Coordinating Bank Dividend and Capital Regulation

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Motivation

During COVID-19, regulators recommended (EU) or compelled (US) banks to suspend dividend payments (*Acharya et al., 2011; Belloni et al., 2024)*

The **short-term** policy effects have been explored **empirically**:

→ Sustained bank lending (*Hardy, 2021; Couaillier et al., 2025*)

→ **but** hurt market value *(Andreeva et al., 2023; Sanders et al., 2024)*

There is (almost) no theory on

- How does dividend regulation (bans, windfall taxes) affect banks' decisions in the long run?
- How does dividend regulation interact with capital regulation?

This paper

Study the optimal control problem of a bank choosing dividends and equity issuance *(Décamps et al., 2011)* under macro risk *(Hackbarth et al., 2006)* and **state-contingent regulation** (dividends and capital requirement)

Main results

→ Dividend taxes (bans) in bad states foster average capital buffers in those states and overall (long run) **but**:

1. Reduce them in good states and hurt long-run bank value
2. Curbs recapitalisation incentives; increases capital buffer dispersion

→ Coordinating dividend taxes and counter-cyclical capital requirements can mitigate (1) but exacerbate (2)

Model (environment)

Time $t \in [0, \infty)$. A risk-neutral manager runs a bank w/o agency conflicts.

- **Macro risk** $I_t \in \{1, 2\}$ Markov chain with transition intensity λ_{I_t}
- **Assets** Fixed loans (L) generate stochastic cash flows

$$dC_{I_t} = \bar{\mu}_{I_t} dt + \sigma_{I_t} dW.$$

$I_t = 1$ (2) "good" ("bad") state ($\bar{\mu}_1 \geq \bar{\mu}_2$, $\sigma_1 \leq \sigma_2$)

- **Liabilities** Insured deposits (D) remunerated at $\rho \geq 0$

Cash-flows can be stored (**buffers**, X_t) or distributed (**dividends**, Z_t)

Model (state-contingent regulation)

1. **Dividend tax** $1 - T_{I_t} := \beta_{I_t}$. $\beta_1 = 1$, $\beta_2 \leq 1$
2. **Capital requirements** ensure deposits safety:

$$X_t \geq x_{R,I_t} = D - \alpha L + \Gamma_{I_t}, \tag{1}$$

with $\alpha \in (0,1)$ fire-sale price, Γ_{I_t} buffer or subsidy

When (1) binds, the bank can:

- Liquidate loans and repay depositors (forgo future dividends)
- Pay fixed cost κ and issue equity G_n (keep operating)

$\rightarrow$ Capital buffers prevent costly recapitalisation

The model (bank optimisation problem)

Given $I_0 = 1$ and $X_0 = x > x_{R,i}$, bank equity has value

$$V(x,i) := \sup_{\{Z_t, G_t, \tau_n\}} \mathbb{E}_0 \left[\int_0^{\tau_\ell} e^{-\delta t} \beta_{I_t} dZ_t - \sum_{n=1}^{\ell-1} e^{-\delta \tau_n} (G_n + \kappa) \right]$$

subject to

$$dX_t = \underbrace{(\bar{\mu}_{I_t} - \rho D)}_{:=\mu_{I_t}} dt + \sigma_{I_t} dW_t - dZ_t, \qquad t \in [\tau_n, \tau_{n+1}),$$

where $\tau_n := \inf \{ t \geq 0 : X_t = x_{R,I_t} \}$ and

$$V(x_{R_i}, i) = \max \left\{ \max_G \{ V(x_{R_i} + G) - G - \kappa \}, \Gamma_i^+ \right\} \textbf{ (icc)}$$

Solution structure (univariate)

In the univariate case w/o taxes (*Moreno-Bromberg & Rochet, 2014*), optimal controls are Markovian and singular:

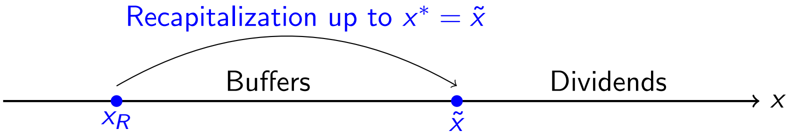

Figure: Solution structure (univariate)

$\rightarrow$ We guess and verify a similar structure in the 2d model (*Cadenillas & Sotomayor, 2011*).

Solution structure (2d model)

For simplicity, set $x_{R,1} = x_{R,2} = x_R$ (and generalise later)

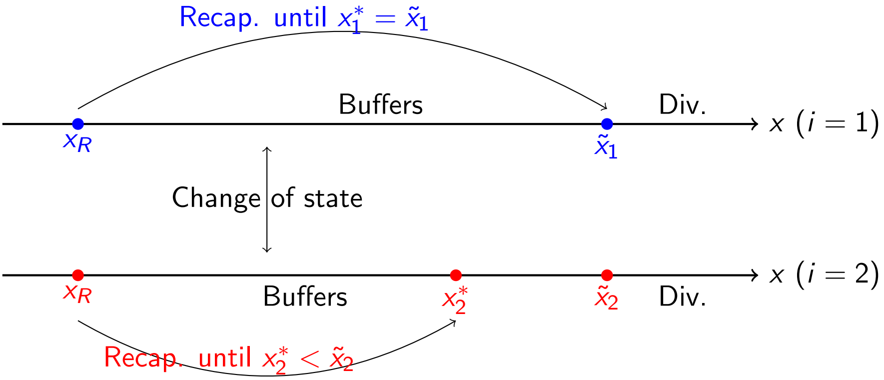

Figure: Solution structure in the 2d model with a-cyclical capital requirements

Bank value

Theorem (Bank value)

- *The candidate value function satisfies*

$$v(x,1) = K_1 + \begin{cases} x - \tilde{x}_1, & x \in [\tilde{x}_1, \infty), \\ \sum_{j=1}^4 A_j e^{\alpha_j (x - \tilde{x}_1)}, & x \in [x_R, \tilde{x}_1), \end{cases}$$

$$v(x,2) = K_2 + \begin{cases} \beta_2 (x - \tilde{x}_2), & x \in [\tilde{x}_2, \infty), \\ \frac{\lambda_2 (x - \tilde{x}_2)}{\delta + \lambda_2} + \sum_{j=1}^2 \tilde{A}_j e^{\tilde{\alpha}_j (x - \tilde{x}_1)}, & x \in [\tilde{x}_1, \tilde{x}_2), \\ \frac{\lambda_2 (\tilde{x}_1 - \tilde{x}_2)}{\delta + \lambda_2} + \sum_{j=1}^4 B_j e^{\alpha_j (x - \tilde{x}_1)}, & x \in [x_R, \tilde{x}_1), \end{cases}$$

  where $\alpha_1 < \alpha_2 < 0 < \alpha_3 < \alpha_4$, $\tilde{\alpha}_1 < 0 < \tilde{\alpha}_2$ *are roots of characteristic eqs, and* A_j, B_j *for* $j = 1, \dots, 4$, $\tilde{A}_i$ *and* K_i *for* $i = 1, 2$ *solve linear systems.*
- *(Verification)* $v(x,i) = V(x,i)$.
- *(Optimal control) Uniqueness* $\tilde{x}_2 \geq x_2^*$, $\tilde{x}_1 = x_1^*$.

Special case (dividend ban) When $\beta_2 \leq \frac{\lambda_2}{\delta + \lambda_2}$, $\tilde{x}_2 \to \infty$

Capital buffers distribution

The stationary PDF of the bank capital buffers $\pi(x, i)$ satisfies FPE

$$\begin{cases} \frac{\sigma_1^2}{2}\pi''(x,1) - \mu_1\pi'(x,1) + \lambda_1\left(\pi(x,2) - \pi(x,1)\right) = 0, \\ \frac{\sigma_2^2}{2}\pi''(x,2) - \mu_2\pi'(x,2) + \lambda_2\left(\pi(x,1) - \pi(x,2)\right) = 0. \end{cases} \tag{2}$$

We solve (3) analytically *(Cox and Miller, 1965*; *Yaegashi et al., 2019)*

$\rightarrow$ Interpret $\pi(x, i)$ as the cross-sectional distribution of buffers in a unit mass of identical banks

$\rightarrow$ Use $\pi(x, i)$ to proxy long-run "credit capacity" and its dispersion

$$\mathbb{E}^\pi[x] := \sum_{i=1,2} \int_{x_R}^{\tilde{x}_i} x\pi(x,i) \cdot dx,$$

$$\mathbb{V}^\pi[x] = \mathbb{E}^\pi[x^2] - \mathbb{E}^\pi[x]^2.$$

Policy analysis

1. Parametrise the model
2. Comparative statics: effect of the bad-state dividend tax β_2 on
   - Bank value and optimal control
   - Capital buffers distribution
   - Credit capacity and “incentive-compatible” recapitalisation
3. Model extension: interaction between dividend taxes and cyclical capital requirements

Parameters   Comparative statics

Dividend taxes and value

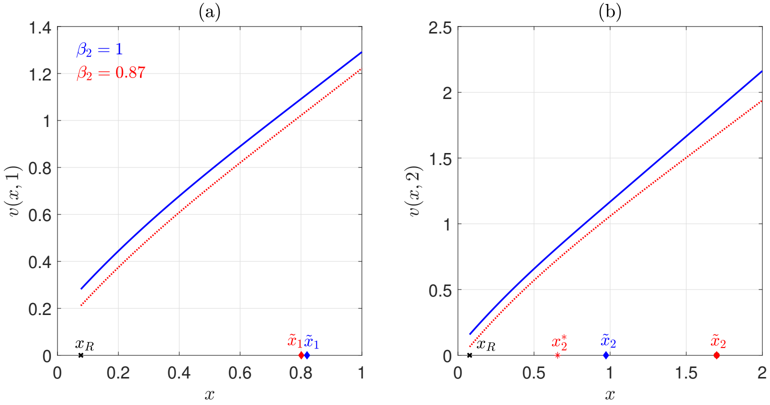

Figure: Bank value and optimal control w (red) and w/o (blue) regulation

Dividend taxes and optimal control

β_2	$\tilde{x}_1$	$\tilde{x}_2$	x_2^*
1.000	0.820	0.950	0.950
0.990	0.819	0.941	0.815
0.950	0.811	1.142	0.724
0.900	0.804	1.421	0.667
0.850	0.800	2.663	0.649
0.834	0.800	17.024	0.649

Table: Optimal dividends and recapitalisation for different values of β_2

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Evaluating dividend regulation (distribution)

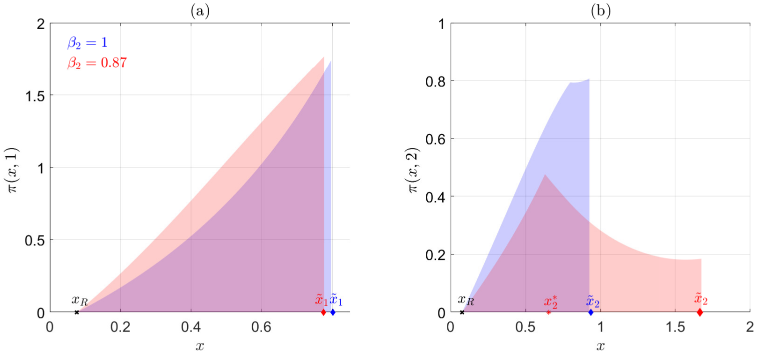

Figure: Dividend taxes and capital buffer distribution

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Dividend taxes and capital buffers distribution

β_2	$\mathbb{E}_1^\pi[x]$	$\mathbb{E}_2^\pi[x]$	$\mathbb{E}^\pi[x]$	$\mathbb{V}_1^\pi[x]$	$\mathbb{V}_2^\pi[x]$	$\mathbb{V}^\pi[x]$	$\bar{\kappa}$
1.00	0.6007	0.6525	0.6214	0.0372	0.0387	0.0389	**0.1351**
0.95	0.5758	0.7473	0.6444	0.0284	0.0609	0.0485	**0.1187**
0.90	0.5698	0.8289	0.6734	0.0280	0.1015	0.0735	**0.1090**
0.87	0.5677	0.8913	0.6971	0.0279	0.1496	0.1017	**0.1057**
0.85	0.5669	0.9448	0.7181	0.0278	0.2118	0.1357	**0.1043**

Table: Credit capacity for different levels of β_2

Dividend taxes increase credit capacity in the bad state (long run) **but**

$\rightarrow$ decrease it in the good state (and increase its dispersion)

$\rightarrow$ **makes (icc) more "binding"**

Counter-cyclical capital requirements

→ Can we use counter-cyclical capital requirements to mitigate the undesirable effects of dividend taxes?

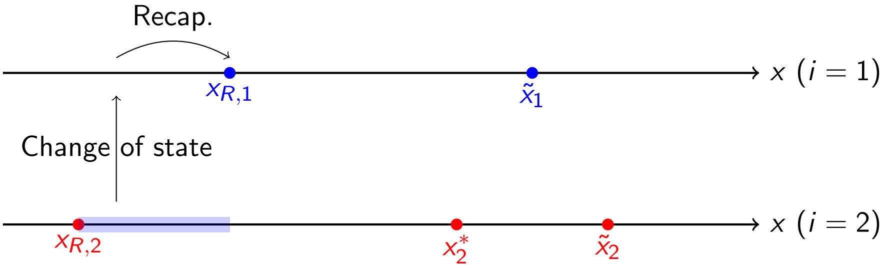

Figure: Solution structure with counter-cyclical capital requirements

Coordinating bank dividend and capital regulation

Mean-preserving counter-cyclical capital regulation:

$$x_R = \underbrace{(D - \alpha L + \Gamma)}_{= x_{R,1}} \underbrace{\frac{\lambda_2}{\lambda_1 + \lambda_2}}_{= \mathbb{P}\{i=1\}} + \underbrace{(D - \alpha L - \Gamma)}_{= x_{R,2}} \underbrace{\frac{\lambda_1}{\lambda_1 + \lambda_2}}_{= \mathbb{P}\{i=2\}} .$$

$x_{R,1}$	$x_{R,2}$	$\tilde{x}_1$	$\tilde{x}_2$	x_2^*	$\mathbb{E}_1^\pi[x]$	$\mathbb{E}_2^\pi[x]$	$\mathbb{E}^\pi[x]$	$\mathbb{V}_1^\pi[x]$	$\mathbb{V}_2^\pi[x]$	$\mathbb{V}^\pi[x]$	$\bar{\kappa}$
0.077	0.077	0.801	1.700	0.655	0.568	0.891	0.697	0.028	0.150	0.102	0.106
0.087	0.062	0.806	1.688	0.643	0.571	0.884	0.696	0.028	0.148	0.099	0.102
0.097	0.047	0.812	1.677	0.631	0.579	0.868	0.694	0.028	0.150	0.097	0.098
0.117	0.017	0.824	1.656	0.609	0.600	0.847	0.693	0.027	0.151	0.092	0.087

Table: Comparative statics for different levels of Γ

- redistributes credit capacity from the bad to the good state
- decreases average reserves and dispersion
- **tightens (icc) further (!)**

Takeaways

We develop a tractable framework to analyse the long-run effects of state-dependent dividend taxes (or bans) and capital regulation on banks

→ Pro-cyclical dividend taxes (bans) foster (reduce) credit capacity in bad (good) states and overall ✓

→ However, they also reduce bank value, harming recapitalisation incentives across states ✗

→ Coordinating dividends and counter-cyclical capital requirements mitigates some adverse effects of the policy but exacerbates others ✓ ✗

Q&A

Did you like the paper (or not)? Let's talk about it!

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SCAN ME

Literature

1. Big picture (*Acharya et al., 2022; Cziraki et al., 2024*).
2. Empirical (*Li et al., 2020; Hardy, 2021; Andreeva et al., 2023; Mücke, 2023; Sanders et al., 2024*).
3. Theory (*Lindensjo and Lindskog, 2020; Vadasz, 2022; Ampudia et al., 2023)*.
4. Dynamic corporate finance (*Jeanblanc-Picqué and Shiryaev, 1995; Hackbarth et al., 2006; Løkka and Zervos 2008; Décamps et al., 2011; Jiang and Pistorius, 2012; Moreno-Bromberg and Rochet 2014; Ferrari et al, 2022)*.

HJBVI

The value function V solves the following HJBVI (system):

$$\max\left\{\mathcal{L}_i V(x,i) - \lambda_i\left[V(x,i) - V(x,3-i)\right], \beta_i - V'(x,i)\right\} = 0,$$

where

$$\mathcal{L}_i\phi = \frac{1}{2}\sigma_i^2\phi'' + \mu_i\phi' - \delta\phi,$$

acts on $\phi \in C^2$ functions for $x > x_{R_i}$, and

$$V(x_{Ri}, i) = \max\left\{\max_G\left\{V(x_{R_i} + G) - G - \kappa\right\}, \Gamma_i^+\right\}, \text{for } i = 1, 2.$$

Building the solution

Aim: find a function $v(x,i) = V(x,i)$.

Steps: (i) Set $x_{R,i} = x_R$ (generalize then), (ii) parametrize $\tilde{x}_i$. (iii) conjecture $x_R < \tilde{x}_1 < \tilde{x}_2$ and identify the regions:

a. $x \in (x_R, \tilde{x}_1)$: continuation in States 1 and 2 ($v'(x,i) < \beta_i$).
b. $x \in (\tilde{x}_1, \tilde{x}_2)$: intervention in State 1 ($v'(x,1) = 1$), continuation in State 2 ($v'(x,2) < \beta_2$).
c. $x \in [\tilde{x}_2, \infty)$: intervention in both states ($v'(x,i) = \beta_i$).

(iv) Impose suitable boundary (continuity, smooth fit, super contact, *Dumas, 1996*) and IC conditions to identify $\tilde{x}_i$.

Region (a)

(a) In $x \in (x_R, \tilde{x}_1)$, continuation is optimal for $i = 1, 2$; $v'(x, i)$ solves

$$\begin{cases} \frac{1}{2}\sigma_1^2 v^{'''}(x,1) + \mu_1 v''(x,1) - (\delta + \lambda_1)\, v'(x,1) + \lambda_1 v'(x,2) = 0, \\ \\ \frac{1}{2}\sigma_2^2 v^{'''}(x,2) + \mu_2 v''(x,2) - (\delta + \lambda_2)\, v'(x,2) + \lambda_2 v'(x,1) = 0. \end{cases}$$

Boundary conditions:

- Optimality: $v'(\tilde{x}_1, 1) = 1$, $v''(\tilde{x}_1, 1) = 0$; *(Dumas, 1996)*.
- Cont and smooth: $v'(\tilde{x}_1^-, 2) = v'(\tilde{x}_1^+, 2)$, $v''(\tilde{x}_1^-, 2) = v''(\tilde{x}_1^+, 2)$.

Regions (b) and (c)

(b) In $x \in (\tilde{x}_1, \tilde{x}_2)$ intervention (continuation) is optimal when $i = 1$ ($i = 2$); $v'(x,2)$ solves

$$\frac{1}{2}\sigma_2^2 v'''(x,2) + \mu_2 v''(x,2) - (\delta + \lambda_2)\, v'(x,2) + \lambda_2 v'(x,1) = 0,$$

and $v'(\cdot,1) = 1$.

Boundary conditions $v'(\tilde{x}_2, 2) = \beta_2$ and $v''(\tilde{x}_2, 2) = 0$ (optimality)

(c) In $x \geq \tilde{x}_2$, intervention is optimal for $i = 1, 2$: $v'(\cdot, i) = \beta_i$.

Parametrization

Parameter	Meaning	Value	Source
μ_1	CF drift, good	0.05	Guo et al. (2005)
μ_2	CF drift, bad	0.02	-
σ_1	CF vol, good	0.25	-
σ_2	CF vol, bad	0.3	-
δ	Discount rate	0.03	-
$1/\lambda_1$	Duration, good	10	Hackbarth et al. (2006)
$1/\lambda_2$	Duration, bad	6.7	-
κ	Recap cost	0.087	P/BV, NYU Stern
x_R	Capital req	0.0769	Endogenous
ρ	Return on deposits	0.0043	FRED
α	Haircut	0.6	Hackbarth et al. (2006)
β_2	Dividend reg	0.87	10 p.p. div tax
L/D	Loan-to-deposit	1.5385	S&P Global

Table: Parameters Back

Capital buffers distribution (credit capacity)

Proposition

Let $x_R \le x_2^* < \tilde{x}_1 < \tilde{x}_2$*. Then, the PDF of the firm's reserves equals*

$$\pi(x,1) = \begin{cases} P_1 e^{r_1 x} + P_2 e^{p_2 x} + P_3 e^{r_3 x} + P_4 e^{r_4 x}, & x \in (x_R, x^*), \\ \tilde{P}_1 e^{r_1 x} + \tilde{P}_2 e^{p_2 x} + \tilde{P}_3 e^{r_3 x} + \tilde{P}_4 e^{r_4 x}, & x \in (x^*, \tilde{x}_1), \\ 0, & x \in (\tilde{x}_1, \infty), \end{cases}$$

$$\pi(x,2) = \begin{cases} Q_1 e^{r_1 x} + Q_2 e^{p_2 x} + Q_3 e^{r_3 x} + Q_4 e^{r_4 x}, & x \in (x_R, x^*), \\ \tilde{Q}_1 e^{r_1 x} + \tilde{Q}_2 e^{p_2 x} + \tilde{Q}_3 e^{r_3 x} + \tilde{Q}_4 e^{r_4 x}, & x \in (x^*, \tilde{x}_1), \\ H_1 e^{s_1 x} + H_2 e^{s_2 x}, & x \in (\tilde{x}_1, \tilde{x}_2), \\ 0, & x \in (\tilde{x}_2, \infty), \end{cases}$$

in which r_j, P_j, $\tilde{P}_j$, Q_j, $\tilde{Q}_j$, *and* s_i, *with* $j = 1, 2, 3, 4$ *and* $i = 1, 2$ *are (constant) solutions to an algebraic equation system and* $\sum_{i=1}^{2} \lambda_{3-1}/(\lambda_1 + \lambda_2) \int_{x_R}^{\infty} \pi(x,i)dx = 1$.

Comparative statics

	$\tilde{x}_1$		$\tilde{x}_2$		x_2^*		$\bar{\kappa}$	
β_2	1.00	0.87	1.00	0.87	1.00	0.87	1.00	0.87
Baseline	0.821	0.801	0.954	1.700	0.954	0.655	0.135	0.106
$\sigma_2 = 0.35$	0.827	0.811	1.051	1.938	1.051	0.710	0.118	0.087
$\mu_1 = 0.07$	0.794	0.776	0.952	1.698	0.952	0.653	0.288	0.251
$\mu_2 = 0.03$	0.820	0.798	0.941	1.651	0.941	0.637	0.194	0.157
$\lambda_1 = 0.05$	0.816	0.806	0.954	1.700	0.954	0.655	0.186	0.160
$\lambda_2 = 0.2$	0.821	0.804	0.950	3.324	0.950	0.672	0.164	0.141
$\Gamma_1 = \Gamma_2 = 0.05$	0.871	0.851	1.007	1.750	1.007	0.705	0.133	0.106
$\Gamma_1 = \Gamma_2 = -0.05$	0.769	0.751	0.923	1.650	0.923	0.605	0.133	0.106

Table: Comparative statics analysis.

Back

Recapitalization frequency

β_2	$\hat{\tau}(1)$	$\hat{\tau}(2)$	$\hat{\tau}$
1.000	11.89	11.56	11.76
0.970	12.44	11.99	12.26
0.870	13.06	12.66	12.90
0.834	13.12	12.74	12.97

Table: Average waiting time (years) between subsequent recapitalisation events, in each State i and overall, for different levels of β_2.

Back

Pro-cyclical capital requirement

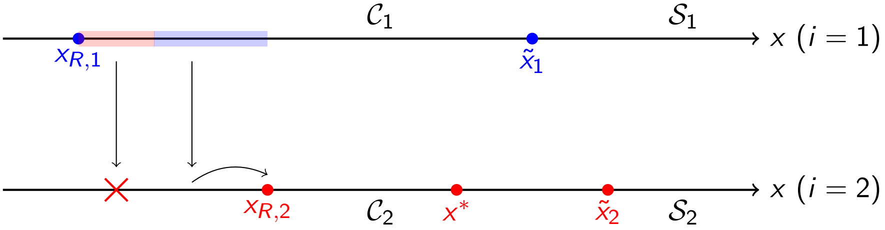

Figure: Solution structure with pro-cyclical capital requirements