Optimal Macro-Prudential and Monetary Policy

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Motivation

- How should a macro-prudential approach to deal with systemic risk interact with monetary policy?
- How should one design the new institutional arrangements of macro-prudential policy?
- Consensus towards an institutional mandate in which the central bank is responsible for macro-prudential policy?
- But are welfare gains from cooperation large enough to justify a combined institutional regime?
- There is a risk of conducting conflicting policies and jeopardizing the reputation and credibility of the central bank during a banking crisis.
Two Main Issues

- Within a NK model with a banking sector and financial frictions, and only a monetary instrument
  1. How do these frictions affect gains from commitment, and how does this compare with conventional (optimized) simple rules?
  2. Is there a welfare benefit from the simple rule also responding to spreads or leverage or Tobin’s Q?
- Using a macro-prudential instrument as well, a subsidy for net worth financed by a tax on loans
  1. How large are the welfare gains from commitment?
  2. For simple rules, should the monetary rule be assigned to macro-variables, and the macro-prudential rule to financial variables?
Consensus was that leaning against the wind using asset prices can generate more problems than it solves.

More recently, Mishkin (2011) suggests reacting to credit-driven bubbles rather than asset-price bubbles, as the latter are more difficult to identify.

Curdia and Woodford suggest a Taylor rule that reacts to certain corporate bond spreads.

Bean et al (2010), Blanchard et al are unconvinced, because monetary policy that is aggressive enough to change credit conditions and asset prices could well have a perverse effect on output.
The Failures of Financial Regulation

- Insufficient regulation encouraged banks to create off-balance sheet entities, thereby increasing leverage (shadow banking)
- Since the crisis, mark-to-market rules and unchanging capital ratios have forced reduced bank balance sheets and deleveraging
- Neither monetary policymakers nor prudential regulators were responsible for promoting stability of the overall financial system
- Hence the need for macroprudential policy that can handle systemic risk, and will be complementary to monetary policy
Framework for Analysis: NK Model with a Banking Sector

- Model with investment costs, sticky prices and exogenous technology, government spending, price mark-up and preference shocks.
- Without financial frictions the expected return on capital would be equal to its expected cost, the expected real interest rate.
- Instead, we replace this with a banking sector as in Gertler and Kiyotaki (2010) that introduces a wedge between the expected cost of loans and the return on capital.
- There are numerous other ways of introducing frictions – see the survey on macroprudential policy by Galati and Moessner (2011) – for example:
  1. Bean et al (2010) induce the friction as a 'no-shirking' condition based on Gertler and Karadi (2009), which ensures that loans are monitored at a resource cost
  2. Diamond and Rajan (2001) introduce the possibility of runs on banks, which induces them to create more liquidity
The Model without Financial Frictions

- Household sector is standard, with a non-separable utility function in consumption and leisure consistent with a balanced growth path.
- Firm sector is almost standard, with an adjustment cost of capital embedded into the capital accumulation equation, and in addition a cost $cY^W$ of converting wholesale goods $Y^W$ into differentiated retail goods.
- As is usual in these types of model, it is also convenient to have capital built up by firms that specialize in producing capital goods only.
Demand for capital by firms satisfies $E_t[R_{t+1}^{ex}] = E_t[R_{t+1}^k]$, where $R_{t}^{ex}$ is the ex post gross real interest rate, and $R_{t}^k$ is the return on capital given by

$$R_{k,t} = \frac{MPK_t + (1 - \delta)Q_t}{Q_{t-1}}$$

where $Q_t$ is the real price of a unit of new capital.

Price stickiness is introduced via the Rotemberg (1982) device of quadratic price adjustment costs (which adds to the resource constraint), and differentiated goods with a homogeneous but variable elasticity of substitution.
The Model without Financial Frictions

- Replace $E_t[R^\text{ex}_{t+1}] = E_t[R_{k,t+1}]$ with a banking sector that introduces a wedge between these expected returns.
- Given a certain deposit level, a bank can lend frictionlessly to nonfinancial firms against their future profits, so firms are offering to banks a state contingent security.
- The activity of the bank can be summarized in two phases.
  1. Banks raise deposits and equity from the households.
  2. Banks use the deposits to make loans to firms.
Banking sequence of events

1. Banks raise deposits, $d_t$ from households at a real deposit net rate $R_{t+1}$ over the interval $[t, t + 1]$
2. Banks make loans to firms.
3. Loans are $s_t$ at a price $Q_t$. The asset against which the loans are obtained is end-of-period capital $K_t$. Capital depreciates at a rate $\delta$ in each period.
Bank Balance Sheet

- \( Q_t s_t = n_t + d_t \), where LHS is assets, RHS liabilities, \( n_t \) is net worth
- \( n_t = R_{k,t} Q_{t-1} s_{t-1} - R_t^{ex} d_{t-1} \) is the accumulation of net worth
- Banks exit with probability \( 1 - \sigma_B \) per period, so banker’s objective is to maximize expected terminal wealth

\[
V_t = E_t \sum_{i=0}^{\infty} (1 - \sigma_B) \sigma_B^i \Lambda_{t,t+1+i} n_{t+1+i}
\]

where \( \Lambda_{t,t+1+i} \) is a stochastic discount factor corresponding to the consumer’s optimization problem

- Note that \( n_t = R_t^{ex} n_{t-1} + (R_{k,t} - R_t^{ex}) Q_{t-1} s_{t-1} \), so that net worth at the end of period \( t \) equals the gross return at the real riskless rate plus the excess return over the latter on the assets.
Endogenous Constraint on the Banks Ability to Obtain Funds

- After a bank obtains funds, the banks manager may transfer a fraction of assets to her family. Assume that the fraction of funds that a banker can divert depends on the composition of the banks liabilities.
- Households therefore limit the funds they lend to banks.
- In order to ensure that bankers do not divert funds the following incentive constraint must hold:

$$V_t \geq \Theta_t Q_t s_t$$

where $1 - \Theta_t$ is the fraction of funds that can be reclaimed by creditors. Thus for households to be willing to supply funds, the banks franchise value $V_t$ must be at least as large as its gain from diverting funds.
Solution of Banker’s Problem

- Bankers maximize $V_t$ by optimally choosing a lending path $\{s_{t+i}\}$ subject to the net worth equation and the incentive constraint.
- This leads to an expression for $V_t$ in terms of expected net worth $V_t = E_t \Lambda_{t,t+1} \Omega_{t+1} n_{t+1}$ where

$$\Omega_t = 1 - \sigma_B + \sigma_B \frac{\Theta E_t \Omega_{t+1} \Lambda_{t,t+1} R_{t+1}^{ex}}{\Theta + E_t \Omega_{t+1} \Lambda_{t,t+1} (R_{t+1}^{ex} - R_{k,t+1})}$$

is the shadow value of a unit of net worth.
- The solution generates a leverage ratio $Q_t s_t / n_t$ for banks that satisfy the incentive constraint.
- The equations all essentially aggregate up, although one has to take account of those banks that quit, and the new banks that enter – the latter beginning operation with a net worth transferred as a fraction of the assets of exiting entrepreneurs.
Model Interconnections

Figure: A Model with a Banking Sector
Calibration of the Banking Model

- Following Gertler and Kiyotaki (2010), choose the value of $\sigma_B$ so that bankers survive 8 years (32 periods) on average.
- Allow for an economy-wide leverage ratio of 3
- Allow for an average credit spread of 0.88% per year
Optimal Monetary Policy ignoring ZLB

Three regimes: ex ante optimal policy with commitment, the time consistent optimal policy and a Taylor-type interest rate rule optimized with respect to smoothing, inflation and output (relative to its deterministic value) and Tobin’s Q.

<table>
<thead>
<tr>
<th>Model</th>
<th>Policy</th>
<th>Frictions</th>
<th>$\Omega_0$</th>
<th>$\sigma_r^2$</th>
<th>$c_e$(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Commit</td>
<td>Product</td>
<td>0</td>
<td>0.225</td>
<td>0</td>
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<tr>
<td>I</td>
<td>Discretion</td>
<td>Product</td>
<td>2.979</td>
<td>0.057</td>
<td>0.03</td>
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<tr>
<td>II</td>
<td>Commit</td>
<td>Product, Financial</td>
<td>0</td>
<td>0.841</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>Discretion</td>
<td>Product, Financial</td>
<td>3.437</td>
<td>4.294</td>
<td>0.04</td>
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</tbody>
</table>

Optimal Rules with and without Commitment: No ZLB

<table>
<thead>
<tr>
<th>Model</th>
<th>Frictions</th>
<th>$\Omega_0$</th>
<th>Rule $[\rho_r, \theta_\pi, \theta_y, \theta_q]$</th>
<th>$\sigma_r^2$</th>
<th>$c_e$(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Product</td>
<td>1.66</td>
<td>$[0.78, 2.25, 0.01, 0]$</td>
<td>0.10</td>
<td>0.02</td>
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<tr>
<td>II</td>
<td>Prod, Fin</td>
<td>0.72</td>
<td>$[1.00, 1.90, 0.01, 0]$</td>
<td>0.05</td>
<td>0.007</td>
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<tr>
<td>II</td>
<td>Prod, Fin</td>
<td>0.70</td>
<td>$[1.00, 1.00, -0.003, 0.04]$</td>
<td>0.03</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Optimized Simple Rules: No ZLB Considerations
Summary of Monetary Policy, No ZLB, Results

- Modest gains from commitment in the basic NK model – 0.03% in consumption equivalent \((c_e)\) and 0.04% with financial frictions (FF).

- Costs of simplicity are also small, \(c_e = 0.02\%\) at most.

- High variances of nominal interest rate, so that ZLB considerations arise with FF for optimal and discretionary policy. These will contribute an increase in the gains from commitment.

- The optimized simple rule is more aggressive in the model with FF and is close to a price-level rule.

- No benefit from targeting spread or leverage (not in table); however modest gains from targeting Tobins Q, at least with regard to nominal interest rate variance.
Interest Rate Zero Lower Bound Considerations

- With a zero-inflation steady state and nominal interest rate of 1% per quarter, optimal policy variances between 0.722 and 3.098 imply a probability per quarter of hitting the ZLB in the range [0.121, 0.284]. At the upper end of these ranges the ZLB would be hit every year on average.

- We can impose a lower bound effect on the nominal interest rate by modifying the discounted quadratic loss criterion to include a term $w_r (r_{n,t} - r_n^*)^2$

- $w_r, r_n^*$ are chosen optimally subject to the constraint that the variance of the nominal interest rate is such that the probability of hitting ZLB is only once every 50 years

<table>
<thead>
<tr>
<th>Mod</th>
<th>Policy</th>
<th>Frictions</th>
<th>$\Omega_0$</th>
<th>$\sigma_r^2$</th>
<th>$w_r$</th>
<th>p(ZLB)</th>
<th>$c_e$ (%)</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Commit</td>
<td>Product</td>
<td>0.19</td>
<td>0.11</td>
<td>0.4</td>
<td>&lt;0.002</td>
<td>0.002</td>
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<tr>
<td>I</td>
<td>Discretion</td>
<td>Product</td>
<td>2.98</td>
<td>0.06</td>
<td>0.00</td>
<td>&lt;0.005</td>
<td>0.03</td>
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<tr>
<td>II</td>
<td>Commit</td>
<td>Prod, Fin</td>
<td>0.18</td>
<td>0.11</td>
<td>0.01</td>
<td>&lt;0.005</td>
<td>0.002</td>
</tr>
<tr>
<td>II</td>
<td>Discretion</td>
<td>Prod, Fin</td>
<td>6.75</td>
<td>0.13</td>
<td>0.16</td>
<td>&lt;0.005</td>
<td>0.07</td>
</tr>
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</table>
Macro-prudential Regulation

We adapt the Gertler et al (2011) revenue-neutral Pigovian subsidy in order to alter the leverage ratio $Q_t s_t / N_t$ from the banks’ laissez-faire choice

$$(1 + \tau_t)Q_t s_t = (1 + \tau_t^s)n_t + d_t \quad \tau_t Q_t s_t = \tau_t^s n_t$$

Thus a counter-cyclical policy to raise capital requirements in an economic upturn will see an increase in a subsidy $\tau_t^s$ for net worth, financed by a tax $\tau_t$ on loans.

The increase in $\tau_t^s$ makes increasing net worth more attractive to banks, and offsets their incentive to adjust liability structure to more short-term debt.
Implications of this Pigovian Subsidy for Policy

- Alters
  1. the value function $V_t$
  2. the build-up of net worth $N_t$
  3. the shadow value of a unit of net worth $\Omega_t$

- We also assume the cost of raising $\tau_t Q_t S_t$ enters the (GDP) resource constraint as $\psi \tau_t^2 Q_t S_t$, with $\psi$ calibrated at 0.85, giving a cost of 0.2% of GDP

- We examine optimal or discretionary policy as before, and a simple Taylor-type rule with smoothing parameter, and a dependence on $Y_t / Y$
**Results**

In steady state, a tax on loans reduces leverage from 3 to 1.64; steady state utility provides a permanent $c_e = 2\%$

<table>
<thead>
<tr>
<th>Model</th>
<th>Policy</th>
<th>Instruments</th>
<th>$\Omega_0$</th>
<th>$\sigma_r^2$</th>
<th>$\sigma_T^2$</th>
<th>$c_e(%)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Commit</td>
<td>MP+MR</td>
<td>0</td>
<td>0.180</td>
<td>221</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>Disc</td>
<td>MP+MR</td>
<td>5.731</td>
<td>5.868</td>
<td>517</td>
<td>0.06</td>
</tr>
<tr>
<td>II</td>
<td>Commit</td>
<td>MP only</td>
<td>0.882</td>
<td>0.320</td>
<td>0</td>
<td>0.01</td>
</tr>
<tr>
<td>II</td>
<td>Disc</td>
<td>MP only</td>
<td>5.221</td>
<td>8.744</td>
<td>0</td>
<td>0.05</td>
</tr>
</tbody>
</table>

**Optimal Rules with and without Commitment: No ZLB.**

**Monetary Policy (MP), Macro-prudential Policy (MR)**

<table>
<thead>
<tr>
<th>Instruments</th>
<th>$\Omega_0$</th>
<th>Rule $[\rho_r, \theta_\pi, \theta_{r,y}, \theta_{\tau,y}, \theta_\tau]$</th>
<th>$\sigma_r^2$</th>
<th>$\sigma_T^2$</th>
<th>$c_e(%)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP+MR</td>
<td>0.57</td>
<td>$[1., 4.7, -0.07, 0.57, 0.93]$</td>
<td>0.08</td>
<td>79</td>
<td>0.005</td>
</tr>
<tr>
<td>MP only</td>
<td>0.1.23</td>
<td>$[1., 5., -0.003, 0, 0]$</td>
<td>0.08</td>
<td>0</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**Optimized Simple Rules: No ZLB**
Comments on Results

- Stabilization gains from macro-prudential regulation are small – at most $c_e = .01\%$ – compared with 2% from steady state.
- The simple rule that mimics the optimal tax policy is counter-cyclical with considerable persistence, with a monetary rule close to a price-level rule:

  \[
  \tau_t = 0.93\tau_{t-1} + 0.57y_t \quad \Delta r_{n,t} = 5\pi_t - 0.003y_t
  \]

- As before nominal interest rate variances of optimized simple rules are small so these pose no ZLB concerns.
- Not the case with optimal commitment and discretion whether MR is in place or not. Variances under discretion are high.
- Main benefit of MR is to reduce the welfare costs of imposing a ZLB constraint under discretion.
- No significant benefit from jointly targeting financial and non-financial variables, so that the benefit from combining MP and MR within one institution may also be insignificant.
Conclusion

- Modest gains from commitment and costs from simple rules in the basic NK model; increase with financial frictions (FF).
- ZLB considerations arise particularly with FF for optimal and discretion, contributing to an increase in the gains from commitment. The optimized simple rule is more aggressive in the model with FF and is close to a price-level rule.
- No welfare benefit from targeting spread, or leverage but modest gains from targeting Tobins Q.
- Significant gains from using tax on loans and a subsidy for banks net worth, with $c_e = 2\%$.
- Stabilization gains from macro-prudential regulation are small.
- Simple rule that mimics the optimal tax policy is counter-cyclical with considerable persistence, alongside an interest rate rule that is almost a price-level rule.
- Main benefit of MR is to reduce the welfare costs of imposing a ZLB constraint under discretion.
Further Work

- Our stabilization results are based on an LQ approximation to the non-linear optimal policy problem about the deterministic Ramsey steady state.
- Since most of the welfare gains from macro-prudential regulation come from a more efficient steady state the question arises as to how our conclusions might change if we approximate about the stochastic steady state as in Gertler et al. (2010).
- In particular the steady state should depend (at the very least) on the covariances of any of variables that appear as expectations. Programming of this is currently in the development stage.