Assessing credit risk sensitivity to climate and energy shocks

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Introduction and objectives

- Financial sector authorities have become increasingly involved in assessing climate change risks and their impact on the financial sector.
- Climate risks: **transition risks** and physical risks.
- The quantification of climate-related financial risks is a challenging task.

lack of detailed data (e.g. **no emissions data for firms**)

Limits of historical data: **need for a forward-looking approach**

- **Stress tests**: useful tools because of their forward-looking nature and their flexibility. Complex modelling finalized to assess the impact of climate risks on banks' PDs.
- **Main contribution**: micro-economic approach with detailed data on Italian non-financial corporations to assess exposure, in terms of one-year probability of default (PD), to climate transition risk.

BI-ICAS Stat model

- **Statistical model** for assessing the **creditworthiness** of Italian non-financial corporations, to be used in the ECAF context.
- It consists of **a system of logistic regressions** and produces **a one-year horizon PD** for non-financial firms having both an available **financial statement** and an **exposure** towards the financial system of at least € 30.000, as reported in the NCR.

Financial Score

$$Z_F = \sum_{k=1}^{K} \beta_k * I_{F,k} + \alpha_F$$

Credit behaviour Score

$$Z_{CB} = \sum_{j=1}^{J} \beta_j * I_{\mathrm{CB},j} + \alpha_{CB}$$

Integrated Score

$$Z_{FIN} = \beta_F * Z_F + \beta_{CB} * Z_{CB} + \alpha_{FI}$$

Previous works

- This work exploits methodologies developed in two different papers.

  1. *Di Virgilio and Narizzano (2022)*: micro-economic approach for assessing the exposure of Italian non-financial corporations to climate transition risk in terms of the effect of a carbon tax on BI-ICAS default probabilities. **Recalculation of financial statements** using additional costs caused by the introduction of a carbon tax.
  2. *Faiella et al. (2022)*: micro-economic stress test for assessing the vulnerability of the Italian financial system to climate transition risk in terms of the effects of a carbon tax on firms' vulnerability. Imputation of the **energy mix at firm-level** and estimation of **price elasticities of energy demand** for different firms' sector/size combination.

Di Virgilio and Narizzano (I)

- **Estimation of firms' emissions**
  1. Calculation of **sectoral carbon intensities** (emissions per unit of turnover) at NACE division level. Use of Air Emissions Accounts (Eurostat), Structural Business Statistics and National Accounts (Istat).
  2. Use of **single firms' revenues** to estimate emissions.
- **Selection of carbon tax values** (according to different **NGFS scenarios)**
  1. Below 2°C: a carbon tax of €40 per ton of CO2 equivalent.
  2. Net Zero 2050: a carbon tax of €90 per ton of CO2 equivalent.
  3. Delayed Transition: a carbon tax of €140 per ton of CO2 equivalent.
- **Calculation of additional costs**

$$AC_{i,c} = E_i * CT_c$$

Di Virgilio and Narizzano (II)

- **Income statement recalculation**

$$VA_{i,c} = VA_{i,0} - AC_{i,c}$$

$$NI_{i,c} = NI_{i,0} - \left[\mathrm{AC_{i,c}} * (1 - \tau)\right]$$

- **Balance sheet recalculation**

  1. Equity adjusted for updated Net income.
  2. For Cash and cash equivalents, estimated value must be at least equal to 10% of the original value. The part of the additional cost that cannot be absorbed by a decrease in cash is added to short term financial debts.

- **Recalculation of probabilities of default using BI-ICAS Stat**

Limitations

1. The work in Di Virgilio, Narizzano does not consider the effect of carbon taxation on energy demand. Using constant sectoral carbon intensities, it is assumed that firms' **energy demand is not affected by the increments in energy prices**.

2. It considers only the effects of **Scope 1** emissions because carbon intensities are derived from Air Emissions Accounts.

3. It can be applied **only to climate shocks**, even if the financial statements recalculation procedure could potentially take as input **any kind of additional cost.**

Faiella et al. (2022)

- Methodology to estimate sectoral **price elasticity of energy demand**
  1. Estimation of the **energy consumption** at firm level, for different energy sources (PEFA, National Accounts, INPS).
  2. Estimation of **total energy consumption** and **average energy price** at company level (Eurostat and MISE unitary prices).
  3. Estimation of the **sectoral relationship between firms' average energy price and total energy consumption (elasticity)**.
- Calculation of **unitary energy price variations** using carbon emission factors, for different values of carbon taxation
- Estimation of **stressed average energy price** at firm level
- Estimation of **stressed energy consumption** and **total energy costs** at firm level (**Scope 1+2**)

Methodologies combination

- We **combine the methodologies** developed in the mentioned papers.
- Our sample consists of more than **200.000 Italian non-financial companies** (firms operating in Mining and Utilities sectors are excluded due to low sample size).
- For each firm, we compute the **stressed energy total cost**, for three different values of carbon tax (€40 , €90 , €140) using the methodology developed in Faiella et al. (2022).
- For each firm, we **recalculate the financial statements** for 2019 using the methodology developed in Di Virgilio and Narizzano (2022), for the three values of carbon tax.
- For each firm and carbon tax, we calculate a **stressed probability of default**.

Main results (I)

Carbon tax effect on different energy prices (2019 prices)

Carbon tax (€/ton)	Power (%)	Gas (%)	Gasoil (%)
40	6.6	23.5	11.2
90	14.9	53.0	25.2
140	23.1	82.4	39.2

- **Moderate** growth in **power** and **gasoil** prices.
- **Large** increase in **natural gas** price.
- Changes in **energy costs depend on firms' energy mix**.

Main results (II)

Average PD increments (basis points) by sector

Sector	Carbon tax			Number of firms
	€ 40	*€ 90*	*€ 140*	
Agriculture	0.8	2.7	5.0	2,084
Construction	0.1	0.4	0.7	25,856
Manufacturing	0.4	1.8	3.3	61,872
Services	0.7	2.9	5.3	116,065
Entire sample	**0.6**	**2.3**	**4.1**	**205,877**

- **Global effects** are **limited**. **Agricolture** and **Services** are the **most affected** industries.
- However, there could be some **heterogeneity** at infra-sector level.

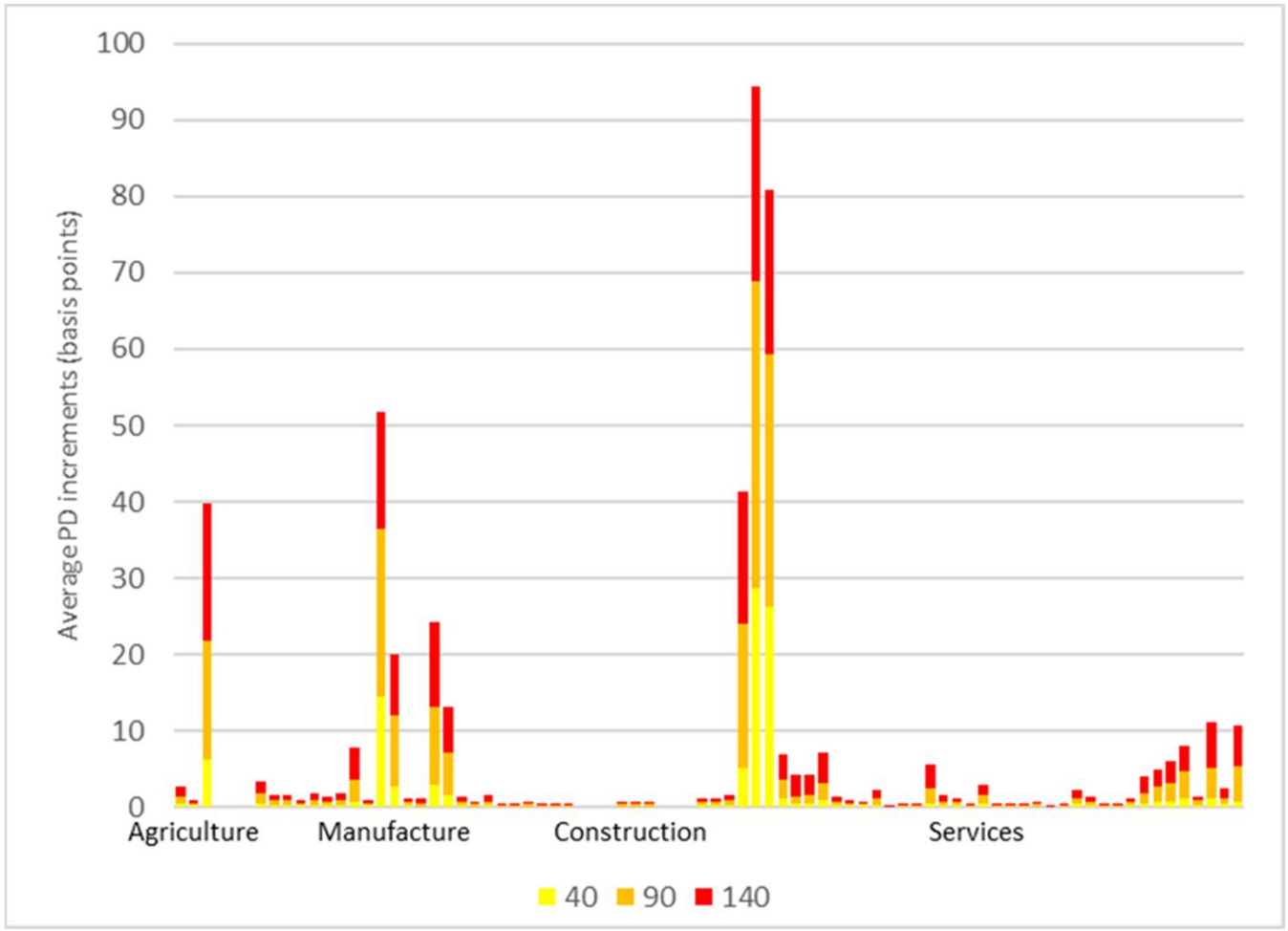
Main results (III)

Most exposed industries:

- *Water transport (50)*
- *Air transport (51)*
- *Petrochemical (19)*
- *Land transport (49)*
- *Fishing (03)*

Sectors with **high dependence** on fossil fuels or **inelastic energy demand**

Average PD increases (basis points) by NACE division



Conclusions

- Limited effect on creditworthiness of Italian non-financial corporations but **widely different** among **economic sectors**.
- Need of a more **granular analysis** at sector level when assessing climate risks (at least NACE division when available).

Advantages

- **Detailed** dataset on a firm level
- Considering **Scope 2** emissions
- Full **integration** with Bank of Italy's ICAS – PD on a firm level
- First step towards **minimum standards** for CCR
- Can be applied to **different types** of energy shocks

Drawbacks

- Only **short-term** effects
- **Partial equilibrium**
- Not considering **demand side** effect of carbon tax
- Not considering eventual firms' **adaptation** to a low-carbon economy

Thanks for your attention