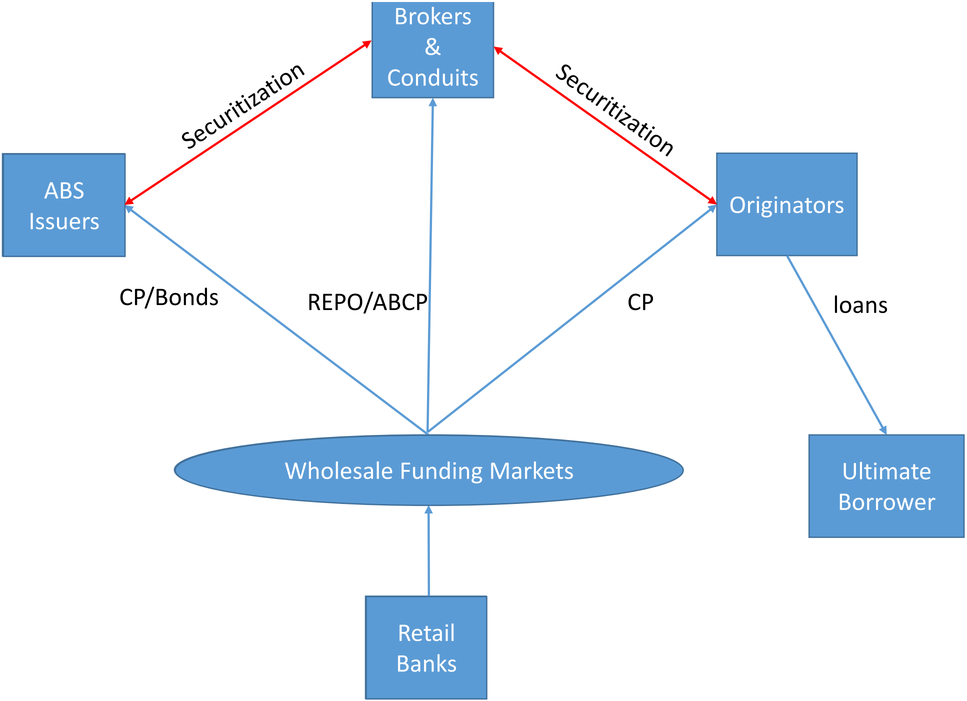
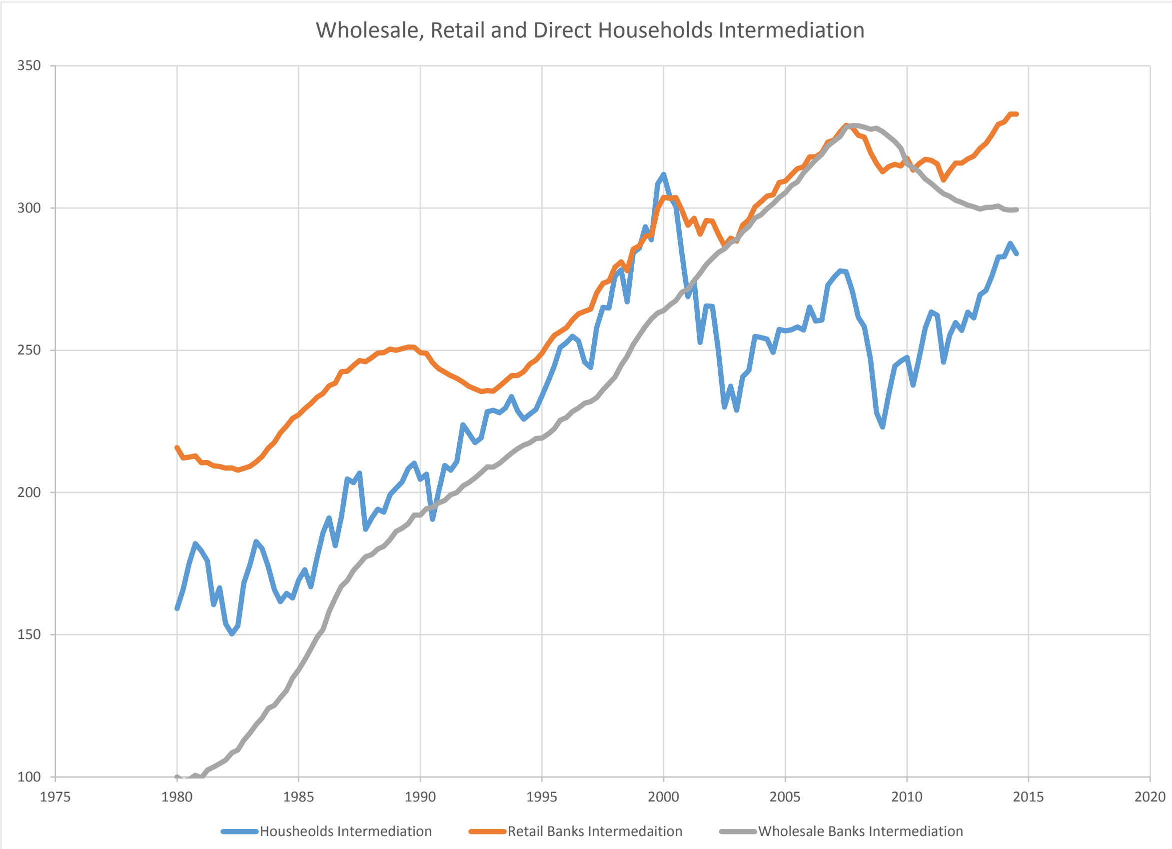
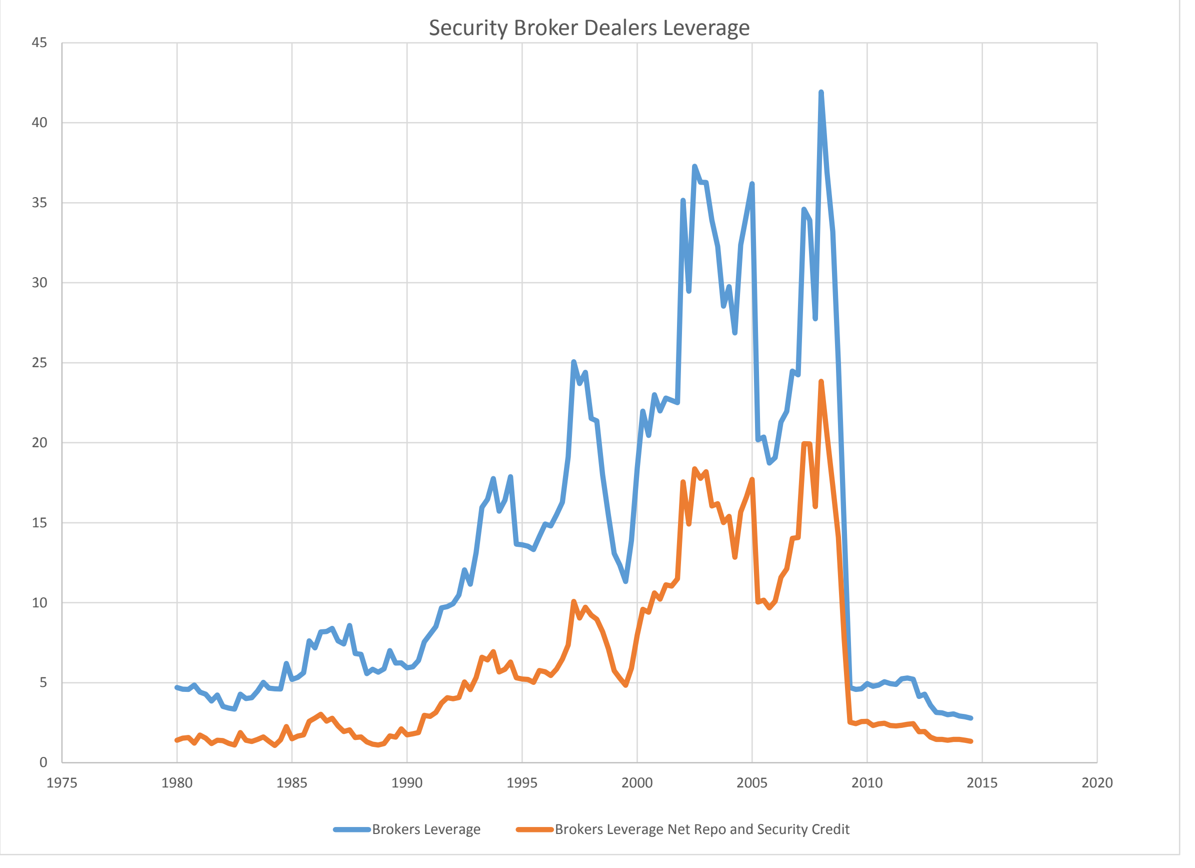


Figure 3: Intermediation by Sector



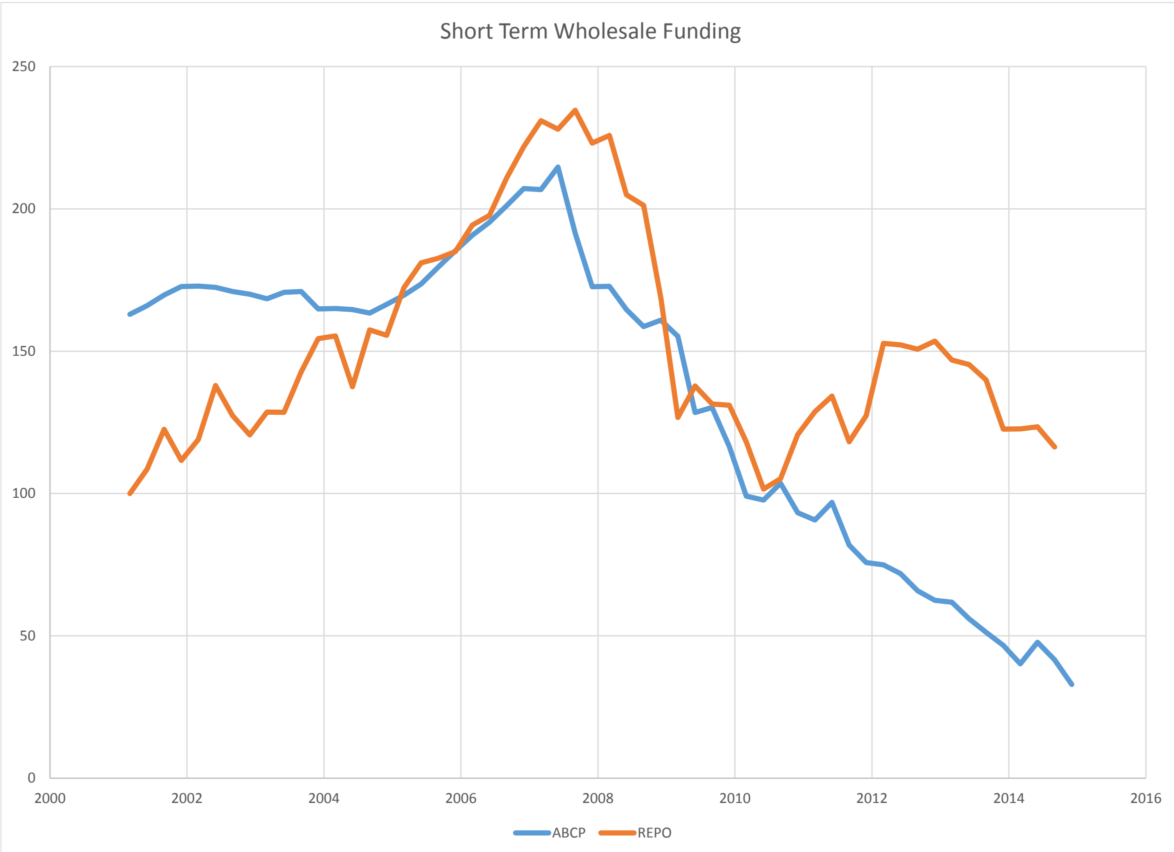
The graph shows the evolution of credit intermediated by the three different sectors. Nominal data from the flow of funds are deflated using the CPI and normalized so that the log of the normalized value of real wholesale intermediation in 1980 is equal to 1. The resulting time series are then multiplied by 100

Figure 4: Brokers Leverage



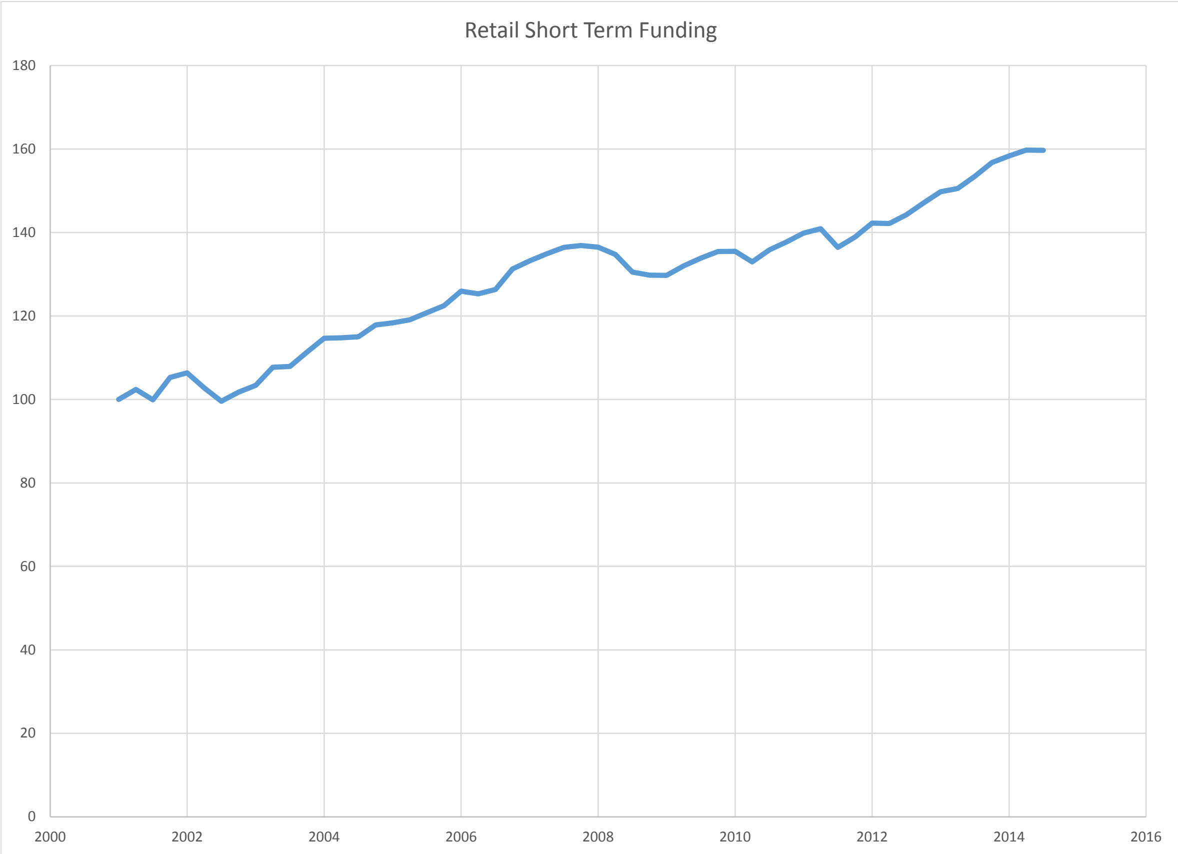
Leverage is given by the ratio of total assets over equity. Equity is computed from the flow of funds by subtracting liabilities other than "holding comanies equity investment" from total assets. The net position leverage computes assets by netting out long and short positions in REPO and Security Credit

Figure 5: Short Term Wholesale Funding



The graph shows the logarithm of the real value outstanding. Nominal values from Flow of FUnds are deflated using the CPI

Figure 6: Retail short term Funding



The graph shows the logarithm of the real value outstanding. Nominal values from Flow of Fnds are deflated using the CPI and normalized so that the log of the normalized value of retail short term funding in 2001 is equal to 100

We develop a macro model of wholesale and retail banks and households

Wholesale banks are better at making business loans

Banks are better in monitoring other banks than households

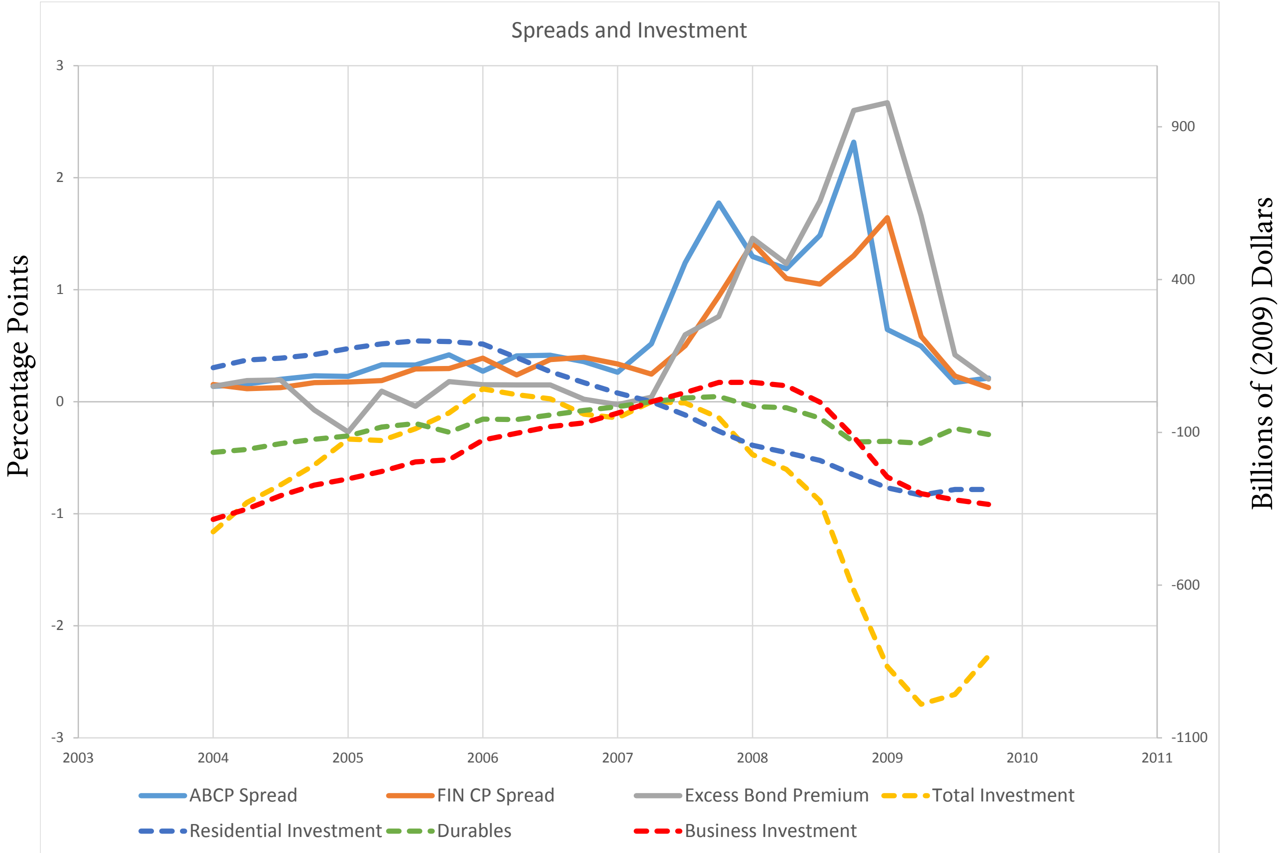
Financial innovation: better monitoring of other banks $\longrightarrow$ wholesale banks borrow more from retail banks

leverage of each bank $\uparrow\uparrow >$ net leverage of banking sector $\uparrow$

Improve efficiency: larger steady state output and smaller financial accelerator

But wholesale banks are more vulnerable to roll-over risk, or "bank run"

Figure 7: Investment Collapse



Basic Model

Capital is either intermediated by banks or held by households

$$K_t^w + K_t^r + K_t^h = \overline{K}$$

$$\begin{array}{ccc} \textit{date } t & & \textit{date } t\text{+1} \\ \left.\begin{array}{c} K_t^j \text{ capital} \\ F^j(K_t^j) \text{ goods} \end{array}\right\} & \longrightarrow & \left\{\begin{array}{c} K_t^j \text{ capital} \\ Z_{t+1}K_t^j \text{ output} \end{array}\right. \end{array}$$

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

Retail bank pays $f_t^r = F^{r\prime}(K_t^j)$ fee per unit of capital to households who provide management service

Retail deposit and interbank loan contracts

Short term

Promised rates of returns $\overline{R}_{t+1}$ and $\overline{R}_{bt+1}$ are non-contingent

With run, the return to the creditor is the minimum of the promised return and total realized debtor bank assets per outstanding credit

In Basic Model, bank run is unanticipated

Households maximize

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

subject to:

$$C_t^h + D_t + Q_t K_t^h + F^h(K_t^h)$$

$$= Z_t W^h + R_t D_{t-1} + (Z_t + Q_t) K_{t-1}^h + f_t^r K_t^r - F^r(K_t^r)$$

$\longrightarrow$

$$1 = E_t\left(\beta \frac{C_t}{C_{t+1}}\right) R_{t+1}$$

$$1 = E_t\left(\beta \frac{C_t}{C_{t+1}} \cdot \frac{Z_{t+1} + Q_{t+1}}{Q_t + F^{h\prime}(K_t^h)}\right)$$

Many bankers of type $j = w, r$

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

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

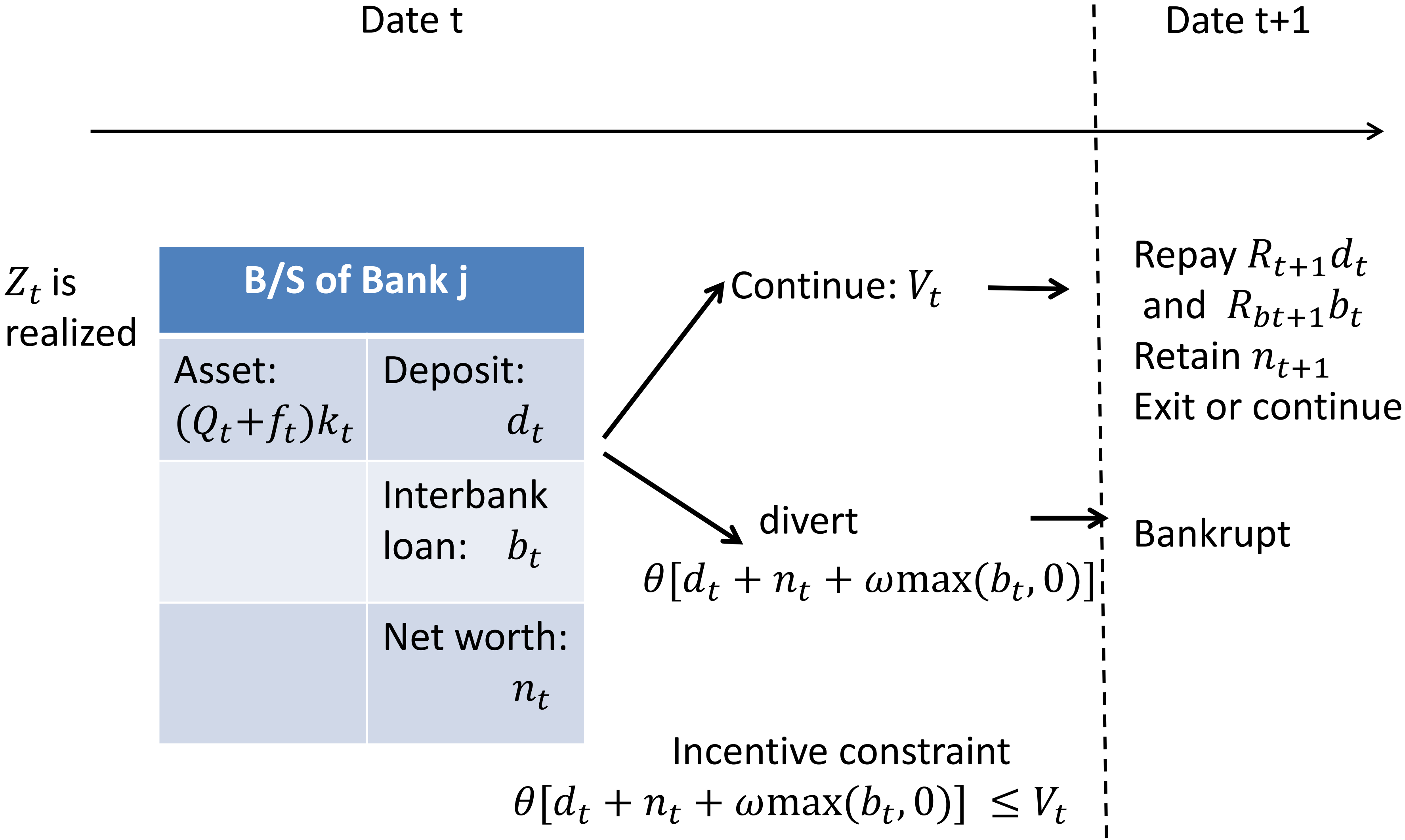
Preferences are linear in "terminal" consumption

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

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

Net worth n_t^j of surviving bankers

$$n_t^j = (Z_t + Q_t)k_{t-1}^j - R_t d_{t-1}^j - R_{bt} b_{t-1}^j$$



Date t
Date t+1
Z_t is realized
B/S of Bank j
Asset: $(Q_t + f_t)k_t$
Deposit: d_t
Interbank loan: b_t
Net worth: n_t
Continue: V_t
Repay $R_{t+1}d_t$ and $R_{bt+1}b_t$
Retain n_{t+1}
Exit or continue
divert
$\theta[d_t + n_t + \omega \max(b_t, 0)]$
Bankrupt
Incentive constraint
$\theta[d_t + n_t + \omega \max(b_t, 0)] \leq V_t$

Consider a bank with $n_t^j = 1$. The bank chooses $(Q_t + f_t^j)k_t^j$ and d_t^j to maximize

$$V_t^j = \beta E_t \left\{ \left(1 - \sigma^j + \sigma^j \frac{V_{t+1}^j}{n_{t+1}^j} \right) n_{t+1}^j \right\}$$

$$= \beta E_t \Omega_{\mathrm{t}+1}^j \left[\left(R_{k\mathrm{t}+1}^j \text{-} R_{b\mathrm{t}+1} \right) (Q_t + f_t^j) k_t^j + (R_{b\mathrm{t}+1} \text{-} R_{\mathrm{t}+1}) d_t^j + R_{b\mathrm{t}+1} \right]$$

$$= \mu_{kt}^j (Q_t + f_t^j) k_t^j + \mu_{bt}^j d_t^j + \nu_{bt}^j, \text{ where } R_{kt+1}^j = \frac{Q_{t+1} + Z_{t+1}}{Q_t + f_t^j}$$

subject to

$$V_t^j \geq \theta \left[1 + d_t^j + \omega Max \left((Q_t + f_t^j) k_t^j - d_t^j - 1, 0 \right) \right]$$

Wholesale banks

$$D_t^w = 0, \text{ if } \omega\mu_{bt}^w < (1-\omega)\mu_{kt}^w$$

$$Q_t K_t^w = \phi_t^w N_t^w = N_t^w + B_t$$

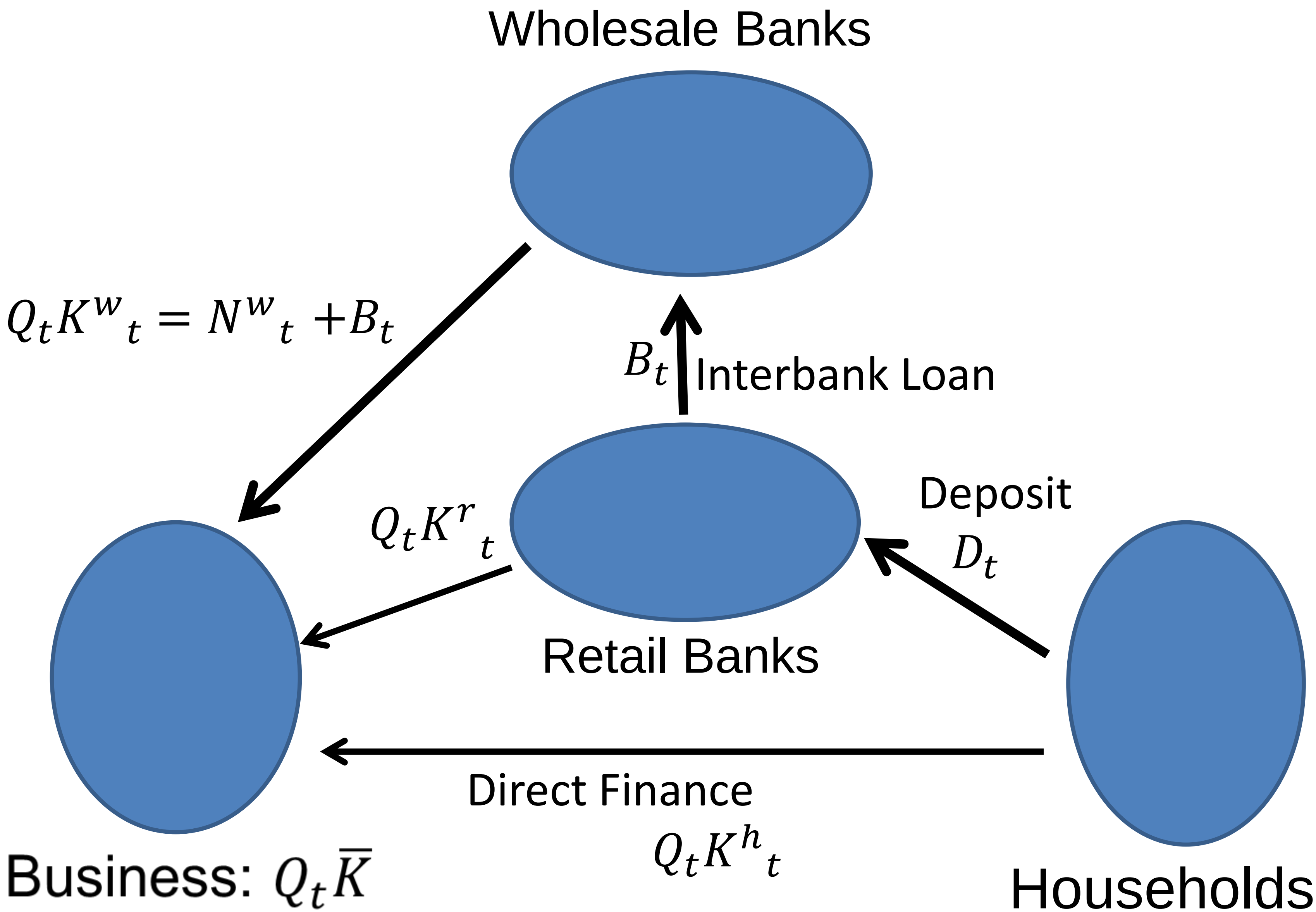
$$\phi_t^w = \frac{\nu_{bt}^w - \theta(1-\omega)}{\theta\omega - \mu_{kt}^w}$$

Retail banks

$$(Q_t + f_t^r)K_t^r + B_t = \phi_t^r N_t^r = N_t^r + D_t^r$$

$$\phi_t^r = \frac{\nu_{bt}^r - \mu_{bt}^r}{\theta - \mu_{bt}^r}$$

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


Wholesale Banks
$Q_t K^w{}_t = N^w{}_t + B_t$
B_t Interbank Loan
$Q_t K^r{}_t$
Deposit
D_t
Retail Banks
Direct Finance
$Q_t K^h{}_t$
Business: $Q_t \bar{K}$
Households

	PARAMETERS	
	Households	
β	discount rate	.99
α^h	Intermediation cost	.03
W^h	Endowment	.006
	Retail Banks	
σ^r	Survival Probability	.95
α^r	Intermediation cost	.0075
W^r	Endowment	.0008
θ	Divertable proportion of assets	.25
	Wholesale Banks	
σ^w	Survival Probability	.9
α^w	Intermediation cost	0
W^w	Endowment	.0004
ω	Shrinkage of divertable proportion of assets	.5
	Production	
σ_z	std of dividends	.05
ρ_z	autocorrelation of dividends	.9

	STEADY STATE	
Q	price of capital	1
K^r	retail intermediation	.4
K^w	wholesale intermediation	.4
R^b	Annual interbank rate	1.052
R	Annual deposit rate	1.04
R^k_w	Annual wholesale return on capital	1.064
ϕ^w	wholesale leverage	25
ϕ^r	retail leverage	10
Y	output	.0225
C^h	consumption	.0168
N^r	retail banks networth	.0785
N^w	wholesale banks networth	.0160

Financial Innovation: A Permanent Fall in ω

Wholesale banks borrow more from retail banks with higher leverage

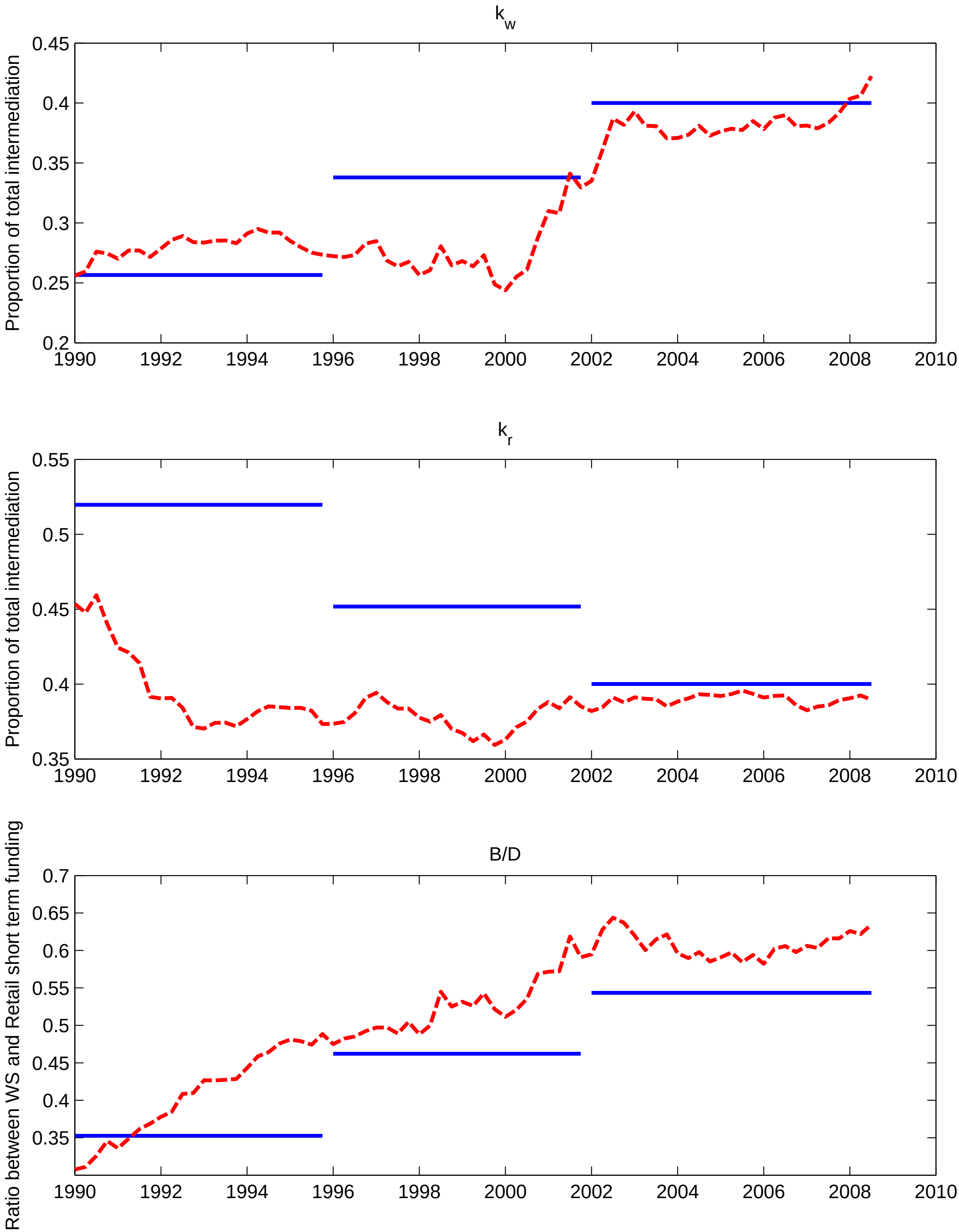
Retail banks reduce business loans

Leverage multiples of individual bank is higher, but

$$\frac{Q_t K_t^w + (Q_t + f_t^r) K_t^r}{N_t^w + N_t^r} < \frac{(Q_t + f_t^r) K_t^r + B_t}{N_t^r} < \frac{Q_t K_t^w}{N_t^w}$$

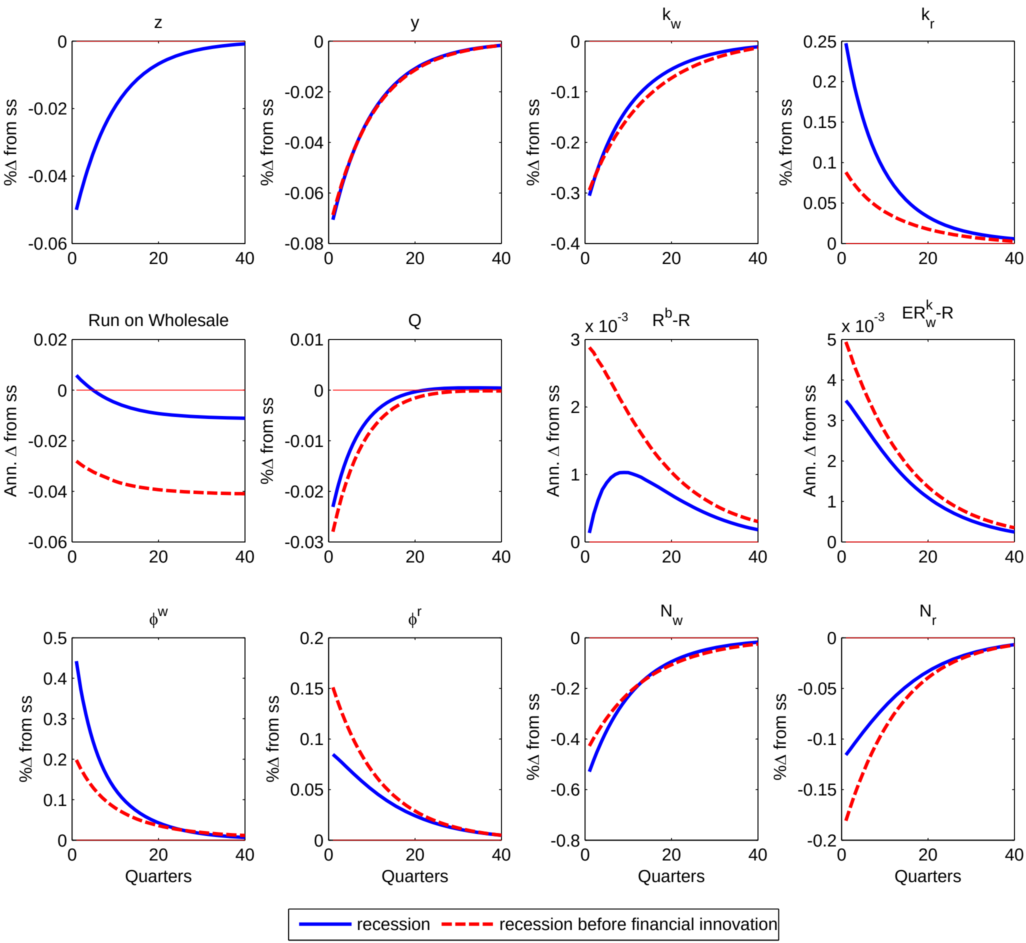
Economy becomes more efficient with larger net output

Financial accelerator becomes SMALLER



k_w
Proportion of total intermediation
0.45
0.4
0.35
0.3
0.25
0.2
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
k_r
Proportion of total intermediation
0.55
0.5
0.45
0.4
0.35
B/D
Ratio between WS and Retail short term funding
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35

Figure 11: A recession before and after financial innovation (NO RUN EQUILIBRIUM)



Wholesale Bank Runs

Ex ante, zero probability of a run

If retail banks do not roll over their interbank credit ("run"), the wholesale banks sell their capital to households and retail banks who are less efficient in managing capital

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

$$\left(Z_t + Q_t^*\right) K_{t-1}^w < R_{bt} B_{t-1}$$

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

After a bank run at t :

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

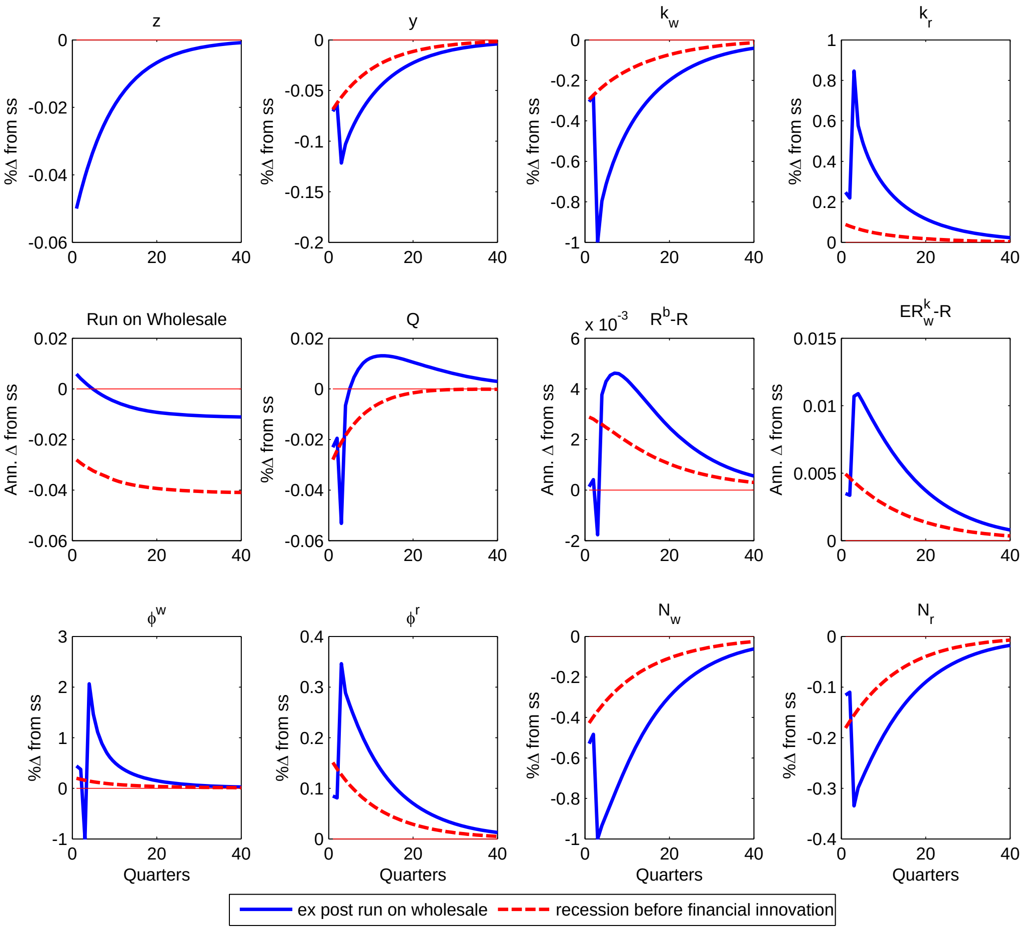
$$N_{t+1}^w = (1 - \sigma^w) w^w + \sigma^w (1 - \sigma^w) w^w$$

$$N_s^w = \sigma^w \left[(Z_s + Q_s) K_{s-1}^w - R_{bs} B_{s-1} \right] + (1\text{-}\sigma^w) w^w, \ \forall \ s \geq t+2$$

Household condition for direct capital holding $\longrightarrow$

$$Q_t^* = E_t \left\{ \sum_{i=1}^{\infty} \Lambda_{t,t+i} [Z_{t+i} - \alpha^h K_{t+i}^h] \right\} - \alpha^h K_t^h$$

Figure 13: A recession followed by a run on wholesale bankers only



Anticipated Bank Runs

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

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

Household attaches the probability of bank run as

$$p_t = p(E_t(x_{bt+1})),\ p\left(1\right) = 0,\ p'(\cdot) < 0$$

FONC for interbank loan is

$$E_t[(1\text{-}p_t)\Omega^r_{t+1}(R^r_{kt+1}\text{-}\overline{R}_{bt+1})+p_t\Omega^{r*}_{t+1}(R^{r*}_{kt+1}\text{-}x_{bt+1}\overline{R}_{bt+1})] = 0$$

Figure 14: A recession in the model with anticipated runs

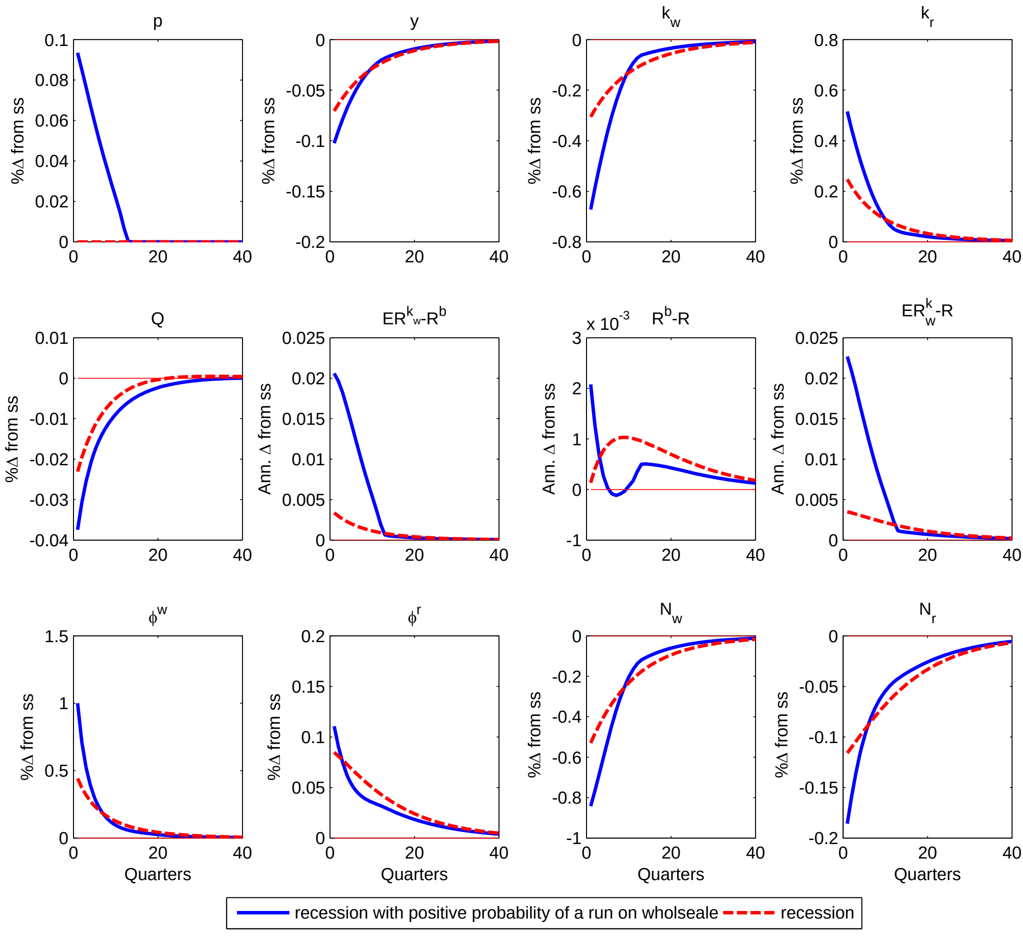
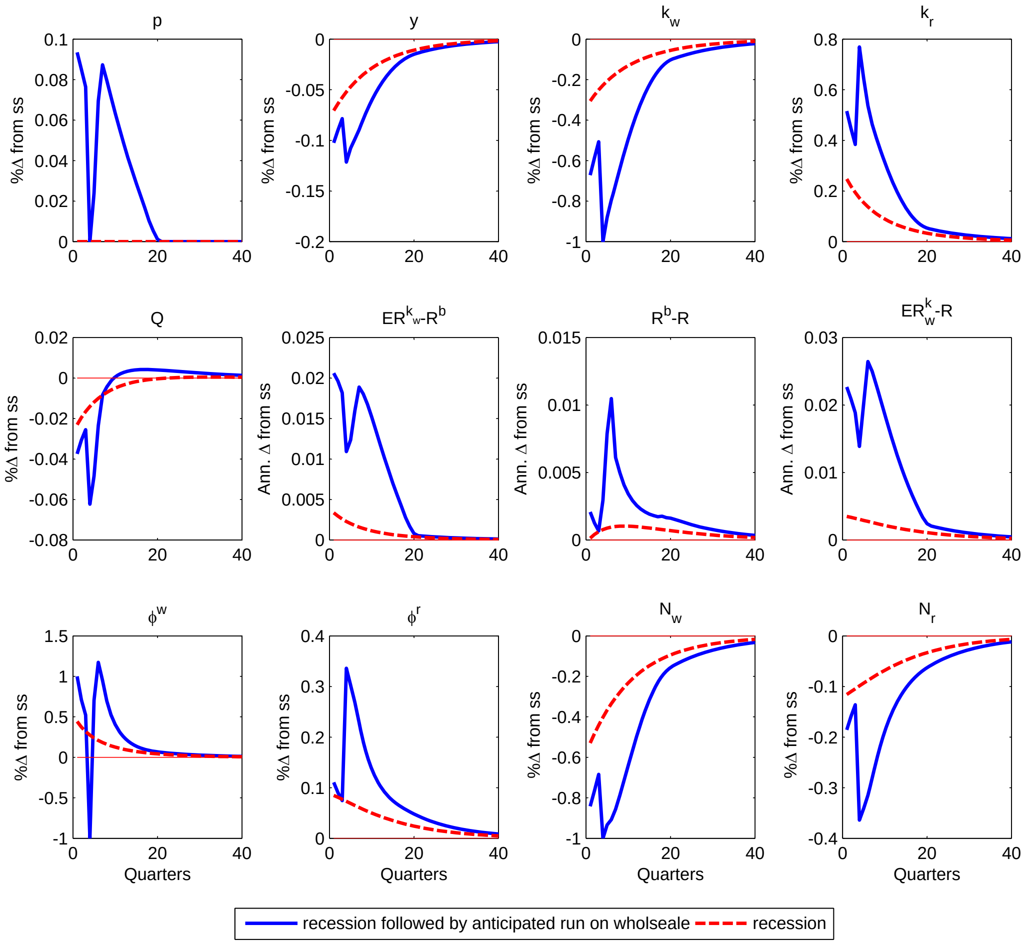
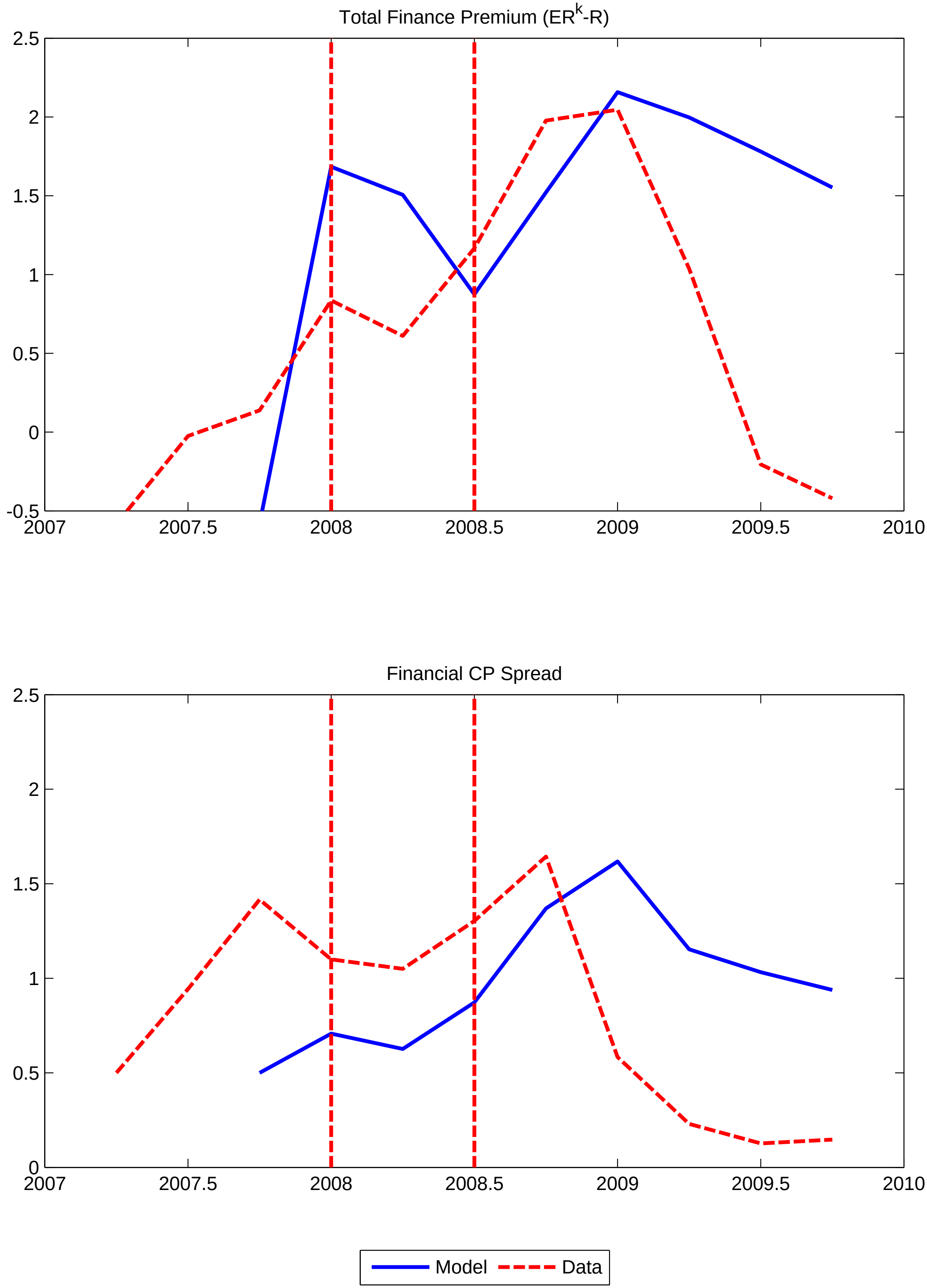


Figure 15: A recession followed by a run in the model with anticipated runs




Total Finance Premium (ER^k-R)
2.5
2
1.5
1
0.5
0
-0.5
2007
2007.5
2008
2008.5
2009
2009.5
2010
Financial CP Spread
Model
Data

Some Remarks About Policy

Capital requirement on all the large banks reduces likelihood of bank run

Can reduce the efficiency of intermediation

Lender-of-last resort stabilizes liquidation price

May reduce the likelihood of run

But increases the leverage multiple ex ante and the financial accelerator