THE INTERDEPENDENCE OF MONETARY AND MACROPRUDENTIAL POLICY UNDER THE ZERO LOWER BOUND

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The views expressed in this paper are solely the authors’ and do not necessarily reflect the views of the Bundesbank or the Eurosystem.
Macroprudential and monetary policy are interdependent (Smets, 2014; Leeper and Nason, 2014; Brunnermeier and Sannikov, 2012).

There exist two constraints on monetary policy (MP):

1. On one hand, MP can be constrained by the zero lower bound (ZLB): Nominal interest rate cannot fall below zero $\Rightarrow$ MP forced to be too tight in a downturn.

2. On the other hand, MP can be constrained by weak MacroPru: Financial dominance (Lewis and Roth, 2016)$\Rightarrow$ MP forced to be too accommodating in a (credit-fuelled) boom.
This paper investigates the implications of these two constraints on the effects and optimal conduct of MP and MacroPru policy in a DSGE model with financial frictions.

We focus on the stability and dynamics of corporate debt

- Macroprudential policy $\Rightarrow$ bank capital $\Rightarrow$ loss absorbing capacity $\Rightarrow$ lending capacity $\Rightarrow$ corporate debt
- Monetary policy $\Rightarrow$ inflation $\Rightarrow$ real value of outstanding debt $\Rightarrow$ repayment capacity $\Rightarrow$ corporate debt
Our Model

Financial frictions

- Entrepreneurs with risky projects and insufficient net worth \(\Rightarrow\) costly state verification problem (Townsend, 1970; Bernanke, Gertler, Gilchrist, 1999)

New Keynesian features

- Market power and price setting frictions

Policies

- **Monetary** policy: inflation target, Taylor-type interest rate rule
- **Macroprudential** policy: capital requirement rule or leaning against the wind (LATW)
Main Model Features

- **Entrepreneurs** fund investment projects using
  - Net worth
  - Bank loans

  They are subject to idiosyncratic productivity shocks.

- **Banks** fund loans to entrepreneurs using
  - Deposits (from households)
  - Equity (from bankers)

- Since the loan contract specifies an interest rate on loans that is not **state-contingent**, banks can make loan losses if a larger number of loans defaults than what was expected at the time of setting the lending rate.
Some key equations – Borrowing

- Entrepreneur’s borrowing requirement

\[ b_t = q_t K_t - n_t^E \]  \hspace{1cm} (1)

- The gross return on capital is \( \omega_{t+1}^{E} R_{t+1}^{E} \), where \( \omega_{t+1}^{E} \) is an idiosyncratic disturbance to the entrepreneur’s return, an i.i.d. log-normal variable with standard deviation \( \sigma_t^E \).

- The lender can observe \( \omega_{t+1}^{E} \) only by paying the monitoring cost, which is a proportion \( \mu^E \) of the realized gross payoff to the entrepreneurial capital.

- The optimal financial contract specifies a cutoff value for the shock, \( \overline{\omega}_{t+1}^{E} \), such that if \( \omega_{t+1}^{E} \geq \overline{\omega}_{t+1}^{E} \) the entrepreneur is able to repay the loan. Alternatively, the borrower gets nothing, the lender pays the auditing costs.

- We define \( x_t^E = \frac{Z_t^E b_t}{q_t K_t} \) the entrepreneur’s leverage, where \( Z_t^E \) is the contractual loan rate.
Banks

Bank’s borrowing requirement

\[ n_t^B = b_t - d_t \] (2)

Bank’s profits

\[ R_{t+1}^F b_t - R_{t+1} d_t = (1 - \Gamma_{t+1}^F) R_{t+1}^F b_t \] (3)

where \( \Gamma_{t+1}^F \) is the share of the project return accruing to the banker after the bank has made interest payments to the depositors.

Ex-post gross return on bank loans

\[ R_{t+1}^F = (\Gamma_{t+1}^E - \mu^E G_{t+1}^E) \frac{R_{t+1}^E q_t K_t}{b_t} \] (4)
Surviving bankers (fraction $1 - \chi^B$) have net worth

$$n_{t+1}^B = (1 - \chi^B) \mathcal{W}_{t+1}^B$$

(5)

Ex-post gross return on banker’s equity

$$R_{t+1}^B = (1 - \Gamma_{t+1}^F) \frac{R_{t+1}^F b_t}{n_t^B}$$

(6)

Banker net worth dynamics

$$n_{t+1}^B = (1 - \chi^B) \left( \frac{R_{t+1}^B}{\Pi_{t+1}} \right) n_t^B$$

(7)

Stability depends on

- Survival rate of bankers, $1 - \chi^B$
- Ex-post real equity return, $\frac{R_{t+1}^B}{\Pi_{t+1}}$
Interest Rate Rule and Capital Requirement Rule

Monetary policy rule

\[
\frac{R_t}{R} = \left( \frac{\Pi_t}{\Pi} \right)^{\tau_{\Pi}} \left( \frac{b_t}{b} \right)^{\tau_b}
\]  

(8)

Macroprudential policy rule

\[
\frac{\phi_t}{\phi} = \left( \frac{b_t}{b} \right)^{\zeta_b}, \text{ where } \phi_t = \frac{n^B_t}{b_t}
\]  

(9)

We consider two special cases

\(\tau_b = 0 \iff \text{ Countercyclical Capital Buffer (CCB)}\)

\(\zeta_b = 0 \iff \text{ Leaning Against the Wind (LATW)}\)
CCB Model: Steady State Capital Ratio 8%

V. Lewis, S. Villa  The Interdependence of Monetary and Macropru Policy under ZLB
CCB Model: Steady State Capital Ratio 12%

Coefficient on lending ($\zeta_b$)
Coefficient on inflation ($\tau_\pi$)

0 5 10 15
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2

Multiple
Unique
Explosive
LATW Model: Steady State Capital Ratio 8%

V. Lewis, S. Villa
The Interdependence of Monetary and Macropru Policy under ZLB
We use the piecewise linear perturbation method by Guerrieri and Iacoviello (JME, 2015) to solve the model with ZLB constraint; we simulate a large risk shock (Christiano et al., 2014) so that the ZLB on the nominal interest rate is attained. The risk shock makes entrepreneurs more likely to declare default. Investment projects become riskier and, as a result, the external finance premium rises and investment falls. We consider the policy scenarios for which there is a unique stable equilibrium:

1. CCB and active MP: $\zeta_b \in [12, 20]$, $\tau_\pi = 1.2$, $\tau_b = 0$;
2. CCB and passive MP: $\zeta_b \in [0, 11]$, $\tau_\pi = 0.9$, $\tau_b = 0$;
3. LATW and passive MP: $\zeta_b = 0$, $\tau_\pi = 0.9$, $\tau_b \in [0, 0.9]$;
Peak responses – CCB and active MP

Monetary policy rate vs. Output vs. Investment vs. Inflation

Return on capital vs. Entrep. net worth vs. Bank net worth vs. Nominal loan growth

Piecewise Linear vs. Linear (ignores ZLB)
Peak responses – CCB and passive MP

\[ \text{Monetary policy rate} \]
\[ \text{Output} \]
\[ \text{Investment} \]
\[ \text{Inflation} \]
\[ \text{Return on capital} \]
\[ \text{Entrep. net worth} \]
\[ \text{Bank net worth} \]
\[ \text{Nominal loan growth} \]

\[ \text{Piecewise Linear} \quad \text{Linear (ignores ZLB)} \]
Peak responses – LATW

Monetary policy rate

Output

Investment

Inflation

Return on capital

Entrep. net worth

Bank net worth

Nominal loan growth

Piecewise Linear
Linear (ignores ZLB)
Optimal simple rules

- We investigate whether the LATW policy and the CCB policy are indeed optimal.
- We follow the literature on optimal simple rules (see Schmitt-Grohe and Uribe, 2007, and Levine et al., 2008, among many others).
- We numerically search for those feedback coefficients in the two policy rules to maximize the present value of life-time utility:

\[ \Omega_t = E_t \left[ \sum_{s=0}^{\infty} \beta^s U \left( c_{t+s}, 1 - l_{t+s} \right) \right] \]  \hspace{1cm} (10)

- The welfare loss \( \omega \) is implicitly defined as

\[ E_t \left\{ \sum_{s=0}^{\infty} \beta^s \left[ U \left( (1 - \omega) c^A_{t+s}, 1 - l^A_{t+s} \right) \right] \right\} = E_t \left\{ \sum_{s=0}^{\infty} \beta^s \left[ U \left( c^B_{t+s}, 1 - l^B_{t+s} \right) \right] \right\} \]  \hspace{1cm} (11)
Table: Optimized monetary policy rules

<table>
<thead>
<tr>
<th>$\tau_R$</th>
<th>$\tau_\pi$</th>
<th>$\tau_b$</th>
<th>$\zeta_b$</th>
<th>$\mathcal{W}$</th>
<th>$100 \times \omega$</th>
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<tbody>
<tr>
<td>$0$</td>
<td>$0.990$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-34.55670$</td>
<td>$0.26$</td>
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<td>$-$</td>
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<td>$0.306$</td>
<td>$-$</td>
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<tr>
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<td>$0.000$</td>
<td>$-$</td>
<td>$-34.55748$</td>
<td>$0.67$</td>
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</table>

*Optimized standard Taylor-type rule*

*Optimized Taylor-type rule and CCB*

*Optimized augmented Taylor-type rule*

*Note:* The term $\omega$ represents the welfare loss relative to the reference regime, which is CCB. The optimized standard Taylor-type rule features interest rate smoothing and response to inflation; the optimized standard Taylor-type rule and CCB is the CCB policy coupled with a Taylor rule responding only to inflation; and the optimized augmented Taylor-type rule is LATW.
A low feedback coefficient in the CCB rule forces MP to be passive. The determinacy region in which MP is active can be enlarged by raising the steady state minimum capital requirement imposed on banks.

Irrespective on the value of the coefficient, the LATW policy always requires a passive MP.

When monetary policy is active, an aggressive CCB is detrimental in terms of output losses in response to a risk shock. And the presence of the ZLB makes the simulated recession more severe.

When monetary policy is passive, output trough is a decreasing function of the CCB/LATW policy. The ZLB, instead, has marginal effects.

The CCB policy coupled with passive monetary policy is optimal, while the LATW policy is detrimental from a welfare perspective.
Contracting Problem

Default by entrepreneur: $\omega_{t+1}^E < \bar{\omega}_{t+1}^E$

- Probability $1 - F^E(\bar{\omega}_{t+1}^E)$
- Entrepreneur not able to repay loan in full
- Bank gets whole return $\omega_{t+1}^E R_{t+1}^E q_t K_t$ less monitoring cost $\mu^E G_{t+1}^E$
- Entrepreneur gets nothing

Non-default by entrepreneur: $\omega_{t+1}^E > \bar{\omega}_{t+1}^E$

- Probability $F^E(\bar{\omega}_{t+1}^E)$
- Entrepreneur repays loan in full
- Bank gets contractual agreed payment $\bar{\omega}_{t+1}^E R_{t+1}^E q_t K_t$
- Entrepreneur gets remainder, $(\omega_{t+1}^E - \bar{\omega}_{t+1}^E) R_{t+1}^E q_t K_t$
Entrepreneur’s objective

\[
\max_{x_t^E, K_t} \mathbb{E}_t \left[ 1 - \Gamma^E \left( \frac{x_t^E}{R^E_{t+1}} \right) \right] R^E_{t+1} q_t K_t
\]

share to entrepreneur

s.t. bank’s participation constraint

\[
\mathbb{E}_t \left\{ \Gamma^E \left( \frac{x_t^E}{R^E_{t+1}} \right) - \mu^E G^E \left( \frac{x_t^E}{R^E_{t+1}} \right) R^E_{t+1} q_t K_t \right\} = \mathbb{E}_t \left\{ R^B_{t+1} (q_t K_t - n_t^E) \right\}
\]
Financial Contract: FOCs

First order condition w.r.t. entrepreneur's leverage $x_t^E$

$$\mathbb{E}_t \{ -\Gamma_t^{E'} + \xi_t^E \left( 1 - \Gamma_t^F \right) \left( \Gamma_t^{E'} - \mu^E G_t^{E'} \right) \} = 0$$

First order condition w.r.t. capital $K_t$

$$\mathbb{E}_t \{ \left( 1 - \Gamma_t^E \right) R_t^E + \xi_t^E \left[ \left( 1 - \Gamma_t^F \right) \left( \Gamma_t^E - \mu^E G_t^E \right) R_t^E - R_t^B \phi_t \right] \} = 0$$

where $\xi_t^E$ Lagrange multiplier on bank’s PC
Bank’s Expected Return

Expected return to bank

$$\mathbb{E}_t \left\{ (\Gamma_{t+1}^E - \mu^E G_{t+1}^E) R_{t+1} q_t K_t \right\}$$

where share of gross return accruing to bank is

$$\Gamma_{t+1}^E \equiv \Gamma^E (\bar{\omega}_{t+1}^E) = \int_0^{\bar{\omega}_{t+1}^E} \omega_{t+1}^E f^E (\omega_{t+1}^E) d\omega_{t+1}^E + \bar{\omega}_{t+1}^E \int_{\bar{\omega}_{t+1}^E}^{\infty} f^E (\omega_{t+1}^E) d\omega_{t+1}^E$$

Monitoring costs are $\mu^E G_{t+1}^E$, with $0 < \mu^E < 1$ and

$$G_{t+1}^E \equiv G^E (\bar{\omega}_{t+1}^E) = \int_0^{\bar{\omega}_{t+1}^E} \omega_{t+1}^E f^E (\omega_{t+1}^E) d\omega_{t+1}^E$$

fraction of return lost due to entrepreneurial defaults
### Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
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<tr>
<td>$\beta$</td>
<td>0.99</td>
<td>Household discount factor</td>
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<tr>
<td>$\eta$</td>
<td>0.2</td>
<td>Inverse Frisch elasticity of labour supply</td>
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<tr>
<td>$\alpha$</td>
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<td>Capital share in production</td>
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<td>Substitutability between goods</td>
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<td>$\kappa_p$</td>
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<td>Price adjustment cost</td>
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<td>Capital depreciation rate</td>
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<td>Investment adjustment cost</td>
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<tr>
<td>$\chi^E$</td>
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<td>Consumption share of wealth entrepreneurs</td>
</tr>
<tr>
<td>$\chi^B$</td>
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<td>Consumption share of wealth bankers</td>
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<tr>
<td>$\mu^E$</td>
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<td>Monitoring cost entrepreneurs</td>
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<td>$\sigma^E$</td>
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<td>Idiosyncratic shock size entrepreneurs</td>
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<td>Bank capital requirement</td>
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<td>$\sigma^A$</td>
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<td>Size technology shock</td>
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<tr>
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<td>Persistence technology shock</td>
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<td>Size firm risk shock</td>
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<td>Persistence firm risk shock</td>
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<td><strong>Interest Rates</strong></td>
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<tr>
<td>$R$</td>
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<td>Policy rate</td>
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<tr>
<td>$R^D$</td>
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<td>Return on deposits (earned by depositors)</td>
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<tr>
<td>$R^F$</td>
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<td>Return on loans (earned by banks)</td>
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<tr>
<td>$R^E$</td>
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<td>Return on capital (earned by entrepreneurs)</td>
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<tr>
<td>$R^B$</td>
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<td>Return on equity (earned by bankers)</td>
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<td><strong>Annualised Spreads and Default Probability</strong></td>
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<tr>
<td>$400 \cdot (R^E - R)$</td>
<td>1.73</td>
<td>Loan return spread p.a., in %</td>
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<td>$400 \cdot (R^E - R)$</td>
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<td>Capital return spread p.a., in %</td>
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<td>$400 \cdot (R^B - R)$</td>
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<td>Equity return spread p.a., in %</td>
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<td>$400 \cdot F^E$</td>
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<td>Default probability p.a., in %</td>
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<td><strong>Leverage</strong></td>
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<td>$\lambda^E$</td>
<td>0.7621</td>
<td>Leverage entrepreneurs</td>
</tr>
<tr>
<td>$1 - \phi$</td>
<td>0.92</td>
<td>Leverage banks</td>
</tr>
</tbody>
</table>
Determinacy Analysis

Figure with determinacy regions
- x-axis: MacPru rule coefficient $\zeta_b$
- y-axis: Taylor Rule coefficient $\tau_{\Pi}$

four quadrants
- Taylor Principle: satisfied ($\tau_{\Pi} > 1$) or violated ($\tau_{\Pi} < 1$)
- MacPru Policy: stabilizing or not stabilizing

Result
- Determinacy if both policies similarly accommodating or aggressive
Financial Dominance Regions

‘Active’ MacPru policy: $\zeta_b$ low

- **Upper left**: TP satisfied ($\tau_\Pi > 1$). Fischer debt-deflation increases real value of outstanding debt $\Rightarrow$ debt unsustainable $\Rightarrow$ explosive
- **Lower left**: TP violated ($\tau_\Pi < 1$). MP allows financial stability concerns to override price stability objective $\Rightarrow$ determinacy

‘Passive’ MacPru policy: $\zeta_b$ high

- **Upper right**: TP satisfied ($\tau_\Pi > 1$). Sufficient bank capital to compensate debt-deflation channel $\Rightarrow$ debt sustainable $\Rightarrow$ determinacy
- **Lower right**: TP violated ($\tau_\Pi < 1$). Bank capital rises strongly with borrowing, but MP passive $\Rightarrow$ indeterminacy
IRF of the monetary policy rate

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