Assessing credit risk sensitivity to climate and energy shocks

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Disclaimer: The views expressed in this presentation represent those of the authors and not necessarily those of the ECB or the Bank of Italy
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.

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

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

\[
Z_{FIN} = \beta_F * Z_F + \beta_{CB} * Z_{CB} + \alpha_{FI}
\]
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.
  3. Delayed Transition: a carbon tax of €140 per ton of CO₂ equivalent.

- **Calculation of additional costs**

\[ AC_{i,c} = E_i \times CT_c \]
Di Virgilio and Narizzano (II)

• **Income statement recalculation**

\[
VA_{i,c} = VA_{i,0} - AC_{i,c}
\]

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

• **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)

<table>
<thead>
<tr>
<th>Carbon tax (€/ton)</th>
<th>Power (%)</th>
<th>Gas (%)</th>
<th>Gasoil (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>6.6</td>
<td>23.5</td>
<td>11.2</td>
</tr>
<tr>
<td>90</td>
<td>14.9</td>
<td>53.0</td>
<td>25.2</td>
</tr>
<tr>
<td>140</td>
<td>23.1</td>
<td>82.4</td>
<td>39.2</td>
</tr>
</tbody>
</table>

- **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

<table>
<thead>
<tr>
<th>Sector</th>
<th>Carbon tax</th>
<th>Number of firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>€ 40</td>
<td>€ 90</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.8</td>
<td>2.7</td>
</tr>
<tr>
<td>Construction</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Services</td>
<td>0.7</td>
<td>2.9</td>
</tr>
<tr>
<td>Entire sample</td>
<td>0.6</td>
<td>2.3</td>
</tr>
</tbody>
</table>

- **Global effects** are limited. **Agriculture** 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.
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