Financial Regulation in General Equilibrium

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Epilogue from the crisis

Banks became very undercapitalized, shadow banks melted down, the economy suffered.

➔New regulation is needed, **but what kind**?

1. Reform bank capital rules
2. Impose new liquidity requirements
3. Change provisioning rules
4. Regulate margins/haircuts for shadow banks
5. Impose direct loan to value ratios

How do we think about these options?

Model Characteristics

General equilibrium

- Incomplete Asset Markets
- Two goods
- Heterogeneous agents

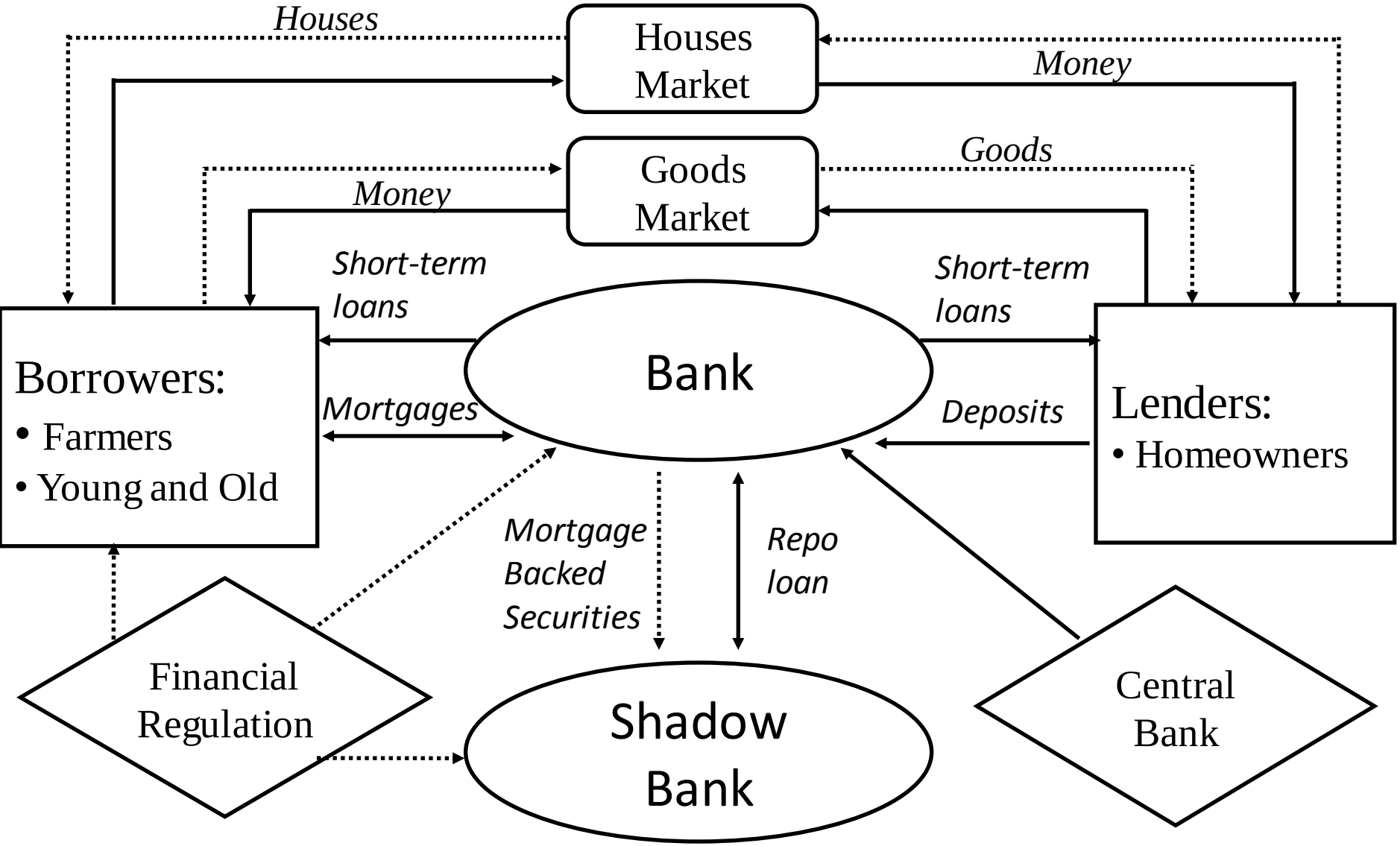
-Pareto Inefficient Competitive Equil.
-Rationale for policy intervention

Externalities from the financial system:

- Default, credit crunches and fire sales

Contracts and transactions in nominal currency

- Price for liquidity


Houses
Houses Market
Money
Goods
Goods Market
Money
Short-term loans
Short-term loans
Borrowers:
• Farmers
• Young and Old
Bank
Mortgages
Deposits
Lenders:
• Homeowners
Mortgage Backed Securities
Repo loan
Financial Regulation
Shadow Bank
Central Bank

Model characteristics

- Uncertainty:
  - Relative quantity of potatoes vs. houses
  - Monetary endowments and banks' capital
  - Central bank policy
- Households try to smooth consumption across goods within the period and total consumption over time
- Intermediaries improve smoothing but at the cost of amplifying shocks
- Regulations damp amplification of shocks but restrict smoothing

Non-financial benchmark

- Imagine no financial intermediation, just a CB with providing short-term liquidity/credit

- Home-owner can self-insure using both cash and holding houses, so he can smooth consumption across goods and across periods.

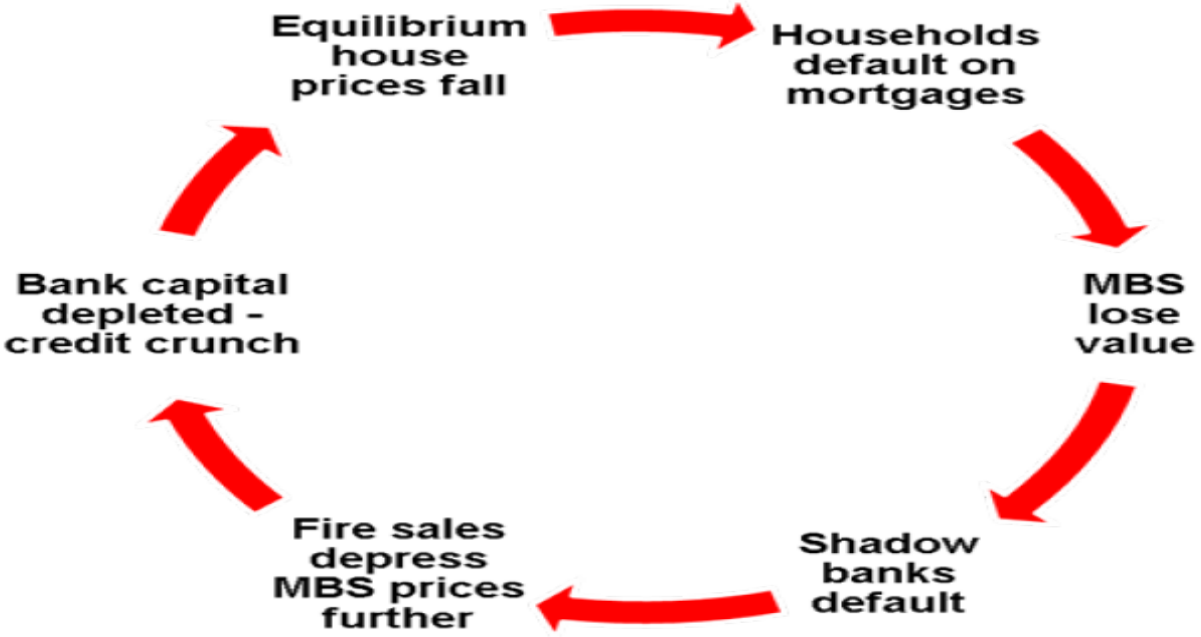
- Farmer can equate marginal utility of houses and potatoes in period 1. But cannot smooth between period 1 and 2.

Actions at t=2

- (Uncertainty revealed: Bad news ➔ house price crash, Good news ➔ a house price boom)
- Focus on the bad news case which includes default
- Financial flows:
  - N defaults on repos, leaving B with losses
  - B partially defaults on long-term deposits, its capital is reduced and this leads to a reduction in lending
  - B might also sell MBS to pay the depositors, but this will further depress house prices
  - Relative price of potatoes must rise
  - F rents a house, P moves to a smaller one

Model properties and questions

- Knock effects from house price collapse and subsequent repo default
  - Fire sale of MBS by banks
  - Deposit defaults
  - Potential margin spiral



Aside – Margin Spiral

$$V_{2b}^{MORT} \equiv \frac{P_{2b,h} c_{1,h}^{P}}{MORT^{B}\left(1+r^{MORT}\right)}$$ and arbitrage pins down MBS prices

$$P_{2b,MBS} = \frac{V_{2b}^{MORT}\left(1+r^{MORT}\right)}{1+r_{2b}^{CB}}$$

$\therefore$ MBS and house prices must be connected

$$P_{2b,MBS} = \frac{P_{2b,h} c_{1,h}^{P}}{MORT^{B}} \frac{1}{1+r_{2b}^{CB}} \quad \Leftrightarrow \quad P_{2b,h} = P_{2b,MBS} \frac{MORT^{B}}{c_{1,h}^{P}} (1+r_{2b}^{CB})$$

Plus cash-in-the-market pricing: $P_{2b,MBS} MBS_{2b}^{N} \leq E_{2b}^{N}$

So more fire sales mean lower house prices!

Potential Policy Respones

Examined in the paper

- Capital requirement & countercyclical capital buffers
- Liquidity regulation (LCR)
- Loan-to-value ratios
- Haircut requirements
- Dynamic provisioning

Future agenda

- Central Bank policies: conventional & unconventional
- Taxes on: bank size, activity, deposits
- DTI, sectoral capital buffers, time-varying regulation

Off the table

- Net Stable Funding Ratio related to bank runs

1. (Countercyclical) Capital

Policy Motivation

Could lessen the spillover of the repo default

Leans against greater risk by raising the cost of credit

Findings

1. Reduces mortgage issuance, raises securitization and raises the mortgage rate
2. Households consume less housing services and banks face less risk-Lower default on deposits
3. Capital is inflated in booms making it difficult to use pre-emptively (procyclical risk-weights)

2. Stricter Haircuts

Policy Motivation

Policy complements cyclical capital requirements

Leans against build up of risks in funding contracts, futures, and derivatives

Findings

1. Reduces repo borrowing, raises costs of mortgages, total bank mortgages are higher
2. Reduces size of repo default, raises mortgage repayment rate, and house prices

3. LTV Ratios

Policy Motivation

LTV caps reduce borrower and lender exposure to asset price declines

LTV caps reduce borrower defaults and lean against price appreciation

Findings

1. Reduces mortgage lending (and MBS which raises mortgage rates)
2. Reduces fire sales and shadow bank instability
3. Problematic as pre-emptive tool due to inflated housing values in the boom

4. Liquidity Coverage Ratio

Policy Motivation

Protects the bank against wholesale funding shocks

Will reduce incentives of banks to sell MBSs – head off the fire sale?

Findings

1. Good pre-emptive tool: Bank reduces mortgages and MBS, raises the mortgage rate, does more short term lending
2. Less severe mortgage default, higher deposit repayment
3. High LCR generates fire sale incentives and margin spiral in crisis->Suggests that LCR should be time varying

4. Dynamic Provisioning

Policy Motivation

Target overall real estate related credit

State-contingent/sectoral tool to control housing price appreciation

Findings

1. Raises the cost of the mortgage loans in the boom
2. Reduces the value of housing in the boom, so raises the value of the endowments of potatoes
3. Could be use to mitigate the unintended consequences of other policies which target the bust

Regulatory Channels

Table 1: Impact of Alternative Regulations on Key Endogenous Variables
(Change relative to baseline equilibrium)

	LTV	MR	CR_1	CR_{2b}	LCR_1	DP
Securitization	-	-	+	+	+	+
Relative price of potatoes to housing-good state	-	≈0	≈0	+	+	+
Profits of the Bank period 1	+	+	+	-	-	-
Profits of Bank good state	+	+	-	-	-	-

Welfare effects

Table 2: Impact of Alternative Regulations on Household Utilities and Financial Institutions' Welfare (Change relative to baseline equilibrium)

	LTV	MR	CR_1	LCR_1	CR_{2b}	DP
P's Utility	-	≈0	+	+	+	+
F's Utility	-	≈0	≈0	+	+	+
R's Utility	≈0	≈0	≈0	-	≈0	-
B's Payoff	+	+	+	-	-	-
N's Payoff	+	+	≈0	≈0	-	-

Combination Regulatory Packages

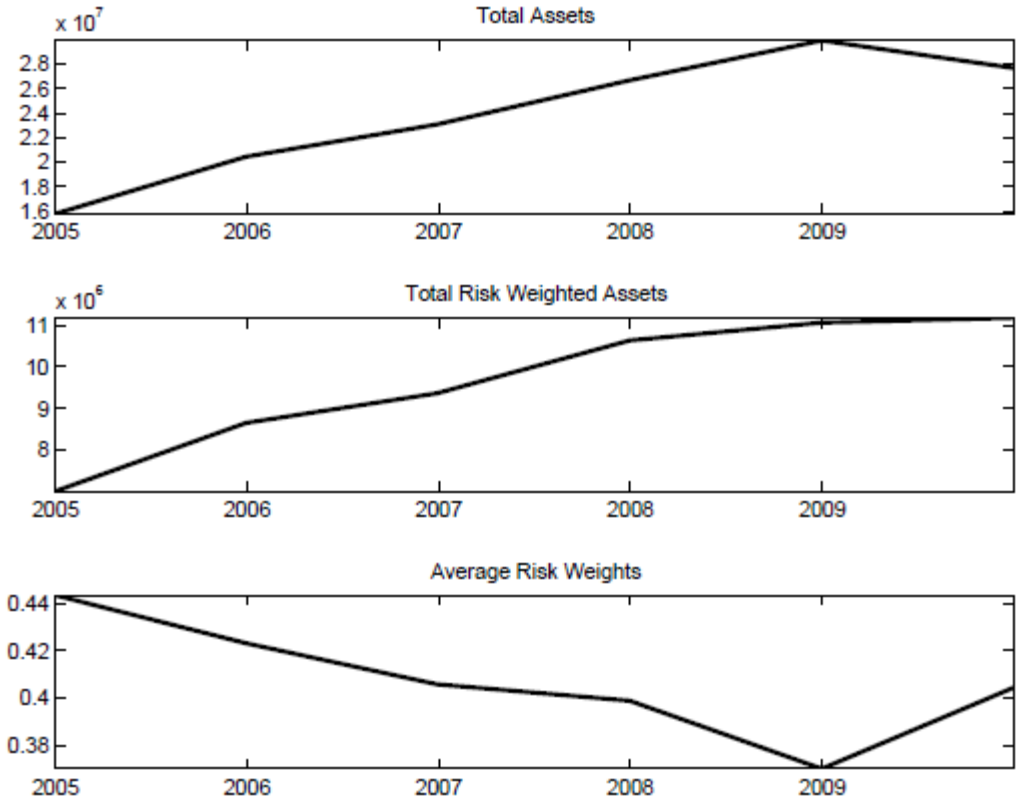
Table 3: Impact of Combining Regulations on Household Utilities and Financial Institutions' Welfare
(Change relative to baseline equilibrium)

	CR_1 , CR_{2b} , MR	CR_1, LCR_1 , MR	CR_1, CR_{2b} , LTV
P's Utility	+	+	≈0
F's Utility	+	-	-
R's Utility	≈0	≈0	≈0
B's Payoff	+	+	+
N's Payoff	+	+	+

Importance of Dynamics

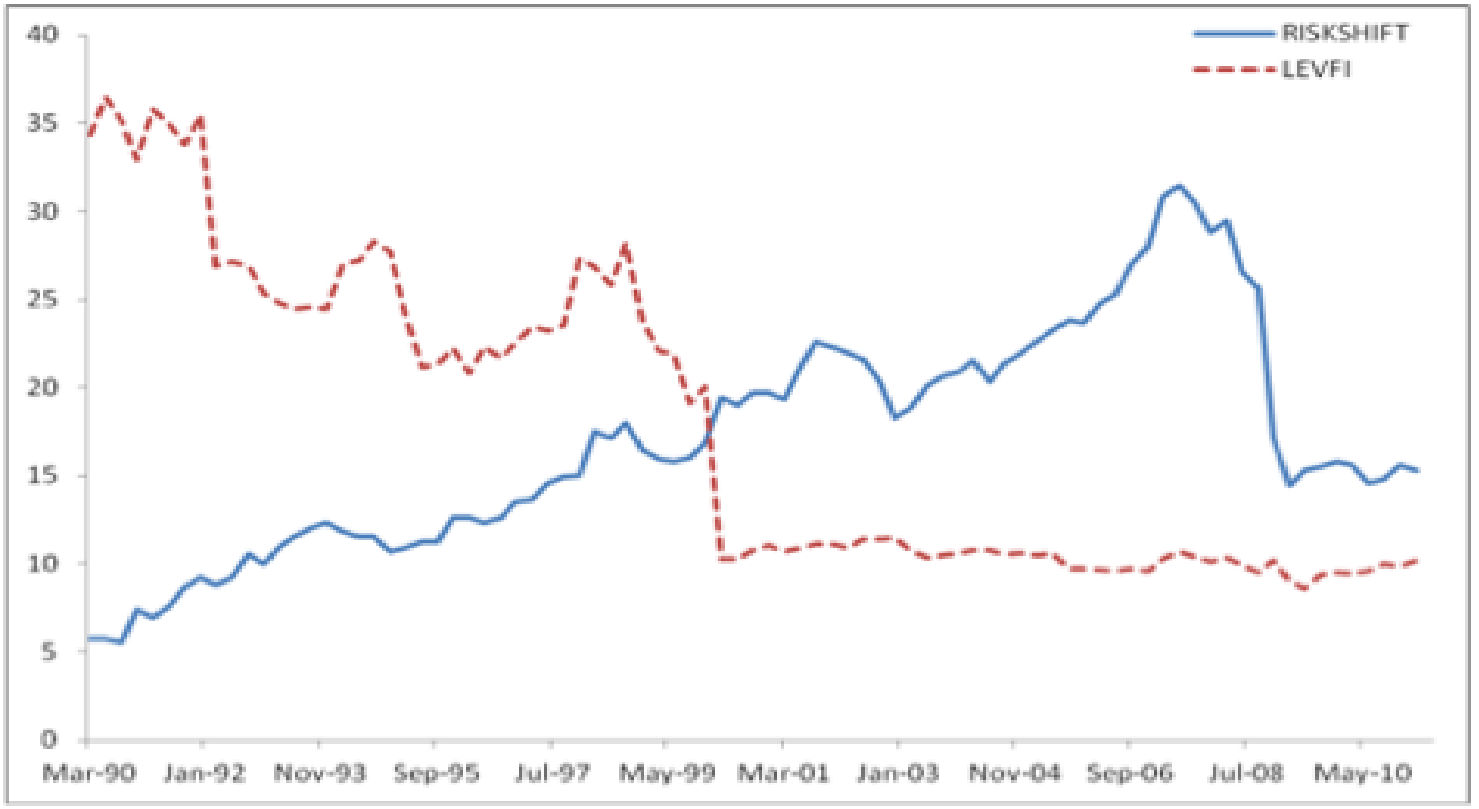
- Procyclicality
  - Dynamically lower margins leading to higher default
  - Distinguish between leverage and credit
  - Marginal buyer / Marginal lender
- Time-varying regulation
  - Which indicators should we use?
- Could give motive for bank runs and hence for NSFR and deposit insurance
- Computational difficulties
  - Discontinuities in the policy and transition functions
  - Non-linearity probably important

Example of procyclicality I



- Aggregate data for Globally Systemically Important Financial Institutions (G-SIFIs)
- Source: Bloomberg

Example of procyclicality II



- LEVFI is the total leverage of all financial institution in the US
- RISKSHIFT is the ratio of broker dealers' liabilities over the liabilities of commercial banks (flow of funds data)

Conclusions

- Need a full GE model to sort out these effects
- Concentrate on the channels through which regulation operates and not on the agents on which rules bind
- Stabilizing both bank and non-banks improves welfare
- Liquidity rules, applied equally to all states of the world, are very pro-cyclical
- Be careful about combining tools, it is easy to design welfare-reducing policies

Extra Slides

Household P's Optimization Problem

$$\overline{U}^{P} = U^{P}\left(c_{1,p}^{P}, c_{1,h}^{P}\right) + \tilde{\xi}_{2g}\left[U^{P}\left(c_{2g,p}^{P}, (1-\delta)c_{1,h}^{P} + c_{2g,h}^{P}\right)\right] +$$
$$\tilde{\xi}_{2b}\left[U^{P}\left(c_{2b,p}^{P}, c_{2b,h}^{P}\right) - \tau_{2b}^{P}\left(MORT^{P}\left(1+r^{MORT}\right) - P_{2b,h}c_{1,h}^{P}\right)\right]$$

where

$$U^{P}\left(c_{ts,p}^{P}, c_{ts,h}^{P}\right) = \frac{1}{1-\gamma^{P}}\left(c_{ts,p}^{P}\right)^{1-\gamma^{P}} + \frac{1}{1-\gamma^{P}}\left(c_{ts,h}^{P}\right)^{1-\gamma^{P}}$$

Household P's budget constraints

$$P_{1,h}c_{1,h}^{P} \le Money_{1}^{P} + MORT^{P} + LST_{1}^{P}$$

$$LST_{1}^{P}\left(1+r_{1}^{ST}\right) \le P_{1,p}q_{1,p}^{P}$$

$$MORT^{P}\left(1+r^{MORT}\right) + P_{2g,h}c_{2g,h}^{P} \le Money_{2g}^{P} + LST_{2g}^{P}$$

$$LST_{2g}^{P}(1+r_{2g}^{ST}) \le P_{2g,p}q_{2g,p}^{P}$$

$$P_{2b,h}c_{2b,h}^{P} \le Money_{2b}^{P} + LST_{2b}^{P}$$

$$LST_{2b}^{P}(1+r_{2b}^{ST}) \le P_{2b,p}q_{2b,p}^{P}$$

Household F's Optimization Problem

$$\overline{U}^F = \omega_{2g}\left[U^F\left(c^F_{2g,p}, c^F_{2g,h}\right)\right] + \omega_{2b}\left[U^F\left(c^F_{2b,p}, c^F_{2b,h}\right)\right]$$

where

$$U^F\left(c^F_{2p}, c^F_{2h}\right) = \frac{1}{1-\gamma^F}\left(c^F_{2p}\right)^{1-\gamma^F} + \frac{1}{1-\gamma^F}\left(c^F_{2h}\right)^{1-\gamma^F}$$

and $$P_{2s,h}c^F_{2s,h} \le Money^F_{2s} + LST^F_{2s}$$

$$LST^F_{2s}(1+r^{ST}_{2s}) \le P_{2s,p}q^F_{2s,p}$$

Household R's Optimization Problem

$$\bar{U}^R = U^R\left(c^R_{1,p}, c^R_{1,h}\right) + \tilde{\xi}_{2g}\left[U^R\left(c^R_{2g,p}, (1-\delta)\left(c^R_{1,h}\right) + c^R_{2g,h}\right)\right]$$

$$+ \tilde{\xi}_{2b}\left[U^R\left(c^R_{2b,p}, (1-\delta)\left(c^R_{1,h}\right) + c^R_{2b,h}\right)\right]$$

where

$$U^R\left(c^R_{s,p}, c^R_{s,h}\right) = \frac{1}{1-\gamma^R}\left(c^R_{s,p}\right)^{1-\gamma^R} + \frac{1}{1-\gamma^R}\left(c^R_{s,h}\right)^{1-\gamma^R}$$

and

$$P_{1,p}c^R_{1,p} + D^R \le Money^R_1 + LST^R_1$$

$$LST^R_1(1+r^{ST}_1) \le P_{1,h}q^R_{1,h}$$

$$P_{2s,p}c^R_{2s,p} \le Money^R_{2s} + LST^R_{2s} + V^D_{2s}D^R\left(1+r^D\right)$$

$$LST^R_{2s}(1+r^{ST}_{2s}) \le P_{2s,h}q^R_{2s,h}$$

Bank B's Optimization Problem

$$\overline{Prof}^{B} = Prof^{B}\left(\pi_1^B\right) + \xi\sum_s \omega_{2s}\left[Prof^{B}\left(\pi_{2s}^B\right) - \tau_{2s}^B\left[1-v_{2s}^B\right]D^B(1+r^D)\right]$$

where

$$Prof\left(\pi_{ts}^B\right) = \frac{1}{1-\gamma^B}\left(\pi_{ts}^B\right)^{1-\gamma^B}$$ and period 1 budget constraints

$$LST_1^B + REPO^B + CC^B \le E_1^B + DISC_1^B + D^B$$

$$MORT^B \le CC^B + P_{1,MBS}^M MBS_1^B$$

$$DISC_1^B\left(1+r_1^{CB}\right) + cash_1^B \le LST_1^B(1+r_1^{ST})$$

Bank B's Second Period Constraints

$$LST_{2g}^{B} + v_{2g}^{B} D^{B}\left(1+r^{D}\right) \leq cash_{1}^{B} + E_{2g}^{B} + DISC_{2g}^{B} + P_{2g,MBS}\sigma_{2g}^{B}\left(MORT^{B} - MBS_{1}^{B}\right)$$

$$\pi_{2g}^{B} \leq LST_{2g}^{B}\left(1+r_{2g}^{ST}\right) + REPO^{B}\left(1+r^{REPO}\right)$$
$$+ (1-\sigma_{2g}^{B})\left(MORT^{B} - MBS_{1}^{B}\right)\left(1+r^{MORT}\right) - DISC_{2g}^{B}(1+r_{2g}^{CB})$$

$$LST_{2b}^{B} + v_{2b}^{B} D^{\beta}\left(1+r^{D}\right) \leq cash_{1}^{B} + E_{2b}^{B} + DISC_{2b}^{B}$$
$$+ P_{2b,MBS}\left[\vartheta_{2b}^{B} MBS_{1}^{B} + \sigma_{2b}^{B}\left(MORT^{B} - MBS_{1}^{B}\right)\right]$$

$$\pi_{2b}^{B} \leq LST_{2b}^{B}\left(1+r_{2b}^{ST}\right) + V_{2b}^{MORT}\left(MORT^{B} - \vartheta_{2b}^{B} MBS_{1}^{B} - \sigma_{2b}^{B}\left(MORT^{B} - MBS_{1}^{B}\right)\right)\left(1+r^{MORT}\right)$$
$$- DISC_{2b}^{B}(1+r_{2b}^{CB})$$

Non-Bank N's Optimization Problem

$$\overline{Prof}^{N} = \tilde{\xi}_{2g} Prof^{N}\left(\pi_{2g}^{N}\right) + \tilde{\xi}_{2b}\left[Prof^{N}\left(\pi_{2b}^{N}\right) - \tau_{2b}^{N}\left[REPO^{N}\left(1+r^{REPO}\right) - V_{2b}^{MORT} MBS_{1}^{N}\left(1+r^{MORT}\right)\right]\right]$$

where

$$Prof\left(\pi_{2s}^{N}\right) = \frac{1}{1-\gamma^{N}}\left(\pi_{2s}^{N}\right)^{1-\gamma^{N}}$$

Non-Bank N's Budget Constraints

$$P_{1,MBS} MBS_1^N \leq E_1^N + REPO^N$$

$$P_{2s,MBS} MBS_{2s}^N \leq E_{2s}^N$$

$$\pi_{2g}^N \leq \left(MBS_1^N + MBS_{2g}^N \right) \left(1 + r^{MORT} \right) - REPO^N \left(1 + r^{REPO} \right)$$

$$\pi_{2b}^N \leq V_{2b}^{MORT} MBS_{2b}^N \left(1 + r^{MORT} \right)$$

Loan to Value and Haircut Regulation

$$LTV^{P} = \frac{MORT^{B}}{P_{1,h} c_{1,h}^{P}}$$ (mortgage divided by house price value)

$$MR^{N} = \frac{E_{1}^{N}}{P_{1,MBS} MBS_{1}^{N}}$$ (N's equity relative to its borrowing)

B's Middle of Period 1 Balance Sheet

Assets	Liabilities
LST_1^B	E_1^B
$REPO^B$	π_1^B
$MORT^B$ -MBS_1^B	D^B
$r_1^{ST} LST_1^B$	$DISC_1^B$
	$r_1^{CB} DISC_1^B$

$$\pi_1^B = r_1^{ST} LST_1^B - r_1^{CB} DISC_1^B + (P_{1,MBS} - 1) MBS_1^B$$

Liquidity and Capital Regulation

$$CR^{B}_{mid1} = \frac{E^{B}_{1} + \pi^{B}_{1}}{rw^{MORT}_{1} \cdot \left(MORT^{B} - MBS^{B}_{1} \right) + rw^{REPO}_{1} \cdot REPO^{B}}$$

(riskless assets get zero risk weight)

$$LCR^{B}_{mid1} = \frac{LST^{B}_{1}}{LST^{B}_{1} + REPO^{B} + MORT^{B} - MBS^{B}_{1}}$$

B's Middle of Period 2 Balance Sheet (Good state)

Assets	Liabilities
LST_{2g}^{B}	$E_1^B + E_{2g}^B + \pi_1^B$
$REPO^B$	$P\_L_{mid\,2g}^B$
$\left(1-\sigma_{2g}^B\right)\left(MORT^B - MBS_1^B\right)$	$DISC_{2g}^B$

$$LCR_{mid\,2g}^{B} = \frac{LST_{2g}^{B}}{LST_{2g}^{B} + REPO^{B} + \left(1-\sigma_{2g}^{B}\right)\left(MORT^{B} - MBS_1^{B}\right)}$$

B's Middle of Period 2 Balance Sheet (Bad state, before deposit default)

Assets	Liabilities
$MORT^B - \vartheta_{2b}^B MBS_1^B$	$E_1^B + E_{2b}^B + \pi_1^B$
$cash_{2s}^B$	$P\_L_{mid\,2b}^B = REPO^B - (1-\vartheta_{2b}^B)MBS_1^B - P_{2b,MBS}\vartheta_{2b}^B MBS_1^B$
	D^B

$$CR_{mid\,2b}^B = \frac{E_1^B + E_{2b}^B + \pi_1^B + P\_L_{mid\,2b}^B}{rw_{2b}^{MORT} \cdot \left(MORT^B - \vartheta_{2b}^B MBS_1^B\right)}$$

b's Middle of Period 2 Balance Sheet (Bad state, after deposit default)

Assets	Liabilities
LST_{2b}^{B}	$E_1^B + E_{2b}^B + \pi_1^B$
$MORT^B - \vartheta_{2b}^B MBS_1^B$	$P\_L_{mid\,2'b}^B$
	$DISC_{2b}^B$

$$LCR_{mid\,2b}^{B} = \frac{LST_{2b}^{B}}{LST_{2b}^{B} + MORT^{B} - \vartheta_{2b}^{\beta} MBS_1^B}$$

Dynamic Provisioning

Define Real Estate Related Credit Growth as

$$g\% = \left(\frac{LST_{2g}^{P} + LST_{2g}^{F}}{MORT^{B} + LST_{1}^{P}} - 1 \right)\%$$

Provision κ per dollar of lending whenever g > "x"

$$LST_{2g,p}^{B} + LST_{2g,h}^{B} + \nu_{2g}^{B} D^{B} \left(1 + r^{D}\right) + \left(g\% - x\%\right)\kappa$$

$$\leq cash_{1}^{B} + E_{2g}^{B} + DISC_{2g}^{B} + P_{2g,MBS}\sigma_{2g}^{B} \left(MORT^{B} - MBS_{1}^{B} \right)$$

Makes it possible to lean against the boom without directly distorting the allocations in the bust

Endowments of goods	Households' wealth	F.I. capital	CB rates	Default penalties	Risk aversion	Other parameters
$e^{P}_{1,p} = 10$	$Money^{P}_{1} = 4.1$	$E^{B}_{1} = 0.5$	$r^{CB}_{1} = 0.12$	$\tau^{P}_{2b} = 4$	$\gamma^{P} = 2.1$	$\omega_{2b} = 0.1$
$e^{P}_{2g,p} = 32$	$Money^{P}_{2g} = 4.1$	$E^{B}_{2g} = 0.5$	$r^{CB}_{2g} = 0.12$	$\tau^{B}_{2g} = 1.2$	$\gamma^{F} = 2.1$	$\xi = 0.85$
$e^{P}_{2b,p} = 5.8$	$Money^{P}_{2b} = 0.1$	$E^{B}_{2b} = 0$	$r^{CB}_{2b} = 0.20$	$\tau^{\beta}_{2b} = 1.2$	$\gamma^{R} = 2.4$	$\delta = 0.15$
$e^{F}_{2g,p} = 11$	$Money^{F}_{2g} = 4.1$	$E^{N}_{1} = 1$		$\tau^{N}_{2b} = 0.2$	$\gamma^{B} = 1.4$	
$e^{F}_{2b,p} = 11$	$Money^{F}_{2b} = 0.1$	$E^{N}_{2g} = 2$			γ^{N} =0.7	
$e^{R}_{1,h} = 1$	$Money^{R}_{1} = 6.5$	$E^{N}_{2b} = 1$				
$e^{R}_{2g,h} = 0$	$Money^{R}_{2g} = 0$					
$e^{R}_{2b,h} = 0$	$Money^{R}_{2b} = 0$					

Prices	Interest rates/Money supply	Aggregate Consumption		Loans		Securitization	Repay-ment rates	F.I. profits
	$r_1^{ST} = 0.12$	$c_{1,p}^P = 0.859$	$c_{1,p}^R = 9.141$	$LST_1^P = 8.81$	$LST_1^B = 42.06$	$MBS_1^B = 21.52$	$V_{2g}^{MORT} = 1$	$\pi_1^B = 0.73$
$P_{2g,p} = 1.39$	$r_{2g}^{ST} = 0.12$	$c_{2g,p}^P = 1.126$	$c_{2g,p}^R = 41.478$	$LST_{2g}^P = 38.41$	$LST_{2g}^B = 67.05$	$\sigma_{2g}^B = 0.456$	$V_{2b}^{MORT} = 0.47$	$\pi_{2g}^B = 1.42$
$P_{2b,p} = 1.48$	$r_{2b}^{ST} = 0.20$	$c_{2b,p}^P = 0.285$	$c_{2b,p}^R = 15.997$	$LST_{2b}^P = 6.82$	$LST_{2b}^B = 19.76$	$\sigma_{2b}^B = 0$	$V_{2g}^D = 1$	$\pi_{2b}^B = 1.00$
$P_{1,h} = 676.96$	$r^D = 0.42$	$c_{1,h}^P = 0.055$	$c_{1,h}^R = 0.945$	$MORT^P = 24.32$	$DISC_1^B = 35.00$	$\vartheta_{2b}^B = 0.068$	$V_{2b}^D = 0.56$	$CC^B = 3.42$
$P_{2g,h} = 1{,}111.41$	$r^{MORT} = 0.75$	$c_{2g,h}^P = 0.047$	$c_{2g,h}^R = 0.788$	$LST_{2g}^F = 13.20$	$DISC_{2g}^B = 99.00$	$MBS_{2g}^N = 1.28$		$cash_1^B = 7.90$
$P_{2b,h} = 362.73$	$r^{REPO} = 0.74$	$c_{2b,h}^P = 0.019$	$c_{2b,h}^R = 0.803$	$LST_{2b}^F = 12.94$	$DISC_{2b}^B = 34.55$	$MBS_{2b}^N = 1.46$		$\pi_{2g}^N = 5.31$
$P_{1,MBS} = 0.97$	$M_1^{CB} = 35.00$	$c_{2g,p}^F = 0.396$		$LST_1^R = 33.25$	$REPO^B = 19.90$			$\pi_{2b}^N = 1.20$
$P_{2g,MBS} = 1.56$	$M_{2g}^{CB} = 99.00$	$c_{2b,p}^F = 0.538$		$LST_{2g}^R = 15.44$				
$P_{2b,MBS} = 0.68$	$M_{2b}^{CB} = 34.55$	$c_{2g,h}^F = 0.016$		$LST_{2b}^R = 0.004$				
		$c_{2b,h}^F = 0.036$		$D^R = 29.88$				

	Period 1	Period 2, State g	Period 2, State b
Potatoes Prices	1.08	1.39	1.48
Housing Prices	676.96	1,111.41	362.73
MBS Prices	0.97	1.56	0.68
Relative price of potatoes to housing	0.0016	0.0013	0.0041

	Period 1	Beginning of bad state	Middle of bad state
Capital adequacy ratio	9.91%	3.46%	8.24%
Liquidity ratio	64.94%	-	46.36%
Margin on repos	4.78%	-	-
Loan-to-value ratio	65.32%	-	-
Note: No dynamic provisions required in the good state. Pick κ to require 0.1 per dollar of reserves for loan growth above 20 percent.			