# Promise and Challenges in Modeling Crisis Risk & Macroprudential Policy

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# The promise

- Macroprudential policy (MPP) aims to weaken credit booms in order to reduce frequency & severity of crises
- Rationale: Credit booms are infrequent, but end in deep, protracted crises. In Mendoza & Terrones (2012):
  1. Credit booms occur with 2.8% frequency
  2. 1/3$^{rd}$ end in banking or currency crises.
  3. After 3 years, GDP is still 5%-8% below trend
- Fisherian models provide useful quantitative framework
  1. Strong financial amplification captures nonlinearities & explains key features of credit booms/crises
  2. Externalities (market-failure) justify policy intervention
  3. Toolbox for MPP evaluation (optimal rules are very effective)

# Three challenges

1. *<u>Complexity</u>:* Optimal MPP follows complex rules. Simple rules are much less effective and can be welfare-reducing

2. *<u>Credibility</u>*: Optimal MPP is time-inconsistent under commitment, hence lacks credibility (1. and 2. illustrated with LTV example)

3. *<u>Coordination failure</u>*: Interaction with monetary policy can result in costly Tinbergen's rule violations and strategic interaction (illustrated with BGG model with risk shocks)

# Fisherian models

- Wide class of models in which market prices affect borrowing capacity (e.g. collateral, scoring, etc.)
- Occasionally binding credit constraints:

$$\frac{b_{t+1}}{R_t} \geq -\kappa_t f(p_t)$$

1. Debt-to-income (DTI) models: $f(p_t^N) = y_t^T + p_t^N y_t^N$
2. Loan-to-value (LTV) models : $f(q_t) = q_t k_{t+1}$

- Market price of collateral determined by aggregate allocations: $f\left(p_t^N(C_t^T, C_t^N)\right)$, $f(q_t(C_t, C_{t+1}))$
- Pecuniary externality: Agents choose debt in "good times" ignoring price responses in "crisis times"

# Where is the externality?

- Decentralized Euler eq. for debt choice:

$$u'(t) = \beta R_t E\left[u'(t+1)\right] + \mu_t$$

  – In normal times $\mu_t$=0 => standard Euler equation

- But for a planner choosing debt internalizing the externality, the Euler eq. is:

$$u'(t) = \beta R_t E\left[u'(t+1) + \mu^*_{t+1}\kappa_{t+1} f'(t+1)\frac{\partial p_{t+1}}{\partial \tilde{C}_{t+1}}\frac{\partial \tilde{C}_{t+1}}{\partial b_{t+1}}\right]$$

- **If** social MC of debt exceeds private MC, private agents "overborrow" in good times

# Proving the social MC of debt *is* higher

- Higher social MC of debt requires:

$$f'(t+1)(\partial p_{t+1}/\partial \tilde{c}_{t+1})(\partial \tilde{c}_{t+1}/\partial b_{t+1}) > 0$$

- These are trivially positive: borrowing capacity rises with collateral values and consumption rises with wealth

- But the sign of this is a key endogenous equilibrium outcome, which can be proven to be positive:

*DTI setup:*

$$\frac{\partial p^N_{t+1}}{\partial C^T_{t+1}} = \frac{-p^N_{t+1} u_{c^T c^T}(t+1)}{u_{c^T}(t+1)} > 0$$

*LTV setup:*

$$\frac{\partial q_{t+1}}{\partial C_{t+1}} = \frac{-q_{t+1} u_{cc}(t+1)}{u_c(t+1)} > 0$$

- A large externality is implied if the model is able to generate large price drops during crises!

# Optimal MPP

- An optimal "macroprudential debt tax" implements the planner's allocations:

$$\tau_t = \frac{E_t\left[\mu^*_{t+1}\kappa_{t+1} f'(t+1)\frac{\partial p_{t+1}}{\partial \tilde{C}_{t+1}}\frac{\partial \tilde{C}_{t+1}}{\partial b_{t+1}}\right]}{E_t\left[u'(t+1)\right]}$$

  - $\tau_t > 0$ only if the constraint is expected to bind with some probability at t+1.

- Equivalent instruments: capital requirements, regulatory LTV or DTI ratios.

# Optimal MPP: LTV example
## (complexity & time inconsistency )

- Bianchi & Mendoza (JPE 2017):
  1. RBC-SOE model with Fisherian constraint
  2. Production w. intermediate goods that require working capital (credit-induced output drop)
  3. Rep. firm-household uses assets in fixed supply as collateral for debt and working capital
  4. Planner internalizes asset pricing condition (asset Euler eq. becomes implementability constraint)
  5. Shocks: TFP $(z_t)$, world interest rate $(R_t)$, and regime-switching LTV or global liquidity $(\kappa_t)$.
  6. Calibrated to U.S. and OECD data

# Rep. firm-household problem

$$\max E_0 \left[ \beta^t \frac{\left( c_t - \chi \frac{h^{1+\omega}}{1+\omega} \right)^{1-\sigma}}{1-\sigma} \right]$$

s.t.

$$q_t k_{t+1} + c_t + \frac{b_{t+1}}{R_t} = q_t k_t + b_t + \left[ z_t k_t^{\alpha k} m_t^{\alpha m} h_t^{\alpha h} - p^m m_t \right].$$

$$\frac{b_{t+1}}{R_t} - \theta p^m m_t \geq -\kappa_t q_t k_t,$$

# Time-consistent social planner

$$V(b,\varepsilon) = \max_{c,b',h,m} \left[ \frac{\left(c - \chi \frac{h^{1+\omega}}{1+\omega}\right)^{1-\sigma}}{1-\sigma} + \beta E\left[V(b',\varepsilon')\right] \right]$$

s.t.

$$c + \frac{b'}{R} = b + \left[ z 1^{\alpha k} m^{\alpha m} h^{\alpha h} - p^m m \right]$$

$$\frac{b'}{R} - \theta p^m m \geq -\kappa q$$

$$q u_c \left( c - \chi \frac{h^{1+\omega}}{1+\omega} \right) = \beta E \left[ u_c \left( \hat{c}' - \chi \frac{\hat{h}'^{1+\omega}}{1+\omega} \right) \left( z' F_k(1, \hat{m}', \hat{h}') + \hat{q}' \right) + \kappa' \hat{\mu}' \hat{q}' \right]$$

# Commitment & time inconsistency

- When $\mu_t$ >0, the planner views the effects of the choice of $b_{t+1}$ on $C_{t+1}$, and hence on $q_t$, differently depending on its ability to commit
- *Commitment:* Promise lower $C_{t+1}$ ,to prop up $q_t$, because $q_t(C_t, C_{t+1})$ is decreasing in $C_{t+1}$, but at t+1 this is suboptimal=> time inconsistency
- *Discretion:* The planner of date t considers how its choices affect choices of the planner of t+1 => Markov stationarity eq. is time-consistent

# Optimal, time-consistent policy

1. Macroprudential component (tackles standard pecuniary externality when $\mu_t$=0 and $E_t[\mu_{t+1}] > 0$):

$$\tau_t^{MP} = \frac{E_t\left[-\kappa_{t+1}\mu_{t+1}^* \frac{u_{cc}(t+1)}{u_c(t+1)} Q_{t+1}\right]}{E_t\left[u_c(t+1)\right]}$$

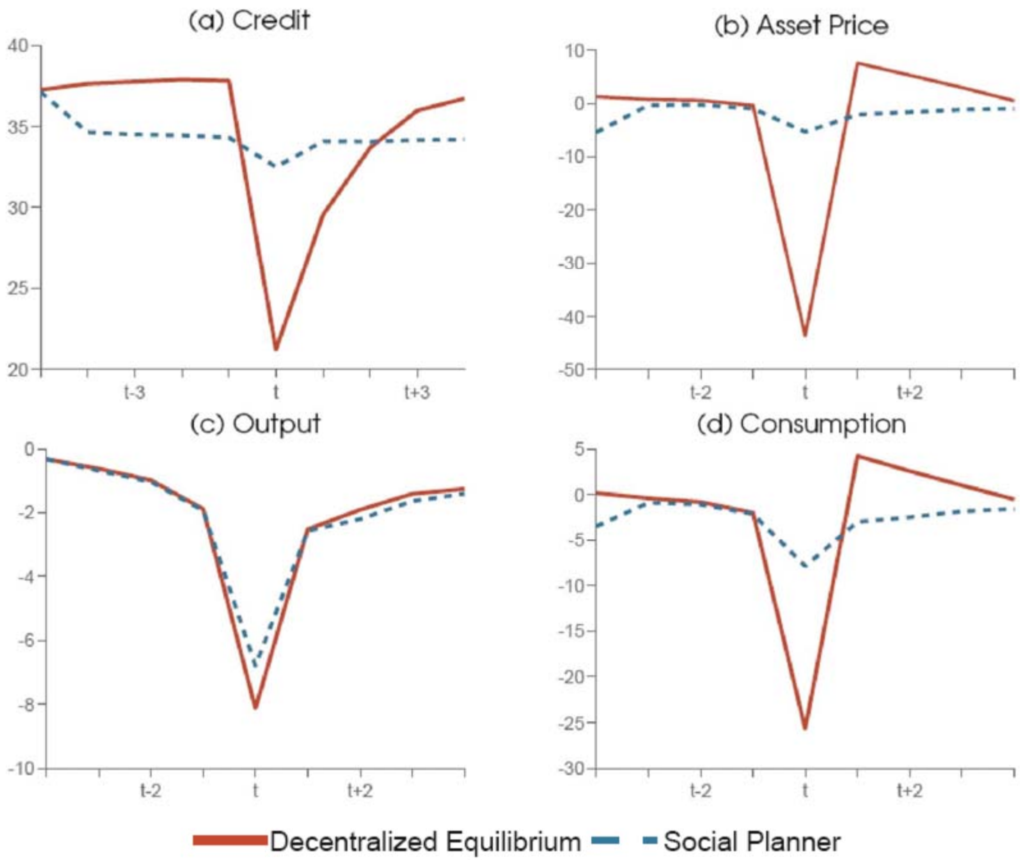
2. Ex-post component (effects on future planners & incentive to prop up value of collateral when $\mu_t > 0$)

$$\tau_t^{FP} = \frac{E_t\left[\frac{\kappa_t\mu_t^*}{u_c(t)}\Omega_{t+1}\right]}{E_t\left[u_c(t+1)\right]} + \frac{\kappa_t\mu_t^* \frac{u_{cc}(t)}{u_c(t)} q_t}{\beta R_t E_t\left[u_c(t+1)\right]}$$

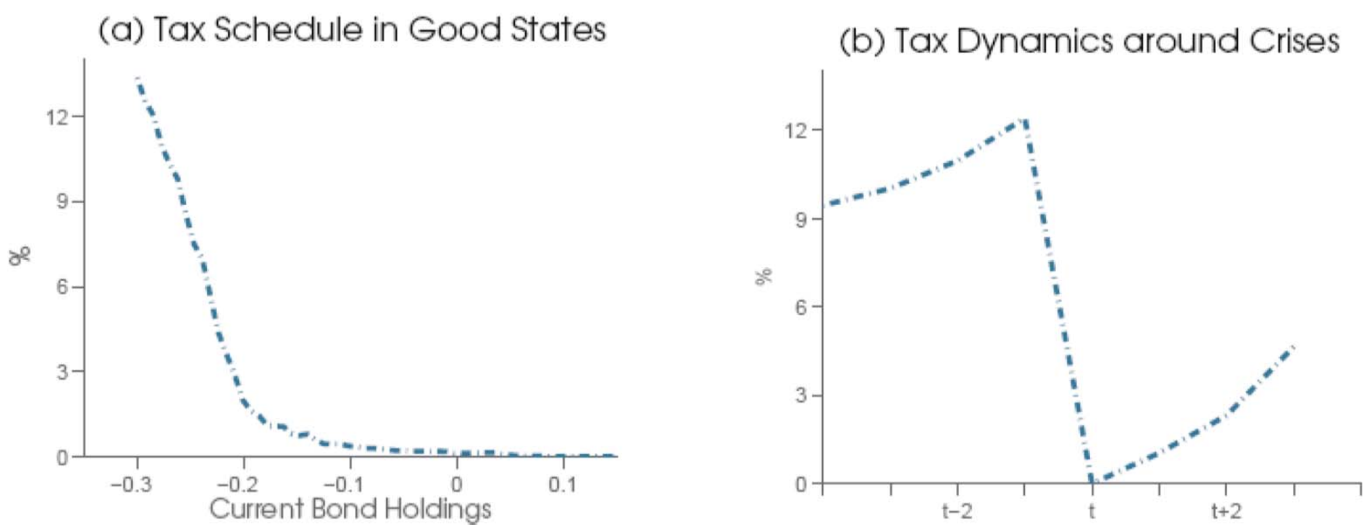
# Calibration to OECD & U.S. data

| Parameters set independently | Value | Source/Target |
|---|---|---|
| Risk aversion | $\sigma = 1.$ | Standard value |
| Share of inputs in gross output | $\alpha_v = 0.45$ | Cross country average OECD |
| Share of labor in gross output | $\alpha_h = 0.352$ | OECD GDP Labor share = 0.64 |
| Labor disutility coefficient | $\chi = 0.352$ | Normalization (mean $h = 1$) |
| Frisch elasticity | $1/\omega = 2$ | Keane and Rogerson (2012) |
| Working capital coefficient | $\theta = 0.16$ | U.S. WK/GDP ratio=0.133 |
| Tight credit regime | $\kappa^L = 0.75$ | U.S. post-crisis LTV ratios |
| Normal credit regime | $\kappa^H = 0.90$ | U.S. pre-crisis LTV ratios |
| Interest rate | $\bar{R} = 1.1\%, \rho_R = 0.68$ $\sigma_R = 1.86\%$ | U.S. 90-day T-Bills |
| **Parameters set by simulation** | **Value** | **Target** |
| TFP shock | $\rho_z = 0.78, \sigma_z = 0.01$ | GDP sd. & autoc. (OECD average) |
| Share of assets in gross output | $\alpha_k = 0.008$ | Value of collateral matches total credit |
| Discount factor | $\beta = 0.95$ | Private *NFA* = −25 percent |
| Transition prob. $\kappa^H$ to $\kappa^L$ | $P_{H,L} = 0.1$ | 4 crises every 100 years (Appendix E2) |
| Transition prob. $\kappa^L$ to $\kappa^L$ | $P_{L,L} = 0.$ | 1 year duration of crises (Appendix E2) |

# Financial crises & policy effectiveness



# Complexity

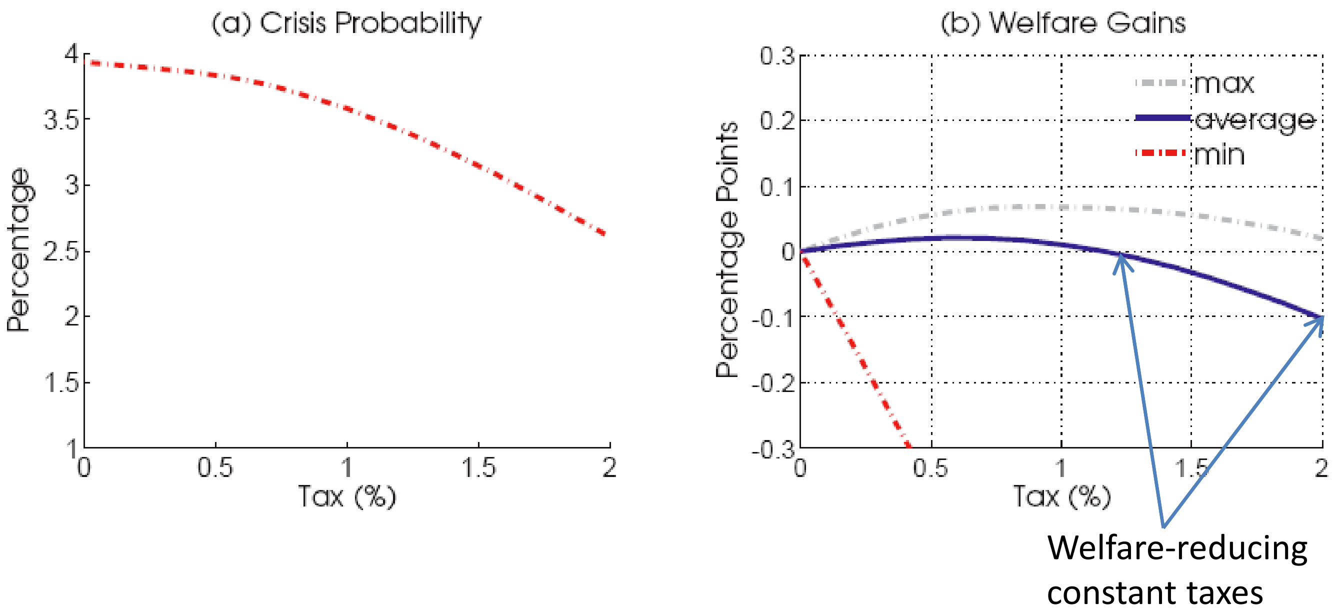

(a) Tax Schedule in Good States
%
12
9
6
3
0
−0.3
−0.2
−0.1
0
0.1
Current Bond Holdings
(b) Tax Dynamics around Crises
%
12
9
6
3
0
t−2
t
t+2

# Optimal (TC) policy & simpler rules

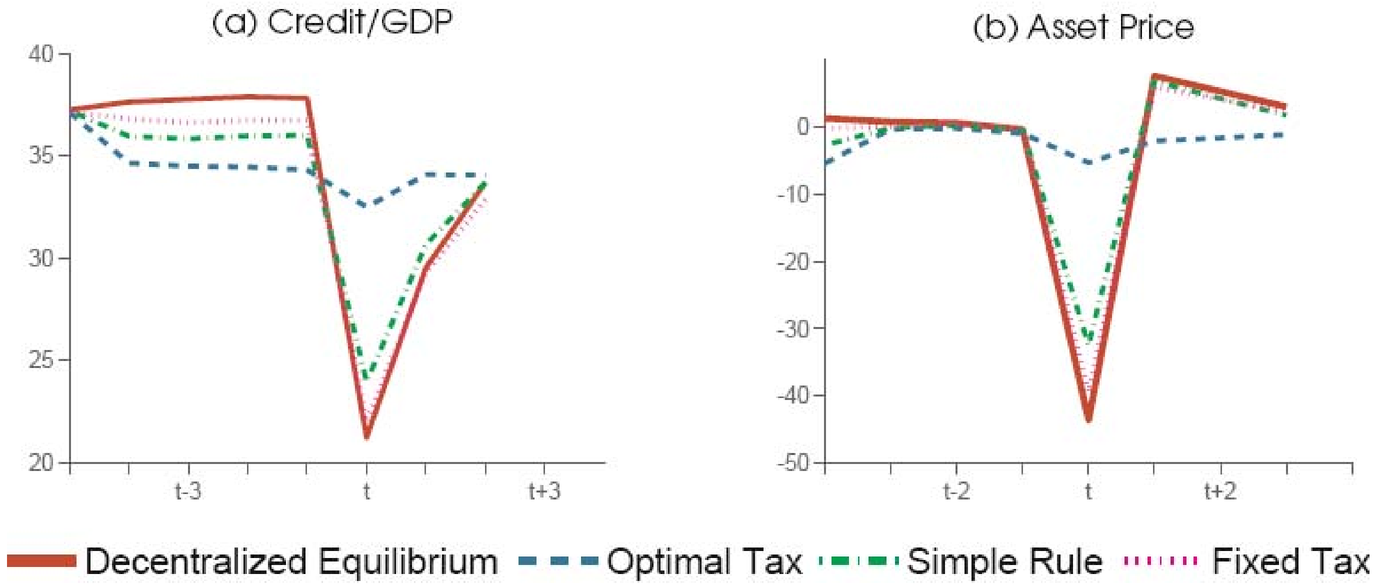
| | Decentralized Equilibrium | Optimal Policy | Best Taylor | Best Fixed |
|---|---|---|---|---|
| Welfare Gains (%) | – | 0.30 | 0.09 | 0.03 |
| Crisis Probability (%) | 4.0 | 0.02 | 2.2 | 3.6 |
| Drop in Asset Prices (%) | −43.7 | −5.4 | −36.3 | −41.3 |
| Equity Premium (%) | 4.8 | 0.77 | 3.9 | 4.3 |
| *Tax Statistics* | | | | |
| Mean | – | 3.6 | 1.0 | 0.6 |
| Std relative to GDP | – | 0.5 | 0.2 | – |
| Correlation with Leverage | – | 0.7 | 0.3 | – |

Financial Taylor Rule: $\tau = \max[0, \tau_0(b_{t+1}/\bar{b})^{\eta_b} - 1]$

# Simple rules: constant taxes



# Effects of simple policies on magnitude of crises

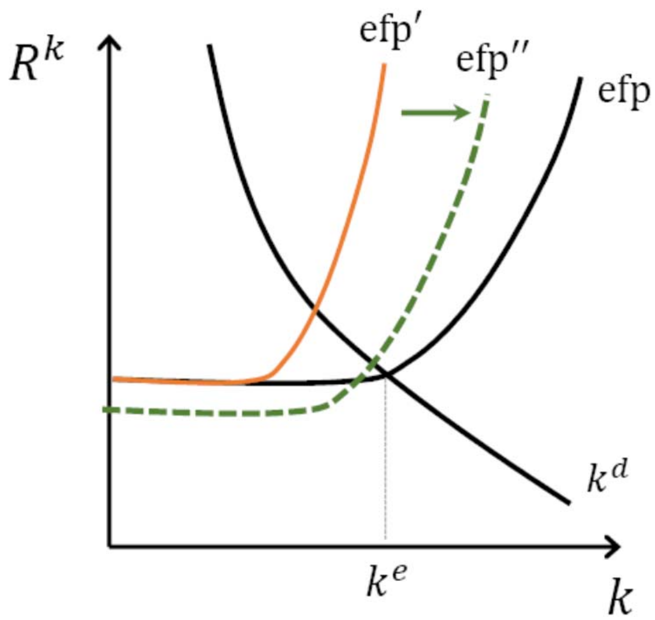


# Policy interactions in NK-BGG model

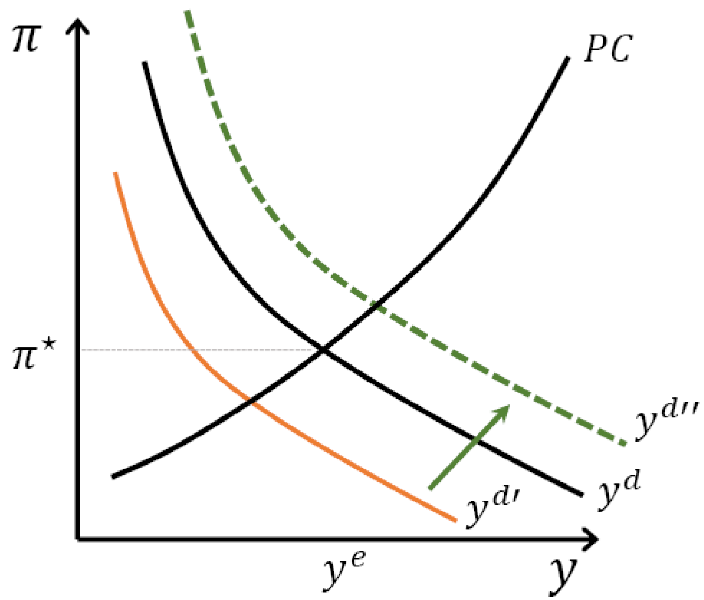
- Carrillo et al. (17) model:
  1. BGG model with risk shocks (Christiano et al. (14))
  2. Calvo pricing=> inefficiencies in goods markets
  3. Costly monitoring=> inefficiencies in credit-capital market
- Risk shocks (fluctuations in variance of entrepreneurs' returns) strengthen financial transmission
- MP instrument is the nominal interest rate, FP instrument is a subsidy to intermediaries (lowers "efp")
- MP (FP) instrument affects target and payoff of FP (MP)
- Two forms of coordination failure: Tinbergen's rule violations and strategic interaction

# Policy interactions in response to risk shocks

Credit-capital market




Aggregate supply & demand



# Policy regimes

- **STR**: Simple Taylor rule, no financial policy rule

$$R_t = R\left(\frac{1+\pi_t}{1+\pi}\right)^{a_\pi}$$

- **ATR**: Augmented Taylor rule ("leaning against the wind"), no financial policy rule

$$R_t = R\left(\frac{1+\pi_t}{1+\pi}\right)^{a_\pi}\left(\mathrm{E}_t\left\{\frac{r^k_{t+1}}{r_t}\right\}\right)^{-\check{a}_{rr}}$$

- **DRR**: Dual rules regime, STR + financial rule:

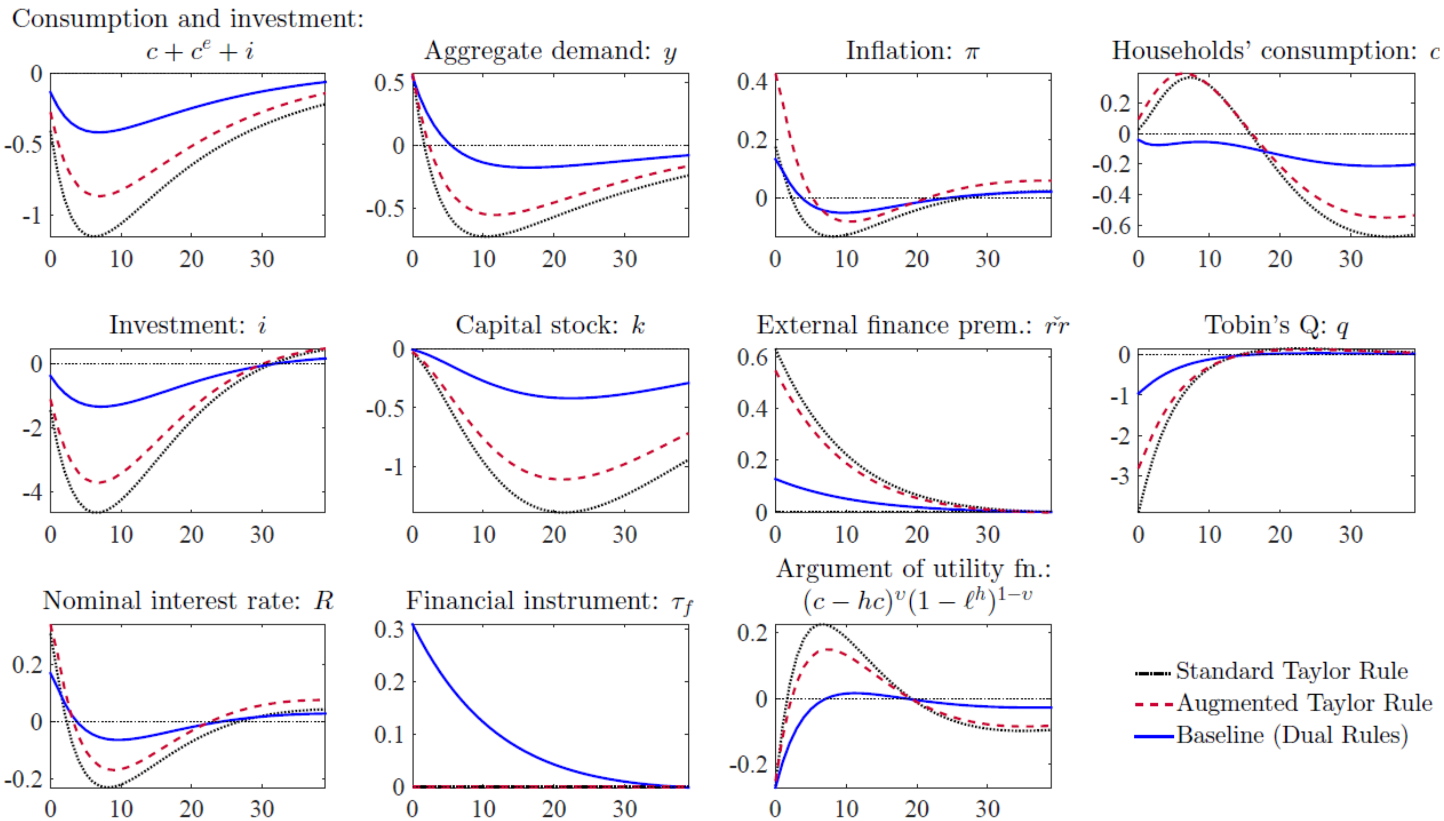
$$R_t = R\left(\frac{1+\pi_t}{1+\pi}\right)^{a_\pi} \qquad \tau_{f,t} = \tau_f\left(\mathrm{E}_t\left\{\frac{r^k_{t+1}}{r_t}\right\}\right)^{a_{rr}}$$

# Relevance of Tinbergen's rule

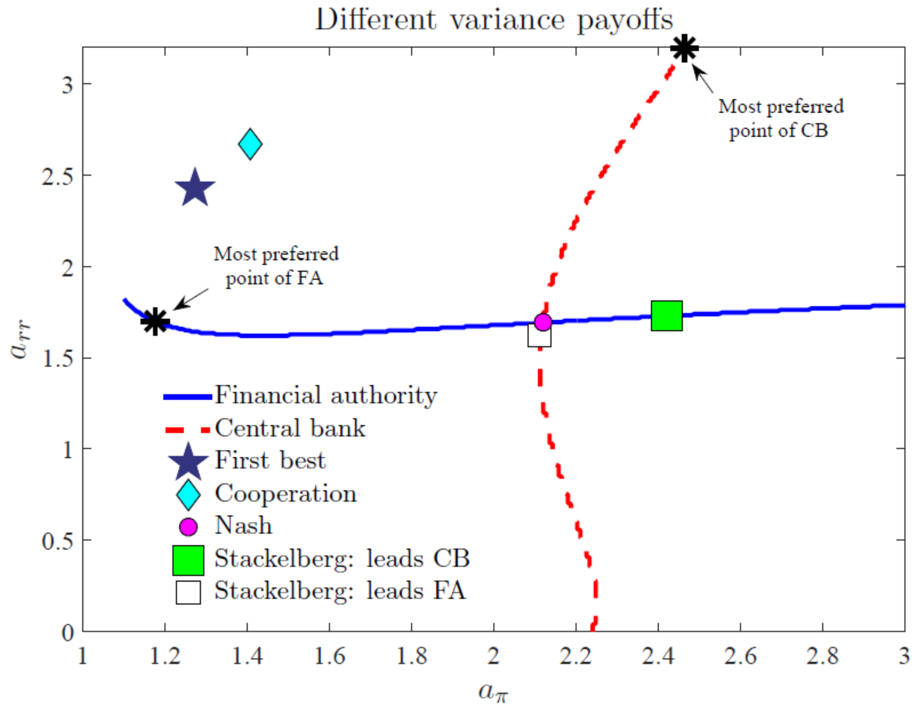
| Regime | $ce$ v. DRR | Param. values of $x$ | | |
|---|---|---|---|---|
| | | $a_{\pi}$ | $a_{rr}$ | $\check{a}_{rr}$ |
| DRR (Best Policy) | – | 1.27 | 2.43 | - |
| Augmented Taylor Rule | -138 bps. | 1.27 | - | 0.36 |
| Standard Taylor rule | -264 bps. | 1.75 | - | - |

- STR & ATR yield large welfare losses
- Policy rules are "too tight" with STR & ATR
- Larger effects from risk shocks under STR & STR

# Effects of risk shocks & policy regimes



# Strategic interaction




- MP and FP have sum-of-variances payoffs
- Strategy space is over policy rule elasticities

# Relevance of strategic interaction

| Regime $x$ v. regime $y$ | $ce$ bps. diff. | Param. values of $x$ $a_{\pi}$ | $a_{rr}$ |
|---|---|---|---|
| Nash v. Best Policy (BP) | 30 | 2.12 | 1.69 |
| Cooperative ($\varphi = 0.5$) v. BP | 4 | 1.41 | 2.67 |
| Cooperative (optimal $\varphi$) v. BP | 1 | 1.33 | 2.10 |
| Simple Taylor rule v. Nash | 234 | 1.75 | - |
| Dual rules regime v. BP | — | 1.27 | 2.43 |

- Cooperation dominates Nash significantly
- Policies again too tight
- …but even Nash is better than STR & ATR

# Conclusions

- *Promise*: Progress in developing quantitative models of fin. crises and MPP, with results showing that it can be a very effective policy
- *Challenges*: Complexity, credibility, coordination. **Careful quantitative evaluation is necessary to avoid outcomes worse than without MPP.**
- *Additional challenges*: fin. innovation, information, heterogeneity, int'l coordination, securitization, interconnectedness