Green Capital Requirements

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**Capital Requirements and Climate Change: Motivation**

**Climate change has become a major topic for financial regulators**
- ECB, Bank of England have conducted climate stress tests
- Federal Reserve announced “pilot climate scenario analysis exercise”

The topic remains *controversial* (in regulatory sphere and more broadly)

**Objective:** Analyze capital requirements as a tool to address
- Climate-related financial risks
- Emissions (causing externalities)
High-Level Takeaways

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- Conceptually not different from other risks, key challenge is estimation

Externalities: Capital requirements are inferior to carbon taxes (even if financial regulators could perfectly measure externalities!). Ineffective if bank capital is ample (or firms can access public markets). If impact is possible, it may require sacrificing financial stability.

Capital requirements may help facilitate carbon taxes if environmental regulation subject to commitment problem.
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- Addressing financial risks $\neq$ lower emissions: Increases in capital requirements for dirty loans may crowd out clean lending!
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Model Ingredients

A single-period model, universal risk-neutrality
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Continuum of cashless, **bank-dependent firms**

- finite mass $\pi_q$ of type $q \in \{\text{Clean}, \text{Dirty}\}$
- invest $I$ at $t = 0$, lognormal cash flow $X_q$ at $t = 1$
- $D$ have higher expected CF $\overline{X}_D > \overline{X}_C$ but higher emissions $\phi_D > \phi_C$
Model Setup

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A continuum of competitive **banks**

- maximize value of (fixed) equity \( E \), raise insured deposits
- deposit insurance not perfectly priced (\( \Rightarrow \) transfer to bank)
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A continuum of competitive **banks**

- maximize value of (fixed) equity $E$, raise insured deposits
- deposit insurance not perfectly priced ($\Rightarrow$ transfer to bank)

A **regulator** who sets **capital requirements** $e = \{e_C, e_D\}$

- lower deposit insurance put and affect mass of funded firms $\omega_q$
Roadmap

Preliminary analysis:
Banking sector equilibrium with heterogeneous borrowers

Policy analysis:
Ad-hoc green tilts to capital requirements:
- Brown penalizing factor (higher capital requirements for dirty loans)
- Green supporting factor (lower capital requirements for green loans)

Optimal capital requirements:
- Prudential mandate (cares only about financial risks)
- Impact mandate (also cares about externalities)
Banking Sector Equilibrium

**Demand** for bank equity (from funded loans) = **Supply** of bank equity
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**Supply curve**: Bank equity $E$ (fixed)

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\text{Demand} = \text{Supply} \\
\text{Demand curve: } q \text{ can offer on a unit of bank equity: } \\
\text{Supply curve: } E (fixed) \\
\text{Numerator: bilateral surplus (cash flow and deposit insurance put)} \\
\text{Denominator: amount of bank equity taken up by the loan}
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Banking Sector Equilibrium

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Banking Sector Equilibrium

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**Supply curve:** Bank equity $E$ (fixed)

**Demand curve:** Maximum RoE type $q$ can offer on a unit of bank equity:

$$r_q^{\text{max}}(e_q) = \frac{\text{NPV}_q + \text{PUT}_q}{l_{e_q}}$$

- **Numerator:** bilateral surplus (cash flow and deposit insurance put)
- **Denominator:** amount of bank equity taken up by the loan
Equilibrium for Equal Capital Requirements
A Smoother Version (Heterogeneous Types)

Equal CR

ROE (%)

Fraction of dirty in each bucket

Supply
Clean
Dirty
Positive Analysis: Green Tilts

Take **equal capital requirements** as **point of departure**

- focus on intermediate bank equity case (most interesting)
- given equal capital requirements, dirty loans rank above clean
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Study positive effects of most commonly proposed interventions

- Brown penalizing factor (BPF)
- Green supporting factor (GSF)
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For now, ad-hoc interventions (but insights relevant for optimal regulation)
Brown Penalizing Factor

Small BPF may crowd out clean loans
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Green Supporting Factor

Small GSF crowds in clean loans
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Positive Analysis: Broader Takeaway

Green tilts to capital requirements have **substitution** and **income** effects:

- **Substitution effect:** relatively cheaper to fund clean loans
- **Income effect:** Banks can afford to fund more/less of both types. GSF and BPF have different income effect sign!

General insights also apply in heterogeneous-type setting.
Effect of BPF with Heterogeneous Types

- Substitution effect: improvement of ranking of clean firms
- Income effect: increase in required equity for dirty loans
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Optimal Prudential Capital Requirements

Prudential regulator maximizes

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Rewrite objective as:

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\max_{\boldsymbol{e}} \Omega_P = E \max_{\boldsymbol{e}} \sum \tilde{\omega}_q (\boldsymbol{e}) \ PPI_q(\underline{e}_q),
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where \( \tilde{\omega}_q \) is fraction of equity allocated to type \( q \) and

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PPI_q(\underline{e}_q) = \frac{\text{NPV}_q - \lambda \cdot \text{PUT}_q(\underline{e}_q)}{\underline{e}_q}
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Climate-related financial risk enters via NPV & deposit insurance put
Effect of Increased Financial Risks for Dirty Firms

- optimal to increase **dirty capital requirement** (BPF)
- **size of climate risks** matters
  - moderate risks: prudentially optimal to crowd out clean loans
optimal to increase dirty capital requirement (BPF)

size of climate risks matters

- moderate risks: prudentially optimal to crowd out clean loans
- large risks: set large BPF to induce ranking change
Capital Requirements as a Tool to Lower Emissions?

Consider now regulator with (hypothetical) impact mandate: maximizes

$$\text{NPV from bank loans} - \lambda \text{[deposit insurance put]} - \text{carbon externality}$$

Interesting case: Large externalities $\Rightarrow$ social value is negative

Deposit insurance distortions can be eliminated by setting $e = 1$.

Not the case for externalities!

The limits of green capital requirements:

If banking sector sufficiently well capitalized, cannot prevent funding of dirty loans.

$$r_{\text{max}}^D(1) > 0$$

If bank equity capital limited, can prevent the funding of dirty loans. BUT may have to reduce the capital requirement for clean loans below prudentially optimal level.

$$r_{\text{max}}^C(e_C) \geq r_{\text{max}}^D(1)$$
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- If bank equity capital limited, can prevent the funding of dirty loans. BUT may have to reduce the capital requirement for clean loans below prudentially optimal level. **IC constraint:** $r_C^{\text{max}}(e_C) \geq r_D^{\text{max}}(1)$
Implications

1) **Non-bank financing**: Substitution to bond market removes financial risks from banking sector, but does not lower pollution.

2) **Bank capital scarcity and the cost of raising equity**: Lower frictions to raising bank equity make it easier for capital requirements to address financial risks, harder to address externalities.

3) **Dirty firms’ abatement incentives**: Additional maximization problem to choose optimal technology $\tau$ maximizing $r_q^{max} = \max_\tau r_q^{max}$.
Carbon Taxes versus Capital Requirements

Carbon taxes directly lower profitability of dirty investment
- independent of source of financing and bank capital scarcity
- \[\Rightarrow\] effective regardless of financing frictions or substitution

Capital requirements ineffective as a direct tool to reduce emissions
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But capital requirements may play an *indirect “facilitator role”*
- if carbon taxes too low for fear of imposing losses on banking sector (stranded assets)
- stricter capital requirements provide cushion against such losses
- make credible that environmental regulator will increase carbon taxes

**NB:** specific conditions needed, no blank cheque for intervention
Conclusion

Flexible framework to study green capital requirements under varying assumptions about the severity of climate risks and objective functions.

Positive analysis: brown penalizing factor may crowd out clean loans

Normative analysis distinguishes between addressing financial risks and lowering emissions (externalities)

- prudential regulation can deal with climate-related financial risks
- reducing pollution via capital requirements not always possible and may require sacrificing financial stability
- potential indirect role: reduce stranded asset risk to facilitate carbon tax