A climate stress-test of financial institutions

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Growing concern by central bankers and regulators about financial system’s exposure to climate risks and implications on financial stability

Dutch central bank introduces new stress test for climate change

Shareholders are increasingly advocating for companies’ climate reporting

Outline

• Growing awareness of climate risks’ implications on prices and financial stability (Carney 2015...Draghi 2017)

• But lack of standardized climate risks/impact metrics for climate-related financial disclosure recognized (FSB TCFD 2017, HLEG 2017)

• We developed the first climate stress-test of individual financial portfolios:
  • Assess individual portfolios’ exposure to climate transition risks (climate Value at Risk (VaR), max loss on portfolio’s value)
  • Network-based: direct and indirect effects via investments chains

• Results on portfolios’ exposure and composition.

Results in a nutshell

1. Direct exposure of top EU banks to fossil sector alone is small (1% of average bank capital)

2. But combined exposures of equity portfolios to climate-policy-relevant sectors is large: 45%-47% for Investment Funds (IF) and Pension Funds (PF)

3. Moreover, exposures of financial investors to each other amplify risk

4. Thus, timely, clear, consistent climate policies would not cause systemic risk:
   • Rather, the lack of climate policies’ implementation could lead to systemic effects (price volatility)

5. Disclosure of climate-related risk not sufficient alone: timing and credibility of climate and regulatory policies matter for a smooth low-carbon transition

5 take-home messages

1. Fostering a smooth low-carbon transition is key for price stability but requires climate risk and impact metrics at individual bank level.

2. It is in the interest and mandate of central banks to encourage banks to run climate stress-tests because...

3. Climate stress-test help banks to internalize price volatility associated with uncertainty of climate policies’ implementation.

4. In presence of shocks (scientific, technological, policies) market players do not fully anticipate prices changes (Monasterolo et al. 2017).

5. This leads to systematic mispricing, which depends on individual portfolios’ allocation.
Challenge: we need the right metrics to assess financial exposure to climate risks

• Traditional cost-benefit analyses are not adequate to identify individual exposures to climate risks and their propagation through the financial system

• Two main information gaps:
  • Imperfect information on investors’ exposure to climate risks
  • Lack of measures of investors’ market share (Monasterolo et al. 2017)

• ...are key obstacles that prevent:
  • Investors to assess losses/gains from portfolios’ decarbonization strategies
  • Policy makers to introduce effective market-based solutions (carbon price)
  • Financial regulators to assess implications of investors’ exposures to climate risks on financial stability (core mandate of central banks)

Our climate stress-test’s methodological framework

• Allows to assess individual portfolios’ direct/indirect exposures to **climate transition** risks:

  1. **Reclassification of NACERev2 sectors (4 digit)** into climate-policy relevant sectors (CPR) according to their contribution to CO2 emissions
  2. **Direct portfolios’ exposure to CPR** through external assets (first round losses)
  3. **Indirect portfolios’ exposure to CPR** (second round losses) using *Debtrank algorithm* (Battiston et al. 2012)

  ➢ **Second round important because represents the amplification of losses due to financial interconnectedness**

• **Empirical analysis - data:**
  • Microlevel data on equity holdings of all EU and US listed companies held by individual financial investors (from Bureau Van Dijk Orbis), 93.47% of their total market cap
  • Balance-sheet data for top 50 listed European banks (Bureau Van Dijk Bankscope);
  • Financial exposures at the sectoral level from the ECB Data Warehouse.
1. New climate-policy-relevant sectors based on emissions

2. Computation of change in sectors’ market share using macro-economic trajectories (e.g. LIMITS scenarios, EIRIN, etc.)

3. Individual portfolios’ exposure and climate VaR computation.

4. Amplification/absorption effects due to financial interconnectedness.

IPCC (2014)

IEA’s energy trajectories

Utility energy mix scenarios
Direct portfolios’ exposure of top world-wide banks to climate-policy relevant sectors (value)

<table>
<thead>
<tr>
<th>Bank</th>
<th>Equity Exposure (USD)</th>
</tr>
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<tbody>
<tr>
<td>JPMORGAN CHASE</td>
<td></td>
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<tr>
<td>BANK OF NY MELLON</td>
<td></td>
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<tr>
<td>NORTHERN TRUST</td>
<td></td>
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<tr>
<td>BANK OF AMERICA</td>
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<td>DEUTSCHE BANK</td>
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<td>WELLS FARGO</td>
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<tr>
<td>BPCE</td>
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<td>TORONTO-DOM. BANK</td>
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<tr>
<td>BNP PARIBAS</td>
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<tr>
<td>R. BANK OF CANADA</td>
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<tr>
<td>PNC FINANC. SERV.</td>
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<td>SOCIÉTÉ GÉNÉRALE</td>
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<tr>
<td>BANK OF MONTREAL</td>
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<tr>
<td>NORGES BANK</td>
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<td>LAZARD</td>
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</tbody>
</table>

- Climate-policy-relevant sectors represent important value of banks’ equity portfolios
Relative portfolio composition of top world-wide banks: exposure to climate-policy relevant sectors (%)

- **Our micro-level approach** allows to understand heterogeneity of investors’ exposure and portfolio allocation across climate-policy-relevant sectors.
- **Such heterogeneity** cannot be easily understood by looking at the value of exposure.
Winners and losers from 1\textsuperscript{st} (top) and 2\textsuperscript{nd} (bottom) round effects for average brown/green bank

- **1\textsuperscript{st} round effect:** brown bank incurs more losses but small in comparison to its total assets (600 mil USD).

- **Adding 2\textsuperscript{nd} round effect** (i.e. only negative shock) further polarizes the distribution of losses between green/brown bank.

- **Overall,** brown bank loses while green bank gains from the introduction of climate policies
Value at Risk (5%) under the scenario of green (brown) banks’ energy investment strategy. **Darker colors:** VaR (5%) in distribution of 1\textsuperscript{st} round losses. **Lighter colors:** VaR(5%) in distribution of 1\textsuperscript{st} and 2\textsuperscript{nd} round losses together.

- **Heterogeneity:** Deutsche Bank and Credit Agricole most affected in both scenarios but different role of first-second round effects!
Climate Stress-test - Conclusions

• Exposures of all financial investors’ types to the fossil-fuels sector alone on their equity portfolios are limited (i.e. 4%-13% equity portfolio)

• However, their combined exposures to all climate-policy relevant sectors is large, in particular for investment funds and pension funds (i.e. 45%-47%)

• Moreover, exposures of financial investors to each other amplify risk

• Climate policies are unlikely to cause banks’ defaults nor systemic risk:
  • Therefore, EU banks should not fear their introduction

• Early and stable introduction of climate policy could lead to gains for those who adapt earlier by rebalancing their investments.
Key challenges for micro-level analysis

• **Trade-offs detail vs. relevance and accountability**

• To extend the climate stress-test at the micro-level, we need to:
  1. Data on emissions intensity of firms at NACE 4 digit level – embryonic (2dii 2017)
  2. Access standardized data on investors’ exposure to companies via loans and bonds at NACE 4 digit level – difficult to obtain by central banks and individual banks/not existing
  3. Estimate climate policies’ shocks transmission from financial actors to real economy actors
  4. Identify and assess shocks’ reinforcing feedback loops from finance to the real economy.

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THANK YOU FOR THE ATTENTION
Identification of direct & indirect exposures to the climate sensitive sectors

Direct exposures: through assets of the market player

\[ A_i = \left( \sum_{j \in S} \sum_{j \in S} \alpha_{ij}^{Equity} + \alpha_{ij}^{Bonds} + \alpha_{ij}^{Loans} \right) + R_i \]

- \( S \) - Set of climate-relevant sectors
- \( A_i \) - Total assets of the financial actor \( i \)
- \( \alpha_{ij} \) - Monetary value of exposure of \( i \) to \( j \)
- \( A_{FS} = \sum_{i \in F} \alpha_{iS} \) - Exposure of institution \( F \) to a given climate sector

Indirect exposures: through interlinckages of the market player with its counterparties

\[ A_i = \left( \sum_{j \in F} \alpha_{ij}^{Equity} (A_j) + \alpha_{ij}^{Bonds} (A_j) + \alpha_{ij}^{Loans} (A_j) \right) + \left( \sum_{k \in A/F} \alpha_{ik}^{Equity} + \alpha_{ik}^{Bonds} + \alpha_{ik}^{Loans} \right) + R_i \]

- \( \alpha_{ij} \) - Product of exposures along the chain
Outline of climate stress-test implementation

<table>
<thead>
<tr>
<th>Time</th>
<th>Round</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t = 0$</td>
<td>Initial allocation</td>
<td>Initial allocation of assets and liabilities</td>
</tr>
<tr>
<td>$t = 1$</td>
<td>First round</td>
<td>Shock on climate-policy-relevant sectors, losses on banks’ balance sheets</td>
</tr>
<tr>
<td>$t = 2$</td>
<td>Second round begins</td>
<td>Reverberation of first round losses on the interbank network according to the DebtRank model</td>
</tr>
<tr>
<td>$t = T$</td>
<td>Second round ends</td>
<td>Model reaches convergence</td>
</tr>
</tbody>
</table>

- Data on bilateral financial exposures among banks is not available because of confidentiality agreements. Interbank networks can be reconstructed from the partial information provided by total interbank lending and borrowing of individual institutions. Therefore, we take the mean vulnerability over the network sample.
- We run the stress-test for each single realization of the shock on all reconstructed networks and then compute the mean global vulnerability over the network distribution.
- We compute statistical measures (VaR) on the mean global vulnerability with respect to the shock distribution.