Central Bank Capital and Shareholder Relationship

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

Unveiling central banks' financial fortitude

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)

Assets (A_t)		Liabilities (L_t)	
Lending operations	M_t	Banknotes	N
Asset purchase program	P_t	Reserves	R_t
		Capital	B_t

Assets:

- M_t : Lending operations grow at rate r
- P_t : Risky assets from an asset purchase program with risk σ
- ω : 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):

$$C_T = \max\{0, A_T - \kappa_C L_T\} \tag{1}$$

- 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):

$$\Pi_T = \max\{0, L_T - A_T\} \tag{2}$$

- In case of a recapitalisation, the capital position is **fully** resolved

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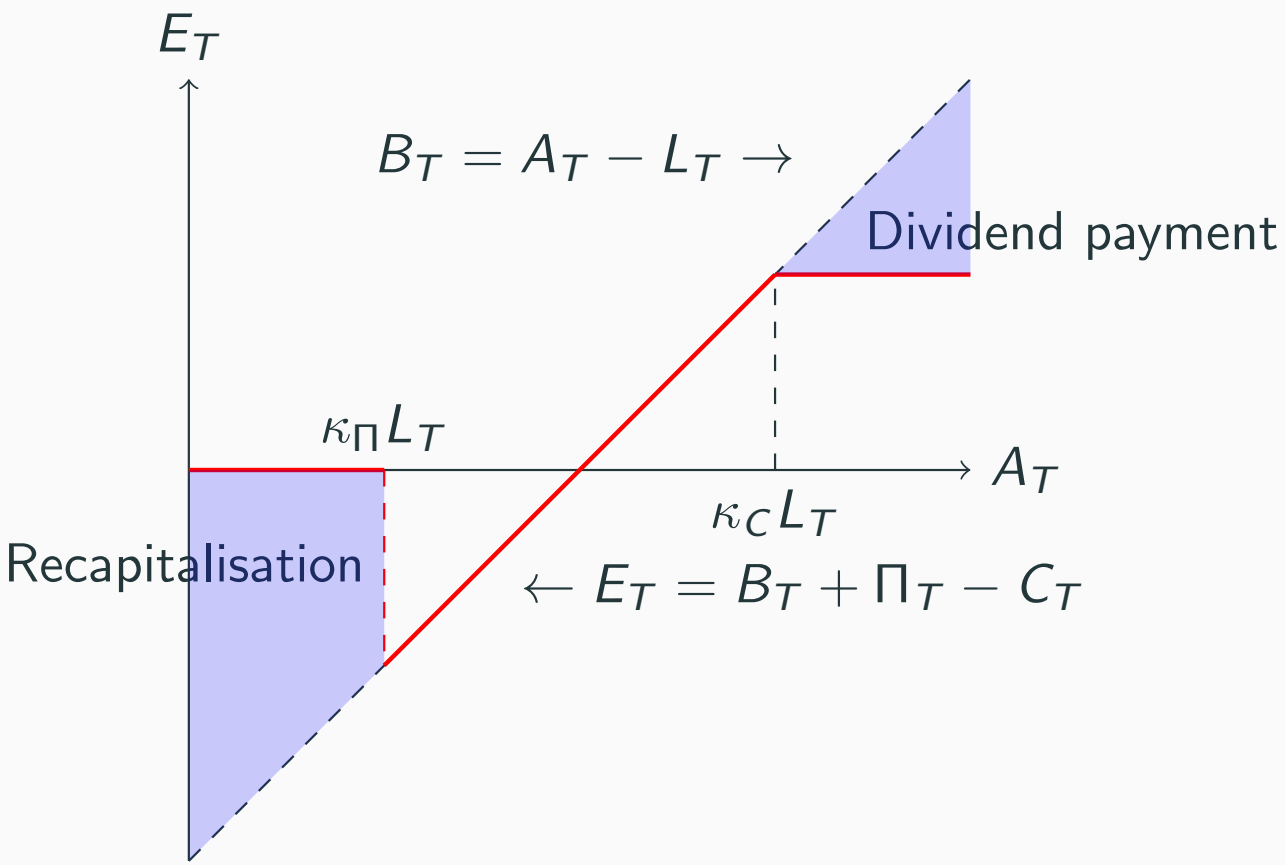
Both policies determine the central bank's equity at maturity

Figure 2: Central bank equity pay-off at maturity



The implicit balance sheet takes policies options into account

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

Assets		Liabilities	
Lending operations	M_t	Banknotes	N
Asset purchase program	P_t	Reserves	R_t
Recapitalization option	Π_t	Dividend option	C_t
		Equity	E_t

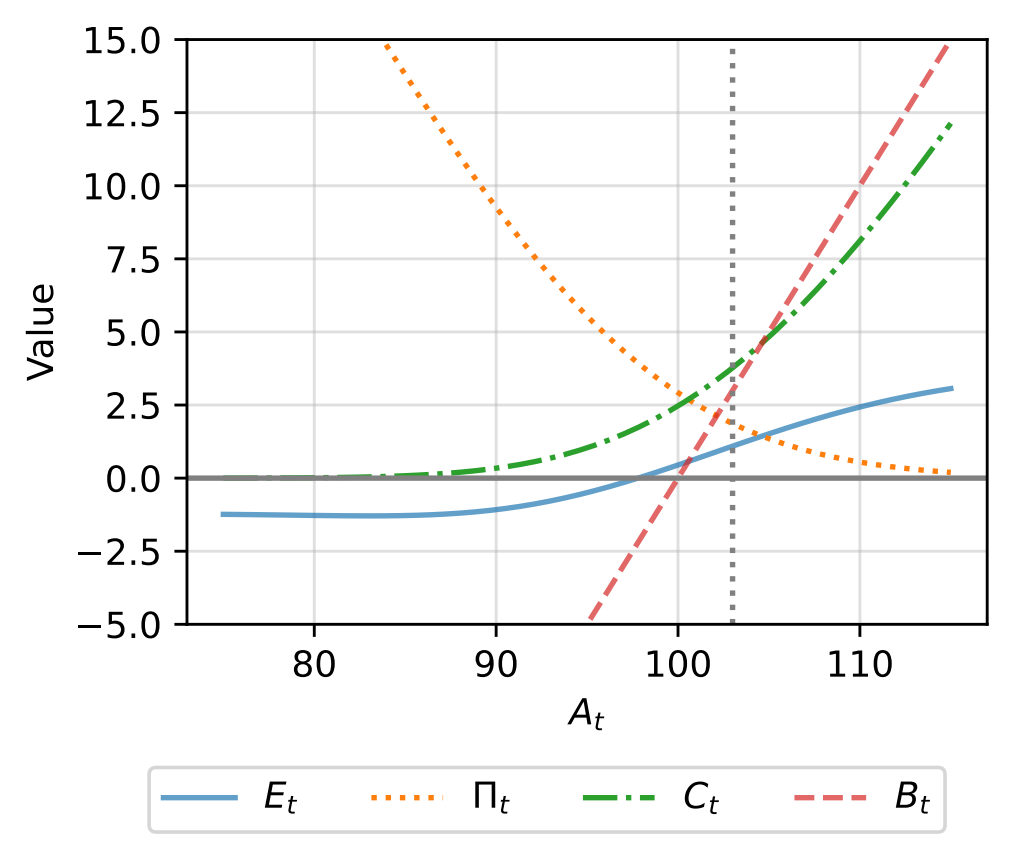
$\Longrightarrow$ The value of the central bank's **equity** is given by:

$$E_t = A_t - L_t + \Pi_t - C_t \tag{3}$$

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 ⏩ Calibration



$\Longrightarrow$ 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)

Determining a capital policy in equilibrium

- The central bank and the shareholder are **risk neutral**
- They determine *ex ante* the **capital policy** defined by κ_C and κ_Π
- 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 **ex ante** to be credible

$$E_t \geq \eta L_t$$

- The central bank needs sufficient funding **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

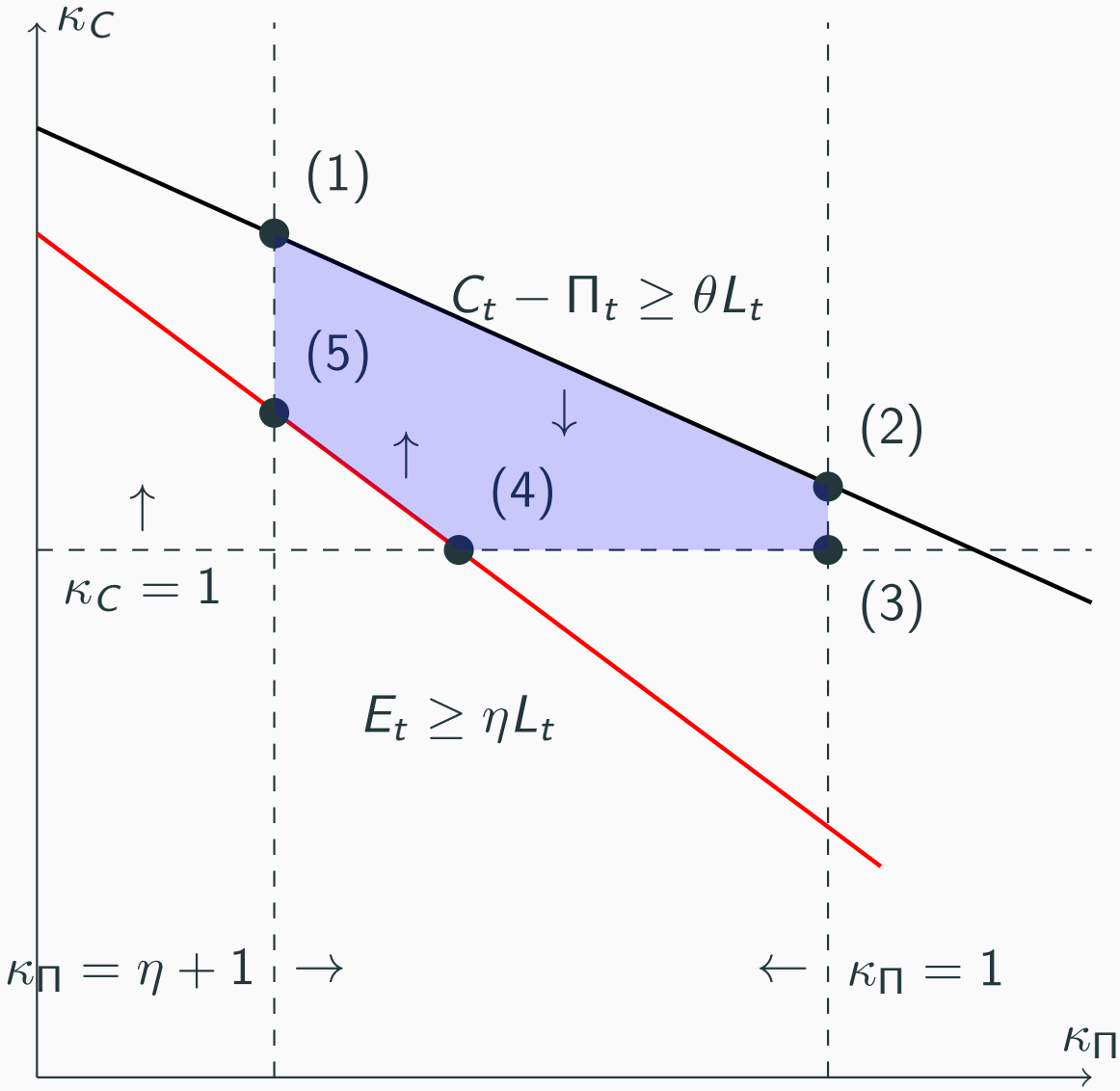
$$\kappa_\Pi \leq 1$$

Distress boundary and central bank credibility

- We assume that the distress boundary or tipping point η 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



Sequential game to derive an equilibrium capital policy

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

⏩ Details

Equilibria under all possible bargaining combinations

Table 2: Sequential Equilibrium Combinations

First mover	Central bank (CB)		Shareholder (SH)	
Who sets which policy				
- Dividend policy	SH	CB	SH	CB
- Recapitalization policy	CB	SH	CB	SH
Equilibrium impact on thresholds				
- Dividend payment threshold	Lower	Higher	Lower	Higher
- Recapitalization threshold	Higher	Lower	Higher	Higher
Equilibrium Point	(3)	(1)	(3)	(1) to (2)

$\Longrightarrow$ Given the similar outcomes it is more important **how** decision rights are allocated than who moves first

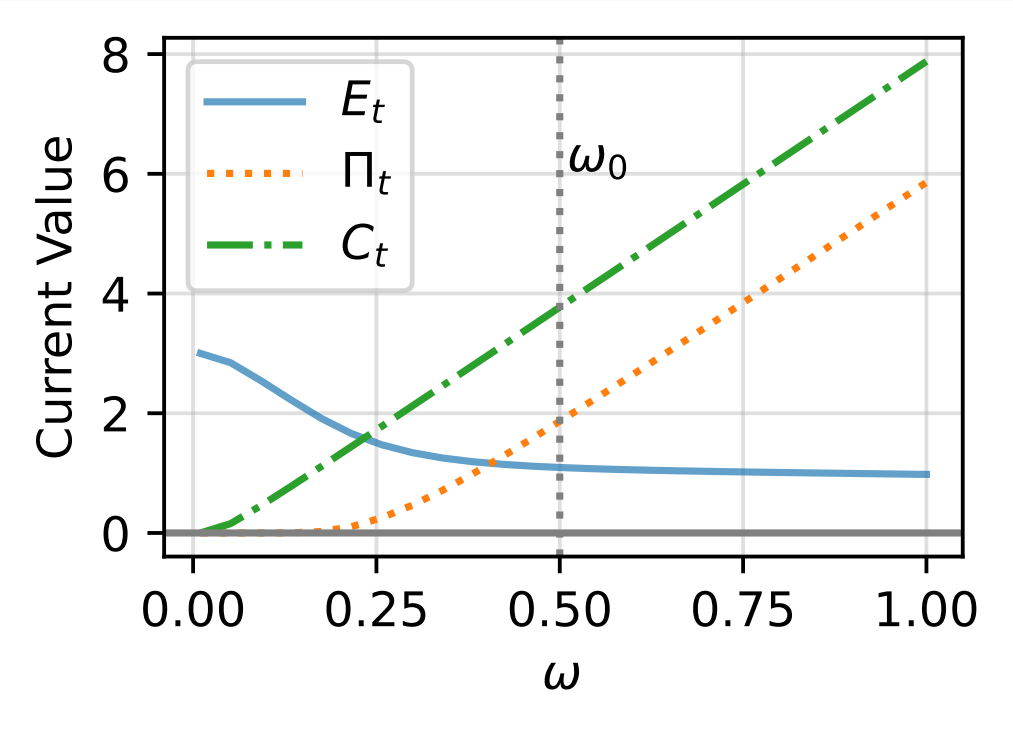
Risk-Shifting Implications (step 3)

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

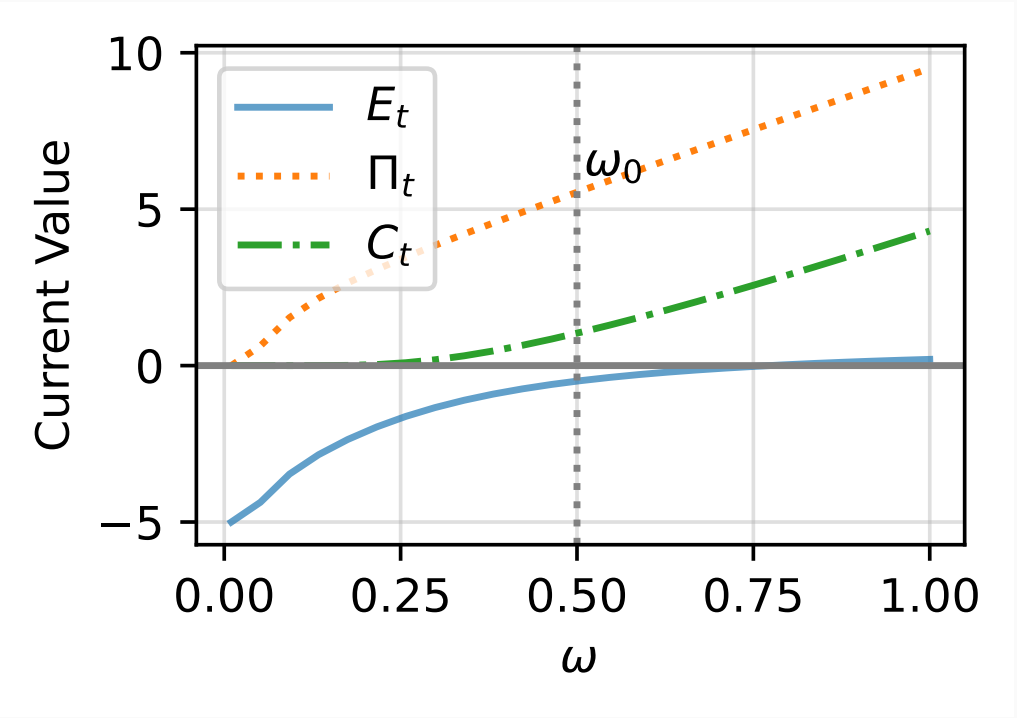


Values calibrated for accounting capital at 3% of Liabilities; $\kappa_C = 105\%, \kappa_\Pi = 95\%$

$\Longrightarrow$ A well capitalized central bank has an incentive to reduce risk in order to increase its equity value

Risk taking incentive for an under-capitalized central bank

Figure 6: Option and equity value as a function of risk



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

$\Longrightarrow$ 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

Appendix: Baseline calibration of the model

Variable	Notation	Value
Model horizon (option maturity in years)	T	1
Banknotes	N	25
Reserves	R_t	75
Total assets	A_t	103
Accounting capital	B_t	3
Share invested in the risky asset	ω	50%
Standard deviation of the risky asset's return	σ	20%
Risk-free rate	r	5%
Dividend (call) strike multiple	κ_C	1.05
Recapitalization (put) strike multiple	κ_Π	0.95
Shareholder participation threshold	θ	2.5%
Central bank viability threshold	η	-15%

Table 3: Baseline Model Calibration

⏩ Back, Equity Value

Sequential solutions based on allocation of decision rights

⏩ Back, Capital Policy