New Models of the Economy and the Financial System

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Frictions and Default

- Inability to commit
  - Ex-post penalties for default allow for borrowing and intertemporal smoothing
- Complete vs. Incomplete Markets
  - If markets are complete and loan terms are comprehensive, i.e. any penalty for default can be applied, then default can be excluded and the Arrow-Debreu equilibrium is reached
  - When markets are incomplete, allowing for positive default in equilibrium can be welfare improving
- Optimizing financial institutions
  - Improve hedging opportunities and consumption smoothing among heterogeneous agents: offer and bridge different types of lending and borrowing contracts

Externalities and Default

- Deadweight loss of default: Price taking behavior can lead to inefficient level of aggregate default and *aggregate* moral hazard

- 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

- Endogenous default and general equilibrium
  - Interaction between liquidity and default
  - Distinct regulatory policies will affect incentives in different ways
  - Externalities from relative price effects (constrained Pareto suboptimality)
  - Macroprudential vs. microprudential regulation

A benchmark model

Financial Regulation in General Equilibrium

Goodhart, Kashyap, Tsomocos & Vardoulakis (2011)

- General equilibrium
- Externalities from the financial system: Default, credit crunches and fire sales
- Financial system that allows
  - Regulatory arbitrage
  - Various regulatory tools
- Liquidity and securitization

Our model ingredients

- Two goods: houses, potatoes
- One security (MBS)
- Timing, t=1 (no uncertainty), t=2 (G or B outcome)
- 3 types of households, which differ in endowments
  - "R" (rich) endowed with lots of houses, present at t=1 & 2
  - "P" (poorer) endowed with potatoes, present at t=1 & 2
  - "F" (first time buyers) endowed with potatoes, present t=2
- 2 types of financial institution
  - b (bank) high risk aversion and big balance sheet
  - N (non-bank) low risk aversion
- CB (central bank) that makes short term loans to b

Model characteristics

- Only uncertainty is relative quantity of potatoes vs. houses and the amount of monetary endowments
- 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

Externalities and tools

- Knock effects from house price collapse and subsequent repo default
  - Fire sale of MBS by banks
  - Deposit defaults
  - Potential margin spiral
  - (Distortion also due to dead weight costs of default that tilts consumption towards the good state)
- Five potential regulatory tools:
  - Loan to value ratios, margin requirements, capital ratio, liquidity ratio, dynamic provisioning
  - **Are they complements or substitutes, why?**

Three channels of financial regulation

1) Ex-ante tools: Discourage initial lending to make the bust less extreme
   - Margin requirements on repos, loan-to-value requirements on mortgages, potentially capital or liquidity requirements on banks
2) Shore up the banks in the event of a bust
   - Insist on capital
   - Liquidity requirement make fire sales worse
3) Lean against the boom
   - Dynamic provisioning on real estate related credit
   - Hard to use capital, loan-to-value or margin requirement

Some conclusions

- Modeling the frictions matters and there is a high payoff to being precise about the failures of Modigliani-Miller

- Our analysis shows that focusing on the channels, through which the regulatory tools operate, is probably more important than the institutions or markets to which they are applied

- Conventional monetary policy affects the short end of the yield curve, while regulatory policy intervenes at a different stage of the transmission mechanism

- Multiple channels of instability require multiple tools (Tinbergen rule), and just capital, or even just capital and liquidity, are not likely to be sufficient

Why the boom is hard to regulate?

- Haircuts on repo loans are endogenous and depend on the prevailing expectations of the marginal buyer (Geanakoplos, 2003)

- Regulatory ratios which incorporate asset prices are high in the upturn

- Bad news about the economic prospects deplete the equity of the natural buyer and lead to a market/funding liquidity spiral (Brunnermeier & Pedersen, 2008)

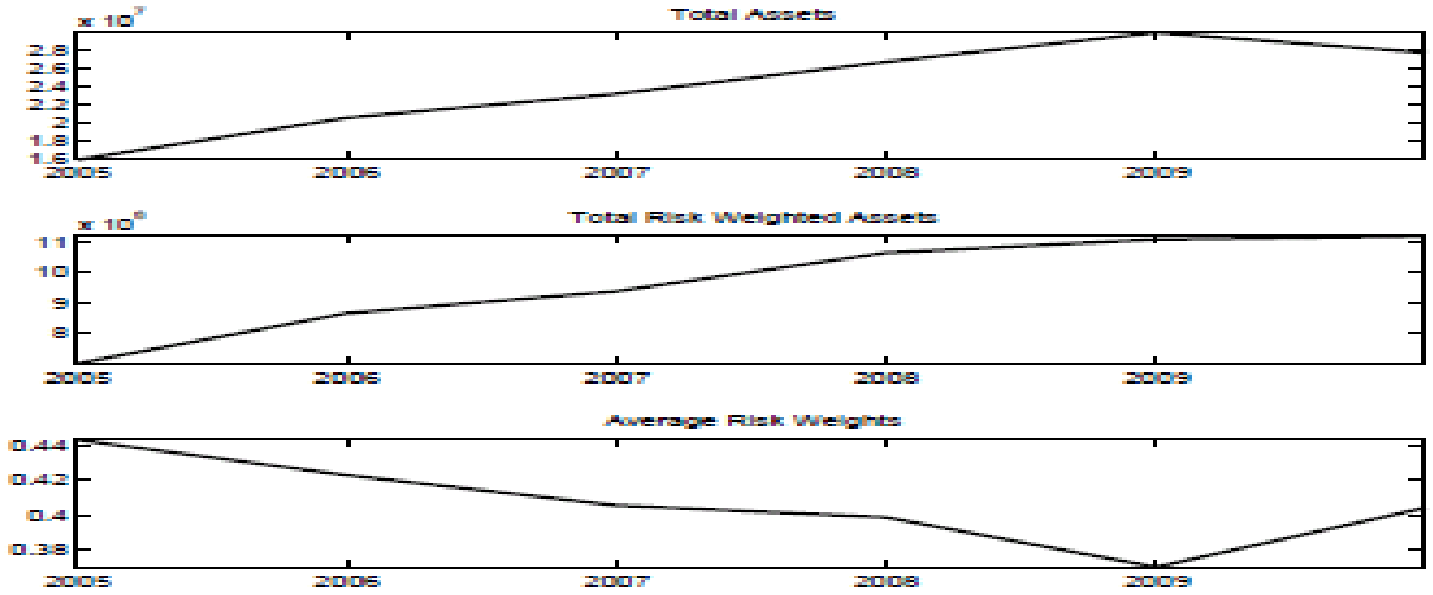
- In Bhattacharya et al. (2011) we focus on the build-up face of risk and how agents shift their portfolios towards riskier assets by increasing borrowing at low interest rates (Minsky's Financial Instability Hypothesis, 1992)

Expectations and Leverage ctd.

- Risk shifting may look efficient due to improved expectations
- However, even in CAPM economies the ability to default makes agents undertake higher downside risk and invest in asset with suboptimal Sharpe ratios
- When they factor their impact on overall-not marginal-default and borrowing rates, they switch to the safer asset with a higher Sharpe ratio
- Unweighted leverage requirement can lead to internal deleveraging by cutting lending to safer assets

Expectations and Leverage ctd.

- Regulate the allocation of borrowed fund to asset classes in terms of quantities, not risk weighted quantities as risk measures are procyclical
- Aggregate figures for 33 biggest international banks



- RWA/Assets close to constant for the whole universe of banks

Dynamics

- Martinez and Tsomocos (2011) take our overall approach to dynamics and consider a model to examine the interaction between liquidity and default in a DSGE framework
- They conclude that liquidity and endogenous default are indispensable parts of any measure of financial stability
- Also, liquidity and default generate medium term effects that are not captured by standard neo-Keynesian models (Bernanke, Gertler and Gilchrist, 1999, Curdia and Woodford, 2009)

Overall

- We propose an approach that brings liquidity and *endogenous* default in the center of macroeconomic analysis
- Institutions and heterogeneity are important
- Model the micro-foundations of regulatory interventions
- Propose a tractable framework to analyse monetary and regulatory policy in an integrated model.

Literature Review

Earlier theoretical work

- Tsomocos (2003), Goodhart, Sunirand and Tsomocos (2006)

Risk assessment

- Goodhart, Sunirand and Tsomocos (2005)

Liquidity and Default

- Espinoza, Goodhart and Tsomocos (2009)
- Goodhart, Tsomocos and Vardoulakis (2010)
- Lin, Tsomocos and Vardoulakis (2011)

Dividend Restrictions

- Goodhart, Peiris, Tsomocos and Vardoulakis (2011)

Learning, Risk taking and Default

- Bhattacharya, Goodhart, Tsomocos and Vardoulakis (2011)

DSGE framework

- Martinez and Tsomocos (2011)

Back-up Slides for Goodhart, Kashyap, Tsomocos, Vardoulakis

Household P's budget constraints

$$P_{1h}c_{1h}^{P} \le E_1^{P} + M^{P} + B_1^{P}$$ Housing constraint

$$B_1^{P}(1+r_1) \le P_{1p}q_{1p}^{P}$$ Bridge loan repayment

$$M^{P}\left(1+\rho^{M}\right) + P_{2gh}c_{2gh}^{P} \le E_{2g}^{P} + B_{2g}^{P}$$ Mortgage repayment and additional housing rental

$$B_{2g}^{P}(1+r_{2g}) \le P_{2gp}q_{2gp}^{P}$$ Bridge loan repayment

$$P_{2bh}c_{2bh}^{P} \le E_{2b}^{P} + B_{2b}^{P}$$ Mortgage default and housing rental

$$B_{2b}^{P}(1+r_{2b}) \le P_{2bp}q_{2bp}^{P}$$ Bridge loan repayment

Household F's Optimization Problem

$$\overline{U}^F = \omega_{2g}\left[U^P\left(c^P_{2gp,}c^P_{2gh}\right)\right] + \omega_{2b}\left[U^P\left(c^P_{2bp},c^P_{2bh}\right)\right]$$

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

$$P_{2sh}c^F_{2sh} \le E^F_{2s} + B^F_{2s} \qquad \text{Housing rental}$$

$$B^F_{2s}(1+r_{2s}) \le P_{2sp}q^F_{2sp} \qquad \text{Bridge loan repayment}$$

Household R's Optimization Problem

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

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

where

$$U^R\left(c_{s,p}^R, c_{s,h}^R\right) = \frac{1}{1-\gamma^R}\left(c_{s,p}^R\right)^{1-\gamma^R} + \frac{1}{1-\gamma^R}\left(c_{s,h}^R\right)^{1-\gamma^R} \quad \text{and}$$

$P_{1p}c_{1p}^R + D^R \le E_1^R + B_1^R$ Potato purchase /deposit choice

$B_1^R(1+r_1) \le P_{1h}q_{1h}^R$ Bridge loan repayment

$P_{2sp}c_{2sp}^R \le E_{2s}^R + B_{2s}^R + V_{2s}^D D^R\left(1+\rho^D\right)$ Potatoes in period 2

$B_{2s}^R(1+r_{2s}) \le P_{2sh}q_{2sh}^R$ Bridge loan repayment

Bank b's Optimization Problem

$$\bar{P}^{\beta} = P^{\beta}\left(\pi_1^{\beta}\right) + \xi \sum_s \omega_s \left[P^{\beta}\left(\pi_{2s}^{\beta}\right) - \tau_{2s}^{\beta}\left[1 - v_{2s}^{\beta}\right] D^{\beta}(1+\rho^{D}) \right]$$

where

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

$$L_1^{\beta} + L_{repo}^{\beta} + CC^{\beta} \le E_1^{\beta} + B_1^{\beta} + D^{\beta}$$ Portfolio allocation

$$M^{\beta} \le CC^{\beta} + P_1^{M}\ \overline{M}_1^{\beta}$$ Securitization decision

$$B_1^{\beta}\left(1 + r_1^{CB}\right) + cash_1^{\beta} \le L_1^{\beta}(1 + r_1)$$ CB repayment

Bank b's Second Period Constraints

$$L_{2g}^{\beta} + v_{2g}^{\beta} D^{\beta} \left(1+\rho^{D}\right) \leq \; cash_{1}^{\beta} + E_{2g}^{\beta} + B_{2g}^{\beta} + P_{2g}^{M} \sigma_{2g}^{\beta} \left(M^{\beta} - \overline{M}_{1}^{\;\beta} \right)$$

$$\pi_{2g}^{\beta} \leq L_{2g}^{\beta} \left(1+r_{2g}\right) + L_{repo}^{\beta} \left(1+\rho^{repo}\right) + (1-\sigma_{2g}^{\beta}) \left(M^{\beta} - \overline{M}_{1}^{\;\beta} \right) \left(1+\rho^{M}\right) - B_{2g}^{\beta} (1+r_{2g}^{CB})$$

$$L_{2b}^{\beta} + v_{2b}^{\beta} D^{\beta} \left(1+\rho^{D}\right) \leq \; cash_{1}^{\beta} + E_{2b}^{\beta} + B_{2b}^{\beta} + P_{2b}^{M} \vartheta_{2b}^{\beta} \, \overline{M}_{1}^{\;\beta}$$

$$\pi_{2b}^{\beta} \leq L_{2b}^{\beta} \left(1+r_{2b}\right) + V_{2b}^{M} \left(M^{\beta} - \vartheta_{2b}^{\beta} \, \overline{M}_{1}^{\;\beta} \right) \left(1+\rho^{M}\right) - B_{2b}^{\beta} (1+r_{2b}^{CB})$$

Non-Bank N's Optimization Problem

$$\overline{P}^{N} = \tilde{\xi}_{2g} P^{N}\left(\pi_{2g}^{N}\right) + \tilde{\xi}_{2b}\left[P^{N}\left(\pi_{2b}^{N}\right) - \tau_{2b}^{N}\left[B_{repo}^{N}\left(1+\rho^{repo}\right) - V_{2b}^{M}\,\overline{M}_{1}^{N}\left(1+\rho^{M}\right)\right]\right]$$

where

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

Non-Bank N's Budget Constraints

$$P_1^M \overline{M}_1^N \leq E_1^N + B_{repo}^N$$

MBS purchase in period 1

$$P_{2s}^M \overline{M}_{2s}^N \leq E_{2s}^N$$

Cash in the market pricing

$$\pi_{2g}^N \leq \left(\overline{M}_1^N + \overline{M}_{2g}^N \right) \left(1+\rho^M\right) - B_{repo}^N \left(1+\rho^{repo}\right)$$

Capital gains minus repo loan repayment

$$\pi_{2b}^N \leq V_{2b}^M \overline{M}_{2b}^N \left(1+\rho^M\right)$$

Default on the repo

Aside – Margin Spiral

$$V_{2b}^{M} \equiv \frac{P_{2bh} c_{1h}^{P}}{M^{P}\left(1+\rho^{M}\right)}$$ and arbitrage pins down MBS prices

$$P_{2b}^{M} = \frac{V_{2b}^{M}\left(1+\rho^{M}\right)}{1+r_{2b}^{CB}}$$

$\therefore$ MBS and house prices must be connected

$$P_{2b}^{M} = \frac{P_{2bh} c_{1h}^{P}}{M^{P}} \frac{1}{1+r_{2b}^{CB}} \quad \Leftrightarrow \quad P_{2bh} = P_{2b}^{M} \frac{M^{P}}{c_{1h}^{P}} (1+r_{2b}^{CB})$$

Plus cash-in-the-market pricing: $P_{2b}^{M} \overline{M}_{2b}^{N} \leq E_{2b}^{N}$

So more fire sales mean lower house prices!

Loan to Value and Haircut Regulation

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

$$MR^N = \frac{E_1^N}{P_1^M \overline{M}_1^N}$$ (N's equity relative to its borrowing)

Liquidity and Capital rules depend on point in time when they are measured

b's Middle of Period 1 Balance Sheet

Assets	Liabilities
L_1^{β}	E_1^{β}
L_{repo}^{β}	π_1^{β}
$M^{\beta} - \bar{M}_1^{\beta}$	D^{β}
$r_1 L_1^{\beta}$	B_1^{β}
	$r_1^{CB} B_1^{\beta}$

$$\pi_1^{\beta} = r_1 L_1^{\beta} - r_1^{CB} B_1^{\beta} + (P_1^M - 1)\overline{\overline{M}}_1^{\beta}$$

Liquidity and Capital Regulation

$$CR_{mid1}^{\beta} = \frac{E_1^{\beta} + \pi_1^{\beta}}{rw_1^{M} \left(M^{\beta} - \overline{M}_1^{\beta} \right) + rw_1^{repo} L_{repo}^{\beta}}$$

(riskless assets get zero risk weight)

$$LCR_{mid1}^{\beta} = \frac{L_1^{\beta}}{L_1^{\beta} + L_{repo}^{\beta} + M^{\beta} - \overline{M}_1^{\beta}}$$

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

Assets	Liabilities
L_{2g}^{β}	$E_1^{\beta} + E_{2g}^{\beta} + \pi_1^{\beta}$
L_{repo}^{β}	$\pi_{\text{securitization}} - \rho D$
$\left(1 - \sigma_{2g}^{\beta}\right)\left(M^{\beta} - \bar{M}_1^{\beta}\right)$	B_{2g}^{β}

$$LCR_{mid\,2g}^{\beta} = \frac{L_{2g}^{\beta}}{L_{2g}^{\beta} + L_{repo}^{\beta} + \left(1 - \sigma_{2g}^{\beta}\right)\left(M^{\beta} - \overline{M}_1^{\beta}\right)}$$

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

Assets	Liabilities
$M^{\beta} - \vartheta_{2b}^{\beta} \bar{M}_1^{\beta}$	$E_1^{\beta} + E_{2b}^{\beta} + \pi_1^{\beta}$
$cash_{2s}^{\beta\ \prime}$	$\pi_{\text{repo default}}$
	D^{β}

$$CR_{mid\,2b}^{\beta} = \frac{E_1^{\beta} + E_{2b}^{\beta} + \pi_1^{\beta} + (L_{repo}^{\beta} - (1 - \vartheta_{2b}^{\beta})\,\overline{M}_1^{\beta} - P_{2b}^{M}\,\vartheta_{2b}^{\beta}\,\overline{M}_1^{\beta})}{rw_{2b}^{M} \left(M^{\beta} - \vartheta_{2b}^{\beta}\,\overline{M}_1^{\beta} \right)}$$

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

Assets	Liabilities
L_{2b}^{β}	$E_1^{\beta} + E_{2b}^{\beta} + \pi_1^{\beta}$
	$\left(1 - v_{2b}^{\beta}\right) D^{\beta} - v_{2b}^{\beta} D^{\beta} \rho^{D}$
$M^{\beta} - \vartheta_{2b}^{\beta} \overline{M}_1^{\beta}$	$\pi_{\text{repo default}}$
	B_{2b}^{β}

$$LCR_{mid\,2b}^{\beta} = \frac{L_{2b}^{\beta}}{L_{2b}^{\beta} + (M^{\beta} - \vartheta_{2b}^{\beta} \overline{M}_1^{\beta})}$$

Dynamic Provisioning

Define Real Estate Related Credit Growth as

$$g\% = \left(\frac{B_{2g}^{P} + B_{2g}^{F}}{M^{P} + B_{1}^{P}} - 1 \right)\%$$

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

$$L_{2gp}^{\beta} + L_{2gh}^{\beta} + v_{2g}^{\beta} D^{\beta} \left(1 + \rho^{D}\right) + \left(g\% - x\%\right)\kappa$$

$$\leq cash_{1}^{\beta} + E_{2g}^{\beta} + B_{2g}^{\beta} + P_{2g}^{M} \sigma_{2g}^{\beta} \left(M^{\beta} - \overline{M}_{1}^{\beta} \right)$$

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

Raising LTVs ➔

$$(LTV^P = \frac{M^P}{P_{1h} c_{1h}^P} \quad)$$

1. T=1 reduces mortgage lending (and MBS which raises mortgage rates)

2. T=2, bad state, raises mortgage repayment rate, reduces deposit default rate, reduces fire sales

3. Mr. P and Mr. F worse off, Mr. R slightly better off, raises utility for b and N (due to much higher MBS prices in the good state and the larger spread between mortgage rates and deposit rates).

Raising haircuts ➔

$$\left(MR^N = \frac{E_1^N}{P_1^M \overline{M}_1^N} \right)$$

1. T=1, reduces repo borrowing, raises costs of mortgages, total bank mortgages are higher

2. T=2, Reduces size of repo default, raises mortgage repayment rate, and house prices

3. Mr P's welfare is ambiguously affected, as is Mr. R's, but F is worse off. Raises utility for b and slightly for N.

Raising Capital Requirements ➔ (middle of period 1)

$$\left(CR_{mid1}^{\beta} = \frac{E_1^{\beta} + \pi_1^{\beta}}{rw_1^M \left(M^{\beta} - \overline{M}_1^{\beta} \right) + rw_1^{repo} L_{repo}^{\beta}} \right)$$

1. T=1, reduces mortgage issuance, raises securitization and raises the mortgage rate
2. T=2, less severe mortgage default, higher deposit repayment
3. Mr P and Mr F are worse off, Mr. R hardly affected
4. b's profits skewed towards period 1, with higher utility, N's profits and utility higher.

(Conjecture: Excess securitization only leads to perverse effects if total mortgage credit is higher)

Raising Capital Requirements ➔
(middle of period 2)

$$\left(CR^{\beta}_{mid\,2b} = \frac{E^{\beta}_{1} + E^{\beta}_{2b} + \pi^{\beta}_{1} + \left(L^{\beta}_{repo} - (1-\vartheta^{\beta}_{2b})\,\overline{M}^{\beta}_{1} - P^{M}_{2b}\,\vartheta^{\beta}_{2b}\,\overline{M}^{\beta}_{1}\right)}{rw^{M}_{2b}\left(M^{\beta} - \vartheta^{\beta}_{2b}\,\overline{M}^{\beta}_{1}\right)} \right)$$

1. T=1, really reduces mortgage issuance, cuts MBS and raises the mortgage rate
2. T=2, more bridge lending, less severe mortgage default, higher deposit repayment
3. Mr P and Mr F are worse off, Mr. R hardly affected. Raises utility for b and N.

Raising LCR ➔

(middle of period 1)

$$\left(LCR^{\beta}_{mid1} = \frac{L^{\beta}_{1}}{L^{\beta}_{1} + L^{\beta}_{repo} + M^{\beta} - \overline{M}^{\beta}_{1}} \right)$$

1. T=1, b reduces mortgages and MBS, raises the mortgage rate, does more bridge lending
2. T=2, less severe mortgage default, higher deposit repayment
3. Mr P's is better off; Mr F is strictly worse off, Mr. R is hardly affected. Massively raises utility for b and N.

(P gains from the easier bridge finance and lower default costs)

Raising LCR ➔

(middle of bad state)

$$\left(LCR^{\beta}_{mid\,2b} = \frac{L^{\beta}_{2b}}{L^{\beta}_{2b} + (M^{\beta} - \vartheta^{\beta}_{2b}\,\overline{M}^{\beta}_{1})} \right)$$

1. T=1, b reduces mortgages and MBS (barely), lowers the mortgage rate, does more bridge lending
2. T=2, forced fire sale, more severe mortgage default, lower deposit repayment
3. Mr P's is better off; Mr F is strictly worse off, Mr. R is hardly affected. Lowers utility for b but raises it for N.

(Fire sale is the only way to comply with the regulation)

Dynamic Provisioning

Marginal cash requirement

$$\kappa\left(\left\{g\% = \left(\frac{B_{2g}^{P} + B_{2g}^{F}}{M^{P} + B_{1}^{P}} - 1\right)\%\right\} - \left\{x\% = 20\right\}\right)$$

- k chosen so that incremental loans require 25 cents to be set aside
- Raises the cost of the mortgage loans in the boom
- Reduces the value of land in the boom, so raises the value of the endowments for P & F ➔ They borrow more
- b also offers more credit in period 1
- F & P are better off, R, b and N worse off

Combo Regulation

- Marginal dynamic provisioning, marginal haircut increase and 1% increase in capital requirements
- Switch from mortgage credit to more bridge lending by the bank in period 1
- Fewer fire sales and higher deposit repayment in period 2
- R gains due to small deposit losses
- P gains to smaller defaults and more housing consumption in the boom
- (β better off and N worse off)