Optimal Monetary and Prudential Policies

Fabrice Collard, University of Bern
Harris Dellas, University of Bern
Behzad Diba, Georgetown University
Olivier Loisel, CREST

3rd Bank of Spain—World Bank Research Conference
“Financing Growth: Levers, Boosters and Brakes”

Madrid, June 23, 2014
The recent crisis has highlighted the need for a policy ensuring financial stability.

The consensus [e.g. Bernanke (2011), IMF (2013)] is that it should be a new prudential policy (PP), rather than monetary policy (MP).

One key PP instrument will be bank capital requirements set conditionally on the state of the economy [Basel Committee on Banking Supervision (2010)].
Contribution of the paper

- This raises the issue of the interactions between
  - MP, i.e. interest-rate policy,
  - PP, i.e. state-contingent capital-requirement policy.

- Our goal is to develop a New Keynesian model with banks to study these interactions from a normative perspective.

- The literature has recently proposed models that address this issue: e.g., Angeloni and Faia (2013), Benes and Kumhof (2012), Christensen, Meh and Moran (2011).

- We depart from this literature in two main ways:
  - by computing the jointly locally Ramsey-optimal policies,
  - by linking the amount of risk to the type of credit.
The literature gets jointly **optimal simple rules**:  
- the deviations of the policy instruments from their steady-state values are optimized within some parametric families of simple rules,  
- the steady-state value of capital requirements is not optimal.

We get jointly **locally Ramsey-optimal policies**, i.e. we get a state-contingent path for the two policy instruments that locally maximizes the representative household’s ex ante utility.
Volume vs. type of credit

- In the literature, the amount of risk is linked to the **volume of credit** (e.g., through a systemic-risk externality in Christensen, Meh and Moran, 2011).

- This link gives rise to a risk-taking channel of MP.

- Our model illustrates another channel of interaction between MP and PP, by linking the amount of risk to the **type of credit**.

- Banks have an incentive to make socially undesirable **risky** loans, rather than **safe** loans, because of a moral-hazard problem.

- The two policies may not affect the same margins:
  - MP affects the volume but not necessarily the type of credit,
  - PP affects both the volume and the type of credit.
Main results

- We first develop a **benchmark model**, in which MP *cannot affect* the type of credit.

- This model implies a clear-cut optimal division of tasks between MP and PP:
  - PP should react only to shocks that affect banks’ risk-taking incentives,
  - in response to these shocks, MP should move *opposite* to PP in order to mitigate its macroeconomic effects [as envisaged by some policymakers and commentators: Macklem (2011), Wolf (2012), Yellen (2010)].

- We then consider two **extensions** to this model, one in which MP *can affect* the type of credit.

- These extensions can account for situations in which MP and PP should both move *counter-cyclically*. 
Outline of the presentation

1. Introduction
2. Model
3. Implications
4. Extensions
5. Conclusion
Extending the New Keynesian model

- Start from the basic New Keynesian model with capital, whose agents are
  - intermediate goods producers,
  - final goods producers,
  - households,
  - a monetary authority.

- There are two inefficiencies on the intermediate goods market:
  - monopolistic competition,
  - price rigidity à la Calvo (1983),

which give a role to monetary policy.

- Introduce, in turn, three additional types of agents:
  - capital goods producers (who have access to a risky technology),
  - banks (which finance capital goods producers),
  - a prudential authority (which imposes capital requirements on banks).
Capital goods producers

- Capital goods producers
  - buy unfurbished capital $x_t$ at the end of period $t$,
  - furbish it between period $t$ and period $t + 1$,
  - sell this furbished capital $k_{t+1}$ at the start of period $t + 1$.

- They are perfectly competitive and owned by households.

- They have access to a safe technology (S): $k_{t+1} = x_t$...

- ...and to a risky technology (R): $k_{t+1} = \theta_t \exp(\eta^R_t) x_t$, where
  - $\theta_t$ is a common (systemic) shock,
  - $\theta_t = 0$ with exogenous probability $\phi_t$,
  - $\theta_t = 1$ with exogenous probability $1 - \phi_t$,
  - all realizations of $\eta^R_t$ are positive,
  - $\text{corr}(\theta_t, \text{other shocks}) = 0$. 

At each period $t$, the timing of events is the following:

1. all exogenous shocks are realized, except $\theta_t$,  
2. all agents observe these realizations and make their decisions,  
3. $\theta_t$ is realized.

$R$ is inefficient in the sense that, for all realizations of $\phi_t$ and $\eta^R_t$,

$$(1 - \phi_t) \exp(\eta^R_t) \leq 1.$$ 

However, because of their limited liability, capital goods producers have an incentive to use $R$ (“heads I win, tails you lose”): this is the first moral-hazard problem in the model.

To buy unfurbished capital, capital goods producers borrow from banks (which can monitor them) at the nominal interest rate $R^i_t$ with $i \in \{S, R\}$, and those choosing $R$ completely default on their loans when $R$ fails.
Banks are perfectly competitive and owned by households.

They pay a tax \( (\tau) \) on their profits.

They finance safe loans \( l_t^S \) and risky loans \( l_t^R \) by raising equity \( e_t \) and issuing deposits \( d_t \), so that their balance-sheet identity is

\[
l_t^S + l_t^R = e_t + d_t.
\]

Because of deposit insurance and their own limited liability, they have an incentive to make risky loans (again, “heads I win, tails you lose”).

This is the second moral-hazard problem in the model (as in the micro-banking literature, Van den Heuvel, 2008, Martinez-Miera and Suarez, 2012).

They can hide risky loans in their portfolio from the prudential authority up to an exogenous fraction \( \gamma_t \) of their safe loans.
The **prudential authority** imposes a risk-weighted **capital requirement**:

\[ e_t \geq \kappa_t \left( l_t^S + l_t^R \right) + \bar{\kappa} \max \left\{ 0, l_t^R - \gamma_t l_t^S \right\}. \]

This capital requirement enables it to tackle the second moral-hazard problem: the higher banks’ capital \( e_t \), the more banks internalize the social cost of risk (as they have more “skin in the game”).

It optimally chooses \( \bar{\kappa} \) high enough for \( l_t^R \leq \gamma_t l_t^S \) in equilibrium.

This is because risky loans are socially undesirable, as

- \( R \) is inefficient on average over \( \theta_t \),
- \( \theta_t \) is independent of the other shocks,
- households are risk-averse.
Two preliminary results

- **Proposition 1:** There are no equilibria with \(0 < l_t^R < \gamma_t l_t^S\).

  This is because banks’ limited liability make their expected excess return *convex* in the volume of their risky loans.

- **Proposition 2:** In equilibrium, the capital constraint is binding:

  \[ e_t = \kappa_t \left( l_t^S + l_t^R \right). \]

  This is because the tax on banks’ profits makes them prefer debt finance to equity finance.
**Proposition 4:** A necessary and sufficient condition for existence of an equilibrium with $l_t^R = 0$ is $\kappa_t \geq \kappa_t^*$ (where $\kappa_t^*$ is a function of shocks, made explicit in the paper).

Starting from a situation in which all banks are at the safe corner, setting $\kappa_t \geq \kappa_t^*$ deters each bank from going to the risky corner by making it sufficiently internalize the social cost of risk.

This threshold value $\kappa_t^*$ is increasing in
- the probability of success of the risky technology $1 - \phi_t$,
- the productivity of the risky technology conditionally on its success $\eta_t^R$,
- the maximum ratio of risky to safe loans $\gamma_t$,

as an increase in $1 - \phi_t$, $\eta_t^R$, or $\gamma_t$ raises banks’ risk-taking incentives.
Monetary policy

- The MP instrument is the risk-free deposit rate $R_t^D$.

- $\kappa_t^*$ does not depend on $R_t^D$: there is no risk-taking channel of MP, or equivalently MP is ineffective in ensuring financial stability.

- This is because, in our benchmark model with perfect competition and constant returns, $R_t^D$ does not affect the spread between $R_t^R$ and $R_t^S$, and hence does not affect banks’ risk-taking incentives.

- Let $(R_t^{D*})_{\tau \geq 0}$ denote the MP that is Ramsey-optimal when PP is $(\kappa^*_\tau)_{\tau \geq 0}$. 
Jointly locally Ramsey-optimal policies

- **Proposition 5:** If the right derivative of welfare with respect to $\kappa_t$ at $(R^D_t, \kappa_t)_{t \geq 0} = (R^D_t, \kappa^*_t)_{t \geq 0}$ is strictly negative for all $t \geq 0$, then the policy $(R^D_t, \kappa_t)_{t \geq 0} = (R^D_t, \kappa^*_t)_{t \geq 0}$ is locally Ramsey-optimal.

- Setting $\kappa_t$ just below $\kappa^*_t$ is not optimal, because it triggers a discontinuous increase in the amount of (inefficient) risk taken by banks.

- Setting $\kappa_t$ just above $\kappa^*_t$ is not optimal, because it has a negative first-order welfare effect that cannot be offset by any change in $R^D_t$ around its optimal steady-state value $R^D_t$ (as this change would have a zero first-order effect).

- We check numerically, using Levin and López-Salido’s (2004) “Get Ramsey” program, that the right derivative of welfare with respect to $\kappa_t$ at $(R^D_t, \kappa^*_t)_{t \geq 0}$ is strictly negative.

- This is because increasing $\kappa_t$ from $\kappa^*_t$ decreases the capital stock, which is already inefficiently low due to the monopoly and tax distortions.
Numerical simulations

- We calibrate the model and consider two alternative PPs:
  - the optimal PP $\kappa_t = \kappa^*_t$, with a steady-state value $\kappa^*_t = 0.10$,
  - the passive PP $\kappa_t = 0.12$, which also ensures $l_t^R = 0$.

- For each PP, we compute the optimal MP using Get Ramsey.

- There are two types of shocks:
  1. shocks that do not affect banks’ risk-taking incentives: $\eta^f_t, G_t$,
  2. shocks that affect banks’ risk-taking incentives: $\eta^R_t, \gamma_t, \phi_t, \Psi_t$.

- Following type-1 shocks, optimal PP does not move, while optimal MP moves in a standard way.

- Following type-2 shocks, optimal MP moves opposite to optimal PP in order to mitigate its macroeconomic effects [as envisaged by some policymakers and commentators: Macklem (2011), Wolf (2012), Yellen (2010)].
Responses to a type-2 shock (positive $\eta^R_t$ shock)

$\kappa_t = \kappa^*$
$\kappa_t = 0.12$
Dashed line: Steady State Level
Two extensions

- In our benchmark model, optimal MP and optimal PP never move in the same direction.

- We consider two extensions to this model, which can make optimal MP and optimal PP move in the same (counter-cyclical) direction.

  - **Extension 1**: we introduce productivity shocks on S that are positively correlated with productivity shocks on R.

  - **Extension 2**: we introduce an externality by assuming that banks’ marginal monitoring cost is increasing in the aggregate volume of loans [as in Hachem (2010)]: \( \log(\Psi_t) = \log(\Psi) + \varrho [\log(l^S_t) - \log(l^S)] \).

- Unlike Extension 1, Extension 2 enables MP to affect the type of credit, i.e. it gives rise to a risk-taking channel of MP, or equivalently it makes MP effective in ensuring financial stability.
Extension 1: responses to a positive $\eta_t^R$ shock

\[ \text{corr}(\eta_t^R, \eta_t^S) = 0.25 \quad \text{corr}(\eta_t^R, \eta_t^S) = 0.50 \quad \text{corr}(\eta_t^R, \eta_t^S) = 0.75 \]

Thin Dashed Line: Steady State Level
Extension 2: responses to a positive $\eta^f_t$ shock
We develop a New Keynesian model with banks to study the interactions between MP and PP from a normative perspective.

We depart from the literature in two main ways:
- by linking the amount of risk to the type of credit,
- by computing the jointly locally Ramsey-optimal policies.

We obtain a clear-cut optimal division of tasks between MP and PP:
- PP should react only to shocks that affect banks’ risk-taking incentives,
- MP should react to all shocks and, for some shocks, only to their effects on the PP instrument.

We can account for situations in which
- MP and PP should move opposite to each other,
- MP and PP should move in the same (counter-cyclical) direction.
Addressing commentators’ and policymakers’ concerns

- Wolf (2012): “How, in practice, will policies aimed at securing financial stability interact with monetary policy? Consider, for example, the possibility that the committee charged with the former is trying to cool lending in, say, the property sector when the committee charged with the latter is seeking to heat it up in the economy. They could find themselves operating in contradiction.”

- Yellen (2010): “[W]e must strive to avoid situations in which macro-prudential and monetary policies are working at cross-purposes, given that macroprudential policies affect macroeconomic performance and that monetary policy may affect risk-taking incentives.”
Our modeling contribution

- **The moral-hazard problem** that gives banks an incentive to make socially undesirable risky loans is due to *limited liability* and *deposit insurance*, as in a branch of the micro-banking literature.

- Van den Heuvel (2008) introduces this kind of moral-hazard problem into a general-equilibrium (GE) model with
  - no systemic risk,
  - no aggregate shocks.

- Martinez-Miera and Suarez (2012) introduce it into a GE model with
  - systemic risk,
  - no aggregate shocks.

- **We introduce it into a GE model with**
  - systemic risk,
  - aggregate shocks,
  - sticky prices,
  - monetary policy.
Intermediate and final goods producers

- **Intermediate goods producers** are monopolistically competitive and face a price rigidity à la Calvo (1983).

- The production function of intermediate goods producer $j$ is

  \[ y_t(j) = h_t(j)^{1-\nu} k_t(j)^\nu \exp \left( \eta_t^f \right). \]

- **Final goods producers** are perfectly competitive.

- Their production function is

  \[ y_t = \left( \int_0^1 y_t(j)^{\frac{\sigma-1}{\sigma}} \, dj \right)^{\frac{\sigma}{\sigma-1}}. \]
Households’ optimization problem

- **Households** choose \( (c_t, h_t, d_t, s_t, k_t, i_t, x_t)_{t \geq 0} \) to maximize

\[
E_0 \sum_{t=0}^{\infty} \beta^t \left[ \log(c_t) - \frac{h_t^{1+\chi}}{1+\chi} \right]
\]

subject to

- the budget constraint \( c_t + d_t + q_t^b s_t + q_t k_t + i_t = w_t h_t + \frac{1 + R^P_{t-1}}{\Pi_t} d_{t-1} + s_{t-1} \omega_t^b + z_t k_t + q_t^x x_t + (\omega_t^k + \omega_t^f - \tau_t^h) \),

- the law of motion of capital \( x_t = (1 - \delta) k_t + i_t \).
At each period $t$, the timing of events is the following:

1. all exogenous shocks are realized, except $\theta_t$,
2. all agents observe these realizations and make their decisions,
3. $\theta_t$ is realized.

$R$ is **inefficient** in the sense that, for all realizations of $\phi_t$, $\eta^R_t$ and $\Psi_t$,

\[
(1 - \phi_t) \exp\left(\eta^R_t\right) \leq 1 - \Psi_t,
\]

where $\Psi_t$ is the marginal resource cost of monitoring capital goods producers.

However, because of their **limited liability**, capital goods producers have an incentive to use $R$ (“heads I win, tails you lose”): this is the **first moral-hazard problem** in the model.
Capital goods producers need to get funds to buy unfurbished capital.

The only agents that have the skills to monitor them (and thus that can solve the first moral-hazard problem) are banks.

Therefore, they get funds from banks to buy unfurbished capital.

We consider loan contracts between capital goods producers and banks.

That is, the capital goods producers choosing technology $i \in \{S, R\}$ borrow the funds they need at the nominal interest rate $R^i_t$...

...and those choosing $R$ completely default on their loans when $R$ fails.
A producer $i$ using technology $S$ chooses $x_t(i)$ to maximize

$$
\beta E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \left[ q_{t+1} x_t(i) - \frac{1 + R_t^S}{\Pi_{t+1}} q_x x_t(i) \right] \right\},
$$

where $\lambda_t$ is households’ marginal utility of consumption at date $t$.

A producer $i$ using technology $R$ chooses $x_t(i)$ to maximize

$$
(1 - \phi_t) \beta E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \left[ q_{t+1} \exp(\eta_t^R) x_t(i) - \frac{1 + R_t^R}{\Pi_{t+1}} q_x x_t(i) \right] \right\} \bigg| \theta_t = 1
$$
Banks only need to monitor the capital goods producers who borrow at the lower rate.

This lower rate is $R_t^S$.

Indeed, if we had $R_t^R < R_t^S$, then funding safe projects would strictly dominate funding risky projects as it would

- pay more even when $R$ is a success,
- incur no monitoring cost.

So banks only monitor the capital goods producers who borrow at rate $R_t^S$, in order to check that they use $S$.

Banks last for only two periods, so that there is no durable relationship between banks and capital goods producers.
The representative bank chooses $e_t$, $d_t$, $l_t^R$ and $l_t^S$ to maximize

$$E_t \left\{ \beta \frac{\lambda_{t+1} (1 - \tau) \omega_{t+1}^b}{\lambda_t} \right\} - e_t - (1 - \tau) \Psi_t l_t^S,$$

where

$$\omega_{t+1}^b = \max \left\{ 0, \frac{1 + R_t^S}{\Pi_{t+1}} l_t^S + \theta_t \frac{1 + R_t^R}{\Pi_{t+1}} l_t^R - \frac{1 + R_t^D}{\Pi_{t+1}} d_t \right\},$$

subject to

- $l_t^S + l_t^R = e_t + d_t$,
- $l_t^R \leq \gamma_t l_t^S$,
- $e_t \geq \kappa_t (l_t^S + l_t^R)$.
The government’s budget constraint is

\[ \tau^h_t = G_t + \int_0^1 \left\{ \zeta_t(j) - \tau[\omega^b_t(j) + \Psi_t l^S_t(j)] \right\} dj, \]

where losses imposed by bank \( j \) on the deposit insurance fund are \( \zeta_t(j) = \max \left\{ 0, 1 + \frac{R^D_{t-1}}{\Pi_t} d_{t-1}(j) - \frac{1 + R^S_{t-1}}{\Pi_t} l^S_{t-1}(j) - \theta_{t-1} \frac{1 + R^R_{t-1}}{\Pi_t} l^R_{t-1}(j) \right\} \).

The goods market clearing condition is

\[ c_t + i_t + G_t + \Psi_t l^S_t = y_t. \]
Proposition 6: Under the PP rule

\[
\kappa_t = \frac{1 - \phi_t}{\phi_t} \frac{\gamma_t}{1 + \gamma_t} \frac{R_t^R - R_t^S}{1 + R_t^D} + \frac{1}{\phi_t} \frac{\gamma_t}{1 + \gamma_t} \Psi_t - \frac{R_t^S - R_t^D}{1 + R_t^D},
\]

there exists a unique equilibrium and, at this equilibrium, \( I_t^R = 0 \) and \( \kappa_t = \kappa_t^* \).

On the right-hand side of this feedback rule, for an individual bank moving from the safe to the risky corner,

- the first two terms represent the benefit of this move: pocketing \( R_t^R - R_t^S \) if risky projects succeed and saving monitoring costs \( \Psi_t \),
- the third term represents the opportunity cost of this move: losing \( R_t^S - R_t^D \) if risky projects fail.
## Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preferences</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta$</td>
<td>Discount factor</td>
<td>0.993</td>
</tr>
<tr>
<td>$\chi$</td>
<td>Inverse of labor supply elasticity</td>
<td>1.000</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\nu$</td>
<td>Capital elasticity</td>
<td>0.300</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Elasticity of substitution</td>
<td>7.000</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Depreciation rate</td>
<td>0.025</td>
</tr>
<tr>
<td><strong>Nominal rigidities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Price stickiness</td>
<td>0.667</td>
</tr>
<tr>
<td><strong>Banking (steady state)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\tau$</td>
<td>Tax rate</td>
<td>0.023</td>
</tr>
<tr>
<td>$\kappa^*$</td>
<td>Capital requirement</td>
<td>0.100</td>
</tr>
<tr>
<td>$\Psi$</td>
<td>Marginal monitoring cost</td>
<td>0.006</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Failure probability</td>
<td>0.029</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>Maximal risky/safe loans ratio</td>
<td>0.427</td>
</tr>
<tr>
<td>$\exp(\eta^R)$</td>
<td>Productivity of the risky technology</td>
<td>1.005</td>
</tr>
</tbody>
</table>

**Shock processes**

| $\rho$ | Persistence | 0.950  |
Responses to a type-1 shock (positive $\eta^f_t$ shock)

- **Output**: The output response shows a decrease over time, with the percentage deviation from the initial value (
- **Inflation Rate**: The inflation rate remains relatively stable over time.
- **Deposit Rate**: The deposit rate decreases over time.
- **Capital Requirement**: The capital requirement is shown in percentages, with a steady state represented by a dashed line.

Mathematical expressions:

\[ \kappa_t = \kappa^* \]
\[ \kappa_t = 0.12 \]

Dashed line: Steady State Level

Collard, Dellas, Diba, and Loisel

Optimal Monetary and Prudential Policies

June 23, 2014
Justification of policy-induced distortions

- There are two policy-induced distortions in the model:
  - deposit insurance, which gives rise to banks’ risk-taking incentives,
  - the tax on banks’ profits, which makes the capital requirement binding.

- We assume that they are not decided by the mon. and prud. authorities.

- These distortions are prevalent in many countries and do not seem to be likely to be removed any time soon.

- We could probably justify deposit insurance by introducing the possibility of bank runs, at the cost of greater complexity.

- When the tax is arbitrarily small,
  - all our analytical results (from Proposition 1 to Proposition 6) still hold,
  - the condition stated in Prop. 5 (the “if” part of this prop.) may not be met,
  - our model is equivalent, at the first order, to a model with no tax and with deposits in the utility function with an arbitrarily small weight.