An Integrated Framework for Multiple Financial Regulation

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Model Characteristics

General equilibrium

- Incomplete Asset Markets
- Two goods
- Heterogeneous agents

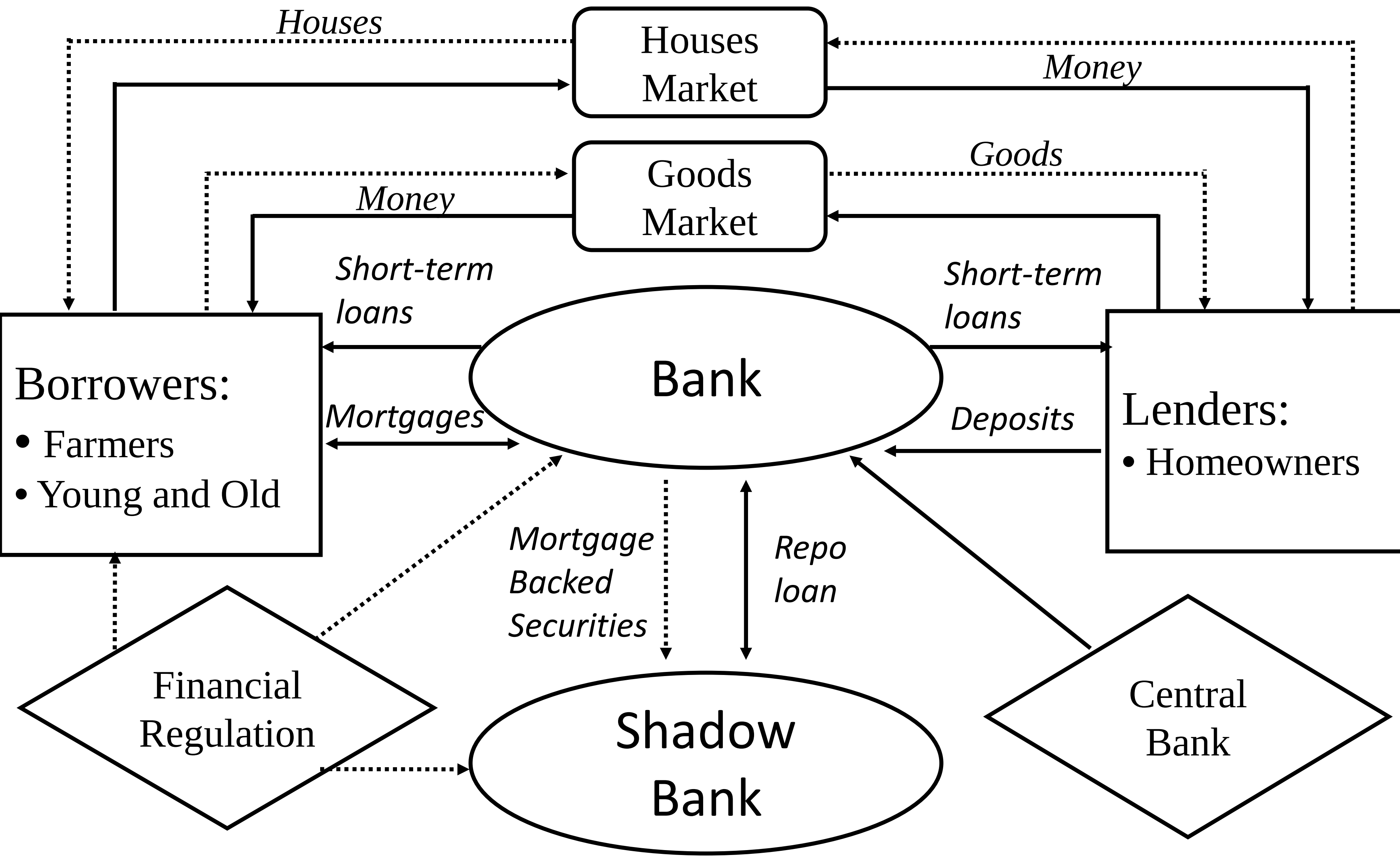
-Pareto Inefficient Competitive Equil.
-Rationale for policy intervention

Externalities from the financial system:

- <u>Default</u>, 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
Lenders:
• Homeowners
Mortgages
Deposits
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.

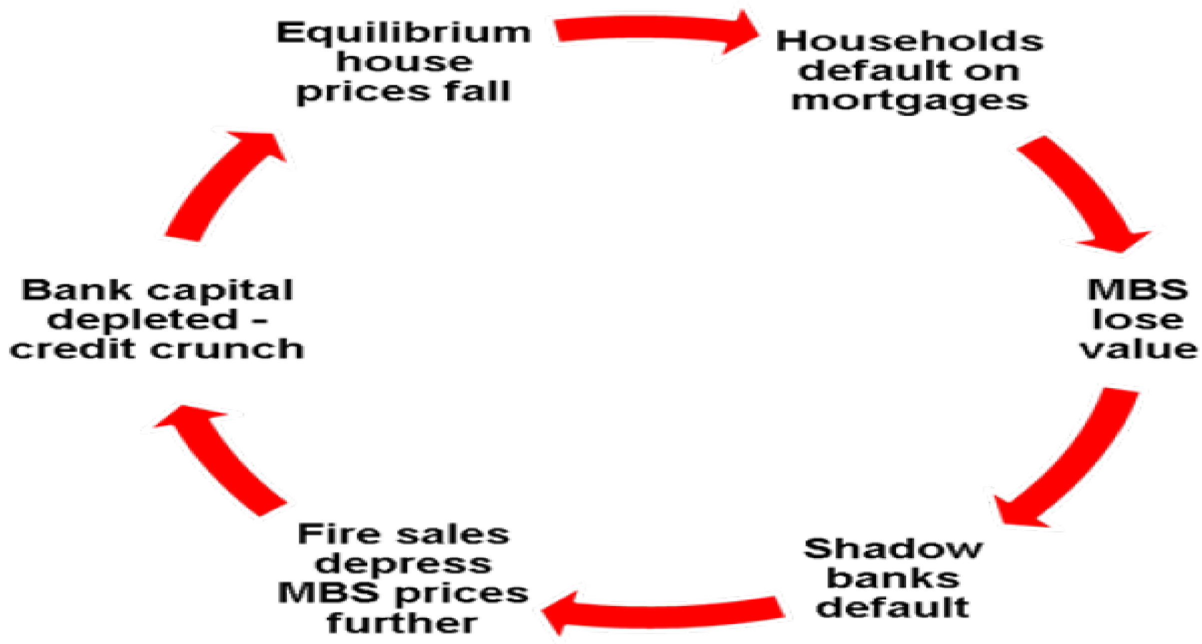
- Farmer can equate marginal utility of houses and potatoes in period 1. But cannot smooth between period 1 and 2.

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
  - o Fire sale of MBS by banks
  - o Deposit defaults
  - o Potential margin spiral



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

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

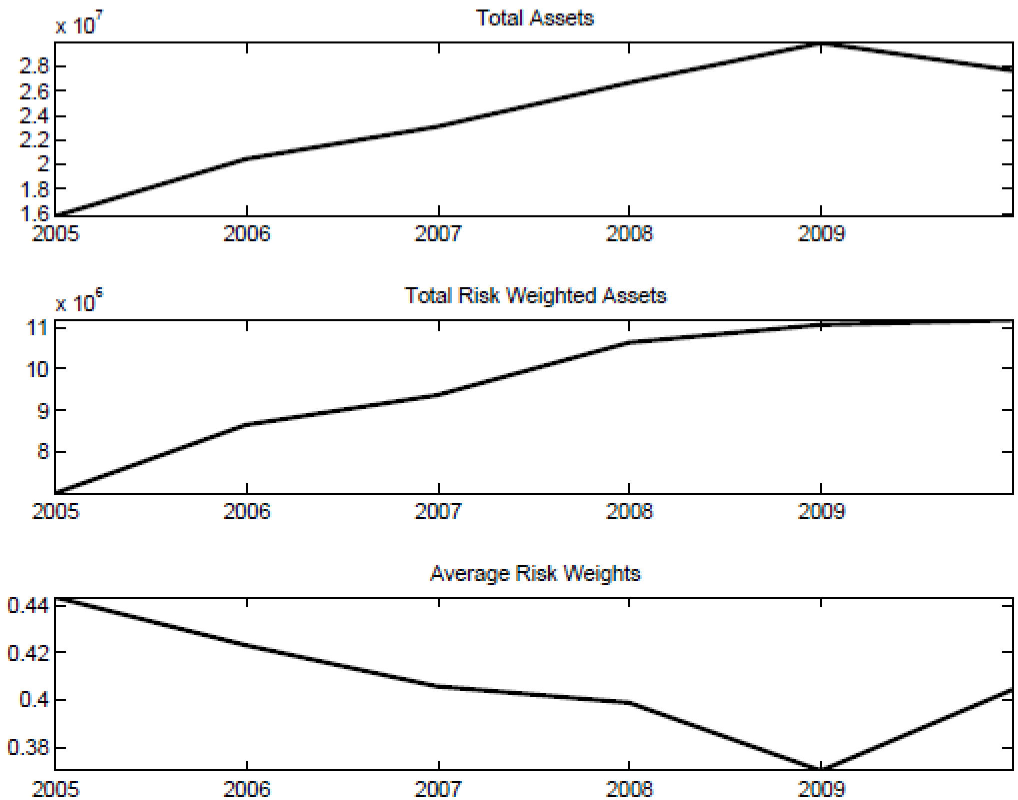
(Change relative to baseline equilibrium)

	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



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

Conclusions

- Need a full GE model to sort out these effects
  - Default in a key element: Can improve hedging, but can act as an amplifier of shocks
- Concentrate on the channels through which regulation operates and not on the agents on which rules bind
- Financial system acts as an amplifier of primitive shocks
  - Drop in the supply of credit due to loan losses further suppresses prices and income making default worse
  - Default by financial institutions results in shocks being transferred throughout the economy
- Two-way interaction between financial instability and the real economy

Conclusions ctd.

- Stabilizing bank and non-banks can improve welfare
- Structural vs. cyclical policy interventions
- Focus not only on credit, but also on leverage
- Multiple externalities require multiple tools: Are the complements or substitutes?
- But, be careful about combining tools, it is easy to design welfare-reducing policies

Extra Slides

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

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

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

So more fire sales mean lower house prices!

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 $\quad P_{2s,h}c^F_{2s,h} \leq Money^F_{2s} + LST^F_{2s}$

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

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

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

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

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

Bank B's Second Period Constraints

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

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

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

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

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

$$CR_{mid1}^{B} = \frac{E_1^B + \pi_1^B}{rw_1^{MORT} \cdot \left(MORT^B - MBS_1^B \right) + rw_1^{REPO} \cdot REPO^B}$$

(riskless assets get zero risk weight)

$$LCR_{mid1}^{B} = \frac{LST_1^B}{LST_1^B + REPO^B + MORT^B - MBS_1^B}$$

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"

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

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

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
$e_{1,p}^{P} = 10$	$Money_{1}^{P} = 4.1$	$E_{1}^{B} = 0.5$	$r_{1}^{CB} = 0.12$	$\tau_{2b}^{P} = 4$	$\gamma^{P} = 2.1$	$\omega_{2b} = 0.1$
$e_{2g,p}^{P} = 32$	$Money_{2g}^{P} = 4.1$	$E_{2g}^{B} = 0.5$	$r_{2g}^{CB} = 0.12$	$\tau_{2g}^{B} = 1.2$	$\gamma^{F} = 2.1$	$\xi = 0.85$
$e_{2b,p}^{P} = 5.8$	$Money_{2b}^{P} = 0.1$	$E_{2b}^{B} = 0$	$r_{2b}^{CB} = 0.20$	$\tau_{2b}^{\beta} = 1.2$	$\gamma^{R} = 2.4$	$\delta = 0.15$
$e_{2g,p}^{F} = 11$	$Money_{2g}^{F} = 4.1$	$E_{1}^{N} = 1$		$\tau_{2b}^{N} = 0.2$	$\gamma^{B} = 1.4$	
$e_{2b,p}^{F} = 11$	$Money_{2b}^{F} = 0.1$	$E_{2g}^{N} = 2$			$\gamma^{N} =0.7$	
$e_{1,h}^{R} = 1$	$Money_{1}^{R} = 6.5$	$E_{2b}^{N} = 1$				
$e_{2g,h}^{R} = 0$	$Money_{2g}^{R} = 0$					
$e_{2b,h}^{R} = 0$	$Money_{2b}^{R} = 0$					

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

	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.