Green Shoots and Climate Pathways
Emergence of Climate Risk as Focus for Finance

Since the Paris Agreement in 2015 regulators around the world have increasing focused on climate risk in their financial systems.

» Early regulatory stress tests focused on top-down analysis.

» Initially the exercises focused on physical or transition risk, but now cover both.

» Regulators have typically used scenarios inspired by the Network for Greening the Financial System (NGFS), tailored for their jurisdiction.

» Complexity is growing, increasing the burden on banks and insurers.

2015

Taskforce for Climate Related Financial Disclosures (TCFD) set up
‘Breaking Tragedy of the Horizon’ Mark Carney gives speech at Lloyds of London

2016

Network for Greening the Financial System (NGFS) set up

2017

Federal Reserve Board: climate related pilot exercise

2018

Energy crisis triggers inflation and yield curve increases

2019

Glasgow Financial Alliance For Net Zero (GFANZ) launched prior to COP26

2020

Principles for Responsible Investing (PRI) publish ‘Inevitable Policy Response’ climate scenarios

2021

De Nederlandsche Bank launches first regulator driven climate stress test. Top-down exercise quantifying transition risk in the financial system.


2022

Blackrock letters to CEOs & investors identifies climate risk as important driver of capital allocations

NGFS publish climate scenarios for financial system

MOODY’S ANALYTICS
Growing Use of Climate Scenario Analysis in Finance

Similar to existing Stress and Scenario Testing which is commonplace across the finance industry to quantify an entity’s risk.

Climate Scenario Analysis models a plausible future state of the world to assess the impact of climate-related risk on business operations.

Network for Greening of Financial System
Scenarios are emerging as a market standard - from the outset these were designed to be used specifically by financial institutions.

Source: NGFS
Physical Climate Modelling & Uncertainty

» Climate models/scenarios (for example CMIP 5 & 6) are used in some applications – for example insurance underwriting

» Emissions pathways from IAMs are often converted into climate and temperatures outputs using the reduced form model MAGICC.

» A single emissions path generates a distribution of temperatures due to uncertainties in climate sensitivity.

» Some feedback impacts are captured in in MAGICC 7, e.g.:
  - Water vapour levels
  - Albedo effects
  - Permafrost loss
  - CH4 cycle feedback effects

Schematic overview of MAGICC calculations showing the key steps from emissions to global and hemispheric climate responses.

Source: Fig A.1. in Meinshausen et al. 2011, ACP
Top-down Impact Analysis

How does it work?

Key steps

1. Understand Climate Pathways
   » Understand the policy and climate change pathways (SSP/RCP, NGFS, PRI)

2. Interpret Economic Implications
   » Interpreting macroeconomic variables including real capital investment, climate/energy inflation

3. Determine Financial Basis Stresses
   » Calculate financial basis variable for each climate path

4. Expand Scenario Variables
   » Translate climate-aligned scenarios into broader financial variables

Inputs into Risk Management models or Strategic Asset Allocation frameworks

Applications

- Impact assessment: analyze financial impact from climate change from macroeconomic view
- Regulatory compliance: Incorporate climate scenarios into internal assessments and regulatory reporting
Three Waves of Real Economic Costs

- Carbon/emission pricing, abatement costs and physical damages/adaption costs
- Productivity impacts can also be significant and included as ‘fourth wave’
- Real costs will vary across regions and scenarios
- Combined, they become a significant proportion of ongoing gross capital formation/investment

Orderly Transition – Net Zero 2050

Hot House Scenario – Nationally Determined Contributions

Source: NGFS, Moody’s Analytics
Cumulative Return Impact
Impact on Equity Total Return Index Relative to Baseline

Source: Moody’s Analytics
**Investment Outcomes**

**Retirement Impacts for UK Living Wage Workers**

- Pension funds and asset managers don’t ‘own’ investments, they are custodians of public’s savings/wealth
- Strongly skewed to wealthier deciles of populations (e.g., the main owners)
- However, in the UK following ‘auto enrollment’ 80% of workers have private pension
- Significant focus for financial regulation is protecting customers/consumers

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Table 6: Summary of the projected outcomes for the representative Generation Z investor

<table>
<thead>
<tr>
<th>Climate Pathway</th>
<th>Percentile Outcome (%)</th>
<th>Final Fund Value (£)</th>
<th>Real Final Fund Value (£)</th>
<th>No Years Wages @5% pa (2020 €)</th>
<th>Income @5% pa (2020 €)</th>
<th>Income @7% pa (2020 €)</th>
<th>Income @7% pa (2020 €)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counterfactual Baseline 10%</td>
<td>96435</td>
<td>35905</td>
<td>2.07</td>
<td>4822</td>
<td>1795</td>
<td>6750</td>
<td>2513</td>
</tr>
<tr>
<td>Counterfactual Baseline 50%</td>
<td>203612</td>
<td>69621</td>
<td>4.01</td>
<td>10181</td>
<td>3481</td>
<td>14253</td>
<td>4873</td>
</tr>
<tr>
<td>Counterfactual Baseline 90%</td>
<td>549133</td>
<td>146948</td>
<td>8.46</td>
<td>27457</td>
<td>7347</td>
<td>38439</td>
<td>10286</td>
</tr>
<tr>
<td>Counterfactual Baseline Average</td>
<td>298632</td>
<td>83059</td>
<td>4.78</td>
<td>14932</td>
<td>4153</td>
<td>20904</td>
<td>5814</td>
</tr>
<tr>
<td>Current Policies Average</td>
<td>284403</td>
<td>79003</td>
<td>4.55</td>
<td>14220</td>
<td>3950</td>
<td>19908</td>
<td>5530</td>
</tr>
<tr>
<td>Below 2C Average</td>
<td>283422</td>
<td>78703</td>
<td>4.53</td>
<td>14171</td>
<td>3935</td>
<td>19840</td>
<td>5510</td>
</tr>
<tr>
<td>Net Zero 2050 Average</td>
<td>278579</td>
<td>77298</td>
<td>4.45</td>
<td>13929</td>
<td>3865</td>
<td>19501</td>
<td>5411</td>
</tr>
<tr>
<td>Delayed Transition Average</td>
<td>264931</td>
<td>73396</td>
<td>4.22</td>
<td>13247</td>
<td>3670</td>
<td>18545</td>
<td>5138</td>
</tr>
</tbody>
</table>

All results show the average outcome except for the first two columns which show percentiles of the baseline projection.

Table 7: Comparison of the impact of climate pathways on retirement income levels for the representative investors using different integrated assessment models outcomes.

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Remind</th>
<th>GCAM</th>
<th>Message</th>
<th>Pathway</th>
<th>Remind</th>
<th>GCAM</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Policies</td>
<td>-1.2%</td>
<td>-1.0%</td>
<td>-1.0%</td>
<td>Current Policies</td>
<td>-3.1%</td>
<td>-2.3%</td>
<td>-2.6%</td>
</tr>
<tr>
<td>Below 2C</td>
<td>-2.7%</td>
<td>-3.0%</td>
<td>-2.6%</td>
<td>Below 2C</td>
<td>-5.7%</td>
<td>-7.2%</td>
<td>-4.5%</td>
</tr>
<tr>
<td>Net Zero 2050</td>
<td>-6.8%</td>
<td>-3.5%</td>
<td>-6.3%</td>
<td>Net Zero 2050</td>
<td>-11.5%</td>
<td>-8.6%</td>
<td>-8.5%</td>
</tr>
<tr>
<td>Delayed</td>
<td>-3.5%</td>
<td>-2.3%</td>
<td>-4.0%</td>
<td>Delayed</td>
<td>-15.2%</td>
<td>-11.1%</td>
<td>-17.7%</td>
</tr>
</tbody>
</table>


Source: Author’s Own Calcs
Short term scenarios
Capitalizing changes in expectations

Long term drag on returns can be brought forward by capitalisation.

Climate scenarios are often considered as slow-onset, long-term effects, which exert a drag on growth and returns over decades, but short-term scenarios are also possible to create.

- Simulate a “Minsky moment” via a change in expectations and pricing in future losses.
- This is particularly relevant for physical risk and hot house scenarios where direct effects take time to impact the economy.
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![Diagram showing cumulative difference from baseline over years, with labels for Baseline, Current Policies, and Current Policies (capitalised).]
Putting the ‘Climate Risk’ Trade Off Into Context

» Highly uncertain economics….

» ……leads to marginal trade offs in global (financial) wealth….

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Present value of consumption (Trillions of 2019 US international $)</th>
<th>Difference from base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>6,266</td>
<td>0.0</td>
</tr>
<tr>
<td>C/8 optimal</td>
<td>6,373</td>
<td>106.8</td>
</tr>
<tr>
<td>T ≤ 2°C</td>
<td>6,349</td>
<td>82.8</td>
</tr>
<tr>
<td>Paris, updated 2022</td>
<td>6,342</td>
<td>76.4</td>
</tr>
</tbody>
</table>

Table 6. Total global wealth (present value of consumption), 2019 US$.


Source: IPCC, 2022, Cross-Working Group Box ECONOMIC.1

» ……at significant ecological and socio-economic cost.
The Stairway to Net Zero
Communicating What Needs to Be Done

» Marginal abatement cost curves can illustrate what needs to be done across the whole economy to achieve net zero

» The stairway to net zero is a series of 5 year timesteps – each requiring a certain level of emission cuts and investment

» Some sectors can decarbonise earlier than others. IAMs/scenarios can differ significantly on sectoral impacts and energy mix

See McKinsey *Pathways to A Low Carbon Economy* and Goldman Sachs *Carbonomics* for similar bottom-up abatement curves split by sector and technology.
Subsidies and Policies Will Drive Outcomes

» The key drivers of outcomes will be future subsidies and policies

» A key focus for finance/investments is keeping aligned with those changes/pathways

Source:
Temperature Alignment Data & Methodologies

Company targeted emissions are quantified over the period 2022-2030...

» Hypothetical company target has a base year of 2019
» Emissions projected from this point assuming target is met
» Cumulative emissions metric calculated

... and compared to IEA* temperature rise benchmarks, to understand level of near-term ambition.

» Aggregate emissions fall between 1.65°C and 2.7°C benchmarks
» Company implied temperature rise of 1.8°C via interpolation

*International Energy Agency

Source: Moody’s Temperature Alignment Data
Conclusions

» Clear alignment/similarities in approach being taken in finance
  – Strong focus on downsides, for ‘burning embers’ cf ‘climate risk’
  – Significant and growing use of climate scenarios/models in finance – based on ‘the science’

» Economic/Financial climate impacts are significant but highly uncertain
  – Uncertainties in fundamental climate science (climate sensitivities, geospatial impacts) are significant, but small compared to broader socio-economic uncertainty
  – Can lead to ‘factionalisation’ - difficulty building mainstream consensus around uncertain exposures/controversial impact analysis
  – Significance of financial/economic trade-off is often overstated

» Growing Focus on Solutions
  – Firm and portfolio alignment metrics cf ‘Green Shoots/Safe Landings’

» Speed of transition will ultimately be driven by policies & subsidies