Central Bank Capital and Shareholder Relationship

OeNB / SUERF Annual Economic Conference
June 10-11, 2024

Matteo Bonetti; Dirk Broeders*; Damiaan Chen; Daniel Dimitrov

*European Central Bank and Maastricht University
**The views expressed are those of the authors and do not necessarily reflect those of the European Central Bank or the Eurosystem
GOVERNANCE

Few central banks have recapitalisation deals – BoE paper

Survey of 70 jurisdictions argues institutions need “robust framework” to repair capital shortfalls

Figure 1: Source: www.centralbanking.com
Motivation
Motivation and economic problem

• In the evolving monetary policy, central banks now take on more financial risk through asset purchase programs.

• Central bank capital serves as a tool in absorbing risks, raising the question of optimal capital levels relative to risk taking.

• Some argue capital is irrelevant, while others stress its importance for credible, independent and effective policy implementation.
Main research question

What **equilibrium capital policies** follow from rational decision making, factoring in the bargaining position of a central bank and its shareholder?
Our contribution to the literature on central bank capital

- We study capital policy as a **financial contract** between the central bank and its shareholder.
- This arrangement involves two mutual obligations:
  - The central bank distributes **dividends** to the shareholder during times of strong capitalization.
  - The shareholder commits to **recapitalizing** the bank if asset values are substantially lower than the liabilities.
- The central bank and the shareholder **bargain** on the parameters of the dividend and recapitalisation policies.
In the paper we follow a three-step approach

- First, we introduce an economic definition of central bank equity including the values of the dividend and recapitalization options
- Second, we formalize the negotiation wherein parties establish the dividend and recapitalization terms via sequential game theory
- Third, we explore the risk-shifting implications of the capital policy via monetary policy that run through these options
Model
Modelling assumptions

- A static, one-period model in the spirit of Merton (1974)
- Information is generated through the standard filtration \( \{ \mathcal{F}_t, \mathbf{P}, \Omega \} \)
- Markets are complete and frictionless
- Any effect of monetary policy is priced in (partial equilibrium)
- After agreeing on capital policy at \( t \), all uncertainty resolves at \( T \)
- There is no discretionary balance sheet expansion or contraction
- The shareholder can always deliver on any promised recapitalization*

*Recapitalization could include a bond-for-equity stake swap or a deferred asset
### Central bank’s accounting balance sheet (marked-to-market)

<table>
<thead>
<tr>
<th>Assets ($A_t$)</th>
<th>Liabilities ($L_t$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lending operations $M_t$</td>
<td>Banknotes $N$</td>
</tr>
<tr>
<td>Asset purchase program $P_t$</td>
<td>Reserves $R_t$</td>
</tr>
<tr>
<td>Capital</td>
<td>$B_t$</td>
</tr>
</tbody>
</table>

**Assets:**
- $M_t$: Lending operations grow at rate $r$
- $P_t$: Risky assets from an asset purchase program with risk $\sigma$
- $\omega$: Share of risky assets, or $P_t$ into $A_t$

**Liabilities:**
- $N$: Banknotes are fixed
- $R_t$: Reserves growth at rate $r$
- $B_t = A_t - L_t$: Accounting capital
Central bank equity
(step 1)
Contingent dividend and recapitalization policies

- The value of equity is driven by capital and the capital policy
- The central bank pays a **dividend** to the shareholder if assets exceed liabilities by a factor $\kappa_C > 1$ at $t = T$
- Size of the dividend (short call option):

$$C_T = \max\{0, A_T - \kappa_C L_T\} \quad (1)$$

- The shareholder **recapitalizes** the central bank if assets fall below liabilities by a factor $\kappa_\Pi < 1$ at $t = T$
- Size of the recapitalization amount (long gap put option):

$$\Pi_T = \max\{0, L_T - A_T\} \quad (2)$$

- In case of a recapitalisation, the capital position is **fully** resolved
Contingent dividend and recapitalization policies

- The value of equity is driven by capital and the capital policy
- The central bank pays a **dividend** to the shareholder if assets exceed liabilities by a factor $\kappa_C > 1$ at $t = T$
- Size of the dividend (short call option):

  $$C_T = \max\{0, A_T - \kappa_C L_T\}$$  \hspace{1cm} (1)

- The shareholder **recapitalizes** the central bank if assets fall below liabilities by a factor $\kappa_\Pi < 1$ at $t = T$
- Size of the recapitalization amount (long gap put option):

  $$\Pi_T = \max\{0, L_T - A_T\}$$  \hspace{1cm} (2)

- In case of a recapitalisation, the capital position is **fully** resolved
Both policies determine the central bank’s equity at maturity

**Figure 2:** Central bank equity pay-off at maturity

\[ E_T = B_T + \Pi_T - C_T \]

\[ B_T = A_T - L_T \rightarrow \]

Dividend payment

Recapitalisation

\[ \kappa \Pi L_T \]

\[ \kappa C L_T \]
The implicit balance sheet takes policies options into account.

### Table 1: Central bank’s balance sheet including the implicit options

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lending operations</td>
<td>$M_t$</td>
</tr>
<tr>
<td>Asset purchase program</td>
<td>$P_t$</td>
</tr>
<tr>
<td>Recapitalization option</td>
<td>$\Pi_t$</td>
</tr>
<tr>
<td></td>
<td>Banknotes $N$</td>
</tr>
<tr>
<td></td>
<td>Reserves $R_t$</td>
</tr>
<tr>
<td></td>
<td>Dividend option $C_t$</td>
</tr>
<tr>
<td></td>
<td>Equity $E_t$</td>
</tr>
</tbody>
</table>

$\implies$ The value of the central bank’s equity is given by:

$$E_t = A_t - L_t + \Pi_t - C_t$$  \hspace{1cm} (3)

Both options be valued through the Black-Scholes-Merton relation.
Capital policy smooths the value of equity vs capital

Figure 3: Equity value as a function of asset value

The dynamics of **equity** value as a function of assets (blue line) versus accounting **capital** (red dashed line) are remarkably different.
Negotiating process
(step 2)
The central bank and the shareholder are risk neutral. They determine ex ante the capital policy defined by $\kappa_C$ and $\kappa_\Pi$. Equilibrium is defined as a mutually beneficial arrangement that discourages deviation for either party.
Relevant constraints in the bargaining process

- The central bank needs sufficient funding \textit{ex ante} to be credible

\[ E_t \geq \eta L_t \]

- The central bank needs sufficient funding \textit{ex post} to be credible

\[ \kappa \Pi \geq \eta + 1 \]

- The shareholder participates only if the NPV is sufficiently positive

\[ C_t - \Pi_t \geq \theta L_t \]

- Dividend is only paid if assets exceed liabilities

\[ \kappa_C \geq 1 \]

- Recapitalization is only done if assets fall short of liabilities

\[ \kappa_\Pi \leq 1 \]
Distress boundary and central bank credibility

- We assume that the distress boundary or tipping point $\eta$ below which the central bank is no longer credible is known.
- In practice this point is influenced by the bank’s perceived ability in maintaining economic stability, policy consistency and independence.
The constraints lead to a feasible region of policy combinations.

**Figure 4:** Constraints and feasible combinations of policy parameters

\[
\kappa_C \leq 1 \\
\kappa_{\Pi} \geq 1 \\
C_t - \Pi_t \geq \theta L_t \\
E_t \geq \eta L_t \\
\kappa_{\Pi} = \eta + 1
\]
Sequential game:  

- Each party is given **authority** over only one parameter  
- The first player leads by making the initial move, assuming that the second player will observe and respond **strategically**  
- **Backward induction** is applied to solve the game
Equilibria under all possible bargaining combinations

## Table 2: Sequential Equilibrium Combinations

<table>
<thead>
<tr>
<th>Who sets which policy</th>
<th>Central bank (CB)</th>
<th>Shareholder (SH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Dividend policy</td>
<td>SH</td>
<td>CB</td>
</tr>
<tr>
<td>- Recapitalization policy</td>
<td>CB</td>
<td>SH</td>
</tr>
</tbody>
</table>

**Equilibrium impact on thresholds**

| - Dividend payment threshold   | Lower             | Higher           |
| - Recapitalization threshold   | Higher            | Lower            |

**Equilibrium Point**

(3) (1) (3) (1) to (2)

⇒ Given the similar outcomes it is more important **how** decision rights are allocated than who moves first
Risk-Shifting Implications (step 3)
Potential risk-shifting and policy implications

- Capital policy **distributes risk** between central bank and shareholder
- **Potential incentives** for the central bank once capital policy is set
  - An incentive to increase risk, shifting it towards the shareholder
  - An incentive to reduce risk to limit shareholder dividend potential
- **Relevant metric**: the change in the value of equity for changes in the share of risky assets (known as “vega”)
Risk reducing incentive for a well-capitalized central bank

Figure 5: Option and equity value as a function of risk

Values calibrated for accounting capital at 3% of Liabilities; $\kappa_C = 105\%$, $\kappa_\Pi = 95\%$

$\implies$ A well capitalized central bank has an incentive to reduce risk in order to increase its equity value
Figure 6: Option and equity value as a function of risk

Values calibrated for accounting capital at $-5\%$ of Liabilities; $\kappa_C = 105\%, \kappa_\Pi = 95\%$

$\Rightarrow$ Without a proper institutional framework an under-capitalized central bank has an incentive for risk taking and increase its equity value.
To sum up...
Our key findings

• The dynamics of a central bank’s accounting capital versus the economic value of its equity are remarkably different.

• The equilibrium capital policy depends on how decision rights are allocated between the central bank and shareholder.

• The implications of shifting risk may result in either an overly aggressive response to policy objectives or excessive caution.
Annex
### Table 3: Baseline Model Calibration

<table>
<thead>
<tr>
<th>Variable</th>
<th>Notation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model horizon (option maturity in years)</td>
<td>$T$</td>
<td>1</td>
</tr>
<tr>
<td>Banknotes</td>
<td>$N$</td>
<td>25</td>
</tr>
<tr>
<td>Reserves</td>
<td>$R_t$</td>
<td>75</td>
</tr>
<tr>
<td>Total assets</td>
<td>$A_t$</td>
<td>103</td>
</tr>
<tr>
<td>Accounting capital</td>
<td>$B_t$</td>
<td>3</td>
</tr>
<tr>
<td>Share invested in the risky asset</td>
<td>$\omega$</td>
<td>50%</td>
</tr>
<tr>
<td>Standard deviation of the risky asset’s return</td>
<td>$\sigma$</td>
<td>20%</td>
</tr>
<tr>
<td>Risk-free rate</td>
<td>$r$</td>
<td>5%</td>
</tr>
<tr>
<td>Dividend (call) strike multiple</td>
<td>$\kappa_C$</td>
<td>1.05</td>
</tr>
<tr>
<td>Recapitalization (put) strike multiple</td>
<td>$\kappa_{\Pi}$</td>
<td>0.95</td>
</tr>
<tr>
<td>Shareholder participation threshold</td>
<td>$\theta$</td>
<td>2.5%</td>
</tr>
<tr>
<td>Central bank viability threshold</td>
<td>$\eta$</td>
<td>−15%</td>
</tr>
</tbody>
</table>
Sequential solutions based on allocation of decision rights

\[ \kappa_C \quad \kappa_\Pi \]

\[ \text{(3)} \]

\[ \kappa_C \quad \kappa_\Pi \]

\[ \text{(1)} \]

\[ \kappa_C \quad \kappa_\Pi \]

\[ \text{(2)} \]

\[ \kappa_C \quad \kappa_\Pi \]

\[ \text{(3)} \]