Credit Risk Where It's Due: Carbon Pricing and Firm Defaults

Green Finance Research Advances Conference

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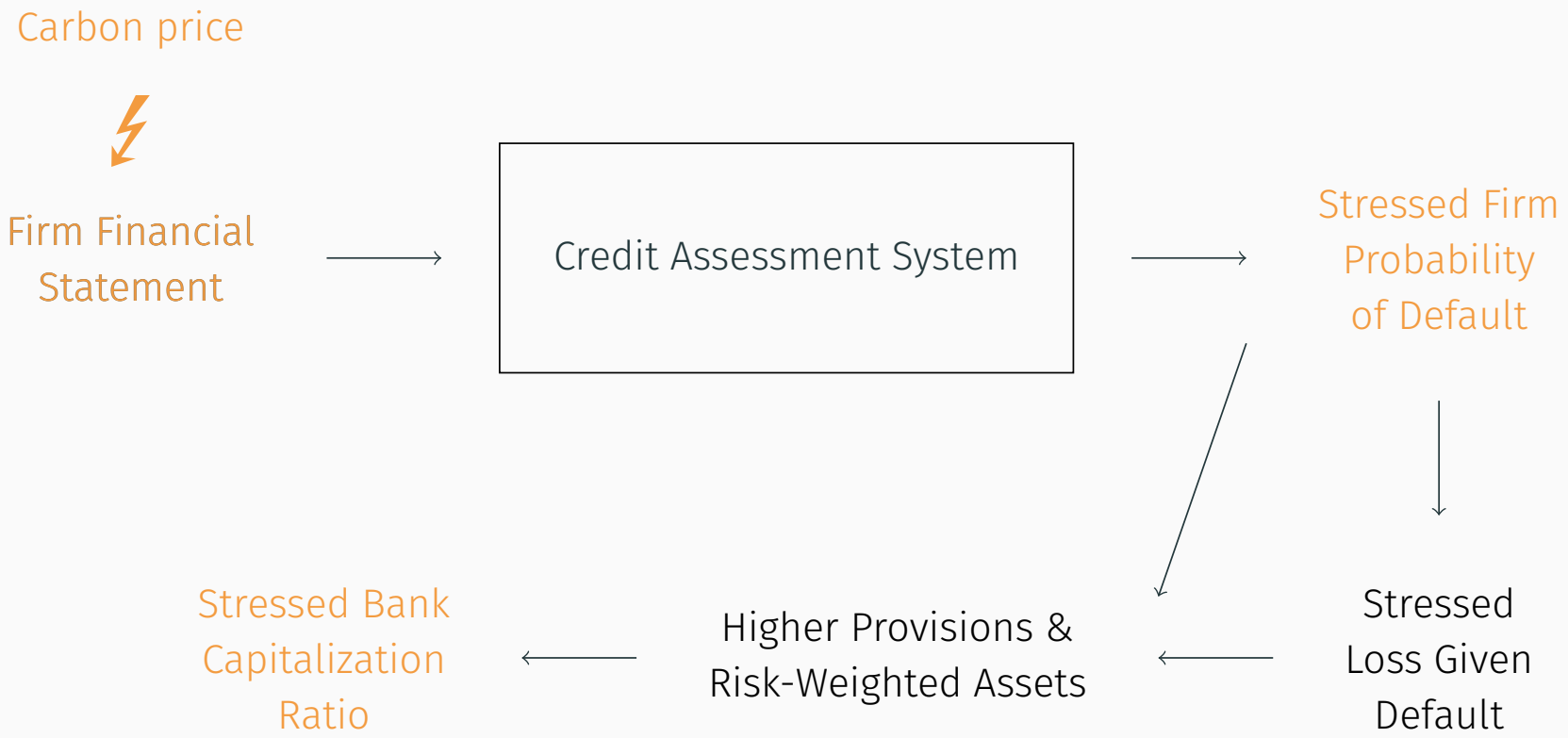
Starting Point - Climate Risks

- **Climate-related financial risks** can arise from the fallout of an ever hotter climate (physical risk) and society's reaction to climate change (transition risk)
- **Transition risk** can be triggered by government policies (most notably carbon pricing), technology and preferences.
- Negative impacts can **be transmitted** via the macroeconomy or affect economic agents directly (micro-economic channel).
- Increased risks can be captured in the **traditional risk categories**: credit risk (PD, LGD), market risk, operational risk, liquidity risk.

Methodology and Data

Methodology: Carbon Price Sensitivity Analysis



Stress Scenarios

Raw scenario

Simple and conservative

- Global carbon price increases *by* EUR 100/ton on Scope 1 emissions
- Firms do not pass-through additional carbon costs, absorb it on their balance sheets/income statements.

Enhanced scenario

More complex and realistic

- Global carbon price increases *to* EUR 100/ton (taking into account firms' costs paid under EU ETS)
- Firms pass-through some of the additional costs (90% for marginal power producer, 50% for firms in other sectors)
- Pass-through leads to costs for Scope 2 emissions

In both scenarios: no macro impact, static balance sheets.

Data on Firms and Banks for 2021

Firm-level data: 776 firms

- Financial statements of European IFRS firms (8 countries)
- Emission data on Scope 1 and 2 and EU ETS (ISS ESG, C4F)

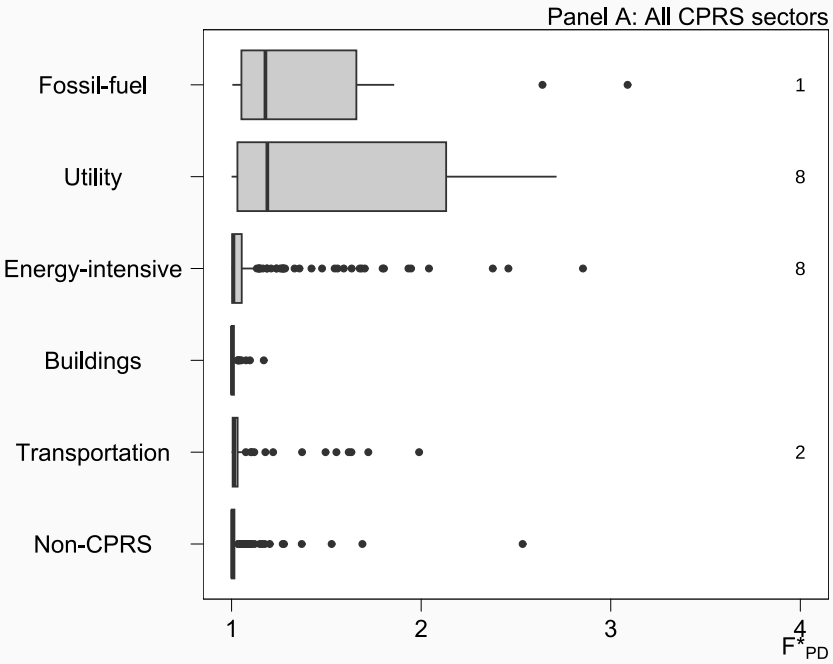
Bank-level data: 81 large banks

- CET1 capital, risk weighted assets from EBA transparency
- Sectoral emission intensities by country and NACE2 level in $tCO_2/Euro$ of turnover from Eurostat
- Exposure data by bank and all firms (about 2.5 million debtors from Anacredit) and aggregate exposure by bank and NACE1 sector from EBA transparency

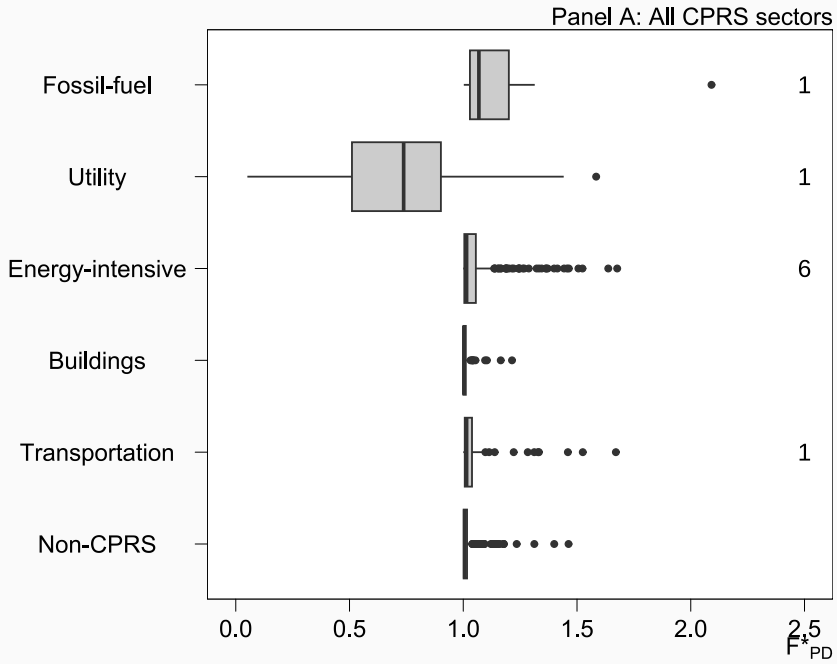
Results

PD Impact on Most Firms is Small

Raw scenario



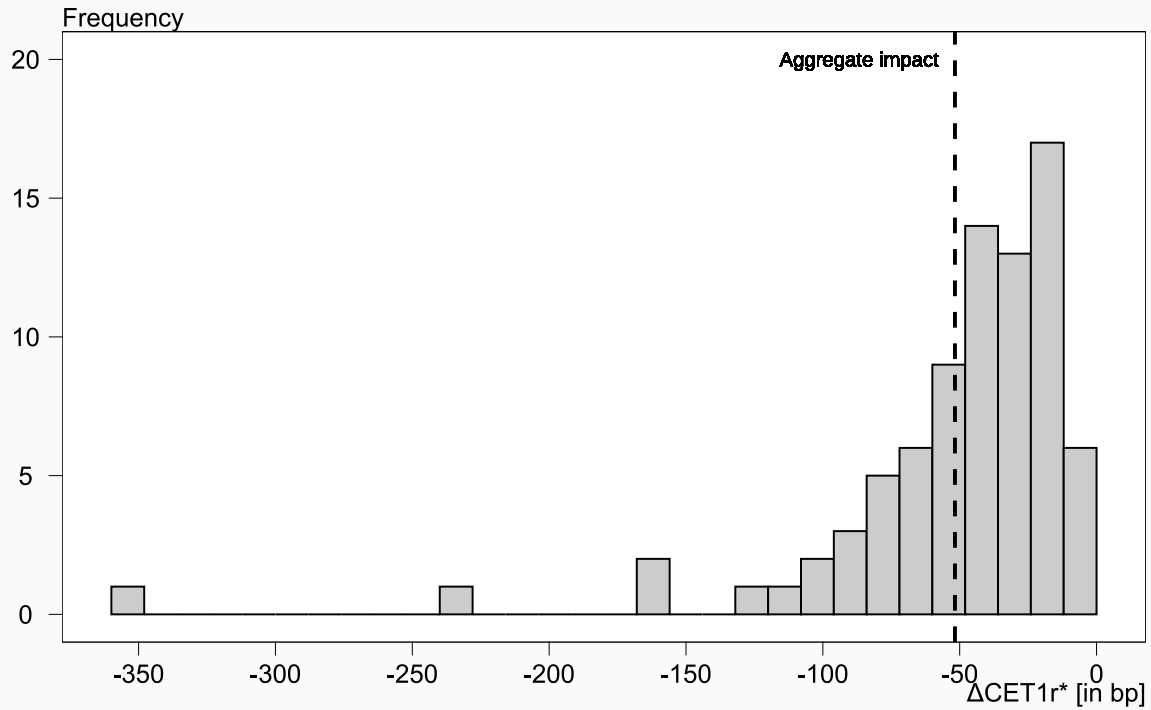
Enhanced scenario



- Raw Highest impact for Fossil fuel (+18%) and Utility (+19%)
- Enhanced Pass-through of costs > smaller PD impact
- Enhanced Utilities benefit from windfall profits > PD decrease

CET1 Impact in the Raw Scenario: -52 bps

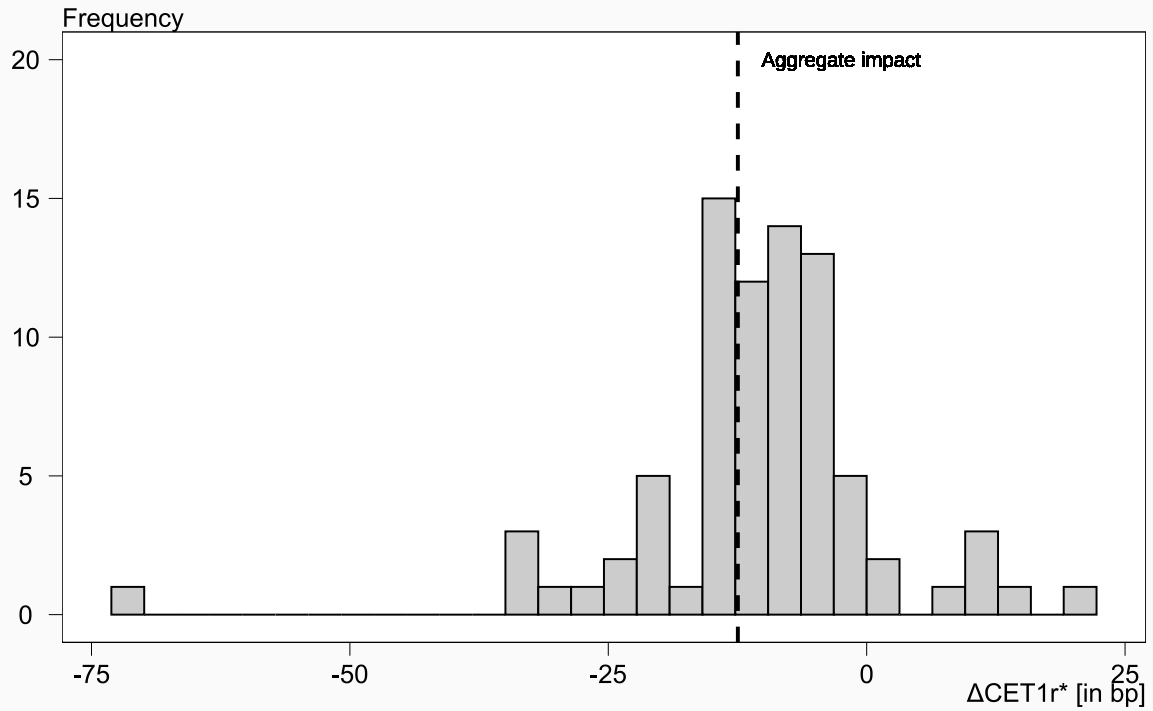
Raw scenario: conservative, increase *by* EUR 100/t, no pass-through.



- Overall, manageable impact for the 81 banking groups
- Some banks strongly affected, but starting from high CET1 ratios

CET1 Impact in the Enhanced Scenario: -13bps

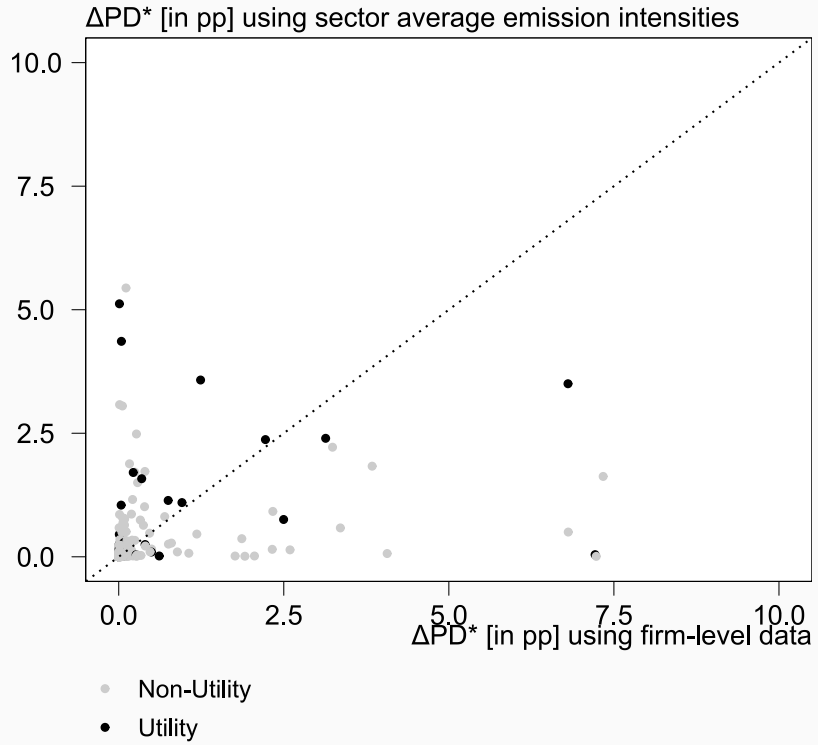
Scenario: more realistic, increase *to* EUR 100/t, pass-through.

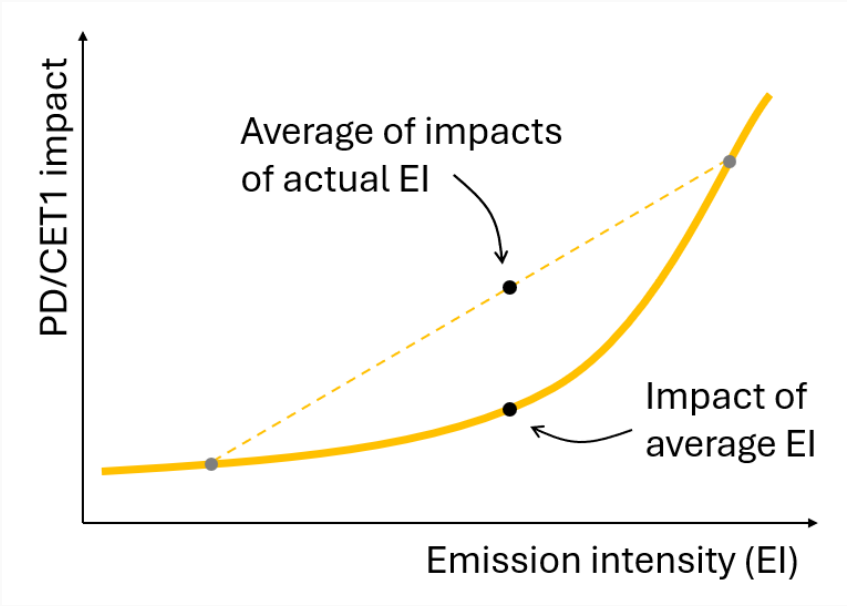


- Carbon cost pass-through mitigates impact
- Increase in CET1r driven by strong exposure to utilities

Discussion and Conclusion

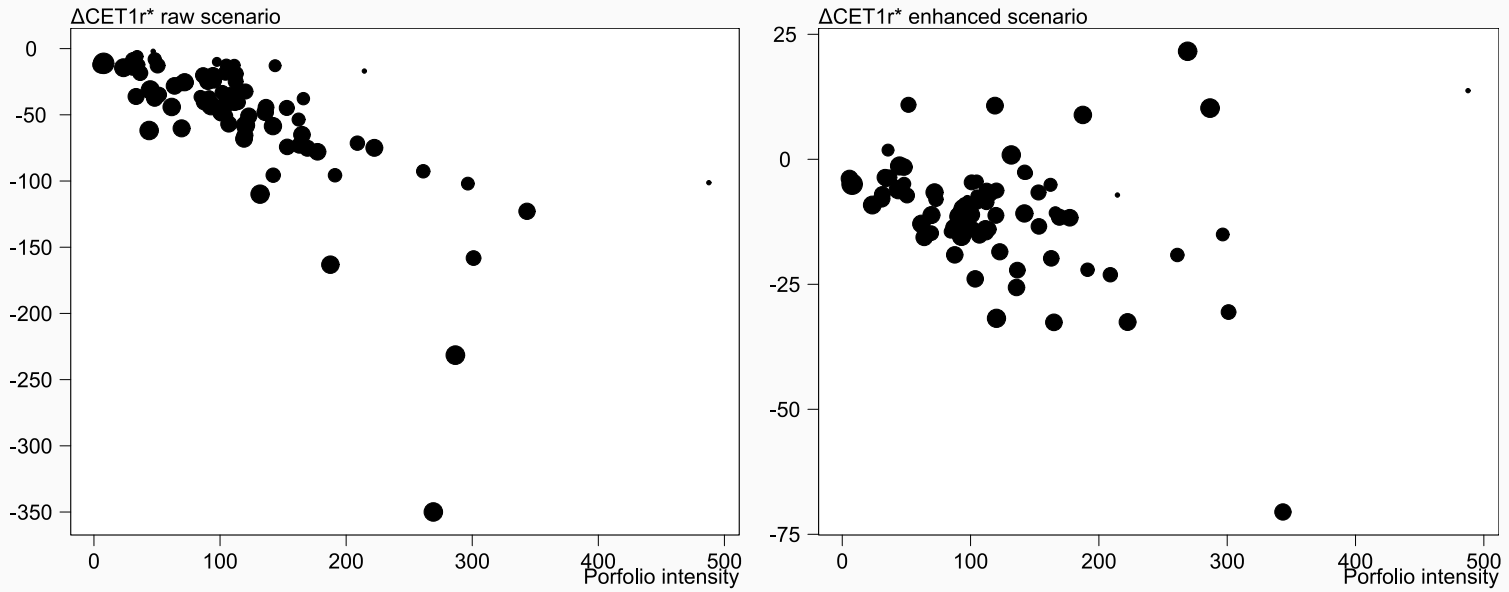
Using sector average emission intensities (EI) biases results





- Avg. abs. PD deviation is 0.24 pp (Buildings: 0.01/Utilities: 1pp)
- Impact of average EI is lower than average impact of actual EI!

Emission intensity is a poor proxy for transition risk



- Raw scenario shows strong correlation between portfolio intensity and CET1r impact
- In enhanced scenario carbon cost pass-through and windfall profits in utilities dilute relationship.

Conclusion

We quantified the carbon pricing-induced default risk of European non-financial firms and impact on banks.

- The aggregate impact of higher carbon prices on firms and banks is expected to be manageable.
- Firms' pass-through of carbon costs key driver of transition risk.

Researchers, banks and regulators should:

- Assess risks on a firm-level not use sector averages to avoid risk underestimation.
- Avoid using emission intensities as *unique* transition risk indicator because of pass-through effects.

Thanks for your attention!

Paper available at SSRN 4572907

Appendix

The OeNB In-house Credit Assessment System (ICAS)

- Operated by the Austrian National Bank (OeNB) since 2011 for accepting bank loans as collateral in Eurosystem monetary policy operations.
- Based on a regression with 6 financial ratios (see Appendix), predicts a Basel III-consistent, 1-year, firm-specific, point-in-time probability of default (PD).
- Tried and tested: subject to yearly independent performance monitoring by the ECB. Consistently shown excellent discriminatory power and calibration quality.

ICAS variables

Ratio	Stressed
EBIT, adjusted	Yes
Self-financing ability	Yes
Net indebtedness ratio	Yes
Capital interest burden	No[20]
Return on cash flow	Yes
EBITDA - ROI	Yes

Table 4: Financial ratios of OeNB's IFRS model.

Methodology for Bank-Level Capitalization Impact

$$CET1r = \frac{CET1}{RWA_{corp,CR} + RWA_{other}} \rightarrow \frac{CET1 - \Delta provisions^*}{RWA^*_{corp,CR} + RWA_{other}}$$

$$RWA^*_{corp,CR} = Basel_{IRB}(PD^*, LGD^*) \times EAD$$

$$\Delta provisions^* = \sum_{firms,sectors} (PD^* \times LGD^* - PD \times LGD) \cdot EAD$$

Details of the calculations in the Appendix

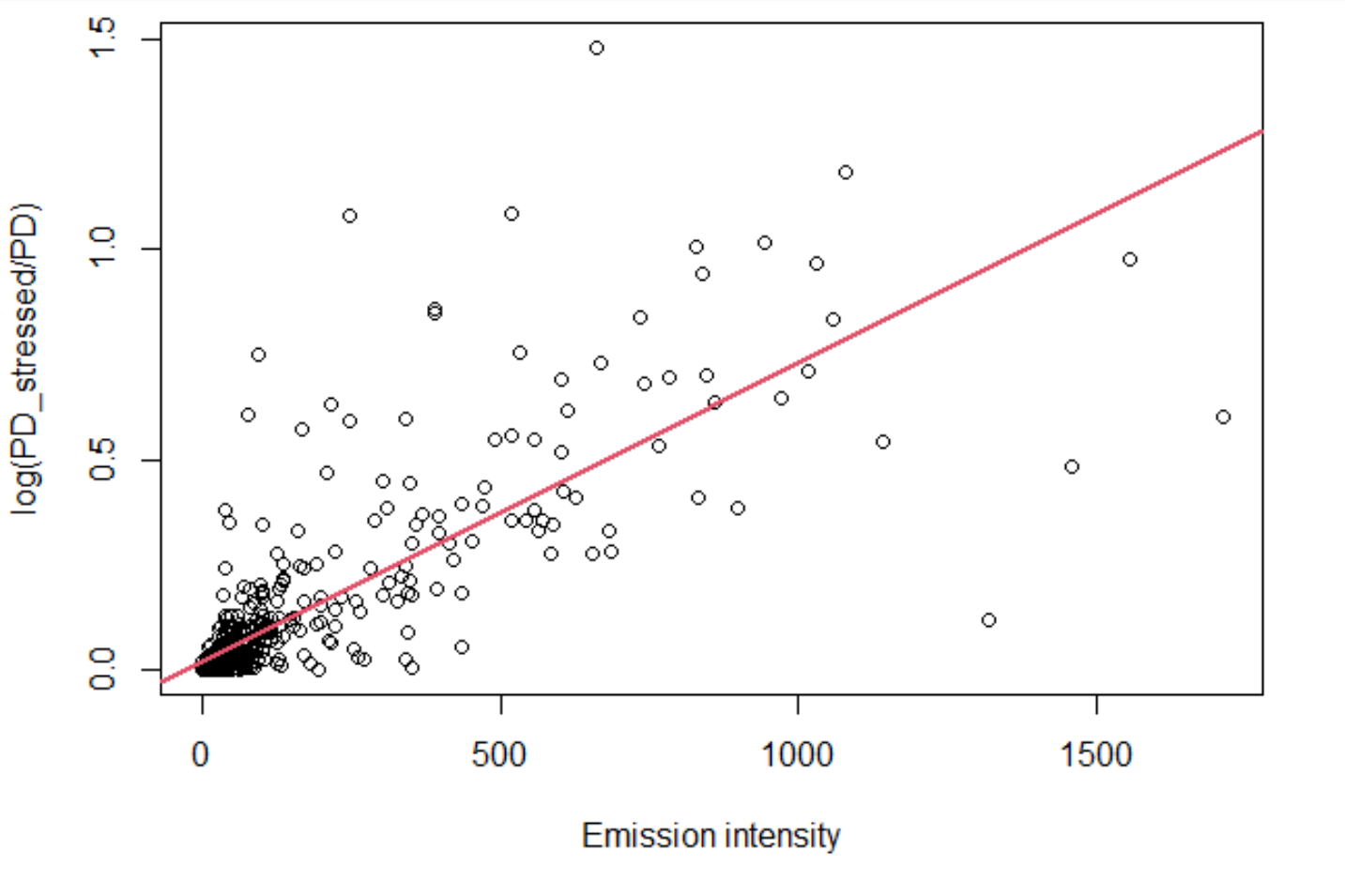
Stressed RWA and provisions

Four categories of exposures are stressed:

- Exposures to 776 firms: bank-level exposure gathered from Anacredit, PD stressed using the ICAS model and the firm-specific emissions.
- Exposures to other firms: bank-level exposure gathered from Anacredit, PD stressed calculated from Anacredit PD using the extrapolation based on sector-level emission intensities.
- Exposures by sectors: the remaining bank-level exposure to each sector (excluding the two kinds of exposures above) is stressed using the sector-level average PD (from Anacredit) and the extrapolation based on sector-level emission intensities.
- Other exposures (households, public sector) and RWA from market risk, operational risk, CCR, etc. are not stressed.

Extrapolating PD impact

For both scenarios (raw/enhanced), we model the PD impact of the stress as a function of the emission intensity. $R^2 = 65\%$



LGD impact

We use the Frye Jacobs model to translate the stressed PD into a stressed LGD.

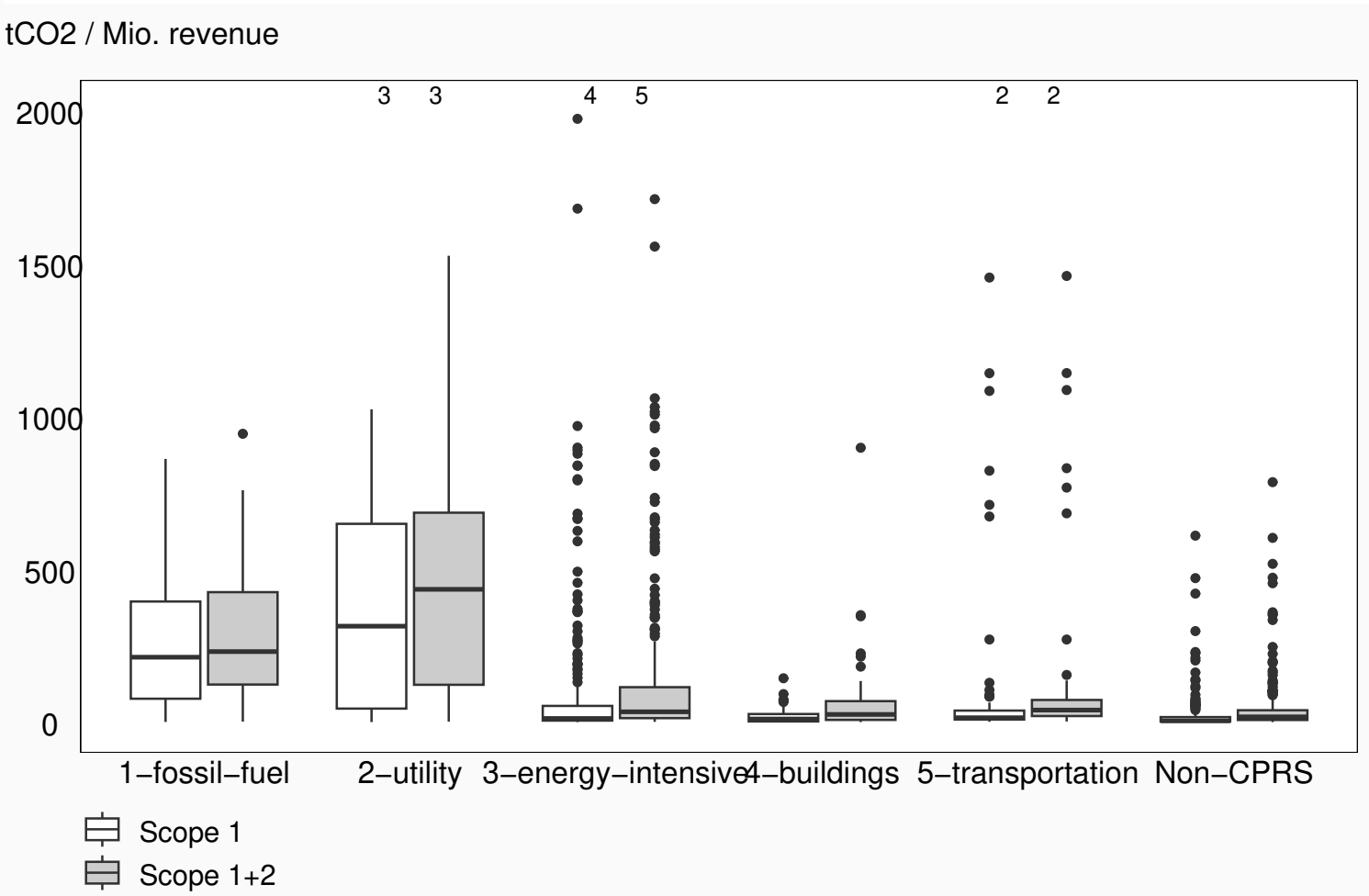
$$LGD_{stressed} = min\left[\frac{\Phi(\Phi^{-1}(PD_{stressed}) - k)}{PD_{stressed}}, LGD_0\right]$$

$$k = \frac{\Phi^{-1}(PD_0) - \Phi^{-1}(PD_0 \times LGD_0)}{\sqrt{1-\rho}}$$

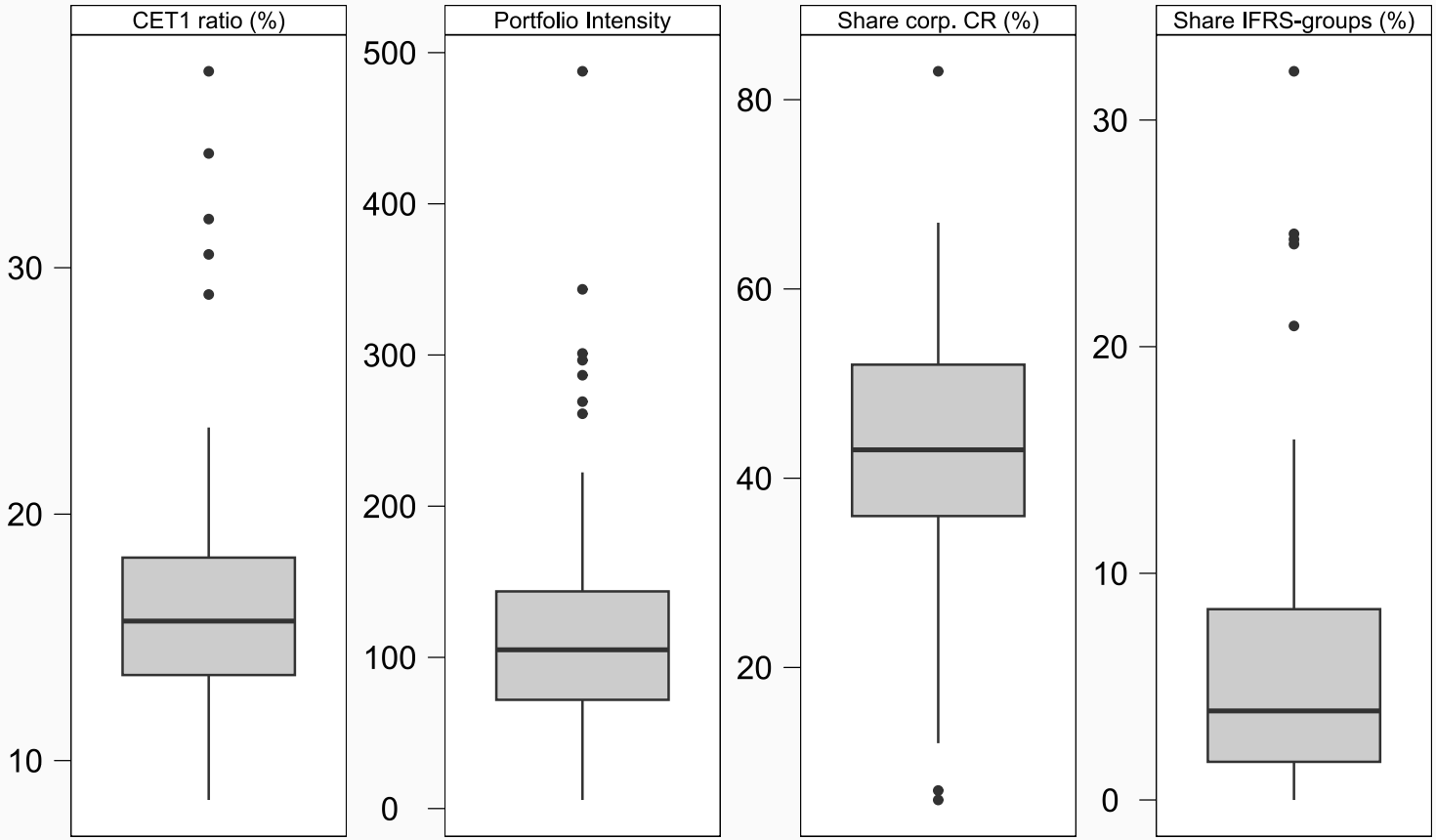
Summary of data sources and calculated values

	Firm-level dataset	Other firms dataset
RWA	EBA	
CET1	EBA	
Financial statements (FS)	ERICA	-
Emission intensity (EI)	ERICA, ISS, C4F	Eurostat
Paid emissions (PE)	EU ETS	Extrapolation
Exposure	Anacredit	Anacredit
PD	ICAS model(FS)	Anacredit
LGD	Implied(RWA, Exposure, PD)	
PD*	ICAS stress model(FS,EI,PE)	Extrapolation
LGD*	Frye-Jacobs(PD, PD*)	Frye-Jacobs(PD, PD*)
RW	Basel formula(PD, LGD)	Basel formula(PD, LGD)
RW*	Basel formula(PD* , LGD*)	Basel formula(PD* , LGD*)
Δ provision$_{firm}$	IFRS staging (PD, PD*)	IFRS staging (PD, PD*)
Δ RWA$_{firm}$	EXP · (RW* - RW)	EXP · (RW* - RW)

Stylized Facts - Emission Intensity by Sector



Stylized Facts - Pre-stress distribution of bank-level variables



Carbon intensity by sector

NACE activity	Section	EU 27	Sample	Revenue share
Agriculture, forestry and fishing	A	0.8917	-	0
Mining and quarrying	B	0.5675	0.4045	0.9%
Manufacturing	C	0.1117	0.1428	53.7%
Electricity, gas, steam and air conditioning supply	D	0.9481	0.5096	14.2%
Water supply; sewerage, waste management and remediation activities	E	0.4605	0.8500	0.9%
Construction	F	0.0277	0.0466	5.5%
Wholesale and retail trade; repair of motor vehicles and motorcycles	G	0.0343	0.0118	9.1%
Transportation and storage	H	0.2229	0.3073	4.1%
Accommodation and food service activities	I	0.0275	0.0273	0.7%
Information and communication	J	0.0055	0.0038	7.7%
Real estate activities	L	0.0031	0.0063	0.5%
Professional, scientific and technical activities	M	0.0094	0.0062	1.0%
Administrative and support service activities	N	0.0251	0.0129	0.4%
Public administration and defence; compulsory social security	O	0.0223	-	0
Education	P	0.0150	-	0
Human health and social work activities	Q	0.0176	0.0160	0.6%
Arts, entertainment and recreation	R	0.0228	0.0024	0.5%
Other service activities	S	0.0347	0.1357	0.1%
Total		0.1043	0.1780	100%

Table 1: GHG emission intensity by NACE activity for the EU 27 and for the sample companies. Column two reports direct emissions in $kgCO_2$ per EUR output for the EU 27 and column three reports direct emissions in $kgCO_2$ per EUR revenue for the sample companies. Column four reports the share of sample companies' revenue per sector. Data source: Eurostat

Sensitivity/Robustness

- Results depend significantly on cost pass-through assumption and on the size of the carbon price increase. This is unsurprising.
- Firms' financing method (reduction in liquid assets vs. higher indebtedness) to pay for carbon costs does not impact results.
- No correlation between bank size and stress impact is observable.
- Effect from IFRS staging (life-time loss provisioning in stage 2) is small but observable