Current approaches to climate stress-testing

Jaromir Benes jaromir.benes@gimm.institute
Tomas Motl tomas.motl@gimm.institute

gimm
Global Institute *for* Macroprudential Modeling

Goal of this presentation

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- Give an overview of the current implementation of climate stress-tests in key institutions
- Highlight shortcomings, but also useful approaches
- Note that most of these are large exercises that require extensive resources

Toronto Centre

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Non-profit organization akin to GIMM.
Capacity building programs and guidance for financial supervisors and regulators, primarily in developing nations, to advance financial stability and inclusion

Good source of practical information. Also do training programs, focused mostly on microprudential regulation.

They published several interesting papers:

- **Introduction for Supervisors to Scenarios and Stress Tests of Climate Change Risks** (link)
  - Concise, precise treatment of climate stress testing area
- **Updated Climate Toolkit** (link)
  - Designed for financial supervisors in emerging markets and developing economies
  - Highlights also biodiversity risk, in addition to climate
  - Provides a short discussion of key topics, with several links to publications that give more detail

Good to follow on LinkedIn.

NBER Paper on Climate Stress Testing

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Published in April 2023, provides a nice review of the current situation, challenges, etc.
Aligns well with many of our views.

Highlights:

- We still **do not understand climate risks well enough**
  - Need more research into *transition* risks to understand what choices policymakers face and what options are available
    - Political economy: Extremely costly measures unlikely to be implemented
    - Regulatory risks seem to be the most important
  - Need more research into *physical* risks to understand interaction with the economy
  - Market risk could be very important: some risks are priced in, but is it enough?
    - Some indications the risks might be underpriced
    - We do not understand how investors reflect climate information in asset prices
  - How are different climate risks cross-correlated?
- We should **focus on the 3-5 year horizon**, which affects the current bank credit portfolio
  - The longer average credit maturity, the higher the possible impact of climate risks

- Transition risks dominate in importance on short horizons, physical risks in 30-50 years

- Design of stress-tests:
  - The scenario should be **severe**
    - Regulations as a policy choice: we want to examine borderline plausible scenarios
  - Need for feedback loops
  - Need for dynamic balance sheets
  - Need to consider market risk, which can be particularly impactful on short horizons

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Dutch experience - DNB Stress tests

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Paper on DNB climate stress tests done in 2018. Example of relatively simple exercise.

- 5y horizon, focus on transition risks
- 2 risk factors: government regulation, technological change
- 4 scenarios:
  - Technology shock - renewables surge, traditional sectors suffer
  - Policy shock - carbon price at 100 USD / ton (ehm...)
  - Confidence shock - uncertainty lowers investment
  - Double shock - technology shock + policy shock
  - All scenarios are global (hence NiGEM)
- Combination of top-down macro modeling with detailed, bank-level exposures
  - NiGEM to generate the macro shock
    - Note: using an established model, rather than developing a new, custom tool
  - Disaggregation to 56 sector with sector-specific transition vulnerability factor, based on emissions
  - Bank-by-bank stress testing
- They consider credit risk, market risk, ...
  - Netherlands has good data on climate exposures
- They find substantial impact,

- Downside: **no feedback loops**

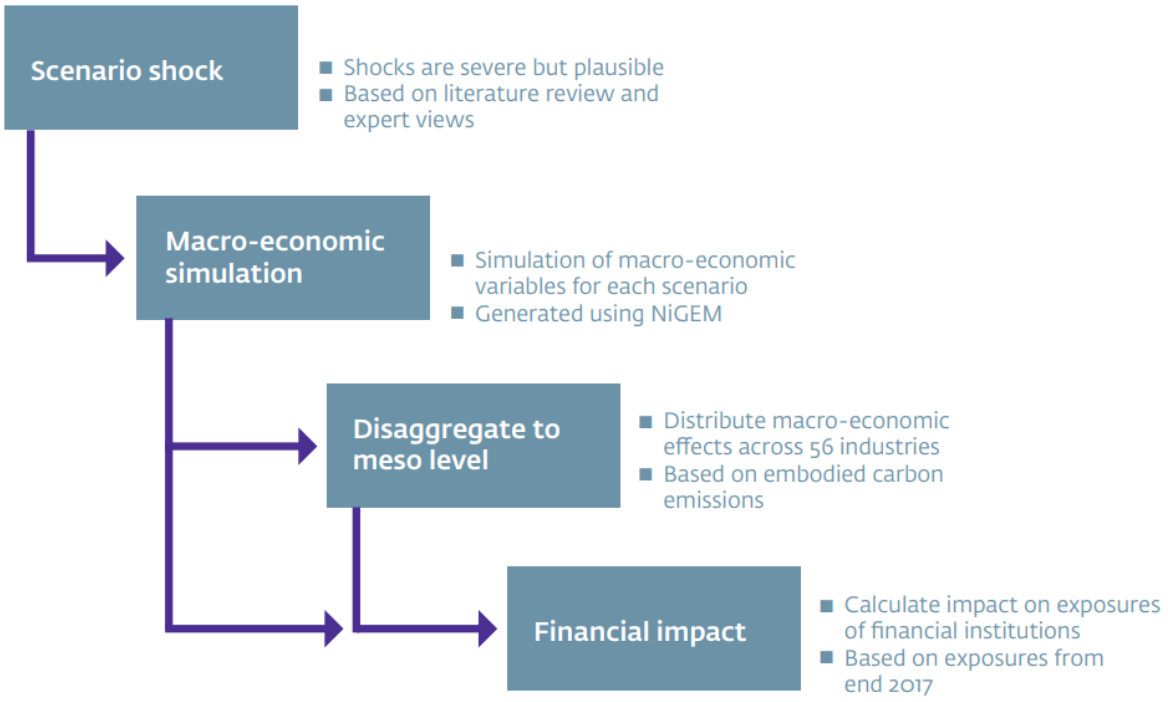
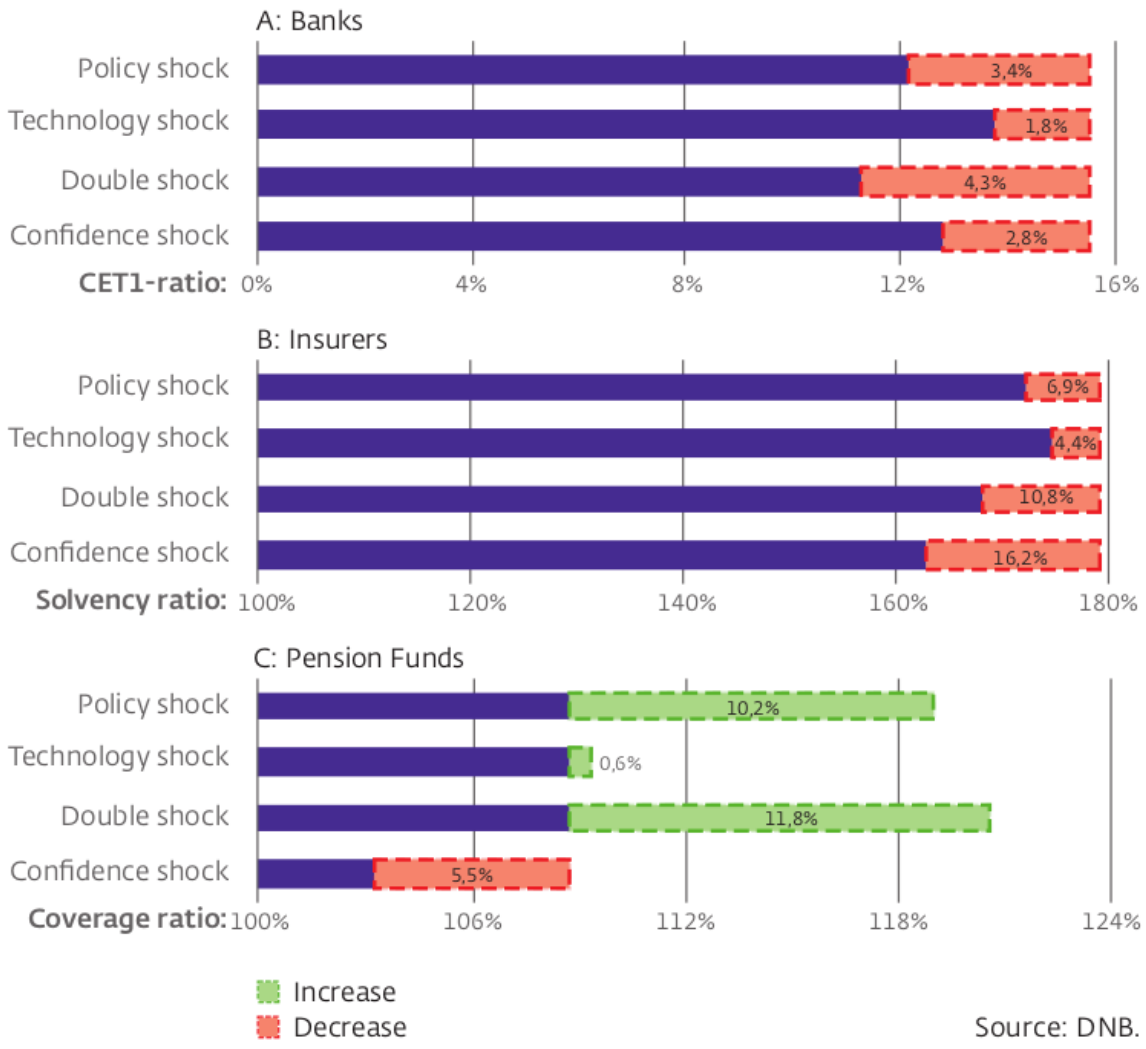


Figure 4.3 Impact on supervisory ratios by sector



Source: DNB.

ECB Climate Stress Tests

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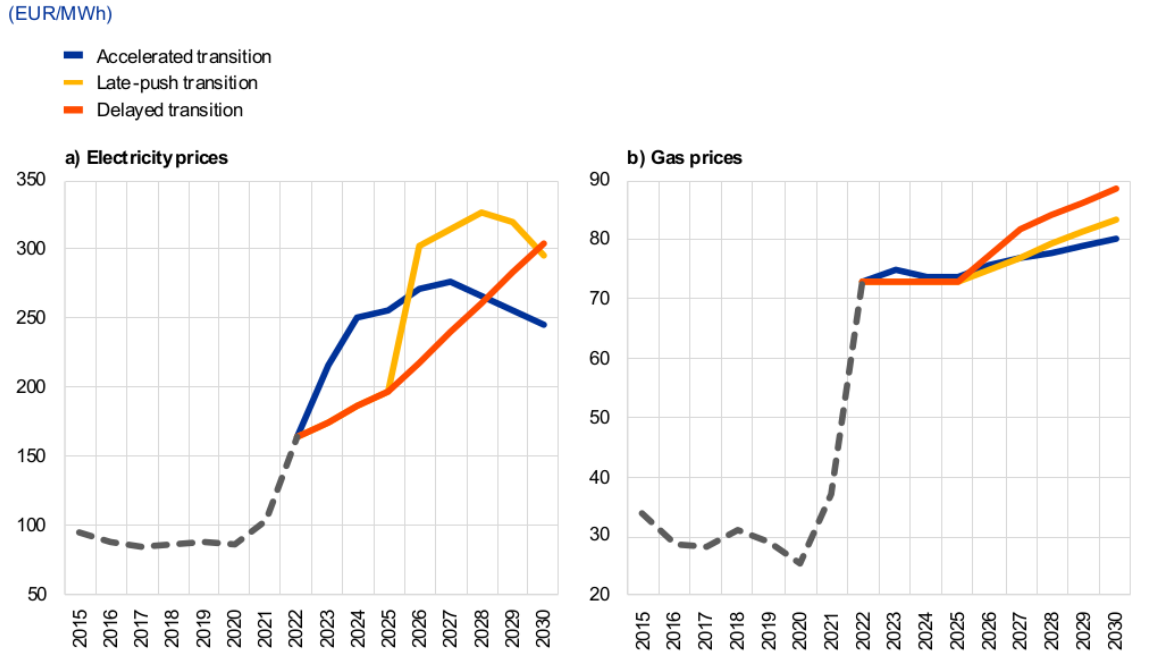
- Does not get much more complicated that this...
- Horizon to 2030
- 3 scenarios:
  - Accelerated transition - high energy prices push towards renewables, quick decline of emissions consistent with NGFS "Net zero by 2050"
  - Late-push transition - real action starts in 2026, more intense, concentrated in 2025-2030
  - Delayed transition - also starts in 2026, but less intense
  - Based on NGFS latest "Net zero by 2050" scenario, but updated to reflect latest energy prices, etc. plus added additional variables
- NGFS pathways for emissions distributed into country-sector level
- Very detailed micro work allowed by good data availability in the EU
  - Lots of work on country- and sector-level on energy mix, GHG emissions, ...
  - Lots of additional assumptions about energy mix development, HH energy consumption, energy prices, green investment
    - Unclear how they deal with elasticities of substitution
  - Detailed work on translating the assumptions into credit performance (PDs, LGDs)

- Consider both credit risk and market risk, with static balance sheets
  - Surprisingly, they find that market risk impact would be limited

- Again, **no feedback loops**

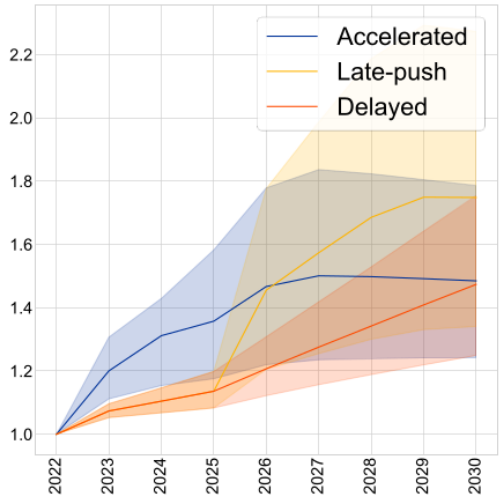
Electricity and gas prices have been deeply affected by the energy crisis, with further rises expected due to green transition



Credit risk would increase due to transition risk until 2030, especially under a late-push transition scenario

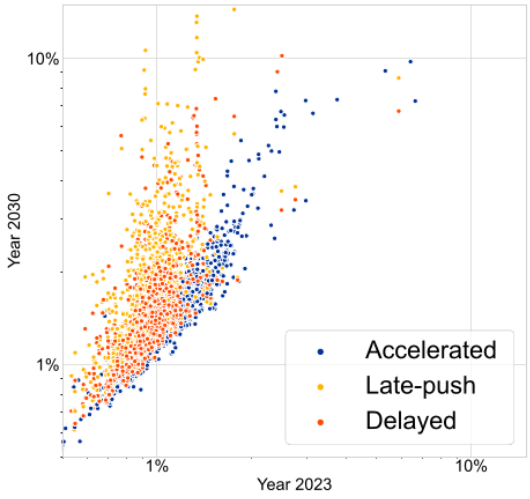
a) Change in probabilities of default relative to 2022

(index, 2022 = 1)



b) Median probabilities of default by sector

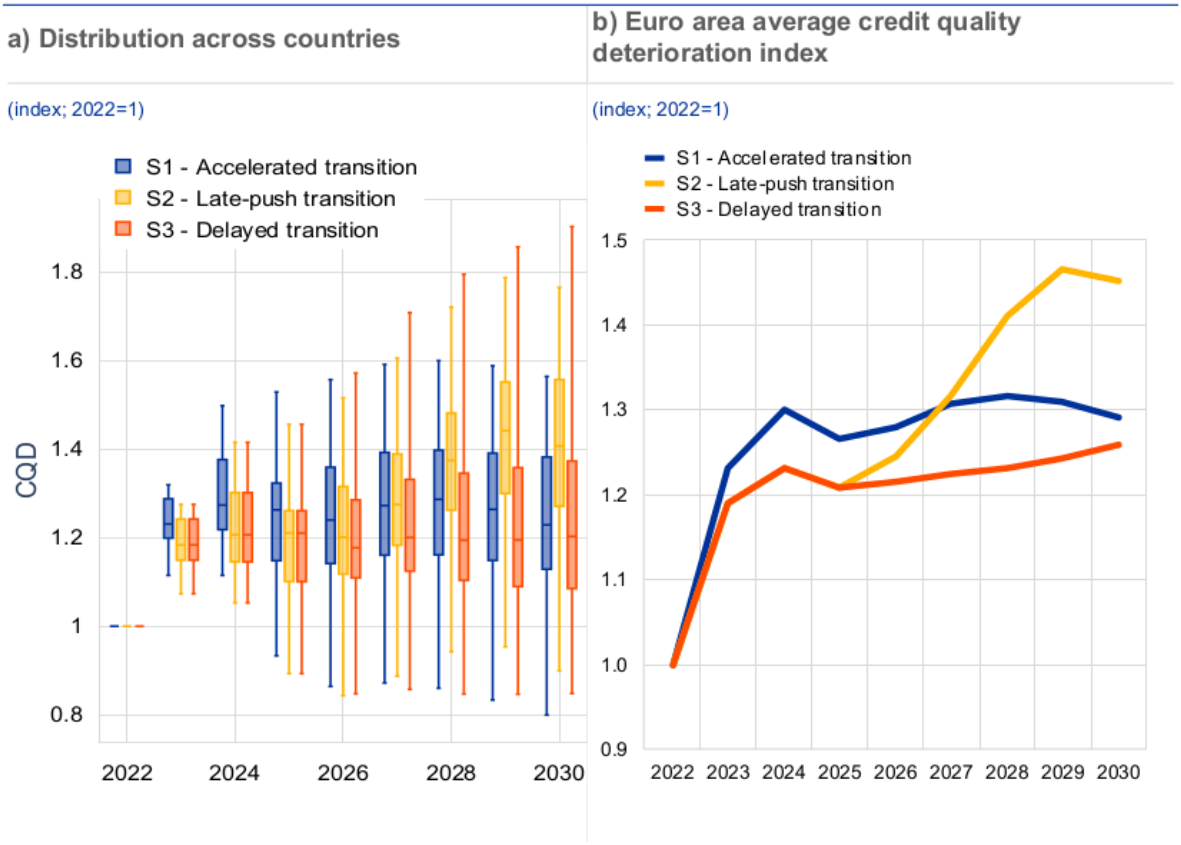
(index, 2022 = 1)



Source: ECB calculations based on Orbis, Urgentem, Eurostat, NGFS, BMPE macroeconomic projections, IRENA (2021) and IPCC (2022) data.

Chart 26

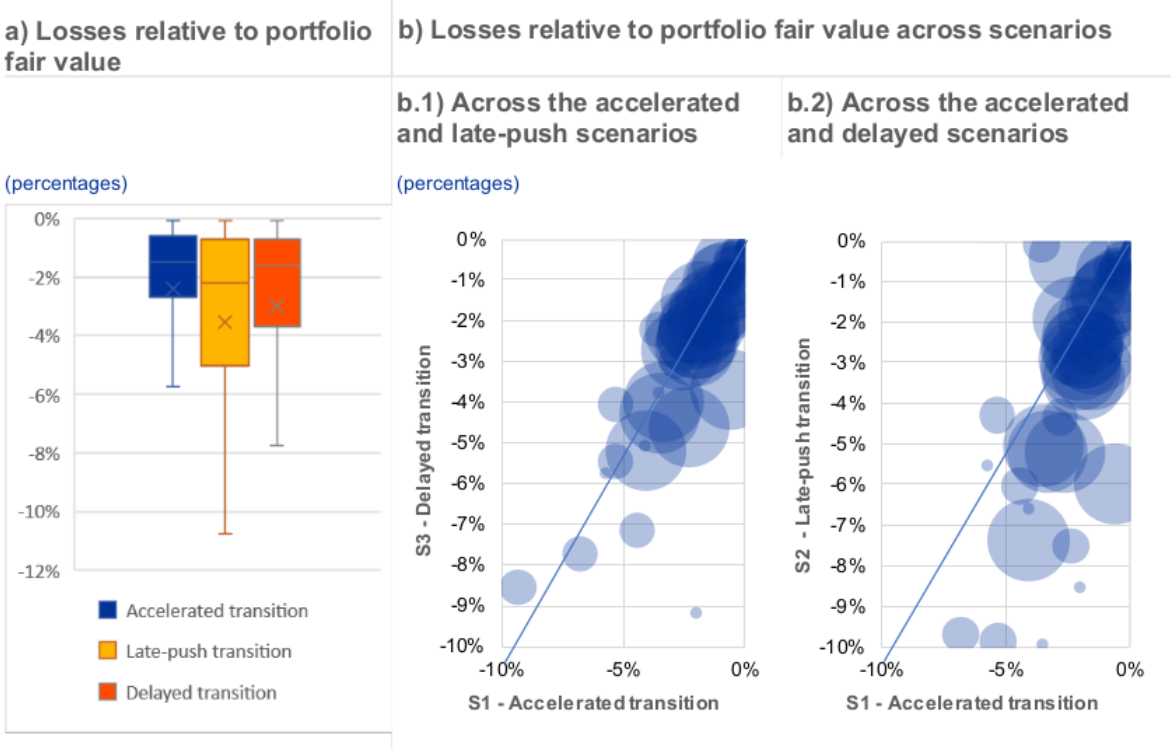
Household portfolio credit quality deterioration would be almost double under a late-push transition than under the other transition scenarios



Source: ECB calculations based on ECB, Eurostat, NGFS, BMPE macroeconomic projections, Greenhouse Gas Protocol and IPCC (2022) data.
Notes: CQD stands for credit quality deterioration. The chart excludes outliers with an indexed CQD above the 95% percentile and below the 5% percentile of the distributions.

Chart 35

Market risk impact would be limited but visible relative to portfolio size



Source: ECB calculations based on Orbis, Urgentem, Eurostat, NGFS, BMPE macroeconomic projections, IRENA (2021) and IPCC (2022) data.
Note: In panels b.1 and b.2, the size of the bubble was determined by the tercile into which the size of banks' corporate bond portfolios fell.

Bank of Canada

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Nice practical example with couple good ideas.

- Pilot in 2022
  - Six financial institutions participated, not system-wide
  - The objective was not to stress-test, but to build capacity for future
- Methodology:
  - Static balance sheets
  - Focused on 10 most emission-intensive sectors
  - Four scenarios: Current policies, Net zero by 2050, Immediate 2 deg, Delayed 2 deg (working paper here)
    - Cover the whole world (8 regions)
  - Developed using a CGE model (MIT-EPPA) linked with two macro DSGE models that analyze impact on US and Canada
    Note the appropriate use of existing, well calibrated, well tested tools!
    However, **no feedback**
    - Horizon 2020 - 2050
  - Calculate carbon price that would be consistent with assumed emissions, given additional assumptions (technology, policies)
  - Scenario details, incl. variable values, are available to download
- Macroeconomic impact:

    - Higher energy prices due to carbon pricing
    - Reduced foreign demand (key factor)
    - Lower commodity export prices

- From macro to credit risk:
    - Banks selected representative borrowers in each loan segment. then micro models (PDs, LGDs) were applied
        - Apparently this was quite difficult for the banks
    - These estimates were then **used for estimation of economy-wide climate transition - credit risk relationship**
        - Some nice charts with estimates are provided
        - Note that by 2030, the effects are not that large

- From macro to market risk:
    - Impact on equities using discounted dividends

- Details on translating macro to credit and market risk are available in a special report

- Experience from the pilot:
    - Far more time and resources needed than anticipated
    - Bottom-up approach yields inconsistencies

- Implausibly high carbon prices?

Chart 3: Global GDP-weighted shadow carbon price

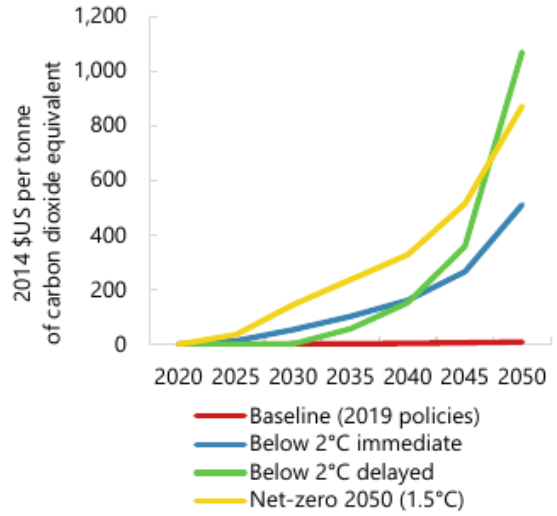


Chart 4: Global greenhouse gas emissions

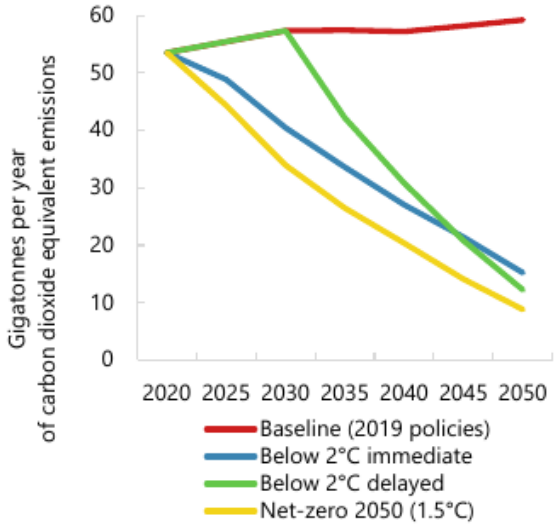


Figure 2-A: The suite of models

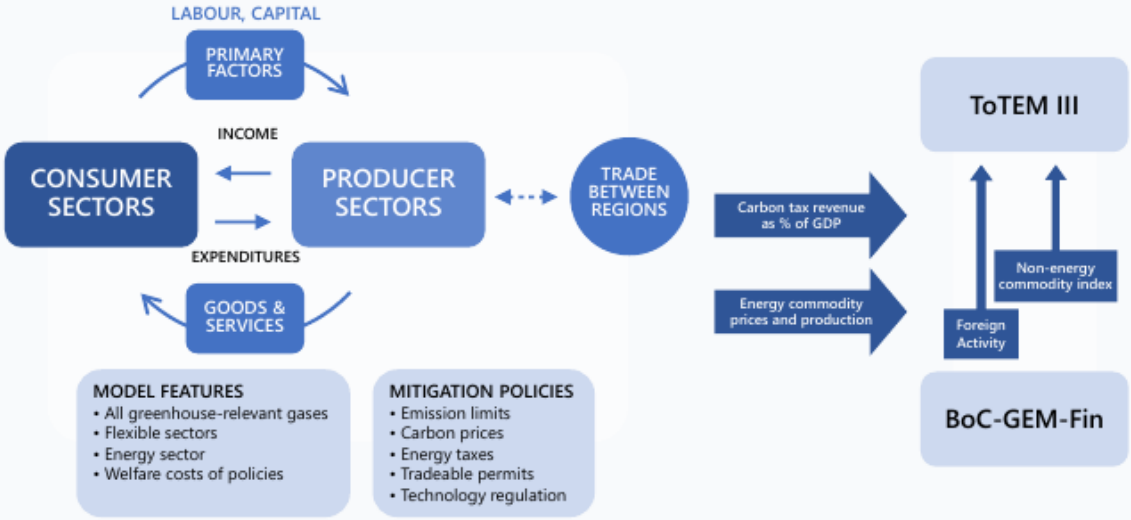


Chart 13: Decomposition of the level of Canadian GDP impacts across scenarios

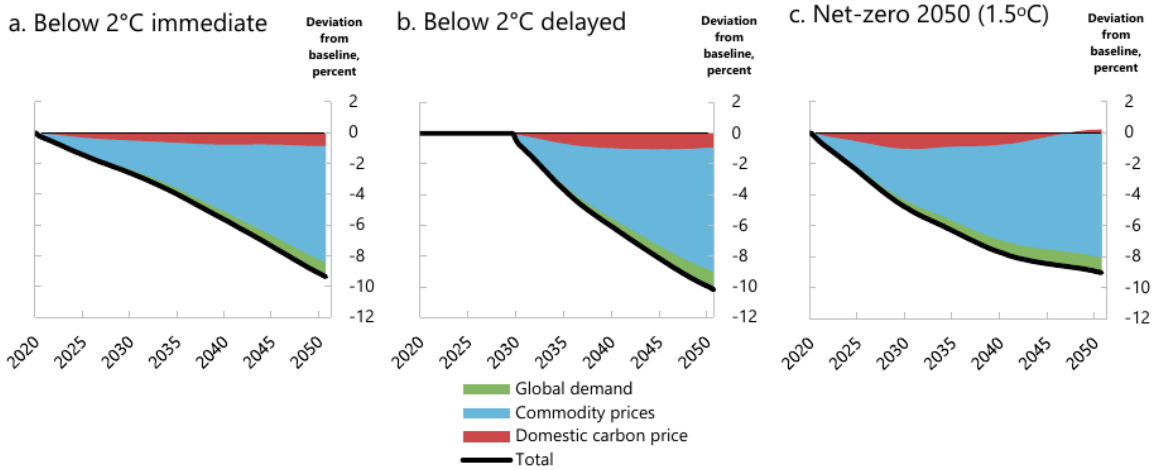


Chart 14: GDP-level impact for the US economy in the transition scenarios

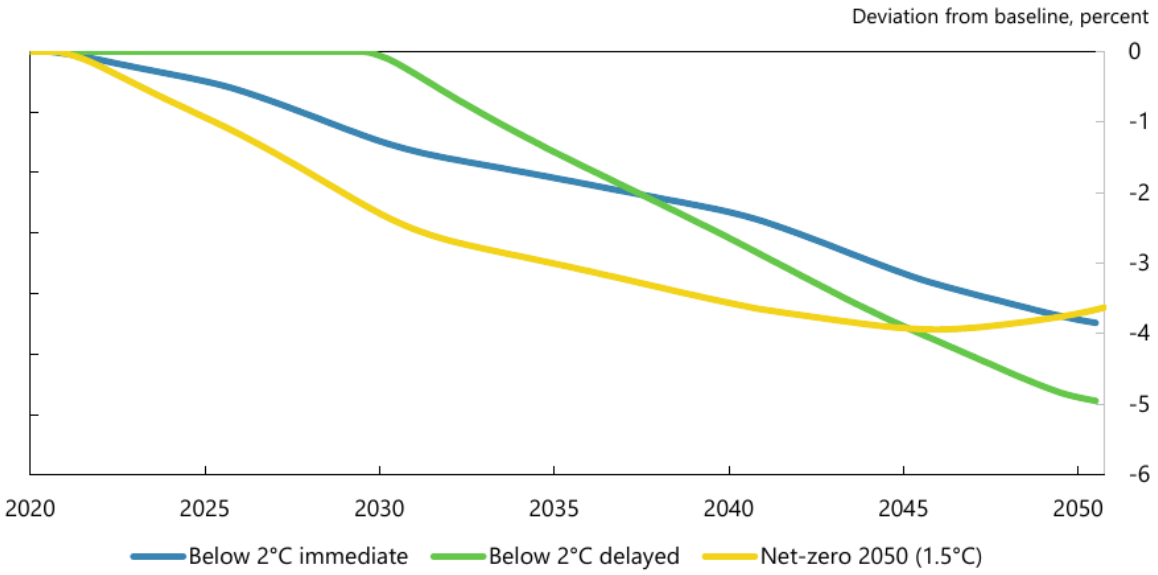


Chart 15: GDP-level impact for the world, below 2°C immediate scenario

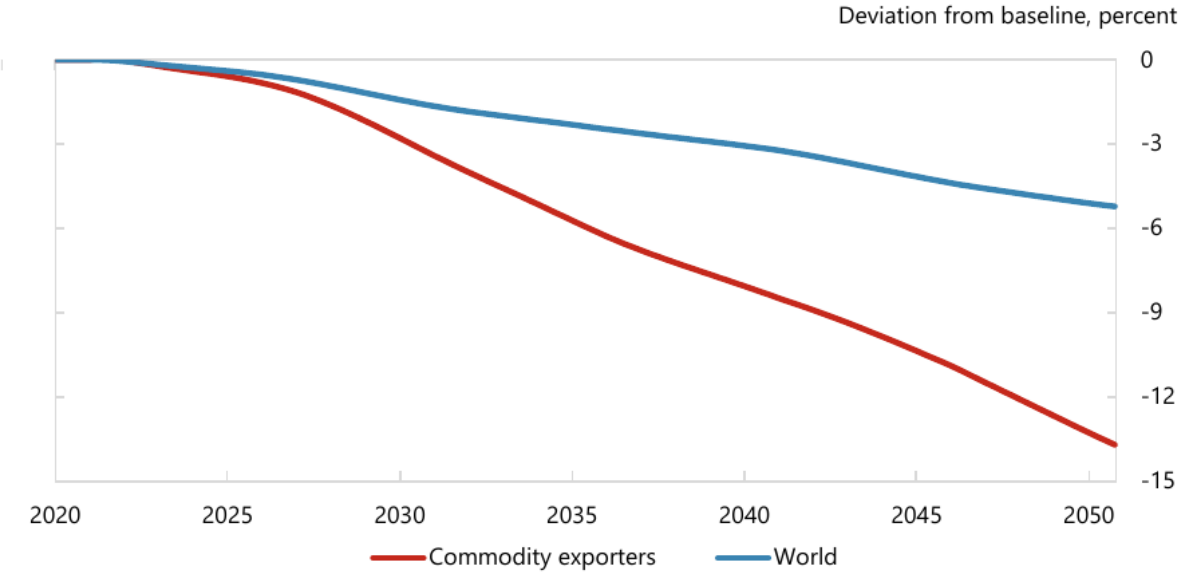


Figure 1: Credit risk methodology

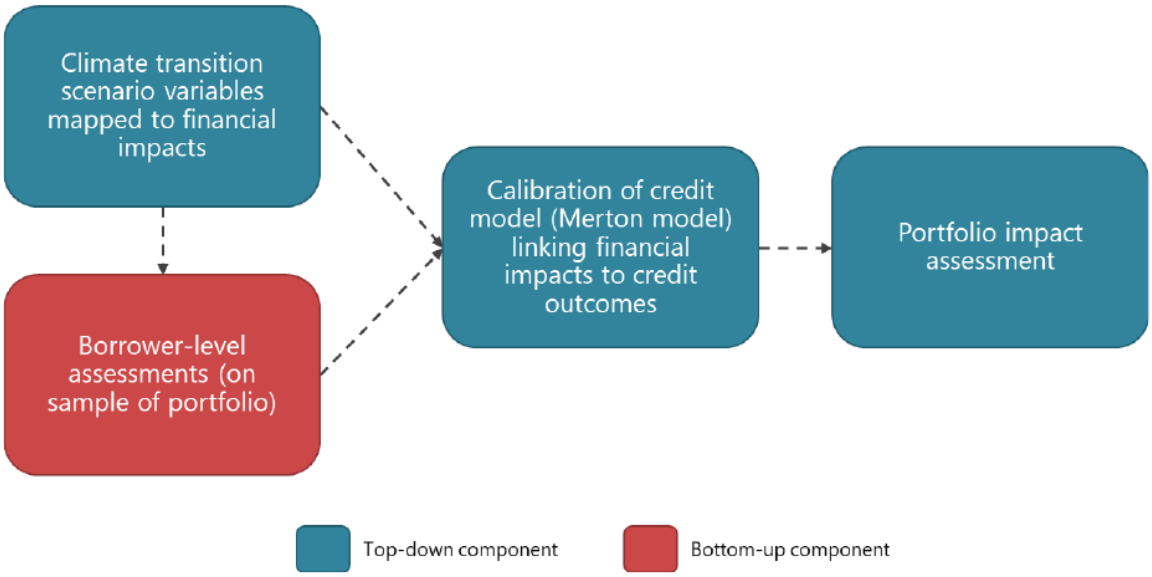


Chart 16: Climate transition–credit risk relationship, Canada, 2050

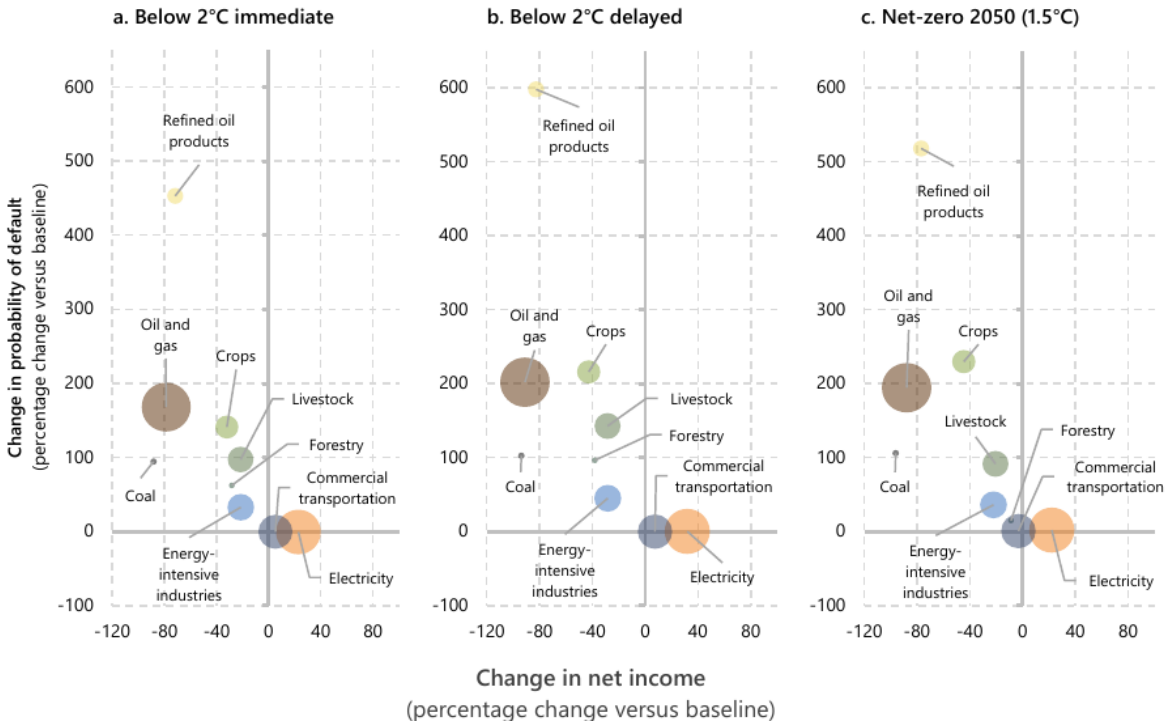


Chart 17: Change in probability of default in Canada across the transition scenarios

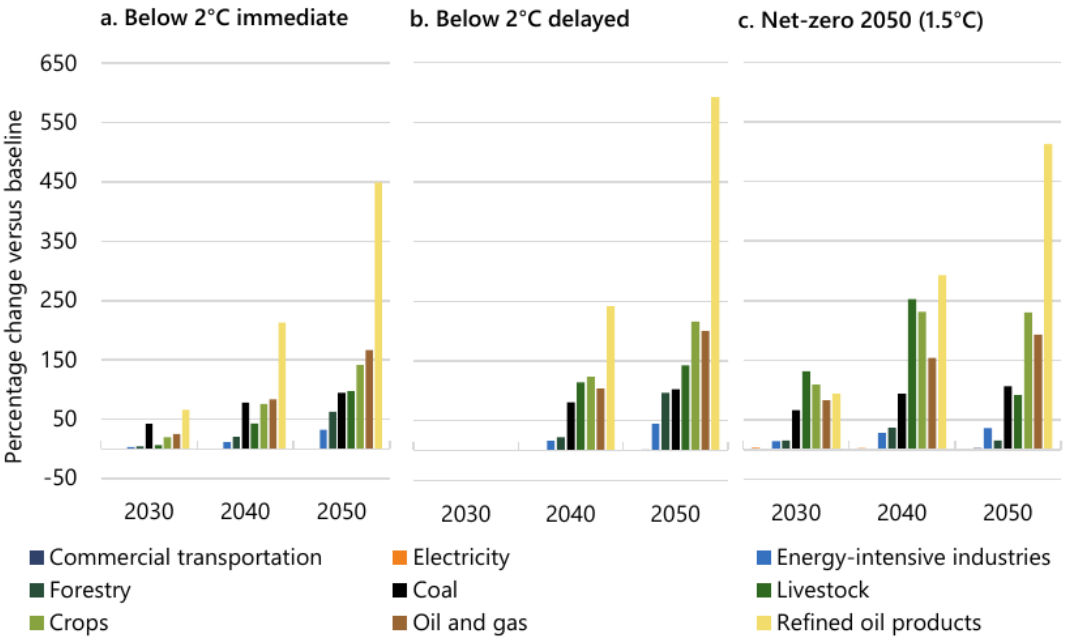
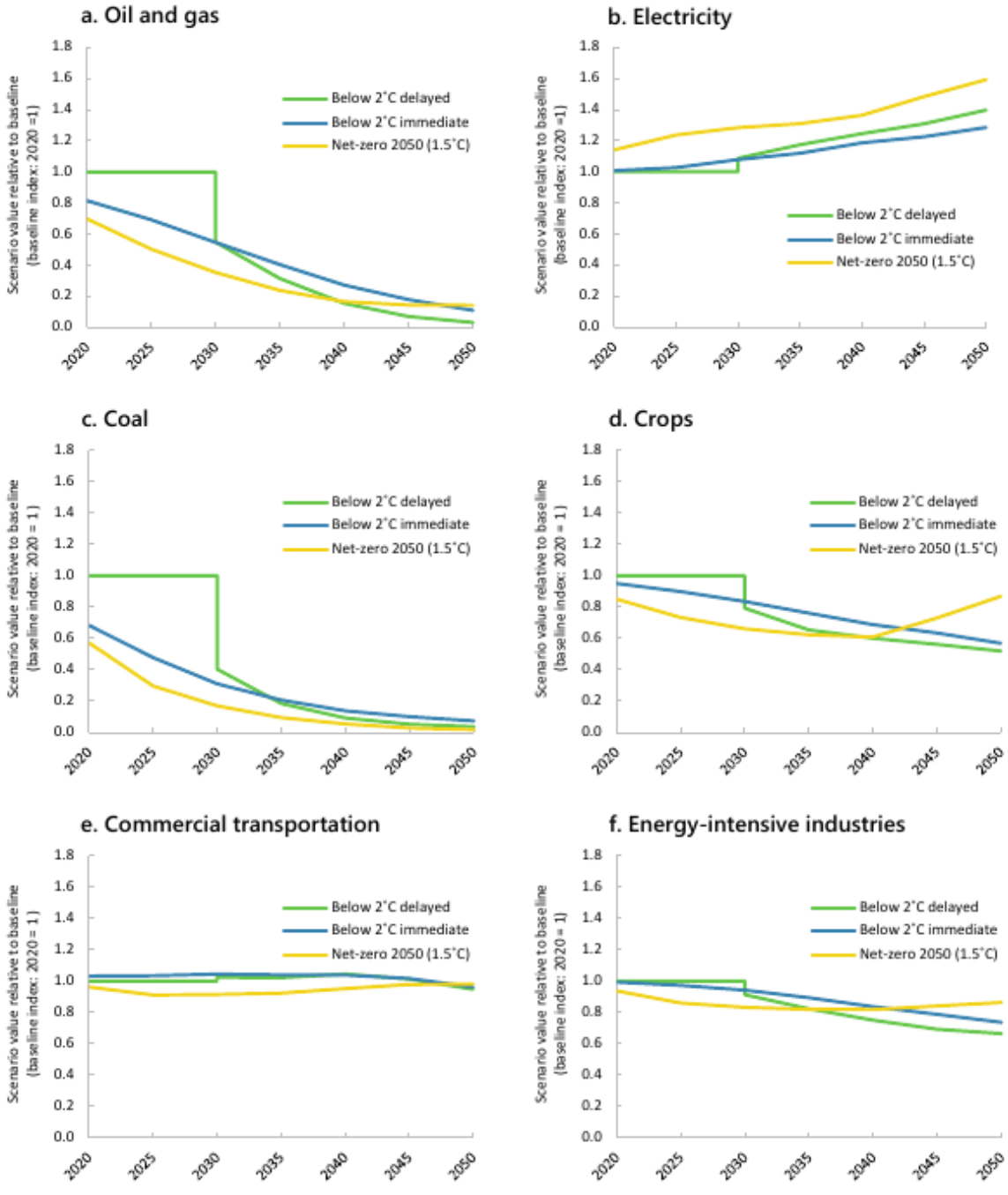


Chart 19: Equity valuation impacts on Canadian sectors following changing global climate policy



Other potentially useful resources

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These might be of interest, but are not as interesting, detailed, or inspiring as the above.

- FSB
  - Overview of the stress testing exercises conducted so far - methods, models, risks considered, identified data gaps, etc.
  - Based on a survey among NGFS and FSB member institutions
  - Serves as a good source of information where the current "industry standards" are
- Riksbank
  - Currently only considers how to implement climate risk stress testing
- Australian Prudential Regulation Authority
  - Cooperating with the 5 largest banks, similar approach as Bank of Canada
  - Two scenarios derived from NGFS run through multi-country model which features also Australia
  - Horizon 2050
- New Zealand
  - Five largest banks, NGFS scenarios adapted to local needs
  - Horizon 2050
  - Problem: their scenarios are designed to really matter only after 2030, so it's not clear what the macropru policy should

> do now

- Bank of France
  > - Very brief, self-congratulatory, but broadly in line with others
- Deloitte
  > - Nice charts, little content
- UN

  Large overview document

  Discusses also organizational issues

  * Not much insight additional to already covered sources