A Theory of Eligibility Requirements and Firm Risk-Taking

Matthias Kaldorf[1] **Florian Wicknig**[1]

[1]Deutsche Bundesbank

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Eligibility Requirements

- Common in regulation/policy (QE, collateral, money market, pension & investment funds...).
- Focus on credit risk via minimum rating/maximum PD requirements.
- Sluggish instrument, but not fixed: ECB lowered min. rating requirement for corporate collateral from A to BBB in 2008. Panel
- Regulator's trade-off follows a risk management perspective.
  - Sufficient amount of eligible assets.
  - Low credit risk of eligible assets.

Firm responses affect the trade-off.

Banks are willing to pay premia on eligible bonds. $\Rightarrow$ (Highly-rated) firms increase bond issuance and leverage.

The Role of Firm Responses: This Paper

Research questions

- How do eligibility requirements affect debt and default risk at the firm level?
- What is the role of endogenous firm responses for macro aggregates?
- How should eligibility requirements be designed?

What we do

- Propose a **heterogeneous firm model** with eligibility premia and endogenous corporate debt and default behavior.
- Apply the model to **Eurosystem collateral policy** and evaluate aggregate effects.

The Role of Firm Responses: What We Find

Micro level: collateral eligibility **affects firms heterogeneously**.

- Low-risk firms issue more debt without losing eligibility (**risk-taking effect**).
- Medium-risk firms reduce their debt issuance to benefit from collateral premia (**disciplining effect**).

Macro level: reduce rating requirement from A to BBB.

- Risk- and disciplining effects **increase quantity** of eligible assets, but have opposing impacts on **quality**.
- In total, **firm responses dampen** the mechanical effect of a policy change on the collateral supply.

Eligibility covenant: extension of a minimum rating requirement to account for risk-taking effects $\Rightarrow$ **alleviates** the dampening effect of firm responses.

Related Literature

Theory

- Koulischer and Struyven (2014) and Choi, Santos, and Yorulmazer (2021): central bank lending against low-quality bonds is beneficial under certain conditions.

  Our paper is the first to study macro impact and policy implications in a setting with endogenous collateral supply response.

Empirics

- Chen et al. (2019), Mésonnier, O'Donnell, and Toutain (2022) and Pelizzon et al. (2020): pledgeability/eligibility premium.
- Grosse-Rueschkamp, Steffen, and Streitz (2019), Todorov (2020), Mota (2021): *QE-eligible* firms increase leverage, debt issuance, investment, dividends.
- Kisgen (2009) and Kisgen (2006): firms near rating thresholds reduce their debt issuance.

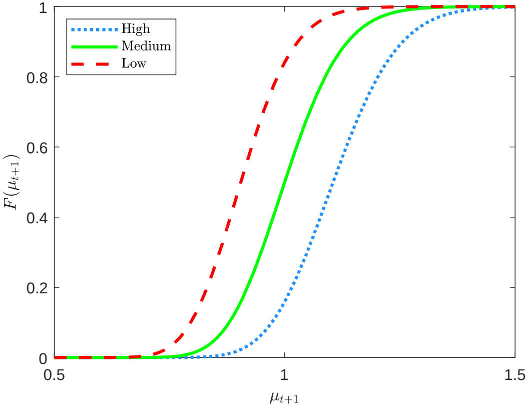
  We provide an analytical framework to study these empirical regularities in equilibrium.

Stylized Model of Eligibility Requirements

- Two (risk-neutral) agents: **banks** and **firms**, trading on the corporate bond market.
- Firm owners/managers are **impatient** ($\beta < 1$): incentive to issue bonds.
- Banks do not discount the future and have an exogenous willingness to pay an eligibility premium.
- Exogenous eligibility threshold (set by the central bank).

Firms: Fundamentals

- Firms receive revenues μ_t^s with a type-specific distribution.
- Denote the cdf by F^s and consider three types $s \in \{low, medium, high\}$.
- These types will arise endogenously from a continuous type distribution.



Corporate Bonds

- One-period discount bonds b_{t+1} are issued at price q_t.
- Firms **default** in $t+1$ if the debt repayment b_{t+1} exceeds the revenues μ_{t+1}.
  $\Rightarrow$ The default probability is given by $F^s(b_{t+1})$.
- Eligibility depends on default risk, where eligibility threshold $\overline{F}$ is a central bank policy variable:

$$\Psi(F_t^s) = \begin{cases} 1 & \text{if } F_t^s \leq \overline{F} \\ 0 & \text{else} \end{cases} \quad .$$

- Banks pay an **eligibility premium** L on eligible bonds. Banks' first-order condition gives the discontinuous bond price schedule for firm type s

$$q_t^s = (1 + \Psi(F_t^s) \cdot L) \cdot (1 - F_t^s) \ .$$

Firms: Optimal Debt Choice details

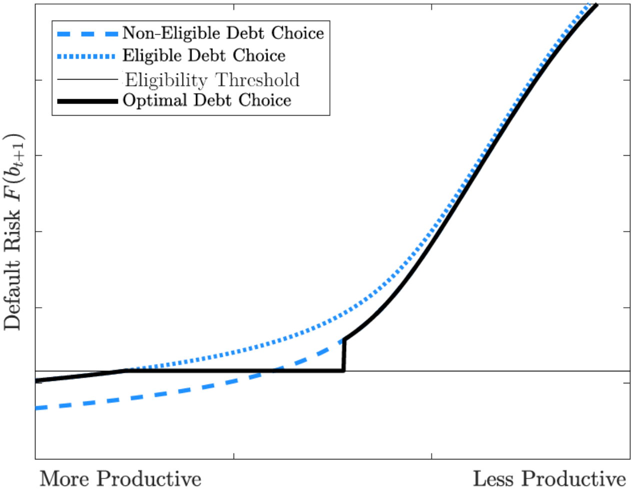
Observation I: Eligible Firms

Under a monotone hazard rate assumption on revenues eligible firms issue more debt than otherwise identical ineligible firms of the same type.

Observation II: Endogenous Firm Types

- Unconstrained eligible (low risk) satisfy $F\left(b_{t+1}^{s}\right) < \overline{F}$.
- Constrained eligible (medium risk) choose $F\left(b_{t+1}^{s}\right) = \overline{F}$.
- Non-eligible (high risk) choose $F\left(b_{t+1}^{s}\right) > \overline{F}$.

Firms: Effect of Eligibility



Eligible debt capacity

Collateral easing

Application to ECB Collateral Policy

Skip to Results

- Modification/extension of Gomes, Jermann, and Schmid (2016).
- **Persistent** idiosyncratic revenues instead of permanently different firms. details
- **Long-term bonds** that mature probabilistically instead of one period bonds $\Rightarrow$ debt rollover in FOC. details
- Free parameters are chosen to match the cross-section of spreads, median debt/EBIT, the collateral premium, and the share of eligible bonds. Full Parameterization

Full Model: Targeted Moments

- Small discrepancy regarding debt/EBIT. The bond spread distribution is matched well.
- We reconcile empirical evidence at the firm level using a simulated cross-section of firms: details

Moment	Data	Model
Eligibility premium $r - r_0$	11	11
Debt/EBIT $Q_{0.50}\vert\overline{F}^A$	4.2	3.2
Bond spread $Q_{0.25}\vert\overline{F}^A$	31	30
Bond spread $Q_{0.50}\vert\overline{F}^A$	51	58
Bond spread $Q_{0.75}\vert\overline{F}^A$	81	80

Macro Effect of Collateral Easing

Formal decomposition Robustness To conclusion

- Decompose the effect on collateral supply into the
  - Mechanical effect (higher $\overline{F}$, constant firm behavior).
  - Firm responses
- Compute the fraction of firms subject to risk-taking or disciplining effects.

	Total Effect	**Mechanical Effect**
Collateral Supply $\overline{B}$	$+62\%$	$+71\%$
Default Costs $\mathcal{M}$	$+8\%$	
Firm Responses	**Disciplining**	**Risk-Taking**
Tight (A)	19%	51%
Lenient (BBB)	3%	79%

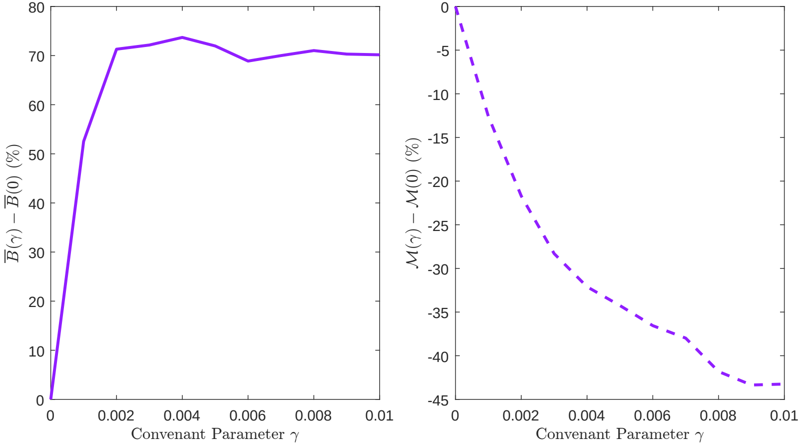
- Driven by increased risk-taking, firm responses dampen the total effect.
  $\Rightarrow$ Long-term debt and persistence of revenue imply debt-rollover risk.

What Can the Central Bank Do?

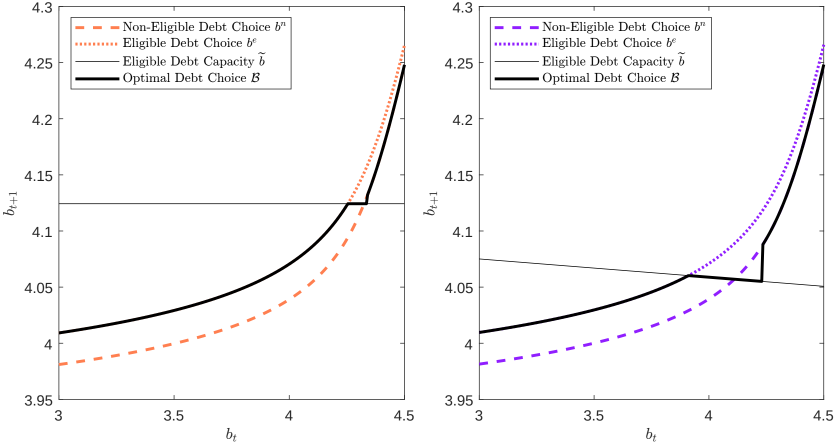
- Disincentivize risk-taking while preserving a sufficiently high supply of collateral.
- How? Condition eligibility on current default risk **and** leverage with **leverage-based** eligibility covenants.
- Leverage-dependent minimum rating requirement with $\frac{\partial \overline{F}_t^j}{\partial b_t^j} < 0$ and policy parameter γ.
- If $\gamma > 0$, highly levered firms have an incentive to deleverage.
- In paper, focus on exponential class to scale the maximum debt a firm can issue without losing eligibility ($\widetilde{b}_{t+1}^j$)

$$\widetilde{b}_{t+1}^{j,covenant} = \exp\{-\gamma b_t^j\} \cdot \widetilde{b}_{t+1}^j$$

Leverage-Based Covenant: Collateral Laffer Curve



Leverage-Based Covenant: Mechanism



Conclusion

This paper:

- We provide a framework to study the endogenous response of firms to eligibility requirements.
- Eligibility requirements have a heterogeneous impact at the firm level.

Application to ECB collateral policy:

- On the aggregate level, firm responses *dampen* the impact of eligibility requirements on collateral supply and increase aggregate default costs.

Policy implication:

- It becomes necessary to account for firm responses in the design of eligibility requirements.
- Eligibility covenants are a potential tool to alleviate these adverse effects.

Corporate Bonds as Collateral: Overview

back

Central bank	**Pre GFC** (Min. rating)	**Post GFC** (Min. rating)	**Post Covid-19** (Min. rating)
Australia	No	Yes (AAA)	Yes (BBB)
Eurosystem	Yes (A)	Yes (BBB)	Yes (BB)*
Japan	Yes (A)	Yes (BBB)†	Yes (BBB)
Switzerland	Yes (AA)	Yes (AA)	Yes (AA)
United Kingdom	No	No	No
United States††	Yes (AAA)	Yes (AAA)	Yes (AAA)

Source: Bank for International Settlements (2013) & national central banks.

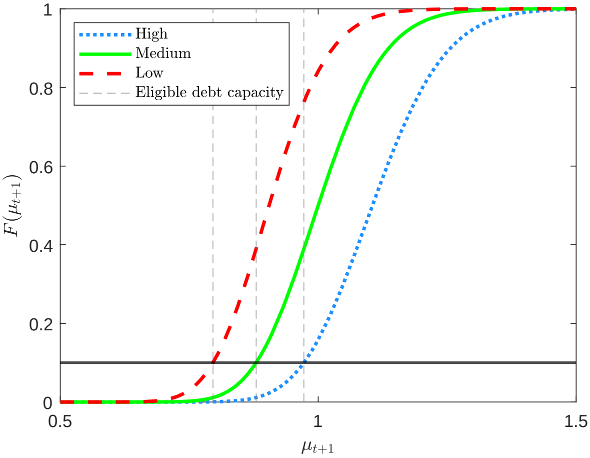
Corporate Bonds as Collateral: Eurosystem back

Timespan	Regime	Haircut:	
		A- or higher	BBB
Jan 2007 - Oct 2008	Fitch, S&P and Moody's accepted as ECAI: minimum requirement A-	4.5 %	100 %
Oct 2008 - Dec 2010	DBRS added as ECAI: minimum requirement BBB-	4.5 %	9.5 %
Jan 2011 - Sep 2013	Tightening of haircuts	5 %	25.5 %
Oct 2013 - today	Relaxation of haircuts	3 %	22.5 %
...	...	...	...
...	...	...	...
April 2020	Relaxation of haircuts by 20 % for duration of PEPP		

Haircuts based on corporate bond with fixed coupon and maturity of 3 to 5 years.

Firms: Eligible Debt Capacity back

Eligible debt capacity: Maximum amount of debt a firm of type s can issue without losing eligibility.



Firms: Debt Choice back

- Solving the firm problem yields the FOC for debt b_{t+1}

$$\frac{\partial q^s(b_{t+1})}{\partial b_{t+1}} b_{t+1} + q^s(b_{t+1}) = \beta\big(1 - F^s(b_{t+1})\big)$$

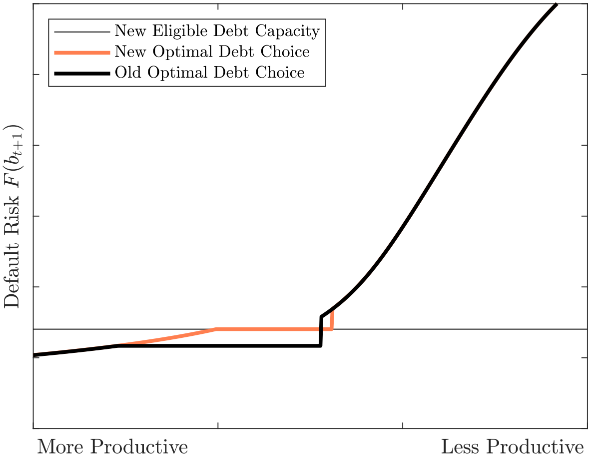
- Derivative of the bond price depends on eligibility

$$\frac{\partial q^s(b_{t+1})}{\partial b_{t+1}} = \begin{cases} -F'(b_{t+1}), & \text{if } F^s_{t+1} > \overline{F} \\ -F'(b_{t+1})(1+L), & \text{if } F^s_{t+1} \leq \overline{F}. \end{cases}$$

- Two potentially optimal debt choices: $b^{s,1}_{t+1}$ and $b^{s,2}_{t+1}$.
- Define the eligible debt capacity as $F(\widetilde{b}^s_{t+1}) = \overline{F}$.
- Denote firm value function by $V^s(\cdot)$. Optimal debt choice

$$\mathcal{B}^s = \mathbb{1}\left\{V^s(b^{s,1}_{t+1}) \leq V^s(\min\{b^{s,2}_{t+1}, \widetilde{b}^s_{t+1}\})\right\} \cdot \min\{b^{s,2}_{t+1}, \widetilde{b}^s_{t+1}\}$$
$$+ \mathbb{1}\left\{V^s(b^{s,1}_{t+1}) > V^s(\min\{b^{s,2}_{t+1}, \widetilde{b}^s_{t+1}\})\right\} \cdot b^{s,1}_{t+1}.$$

Firms: Collateral Easing back



Firms: Fundamentals back

- Firm j receives idiosyncratic revenues $e^{\mu_t^j}$.
- Revenues follow AR(1)-process: $\mu_t^j = \rho_\mu \mu_{t-1}^j + \sigma_\mu \epsilon_t^j$ and $\epsilon_t^j \sim N(0,1)$.
- Bonds mature with probability π.
- Default probability given by

$$F_{t+1}^j = \Phi\left(\frac{\log\left(\pi b_{t+1}^j\right) - \rho_\mu \mu_t^j}{\sigma_\mu}\right) .$$

- Re-arranging gives eligible debt capacity

$$\widetilde{b}_{t+1}^j = \frac{\exp\{\sigma_\mu \Phi^{-1}(\overline{F}) + \rho_\mu \mu_t^j\}}{\pi}$$

Banks: Bond Pricing back

- Price schedule for long-term bonds contains two parts:

$$q(b^j_{t+1}, \mu^j_t) = \frac{1 + \Psi(F(b^j_{t+1}|\mu^j_t))L}{1 + r^{rf}} \left(\pi \cdot \left(1 - F(b^j_{t+1}|\mu^j_t)\right) - (1-\pi) \cdot \mathbb{E}_t \left[q\left(\mathcal{B}(b^j_{t+1}, \mu^j_t), \mu^j_{t+1} \right) \right] \right)$$

1. Repayment and rollover.
2. Eligibility premium.

Firm: Debt Problem back

- The maximization problem can be represented by the Bellman equation

$$W(b^j_t, \mu^j_t) = \max_{b^j_{t+1}} \quad V(b^j_{t+1}, \mu^j_t) \quad \text{with}$$

$$V(b^j_{t+1}, \mu^j_t) = \mathbb{1}\{e^{\mu^j_t} > \pi b^j_t\} \left(e^{\mu^j_t} - \pi b^j_t\right) + q(b^j_{t+1}, \mu^j_t)\left(b^j_{t+1} - (1-\pi)b^j_t\right) + \beta \mathbb{E}_t\left[W(b^j_{t+1}, \mu^j_{t+1})\right] .$$

- FOC for debt

$$\frac{\partial q(b^j_{t+1}, \mu^j_t)}{\partial b}\left(b^j_{t+1} - (1-\pi)b^j_t\right) + q(b^j_{t+1}, \mu^j_t) = \beta\left(\pi(1 - F(b^j_{t+1})) + (1-\pi)\mathbb{E}_t\left[q_{t+1}\right]\right)$$

- Derivative of the bond price

$$\frac{\partial q(b^j_{t+1}, \mu^j_t)}{\partial b^j_{t+1}} = \begin{cases} -F'(b^j_{t+1})\pi \frac{1}{1+r^{rf}} , & \text{if } F^j_{t+1} > \overline{F} \\ -F'(b^j_{t+1})\pi \frac{1+L}{1+r^{rf}} , & \text{if } F^j_{t+1} \leq \overline{F} . \end{cases}$$

Full Parameterization back

Parameter	Value	Source
Bank discount rate r^{rf}	0.0035	EURIBOR-HCPI
Borrower discount factor β	0.995	Standard
Coupon Rate κ	0.01	*Markit* iBoxx
Maturity Parameter π	0.0625	*Markit* iBoxx
Eligibility premium L	0.004	Calibrated
Bankruptcy costs m	0.2	Calibrated
Revenue persistence ρ_μ	0.93	Calibrated
Revenue shock std. dev. σ_μ	0.0375	Calibrated
A-eligibility threshold $\overline{F}^A$	1.4%	Calibrated
BBB-eligibility threshold $\overline{F}^{BBB}$	18.5%	Calibrated

Reconciling Micro-Evidence

back

- Using the model-implied firm cross-section, we run the following regression

$$x^j = \beta_0 + \beta_1 Eligible_t^j + \beta_2 Eligible_t^j \frac{b_t^j}{\mu_t^j} + \epsilon^j \ .$$

- We use the yield reaction, debt issuance, and dividend reaction to surprise eligibility as outcome variables.

- Coefficient signs:

	Data			Model		
Control	$r_t^{j,0} - r_t^j$	$\mathcal{B}_{t+1}^j - b_{t+1}^{j,1}$	$\mathcal{D}_t^j - d_t^{j,1}$	$r_t^{j,0} - r_t^j$	$\mathcal{B}_{t+1}^j - b_{t+1}^{j,1}$	$\mathcal{D}_t^j - d_t^{j,1}$
Eligibility	$+$	$+$	$+$	$+$	$+$	$+$
Leverage $\times$ Eligibility	-	-	-	-	-	-

Collateral Easing in Equilibrium back

The change in collateral supply $\Delta(\overline{B})$ can be decomposed into

$$
\begin{aligned}
\overline{B}^{BBB} - \overline{B}^{A} &\equiv \int \mathbb{1}\{F^{BBB} < \overline{F}^{BBB}\} q^{BBB} b^{BBB} dG^{BBB}(\mu, b) - \int \mathbb{1}\{F^{A} < \overline{F}^{A}\} q^{A} b^{A} dG^{A}(\mu, b) \\
&= \underbrace{\int \mathbb{1}\{F^{BBB} < \overline{F}^{BBB}\} q^{BBB} b^{BBB} dG^{BBB}(\mu, b) - \int \mathbb{1}\{F^{A} < \overline{F}^{BBB}\} q^{A} b^{A} dG^{A}(\mu, b)}_{\text{Firm response}} \\
&\quad + \underbrace{\int \mathbb{1}\{F^{A} < \overline{F}^{BBB}\} q^{A} b^{A} dG^{A}(\mu, b) - \int \mathbb{1}\{F^{A} < \overline{F}^{A}\} q^{A} b^{A} dG^{A}(\mu, b)}_{\text{Mechanical effect}} .
\end{aligned}
$$

Macroeconomic Aggregates: High Fundamental Risk back

	Total Effect	**Mechanical Effect**
Collateral Supply $\overline{B}$	$+58\%$	$+67\%$
Default Costs $\mathcal{M}$	$+7\%$	
Firm Responses	**Disciplining**	**Risk-Taking**
Tight (A)	16%	52%
Lenient (BBB)	0%	77%

Macroeconomic Aggregates: Endogenous Premia back

	Total Effect	Mechanical Effect
Collateral Supply $\overline{B}$	+53%	+66%
Default Costs $\mathcal{M}$	-2%	
Firm Responses	**Disciplining**	**Risk-Taking**
Tight (A)	17%	51%
Lenient (BBB)	0%	82%