Macro-prudential Policy in a Fisherian Model of Financial Innovation

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Interaction of financial innovation, imperfect information and credit frictions plays a key role in credit cycles.

It is widely agreed that macro-prudential policies have to be part the policy toolbox to address credit cycles.

To-date we don’t have models of macro-prudential policies in which this interaction is the key driver of the financial amplification mechanism.
Key Ingredients of the Fisherian Model

- Ingredient 1: Informational frictions
  - Financial innovation due to new products and new laws
  - Learning about the new financial environment
    - No data on default and performance
    - “Layering of risk” created the belief that instruments were risk free.
Key Ingredients of the Fisherian Model

- Ingredient 2: Credit frictions
  - Collateral constraints limit agents' ability to borrow to a fraction of the value of their assets
  - Pecuniary externality: Agents fail to internalize the effect of their borrowing decisions on asset prices.
Analysis

- Positive: decentralized equilibrium (DE) in which learning and credit frictions are present.
- Normative: planner can undo the externality but maybe not the informational friction
  - SP1: Uninformed as private agents and faces the same set of feasible credit positions as DE with learning (same collateral pricing function)
  - SP2: Fully informed but faces the same set of feasible credit positions as DE with learning
  - SP3: Fully informed and faces the same set of feasible credit positions as DE with full information
Learning Scenario

- Agents face a collateral constraint that limits debt not to exceed a fraction $\kappa$ of the value of their land holdings.
- Financial innovation introduces two regimes: $\kappa^l < \kappa^h$.
- Agents know $\kappa^h$ & $\kappa^l$ but not the regime-switching probabilities. They learn by observing regime realizations, and in the long-run beliefs converge to true probs.
- Overborrowing and overpricing followed by sharp reversals occur because learning leads to optimism and pessimism.
- Learning dynamics interact with Fisherian deflation and produce strong amplification effects.
Main Findings: Decentralized Equilibrium (DE)

- After short spell of $\kappa^h$ agents turn optimistic and believe $\kappa^h$ is “almost absorbent.”
- “Optimistic phase” generates a boom in borrowing and residential land value.
- First $\kappa^l$ starts “pessimistic phase,” triggers credit crunch, land price collapse amplified by Fisherian deflation.

The model at hand is a reasonable laboratory to study policy!
Main Findings: Policy

- Effectiveness of policy depends on SPs information sets and the set of credit positions they can support.
- All SPs choose lower debt than DE during optimistic phase:
  - SP3 reduces the debt buildup to 1/10th of DE
  - SP1 is more effective in reducing overborrowing when priors produce milder optimism and the constraint is less tight.
- Only SP3 can prevent an increase in the price of the asset.
- SP2 chooses lower debt but ends up with similar prices as DE.
- Taxes on debt required to implement SP allocations can be as high as 8-9 percent
  - SP2 and SP3 tax more heavily than SP1.
Model: Private Agents’ Problem

Agents maximize

$$E_0^s \left[ \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma} \right]$$

subject to the budget constraint

$$q_t k_{t+1} + c_t + \frac{b_{t+1}}{R_t} = q_t k_t + b_t + \varepsilon_t Y(k_t)$$

and a collateral constraint

$$-\frac{b_{t+1}}{R_t} \leq \kappa_t q_t k_{t+1}.$$
Learning Problem

- Agents learn by observing realizations of $\kappa$’s.
- They take as given
  - A history of realizations of $\kappa$ observed over $T$ periods,
  - Initial priors for date $t = 0$
- $n_{ij}^t$: the number of transitions from state $\kappa^i$ to $\kappa^j$
- Posterior means satisfy:
  \[ E_t[F_{hh}^s] = \frac{n_{hh}^t}{n_{hh}^t + n_{hl}^t} \]
  \[ E_t[F_{ll}^s] = \frac{n_{ll}^t}{n_{ll}^t + n_{lh}^t} \]
- Two stage solution:
  - Learning dynamics,
  - Recursive Anticipated Utility optimization problems (AUOP).
Constrained Planners’ Problems

Planners maximize

\[
E_i^0 \left[ \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma} \right]
\]

for \( i = SP1, SP2, SP3 \)

subject to

\[
c_t + \frac{b_{t+1}}{R_t} = b_t + \varepsilon_t Y(1)
\]

and

\[-\frac{b_{t+1}}{R_t} \leq \kappa_t q_t^i.\]

▶ SP1: \( E^i = E^s \) and \( q_t^i = q_t^{DEL} \)

▶ SP2: \( E^i = E^a \) and \( q_t^i = q_t^{DEL} \)

▶ SP3: \( E^i = E^a \) and \( q_t^i = q_t^{DEF} \)
Externality, Information and Interaction

Euler Equation:

\[ u'(c_t(b, \varepsilon, \kappa)) - \mu_t(b, \varepsilon, \kappa) = \beta RE_t \left[ u'(c_t(b', \varepsilon', \kappa')) \right] \]
Externality, Information and Interaction

Euler Equation:

\[ u'(c_t(b, \varepsilon, \kappa)) - \mu_t(b, \varepsilon, \kappa) = \]

\[ \beta RE_t^i \left[ u'(c_t'(b', \varepsilon', \kappa')) + \kappa' \mu_t(b', \varepsilon', \kappa') \frac{\partial q_t^i(.)}{\partial b'} \right] \]
Externality, Information and Interaction

Euler Equation:

\[ u'(c_t(b, \varepsilon, \kappa)) - \mu_t(b, \varepsilon, \kappa) = \]

\[ \beta RE_t^i \left[ u'(c_t(b', \varepsilon', \kappa')) + \kappa' \mu_t(b', \varepsilon', \kappa') \frac{\partial q_t^i(.)}{\partial b'} \right] \]
Quantitative Analysis: Financial Innovation Experiment

- **Pre-financial innovation:** Before 1997, regime with constant $\kappa^l$ but stochastic TFP
- **Financial Innovation:** 1997Q1, introduction of regime with two possible values of $\kappa$ and first realization of $\kappa^h$
  - First publicly available securitization of CRA loans.
  - Net credit assets-GDP ratio started to fall in 1997.
- **Financial crisis:** 2007Q1, first realization of $\kappa^l$. Early stages of the subprime mortgage crisis in Fall 2006.
- **Learning period** of $T = 48$ quarters, first 40 with $\kappa^h$ and remaining 8 with $\kappa^l$. 
## Calibration

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Time Series Simulations: Baseline 1

(a) Bonds

(b) Land Price

Student Version of MATLAB
Bond Holdings and Asset Prices at date-40: Baseline 1

(a) Bond Holdings: $b'(b,1,\kappa^h)$

(b) Asset Prices: $q(b,1,\kappa^h)$

(c) Bond Holdings: $b'(b,1,\kappa^l)$

(d) Asset Prices: $q(b,1,\kappa^l)$
Time Series Simulations: Baseline 2

(a) Bonds

(b) Land Price

DE
SP1
SP2
SP3

Student Version of MATLAB
Decentralization of Planners’ Allocations

- SPs use taxes on debt ($\tau_{b,t}^i$) and land dividends ($\tau_{l,t}^i$) to implement constrained efficient allocations

$$u'(t) = \beta R(1 + \tau_{b,t}^i) E_t^s [u'(t + 1)] + \mu_t$$

$$q_t(u'(t) - \mu_t \kappa) = \beta E_t^s [u'(t + 1) (\varepsilon_{t+1} Y_k(k_{t+1})(1 - \tau_{l,t}^i) + q_{t+1})].$$
Decentralization of Planners’ Allocations

\[ \tau^i_{b,t} = \frac{E^i_t[u'(t + 1)]}{E^s_t[u'(t + 1)]} - 1 + \]
\[ \frac{E^i_t[\kappa' \mu(t + 1) \frac{\partial q^i_t(.)}{\partial b'}] - E^s_t[\kappa' \mu(t + 1) \frac{\partial q^i_t(.)}{\partial b'}]}{E^s_t[u'(t + 1)]} \]
\[ + \frac{E^s_t[\kappa' \mu(t + 1) \frac{\partial q^i_t(.)}{\partial b'}]}{E^s_t[u'(t + 1)]} \]

information

interaction

externality
Taxes on Debt: Baseline 1

Information

Interaction

Externality

Total Tax

Student Version of MATLAB
Conclusion

- In a credit boom episode, macro-prudential policies are effective when regulators
  - Have better information than private agents and
  - Can implement feasible sets of credit positions consistent with this information set.

- If regulators operate with the same incomplete information as private agents, the effects of these policies may be more limited depending on the degree of optimism after financial innovation.

- Conversely, poorly informed regulators can make matters worse.