Collateral Constraints, Banking Competition and Optimal Monetary Policy

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Motivation

- An increasing literature has emphasized the role of credit frictions for **business cycle fluctuations** and the **optimal conduct of monetary policy**:
  - Iacoviello (2005), Mendicino and Pescatori (2005), Monacelli (2007): focus on borrowing constraints (à la Kiyotaki-Moore) and asset prices fluctuations, but without financial intermediation (i.e. no lending spreads).
  - Curdia and Woodford (CW; 2008): focus on frictions in financial intermediation consistent with positive lending spreads, but without borrowing constraints.
- In actual economies, **asset prices**, **borrowers' credit capacity** and **lending spreads** all react to exogenous perturbations, specially at times of financial distress.
- Hence, it is natural to put all of them under the same umbrella.

This paper

- **The question:** How is optimal monetary policy affected by the coexistence of borrowing constraints and endogenous lending spreads?
- **What we do:** A model with endogenous borrowing limits and imperfect banking competition in the loans market based on Andrés and Arce (2008):
- *Credit supply*: Competition à la Salop (1979), "circular city" model, with some key features:
    - Each borrower may borrow from one bank with fully flexible rates, no switching costs.
- *Credit demand*: A *model* featuring *consumer heterogeneity* (patient-saver and impatient-borrower) and *collateral constraints* (with collateralizable housing), as in Iacoviello (2005).

This paper (cont'd)

What we get:

- The presence of collateral constraints creates a short-run trade-off between (1) inflation, (2) output gap, (3) risk sharing and (4) efficient distribution of housing stock.

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  - stabilization goals become more volatile
  - welfare losses increase
- **Mechanism**: as loan spreads fall, housing wealth of credit-constrained agents increases $\Rightarrow$ same fluctuations in house prices have stronger effects on their net worth and hence on their consumption.

Model structure

5 types of agents,

1. **Households** (savers): supply labor, hold residential housing and bank deposits
2. **Entrepreneurs** (borrowers): use labor and commercial housing to produce intermediate good, perfect competition
3. **Banks**: lend to entrepreneurs under monopolistic competition
4. **Retailers**: buy intermediate good, transform it one-for-one into final good varieties, monopolistic competitors, set prices à la Calvo
5. **Central bank**: sets nominal deposit rates (perfect competition in market for bank deposits)

Households

Mass $\omega < 1$ of identical households. Each household maximizes

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\log c_t - \frac{\left(l_t^s\right)^{1+\varphi}}{1+\varphi} + \vartheta_t \log h_t \right)$$

subject to (ignoring lump-sum transfers)

$$w_t l_t^s + \frac{R_{t-1}^d d_{t-1}}{\pi_t} = c_t + p_t^h \left[\left(1+\tau^h\right) h_t - h_{t-1} \right] + d_t,$$

c_t: consumption, l_t^s: labor hours, h_t: residential housing, p_t^h: real housing price, d_t: real deposits, R_t^d: nominal deposit rate, π_t: gross inflation rate, τ^h: tax rate on housing purchases, $\log \vartheta_t \sim AR(1)$. FOCs,

$$w_t = c_t \left(l_t^s\right)^{\varphi},$$

$$\frac{1}{c_t} = \beta R_t^d E_t \left\{ \frac{1}{c_{t+1}\pi_{t+1}} \right\},$$

$$\frac{\left(1+\tau^h\right) p_t^h}{c_t} = \frac{\vartheta_t}{h_t} + \beta E_t \frac{p_{t+1}^h}{c_{t+1}}.$$

Entrepreneurs

Mass $1-\omega$ of identical entrepreneurs. Each entrepreneur maximizes

$$E_0 \sum_{t=0}^{\infty} (\beta^e)^t \left(\log c_t^e - \alpha d_t^i\right),$$

$\beta^e < \beta$, subject to

$$b_t + (1-\tau^e)\left(p_t^l y_t - w_t l_t^d\right) = c_t^e + p_t^h (h_t^e - h_{t-1}^e) + \frac{R_{t-1}^e b_{t-1}}{\pi_t},$$

$$y_t = a_t \left(l_t^d\right)^{1-\nu} (h_{t-1}^e)^{\nu},$$

$$b_t \leq m E_t \frac{\pi_{t+1}}{R_t^e} p_{t+1}^h h_t^e, \tag{1}$$

d_t^i: distance to bank i, α: utility cost per unit distance, c_t^e: consumption, b_t: real debt, l_t^d: labor demand, R_{t-1}^e: nominal loan rate, h_t^e: commercial housing, y_t: output, p_t^l: real price of intermediate good, τ^e: tax rate on entrepreneur profits, $\log a_t \sim AR(1)$, m: loan-to-value ratio.

Entrepreneurs(2)

FOCs,

$$w_t = p_t^l (1-\nu) \frac{y_t}{l_t^d},$$

$$\frac{1}{c_t^e} = \beta^e R_t^e E_t \left\{ \frac{1}{c_{t+1}^e \pi_{t+1}} \right\} + \xi_t,$$

$$\frac{p_t^h}{c_t^e} = E_t \frac{\beta^e}{c_{t+1}^e} \left\{ (1-\tau^e) p_{t+1}^l \nu \frac{y_{t+1}}{h_t^e} + p_{t+1}^h \right\} + \xi_t m E_t \frac{\pi_{t+1}}{R_t^e} p_{t+1}^h,$$

ξ_t: Lagrange multiplier on borrowing constraint, which holds in a neighborhood of SS $\Rightarrow$ entrepreneur consumes a constant fraction of her net worth,

$$c_t^e = (1-\beta^e) \left\{ (1-\tau^e) p_t^l \nu y_t + p_t^h h_{t-1}^e - \frac{R_{t-1}^e b_{t-1}}{\pi_t} \right\}.$$

Banks

Bank $i \in \{1, 2, .., n\}$ chooses $\{R_t^e(i)\}_{t=0}^{\infty}$ to maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t \Omega_t^i, \quad \text{s.t.:}$$

$$\Omega_t^i + B_t^{i,e} + R_{t-1}^d D_{t-1}^i / \pi_t = R_t^{i,e} B_{t-1}^{i,e} / \pi_t + D_t^i$$

$$D_t^i = B_t^{i,e}$$

Ω_t^i : profits; $B_t^{i,e}$: loans; D_t^i : deposits; $R_t^{i,e}$: lending rate; R_t^d : deposit rate (competitive price)

Banks (cont'd)

In a symmetric equilibrium ($R_t^{i,e} = R_t^e$, for all i),

$$R_t^e - R_t^d = \frac{1 - mE_t\left(\frac{\pi_{t+1}}{R_t^d}\frac{p_{t+1}^h}{p_t^h}\right)}{\eta m E_t\left(\frac{\pi_{t+1}}{R_t^d}\frac{p_{t+1}^h}{p_t^h}\right) - 1} R_t^d,$$

$$\eta \equiv 1 + \frac{n}{\alpha}\frac{\beta^e}{1-\beta^e}.$$

- Spreads increase with deposit rates (R_t^d) and decrease with leverage ratio ($mE_t\left[\pi_{t+1}p_{t+1}^h / p_t^h\right] = R_t^e b_t / p_t^h h_t^e$).
- In addition, spreads decrease with the number of banks (n) and increase with the utility cost (α).

Retailers

Buy intermediate good at real price p_t^I, transform it one-for-one into differentiated final goods $\Rightarrow p_t^I =$ retailers' *real marginal cost*. Demand curve of each retailer $j \in [0, 1]$,

$$y_t^f(j) = (P_t(j) / P_t)^{-\varepsilon} \, y_t^f,$$

ε: elasticity of subst. across varieties, y_t^f: aggregate demand of final goods. Set prices à la Calvo (1983). Optimal price decision $\tilde{P}_t$,

$$E_t \sum_{T=t}^{\infty} (\beta\theta)^{T-t} \frac{c_t}{c_T} \left\{ (1+\tau) \frac{\tilde{P}_t}{P_T} - \frac{\varepsilon}{\varepsilon - 1} p_T^I \right\} P_T^{\varepsilon} y_T^f = 0,$$

θ: Calvo parameter, τ: subsidy rate for retailers. Law of motion of price level,

$$P_t = \left[\theta P_{t-1}^{1-\varepsilon} + (1-\theta) \tilde{P}_t^{1-\varepsilon} \right]^{1/(1-\varepsilon)}.$$

Closing the model

All variables in per capita terms. Equilibrium in intermediate good market,

$$(1-\omega)\, y_t = \Delta_t y_T^f,$$

$\Delta_t \equiv \int_0^1 \left(P_t(j)/P_t\right)^{-\varepsilon} dj$: price dispersion in final goods,

$$\Delta_t = (1-\theta)\left(\tilde{P}_t/P_t\right)^{-\varepsilon} + \theta \pi_t^{\varepsilon} \Delta_{t-1}.$$

Equilibrium in final goods markets,

$$y_t^f = \omega c_t + (1-\omega)\, c_t^e.$$

Equilibrium in labor market,

$$\omega l_t^s = (1-\omega)\, l_t^d.$$

Equilibrium in housing market,

$$\bar{h} = \omega h_t + (1-\omega)\, h_t^e. \tag{2}$$

Efficient equilibrium

Normative benchmark. Assume social planner assigns discount factor β to entrepreneurs (otherwise, problem is *not* time-invariant!). Maximize aggregate welfare,

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \omega \left[\log(c_t) - \frac{(l_t^s)^{1+\varphi}}{1+\varphi} + \vartheta_t \log(h_t) \right] + (1-\omega) \log(c_t^e) \right\},$$

subject to

$$(1-\omega)\, y_t = \omega c_t + (1-\omega)\, c_t^e,$$

$$y_t = a_t \left(\frac{\omega}{1-\omega} l_t^s \right)^{1-\nu} \left(h_{t-1}^e \right)^{\nu}.$$

$$\bar{h} = \omega h_t + (1-\omega)\, h_t^e.$$

Efficient equilibrium (2)

FOCs and constraints imply

$$c_t = c_t^e,$$

$$l_t^s = \left(\frac{1-\nu}{\omega}\right)^{1/(1+\varphi)} \equiv l^{s,*} \Rightarrow y_t^* = a_t \left(h_{t-1}^e\right)^{\nu} \left(l^{s,*}\right)^{1-\nu}, \tag{3}$$

$$\frac{h_t^e}{h_t} = \frac{\beta\nu}{(1-\omega)\,\vartheta_t} \Rightarrow \omega h_t = \frac{\omega\vartheta_t}{\omega\vartheta_t + \beta\nu}\bar{h}. \tag{4}$$

Efficient equilibrium implies

1. perfect risk sharing
2. constant labor hours
3. distribution of housing driven only by preferences (ϑ_t).

Optimal monetary policy

Linear-quadratic approach (Rotemberg & Woodford, 1997, Benigno & Woodford, 2008):

- Quadratic approximation of welfare criterion
- Linear approximation of equilibrium conditions

Clarifies stabilization goals and trade-offs among goals

Quadratic loss function

Assuming an efficient steady-state (implemented by τ, τ^e, τ^h),

$$\sum_{t=0}^{\infty} \beta^t \left\{ \omega \left[\log c_t + \vartheta_t \log h_t - \frac{\left(l_t^s\right)^{1+\varphi}}{1+\varphi} \right] + (1-\omega) \log c_t^e \right\} = -\sum_{t=0}^{\infty} \beta^t L_t$$

$$+t.i.p. + O^3,$$

where

$$L_t = \lambda_\pi \hat{\pi}_t^2 + \lambda_y \left(\hat{y}_t - \hat{y}_t^{*|h} \right)^2 + \lambda_c \left(\hat{c}_t - \hat{c}_t^e \right)^2 + \lambda_h \left(\hat{h}_t - \hat{h}_t^* \right)^2,$$

$$\lambda_\pi \equiv \frac{\varepsilon\theta}{(1-\theta)(1-\beta\theta)}, \lambda_y \equiv \frac{1+\varphi}{1-\nu}, \lambda_c \equiv \omega(1-\omega), \lambda_h \equiv \omega\vartheta \frac{\omega\vartheta + \beta\nu}{\beta\nu}$$

$$\hat{y}_t^{*|h} \equiv \hat{a}_t + \nu \hat{h}_{t-1}^e$$

$$\hat{h}_t^* \equiv \frac{\beta\nu}{\omega\vartheta + \beta\nu} \hat{\vartheta}_t^h$$

Quadratic loss function (2)

Four stabilization goals for monetary policy:

1. Inflation
2. Output gap
3. *Consumption gap*: inefficient risk-sharing between constrained and unconstrained consumers
4. *Housing gap*: distortion in the distribution of the housing stock (residential vs. commercial)

Policy trade-offs

- Aggregate resource constraint,

$$\hat{y}_t = \omega \hat{c}_t + (1 - \omega)\, \hat{c}_t^e.$$

Collateral constraints $\Rightarrow |\Delta \hat{c}_t^e| > |\Delta \hat{c}_t| \Rightarrow |\Delta \hat{y}_t| > |\Delta \hat{c}_t|$.

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- Labor market equilibrium,

$$\overbrace{\hat{c}_t + \varphi \hat{l}_t^s}^{mrs} = \hat{w}_t = \overbrace{\hat{p}_t^l + \hat{y}_t - \hat{l}_t^s}^{mrpl}.$$

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- Production function,

$$(1-\nu)\,\hat{l}^s_t = \hat{y}_t - \hat{a}_t - \nu \hat{h}^e_{t-1} = \hat{y}_t - \hat{y}^{*|h}_t.$$

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- New Keynesian Phillips curve,

$$\hat{\pi}_t = \kappa \frac{1+\varphi}{1-\nu}\left(\hat{y}_t - \hat{y}_t^{*|h}\right) + \beta E_t \pi_{t+1} + \kappa\,(1-\omega)\,(\hat{c}_t - \hat{c}_t^e)\,.$$

$\kappa \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta}$. Consumption gap as an endogenous *cost-push* shifter!

Policy trade-offs (2)

- Entrepreneur (constrained) consumption (assume $\tau^e = 0$),

$$\hat{c}_t^e \propto \nu\left(\hat{p}_t^l + \hat{y}_t\right) + s_h^e\left(\hat{p}_t^h + \hat{h}_{t-1}^e\right) - s_h^e m\left(\hat{R}_{t-1}^e + \hat{b}_{t-1} - \hat{\pi}_t\right)$$

$$= \nu\left(\hat{p}_t^l + \hat{y}_t\right) + s_h^e\left[\hat{p}_t^h - mE_{t-1}\hat{p}_t^h + (1-m)\,\hat{h}_{t-1}^e + m\left(\hat{\pi}_t - E_{t-1}\hat{\pi}_t\right)\right]$$

$s_h^e \equiv p_{ss}^h h_{ss}^e / y_{ss}$. Closing the consumption gap ($\hat{c}_t^e = \hat{c}_t$) involves active demand management (to manipulate profits and housing prices) and inflation surprises ($\hat{\pi}_t \neq E_{t-1}\hat{\pi}_t$).

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- Therefore,
  - Strict *inflation targeting* ($\hat{\pi}_t = 0$) $\Rightarrow$ deviations from efficient risk-sharing ($\hat{c}_t^e \neq \hat{c}_t$) and efficient output ($\hat{y}_t \neq \hat{y}_t^{*|h}$)

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  - Optimal monetary policy: surprise movements in inflation and output gap can reduce consumption gap, thus improving output-inflation trade-off in subsequent periods

Calibration

	Value	Target	Description
β	0.993	$R^d_{ss}/\pi_{ss} = 1.03$	household discount factor
β^e	0.95	standard	entrepreneur discount factor
ν	0.05	$p^h_{ss}h^e_{ss}/(4y_{ss}) = 0.62$	elasticity of output wrt housing
n, α	10, 6.32	$4(R^e_{ss} - R^d_{ss}) = 2.5\%$	number of banks, distance cost
ω	0.979	$\tau^e = 0$	household share of population
m	0.85	standard	loan-to-value ratio
ϑ	0.11	$p^h_{ss}h_{ss}/(4y_{ss}) = 1.40$	relative weight on housing utility
φ	2	$1/\varphi = 0.5$	(inverse of) labor supply elasticity
ε	6	$(1+\tau)/p^l_{ss} = 1.20$	intratemporal elasticity of subst.
θ	0.67	$1/(1-\theta) = 3$ qrts.	Calvo parameter
ρ_a	0.95	standard	autocorrelation productivity shock
τ^h	0.012	efficient SS	tax rate on residential house purchases

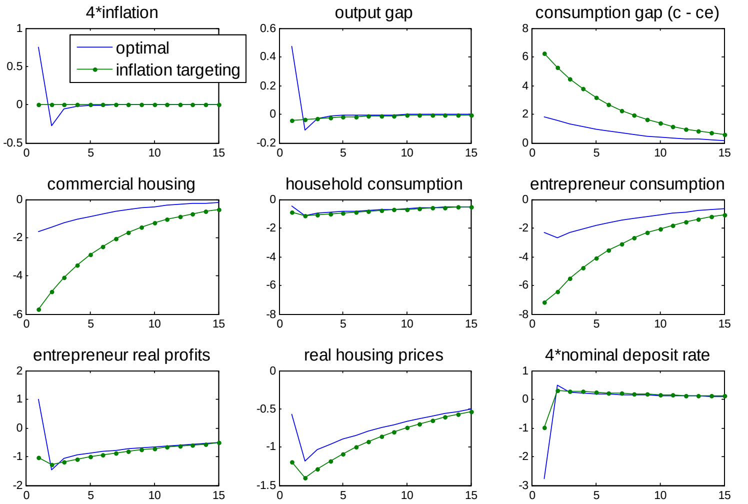
Normalized weights: $(\lambda_\pi, \lambda_y, \lambda_c, \lambda_h) = (0.909, 0.091, 0.009, 0.001)$.

Impulse-response analysis

Compare the economy's response to shocks under

- **Strict inflation targeting**: $\hat{\pi}_t = 0$
- **Optimal monetary policy**: minimize $\sum_{t=0}^{\infty} \beta^t L_t$ subject to log-linear constraints

1% negative productivity shock



Negative productivity shock

- **Inflation targeting**: fall in productivity $\Rightarrow$ drop in housing prices $\Longrightarrow$ fall in entrepreneurs' net worth and consumption $\Longrightarrow$ positive consumption gap $\Longrightarrow$ output gap must fall to guarantee $\hat{\pi}_t = 0$.
- **Optimal policy**: raise output gap (reduce drop in aggregate demand) on impact $\Rightarrow$ increase entrepreneur profits and reduce drop in housing prices $\Longrightarrow$ smaller consumption gap allows for smoother $\{\hat{\pi}_t, \hat{y}_t - \hat{y}_t^*\}$ path from $t = 2$.

Volatility of stabilization goals and welfare loss

Standard deviation of goals and welfare loss*

Policy rule	$4\hat{\pi}_t$	$\hat{y}_t - \hat{y}_t^*$	$\hat{c}_t - \hat{c}_t^e$	$\hat{h}_t - \hat{h}_t^*$	Welfare loss**
inflation targeting	0	0.08	11.67	4.73	0.11
output gap targeting	0.85	0	9.79	3.97	0.09
optimal policy	0.81	0.49	3.49	1.41	0.03

* Conditional on productivity shocks (1%)

** As a % of steady-state consumption

The effects of banking competition

- We want to isolate the effects of banking competition on monetary policy trade-offs.
- We repeat our exercises under the assumption of perfect banking competition ($\alpha = 0$, or $n \rightarrow \infty$).
  $\Rightarrow$ Loan rate R^e_{ss} falls from baseline to $R^d_{ss} = 1/\beta$.

The effects of banking competition (2)

- SS collateral constraint,

$$b_{ss} = \frac{m}{R^e_{ss}} p^h_{ss} h^e_{ss}.$$

The fall in R^e_{ss} relaxes the entrepreneur's collateral constraint, for given housing wealth...

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- SS housing demand condition of entrepreneurs (rescaled by y_{ss} / h^e_{ss}),

$$\frac{p^h_{ss} h^e_{ss}}{y_{ss}} = \beta^e \overbrace{(1 - \tau^e)\,\nu}^{\text{flow profits}} + \beta^e \frac{p^h_{ss} h^e_{ss}}{y_{ss}} + \overbrace{m \left(\frac{1}{R^e_{ss}} - \beta^e \right) \frac{p^h_{ss} h^e_{ss}}{y_{ss}}}^{\text{marginal collateral value of housing}}.$$

... as a result, the marginal value of commercial housing increases

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- Entrepreneur consumption under inflation targeting,

$$\hat{c}^e_t \propto (1-\tau^e)\,\nu\left(\hat{p}^l_t + \hat{y}_t\right) + \frac{p^h_{ss} h^e_{ss}}{y_{ss}}\left[\hat{p}^h_t - mE_{t-1}\hat{p}^h_t + (1-m)\,\hat{h}^e_{t-1}\right].$$

The increase in $p^h_{ss} h^e_{ss} / y_{ss}$ (from 65% to 85% under our calibration) strengthens the effects of house price fluctuations

Banking competition and volatility of goals

Inflation targeting

Banking regime	$4\sigma(\hat{\pi}_t)$	$\sigma(\hat{y}_t - \hat{y}_t^*)$	$\sigma(\hat{c}_t - \hat{c}_t^e)$	$\sigma(\hat{h}_t - \hat{h}_t^*)$
baseline calibration	0	0.08	11.67	4.73
perfect competition	0	0.27	40.94	12.53

Output gap targeting

Banking regime	$4\sigma(\hat{\pi}_t)$	$\sigma(\hat{y}_t - \hat{y}_t^*)$	$\sigma(\hat{c}_t - \hat{c}_t^e)$	$\sigma(\hat{h}_t - \hat{h}_t^*)$
baseline calibration	0.85	0	9.79	3.97
perfect competition	5.36	0	21.94	6.60

Optimal policy

Banking regime	$4\sigma(\hat{\pi}_t)$	$\sigma(\hat{y}_t - \hat{y}_t^*)$	$\sigma(\hat{c}_t - \hat{c}_t^e)$	$\sigma(\hat{h}_t - \hat{h}_t^*)$
baseline calibration	0.81	0.49	3.49	1.41
perfect competition	1.12	0.69	3.00	0.64

Banking competition and welfare loss

Welfare loss*

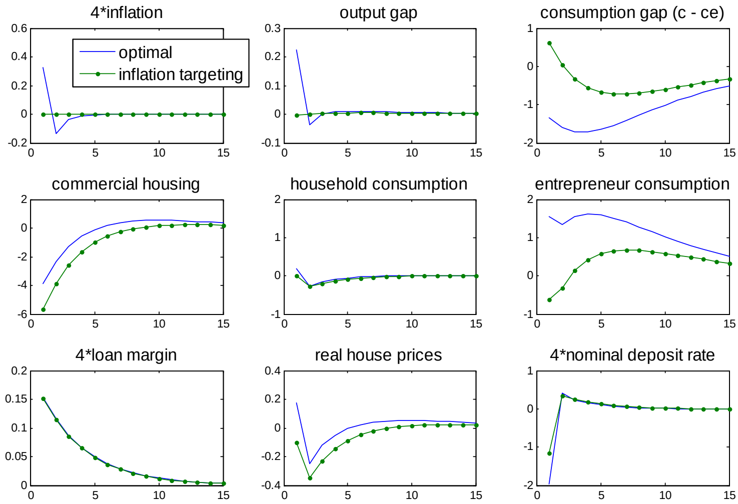
Policy rule	baseline	perf. comp.
inflation targeting	0.11	0.92
output gap targeting	0.09	0.89
optimal policy	0.03	0.05

* As a % of steady-state consumption

Loan-to-Value (LTV) ratio shocks

- May be related to recent developments in credit markets
- Assume stochastic LTV ratio: m_t, $\log m_t \sim AR(1)$.
- Loss function unaffected
- Trade-offs: a fall in the LTV ratio
  - increases loan spread (by reducing loan demand elasticity)
  - less borrowing for same collateral $\Rightarrow$ ambiguous effect on entrepreneur consumption (lower debt burden, but lower housing wealth)

1% negative Loan-to-Value ratio shock



Banking competition and LTV ratio shocks

Inflation targeting

Banking regime	$4\sigma(\hat{\pi}_t)$	$\sigma(\hat{y}_t - \hat{y}_t^*)$	$\sigma(\hat{c}_t - \hat{c}_t^e)$	$\sigma(\hat{h}_t - \hat{h}_t^*)$	w-loss
baseline	0	0.01	2.19	3.37	0.042
perfect comp.	0	0.02	2.39	3.65	0.049

Output gap targeting

Banking regime	$4\sigma(\hat{\pi}_t)$	$\sigma(\hat{y}_t - \hat{y}_t^*)$	$\sigma(\hat{c}_t - \hat{c}_t^e)$	$\sigma(\hat{h}_t - \hat{h}_t^*)$	w-loss
baseline	0.31	0	2.08	3.45	0.046
perfect comp.	0.52	0	1.93	3.80	0.059

Optimal policy

Banking regime	$4\sigma(\hat{\pi}_t)$	$\sigma(\hat{y}_t - \hat{y}_t^*)$	$\sigma(\hat{c}_t - \hat{c}_t^e)$	$\sigma(\hat{h}_t - \hat{h}_t^*)$	w-loss
baseline	0.36	0.23	4.94	2.21	0.027
perfect comp.	0.11	0.08	5.66	3.11	0.042

Conclusions

- Collateral constraints introduce a case against strict inflation targeting in the New Keynesian model
- Optimal monetary policy involves a trade-off between inflation stabilization, output-gap stabilization and risk sharing.
- The severity of these trade-offs increases as the banking sector becomes more competitive (i.e. as endogenous lending spreads fall), especially for suboptimal policy rules.