

South Africa Series: ESG Assessments & Risk Management

June 29, 2021



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Today's Speakers

Predictive Analytics



Brenda Solis Gonzalez
Associate Director



Cristina Daverio
Head of ESG Research



Petr Zemcik, PhD
Senior Director



James Edwards, PhD
Director



Rebecca Cui, MFE
Assistant Director

Moody's Climate Risk Solutions

Forward-looking exposure metrics and risk analytics

Transition Risk Data

Assessment of 5,000 listed companies and on-demand scoring available to identify transition risk exposure from different fossil fuel resource types and power generation technologies.

Macroeconomic Scenarios

Climate-adjusted macroeconomic forecasts with an 80-year horizon. Fully aligned with the Network for Greening the Financial System's (NGFS) representative scenarios for physical and transition risk.

Climate Pathway Scenarios

Tools that translate climate pathways into financial risk variables to inform asset allocation and liability models. Based on Moody's award-winning scenario generation software.



Physical Risk Data

Forward-looking data capturing exposure to climate hazards for 5,000 listed companies with 2.5m corporate facilities globally and 10m commercial real estate properties in the US. On-demand scoring is also available.

Climate-Adjusted PDs

Climate-adjusted probability of default (PD) for listed and unlisted companies powered by Moody's award-winning Expected Default Frequency (EDF™) model.

Compliance Tools

Powerful yet easy-to-use reporting tools and analytics based on climate scenarios and climate-risk data. Used for stress testing and Task Force on Climate-related Financial Disclosures (TCFD) reporting.

Agenda

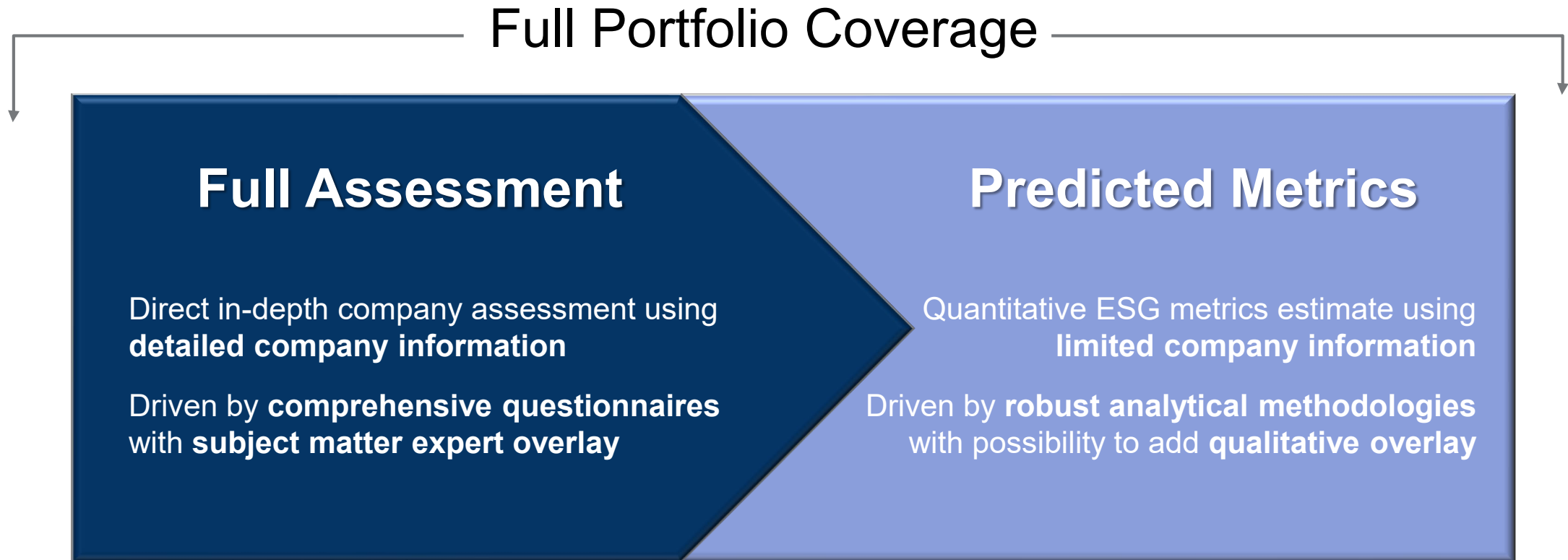
1. Assessing ESG Risk Across Types of Business
2. Climate Change Risk & Stress Testing
3. Climate Change and Corporate Credit Risk
4. Conclusion

1

Assessing ESG Risk Across Types of Business

Levels of ESG Risk Assessment

How to bridge the disclosure data gaps



ESG Risk Assessment

Vigeo Eiris ESG & Climate Data



Leveraging on VE data for carbon footprint & more at multiple levels of granularity



ESG Assessment Scores

- » An assessment of how companies are managing their ESG risks and opportunities.
- » Multiple layers of granular scoring
- » 0 – 100 scoring scale



Energy Transition Scores

- » An assessment of how companies are tackling the risks and opportunities tied to the transition to a low carbon economy
- » 0 - 100 scoring scale



Physical Risk Management Scores

- » An assessment of how companies anticipate, prevent and manage the **physical risks** of climate change
- » 0-100 scoring scale

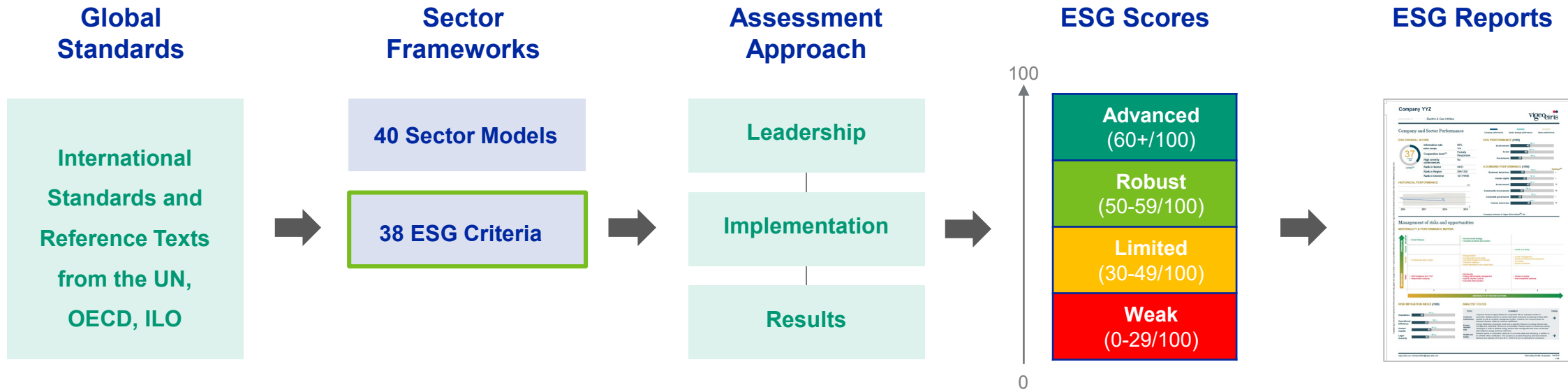


Carbon Emissions Data

- » Scope 1 data (direct)
- » Scope 2 data (indirect)
- » Scope 3 data (other indirect)
- » + modelled data

ESG Scoring - High Level Methodology

A systematic view on three angles of corporate management of ESG risks



ESG assessment methodology built around international standards and reference texts.



ESG Scoring – Criteria



ESG CRITERIA

Environmental Domain

Environmental Strategy
 Pollution Prevention and Control
 Green Products and Services
 Biodiversity
 Water
 Energy
 Atmospheric emissions
 Waste management
 Local Pollution (noise/vibration)
 Transportation
 Impacts of Product Use and Disposal

Business Behaviour Domain

Product Safety
 Information to Customers
 Customer Relations
 Sustainable Supplier Relationships
 Environmental Standards in the Supply Chain
 Social Standards in the Supply Chain
 Corruption
 Anti-Competition
 Lobbying

Human Resources Domain

Social Dialogue
 Employee Participation
 Reorganisations
 Career Development
 Remuneration Systems
 Health and Safety
 Working Hours

Human Rights Domain

Fundamental Human Rights
 Fundamental Labour Rights
 Non Discrimination and Diversity
 Child and Forced Labour

Corporate Governance Domain

Board of Directors
 Audit and Internal Controls
 Shareholders
 Executive Remuneration

Community Involvement Domain

Social and Economic Development
 Societal Impact of Products and Services
 Philanthropy

ESG Scoring – Case Study

Water Management Scores – Mining & Metals South Africa



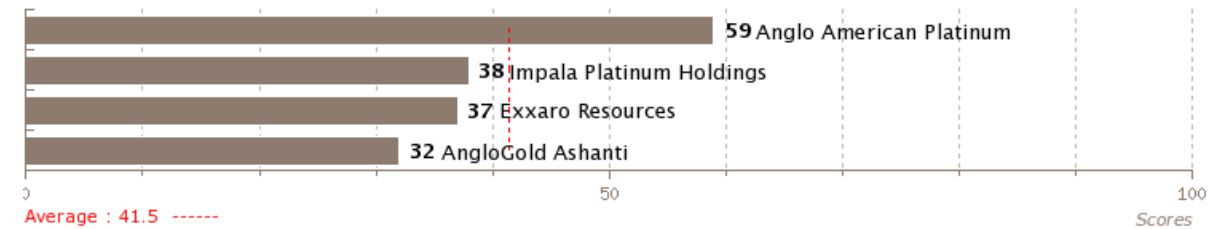
	Anglo American Platinum	Impala Platinum Holdings
Water Score	59/100 [robust]	38/100 [limited]
Leadership	<ul style="list-style-type: none"> Quantified targets 	<ul style="list-style-type: none"> General commitment on water consumption
Implementation	<ul style="list-style-type: none"> Actions to optimise the production process to reduce water consumption and pollution 	<ul style="list-style-type: none"> Unclear measures to reduce water consumption and pollution
Results	<ul style="list-style-type: none"> Positive trend water consumption Involvement in a controversy but disclosure of voluntary corrective actions 	<ul style="list-style-type: none"> Positive trend water consumption No controversies

ENV2.1 Protection of water resources

% info = 71 %

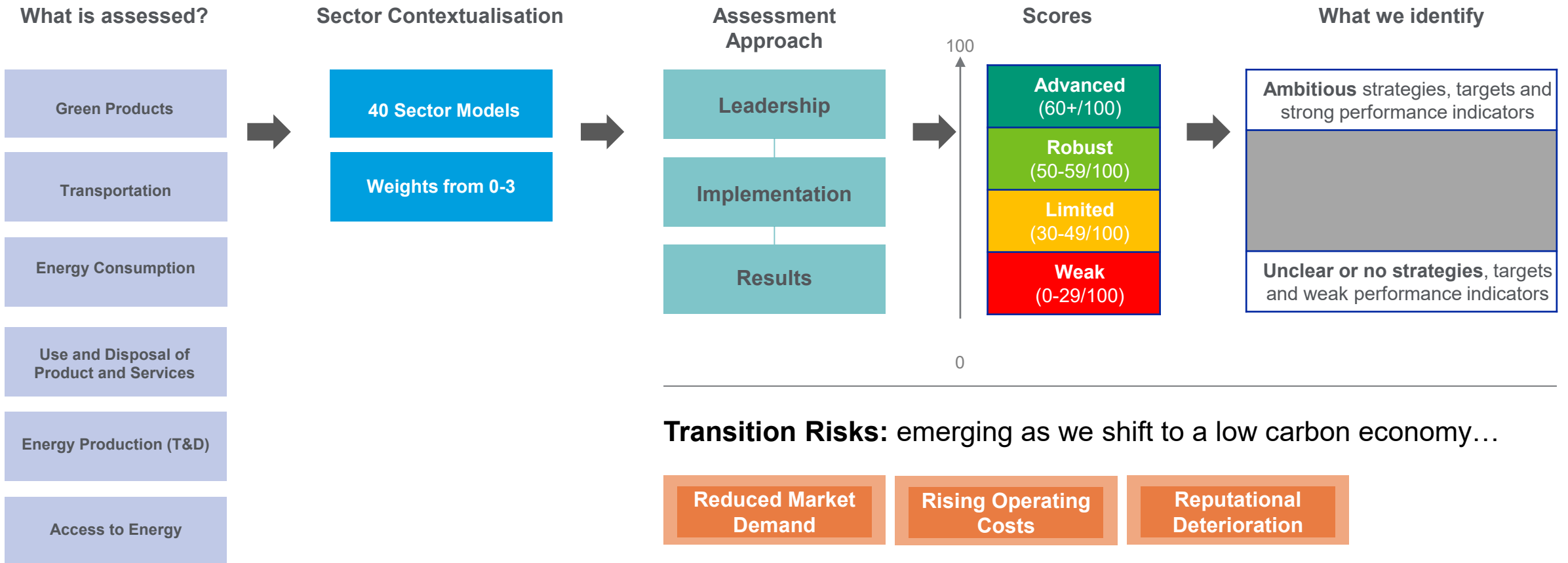
Protection of water resources (Weight: 3)

Criterion ENV2.1



Energy Transition Assessments

An assessment of how companies are tackling the **risks** and **opportunities** tied to the transition to a low carbon economy



Case Study Energy Transition Assessments

Tracking and understanding improvement over time



Title	Sector	2016	2018	2020
Anglo Gold Ashanti	Mining and metals	Weak	Weak	Weak
Growthpoint Properties	Real Estate	Limited	Limited	Limited
BMW	Automobiles	Limited	Limited	Robust
Enel	Electric & gas utilities	Advanced	Advanced	Advanced
Centrica	Electric & gas utilities	Limited	Limited	Limited

ENEL - (zoom on renewables strategy)

- ✓ Public commitments and targets to develop renewables
- ✓ Current installed renewable capacity disclosed **and** in line with sector average
- ✓ Ongoing renewable projects disclosed (wind/solar/biomass)
- ✓ Current renewable energy generation disclosed **and** in line with sector average.

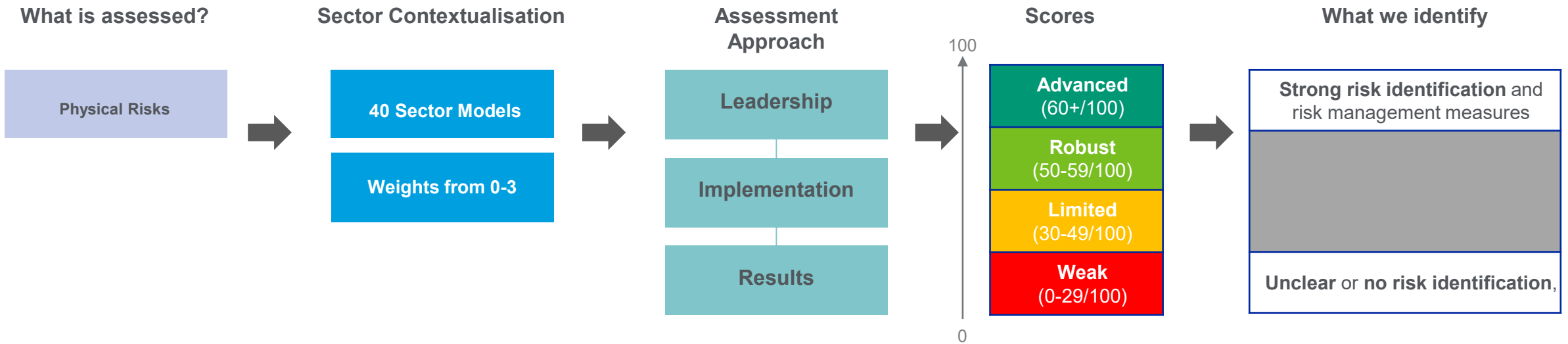
Centrica - (zoom on renewables strategy)

- ✓ Public commitments to develop renewables (general commitment)
- ✓ Current installed capacity in renewable sources - **not disclosed**
- ✓ Ongoing renewables development projects - **not disclosed**
- ✓ Current renewable energy generation – **not disclosed**

Source: V.E Energy Transition Assessment Database

Physical Risk Management Assessments

An assessment of how companies anticipate, prevent and manage the **physical risks** of climate change

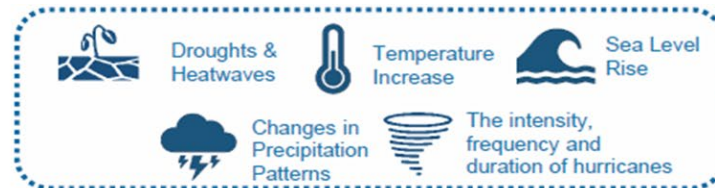


Physical Risk Impacts:

- ✓ Corporate assets
- ✓ Costs
- ✓ Impact on corporate ability to conduct activities and operations
- ✓ Supply Chain



Climate Change Impact on the company

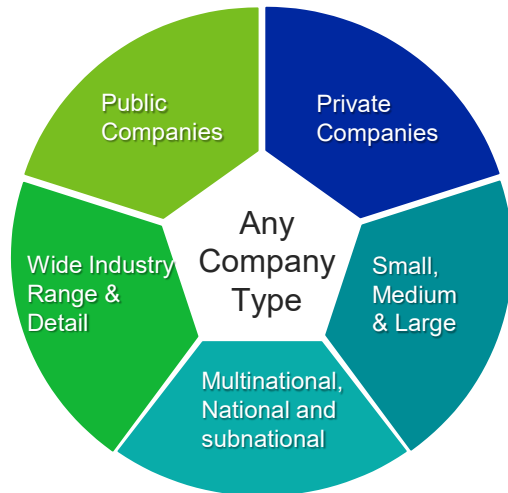


Quantitative Approach for Expanding Company Coverage

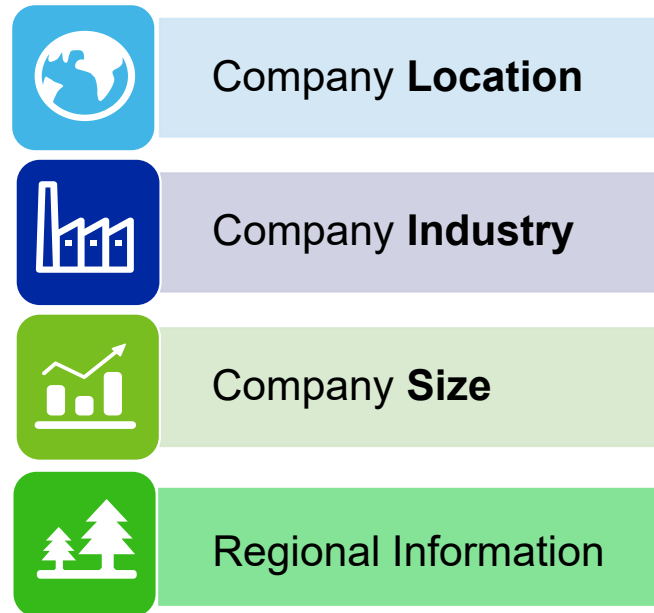
Bridging the ESG Risk Data Gaps

Applying ESG Score Predictor analytical models

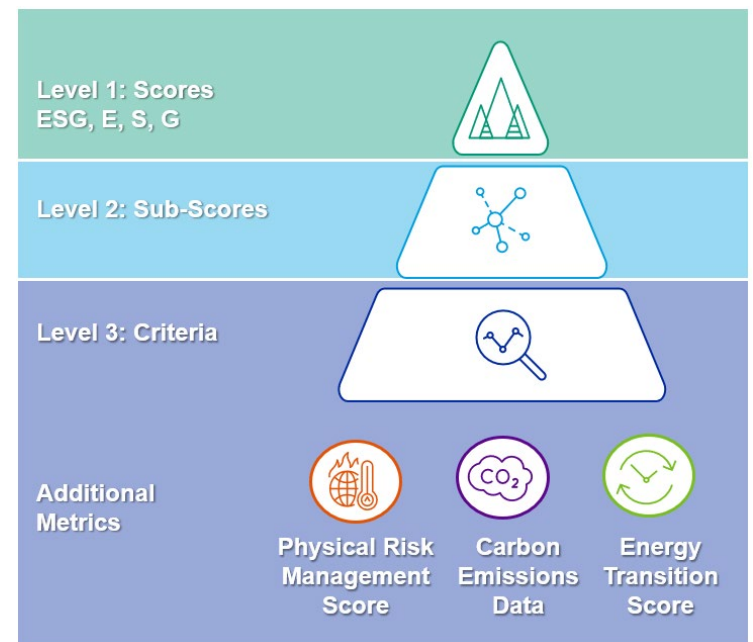
1 Portfolio



2 Analytics



3 Metrics Estimates



Leading Features to Estimate Metrics

Using Machine Learning techniques to train the models



Company Size, Location, Industry

- Total assets
- Number of employees
- Turnover, revenues
- Country, region
- Industry classification, NACE 1-4



Physical Risk

- Hurricanes and typhoons risk
- Heat and water stress
- Sea rise and floods
- Extreme precipitations
- Historical exposure to natural catastrophes



Development and Freedom Indicators

- Life expectancy, income index
- Expected years of schooling
- Political rights, civil liberty, electoral process score
- Overall freedom index, corruption perception

Macroeconomic Indicators

- GDP, industrial production
- Population
- Unemployment
- Indebtedness
- Foreign direct investments



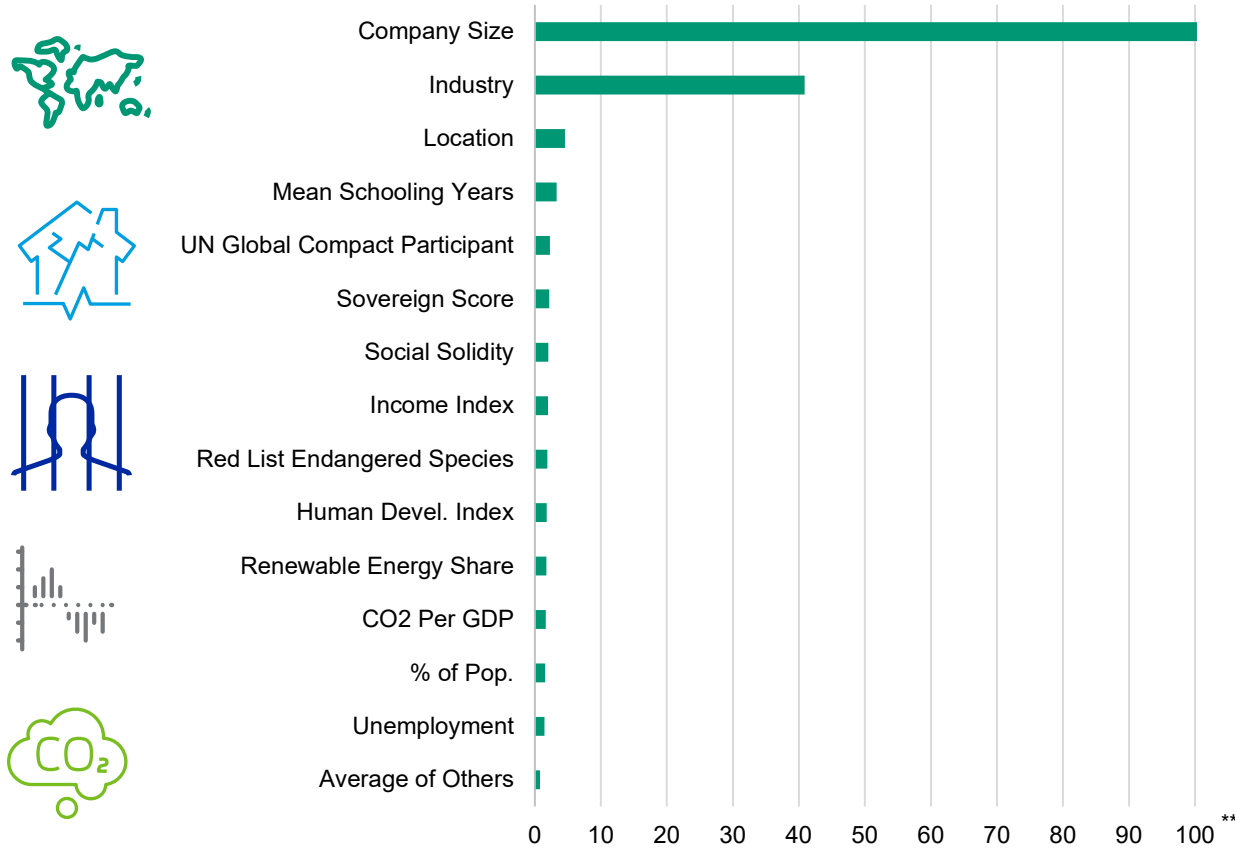
Sustainability Indicators

- CO2 emissions per GDP
- Used material within economy
- Share of population living in extreme poverty
- Income share of richest
- Sustainability commitment

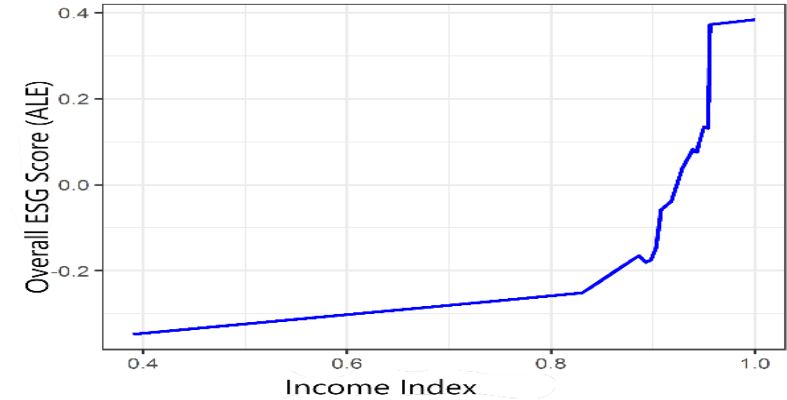


Overall ESG Score – Interpreting the Metric

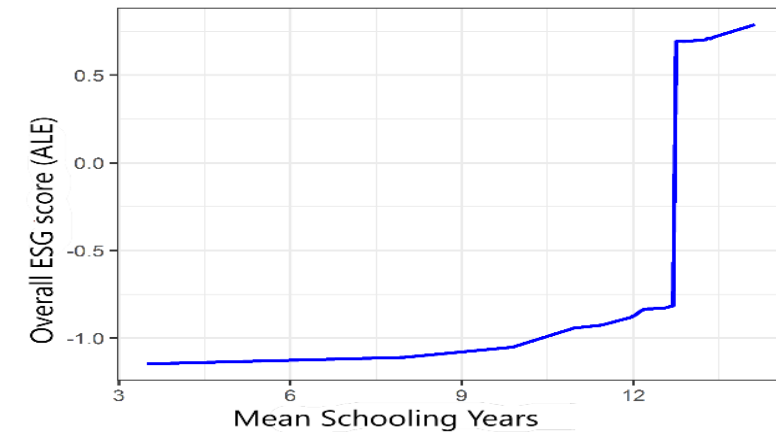
Illustration of importance & impact direction for model features



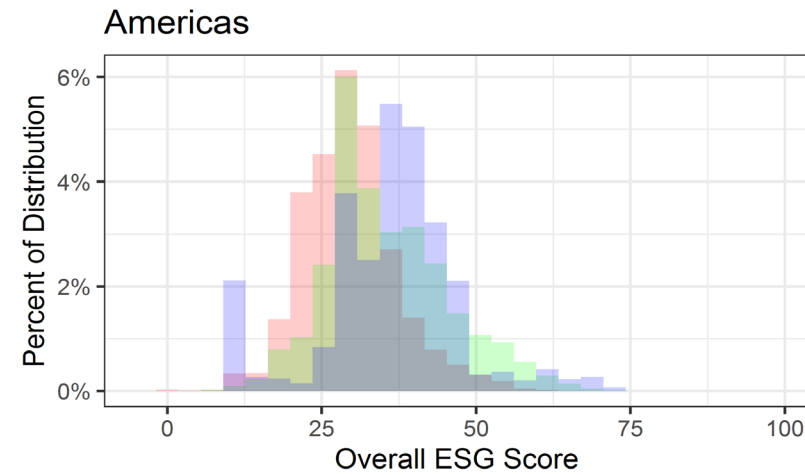
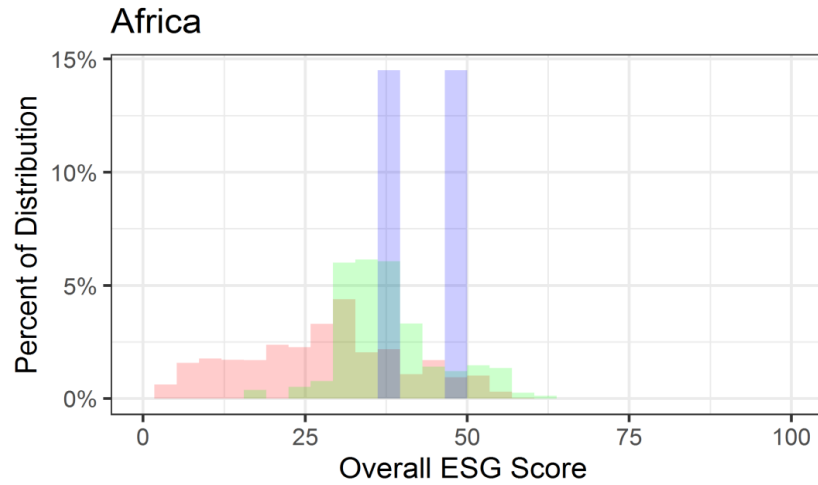
** Contribution measure for feature importance



*Accumulated Local Effect (ALE) measure for impact direction



Overall ESG Score: Heterogeneity by Region

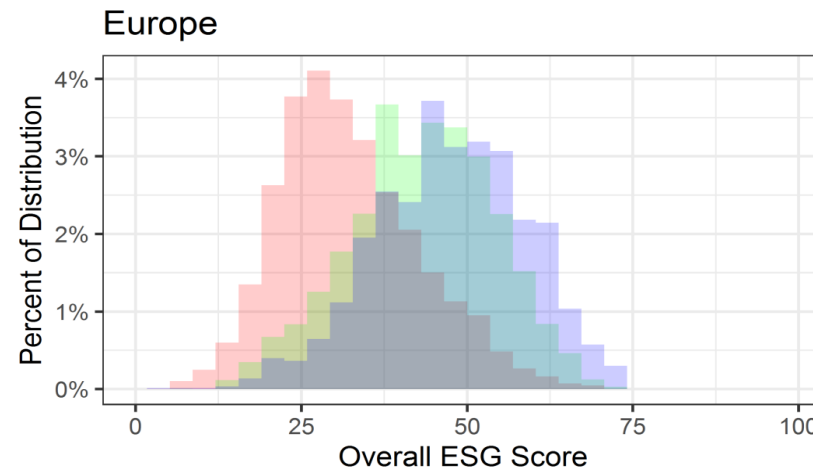
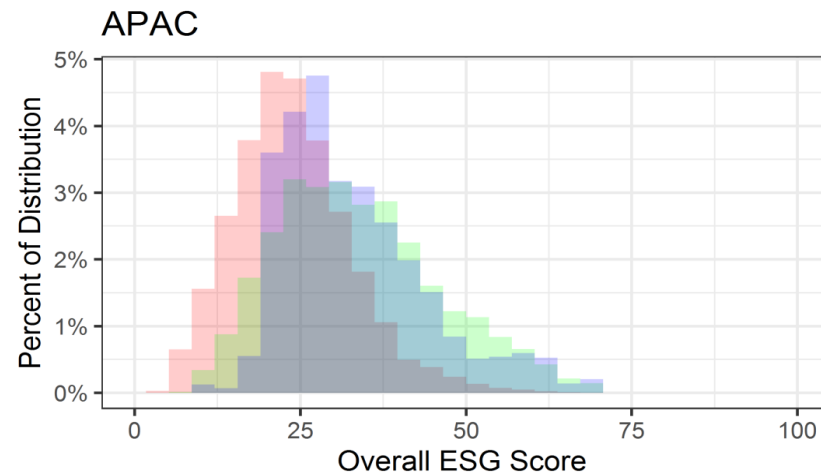


Business Size

>2.6 Billion USD

2.6M – 206 Billion USD

<2.6 million USD



ESG Score Predictor for Vulnerability Analysis



Key characteristics of the illustrative portfolio

FULL PORTFOLIO

107 countries

20 NACE1 industries

62,632 companies

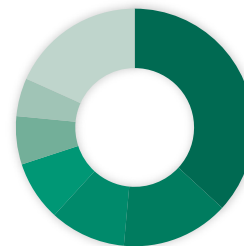
Location

- US (20.31%)
- Japan (8.28%)
- China (6.39%)
- Canada (6.05%)
- UK (5.68%)
- India (5.32%)
- Australia (4.66%)
- South Korea (4.12%)
- Taiwan (3.58%)
- South Africa (0.91%)
- Other (34.69%)



Industry

- Manufacturing (37%)
- Financial & insurance (15%)
- Information & communication (10%)
- Mining & quarrying (8%)
- Wholesale & retail trade (7%)
- Real estate (5%)
- Other (18%)



Size

Company Turnover mln USD	Exposure
< 1	2.04%
[1-100)	35.11%
[100-1,000)	44.12%
1,000>=	18.73%

AFRICA SUBSET

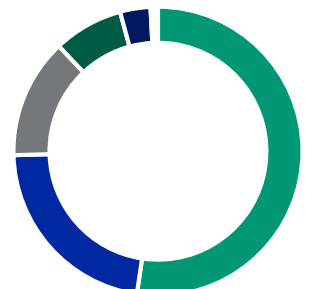
11 countries

18 NACE1 industries

1,089 companies

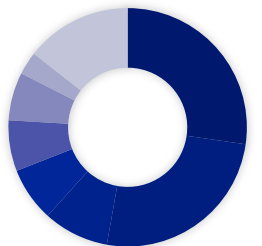
Location

- South Africa (52%)
- Egypt (22%)
- Nigeria (13%)
- Morocco (8%)
- Zimbabwe (3%)
- Liberia (0.3%)
- Zambia (0.2%)
- Botswana (0.09%)
- Gabon (0.1%)
- Ivory Coast (0.1%)
- Togo (0.1%)



Industry

- Manufacturing (27.3%)
- Financial & insurance (25.5%)
- Real estate (8.9%)
- Mining & quarrying (7.3%)
- Wholesale & retail trade (6.9%)
- Information & communication (6.5%)
- Construction (3.1%)
- Other (14.4%)



Size

Company Turnover mln USD	Exposure
< 1	0.4%
[1-100)	2%
[100-1,000)	0.1%
1,000>=	98%

Source: Moody's Market Implied Ratings (MIR)

Relevance of Individual ESG Metrics to Sectors



Metrics in deviations from portfolio average

Industry - Nace1	Exp	FULL PORTFOLIO							Exp	AFRICA SUBSET						
		Overall ESG	Overall Environment	Overall Social	Overall Governance	Physical Risk Mgmt	Energy Transition	Carbon Emissions (Scope 1+2)		Overall ESG	Overall Environment	Overall Social	Overall Governance	Physical Risk Mgmt	Energy Transition	Carbon Emissions (Scope 1+2)
Manufacturing	37%	Yellow	Yellow	Yellow	Red	Yellow	Yellow	Yellow	27%	Red	Yellow	Yellow	Red	Yellow	Yellow	Yellow
Financial & insurance	15%	Green	Green	Green	Green	Green	Green	Green	26%	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Yellow
Information & communication	10%	Yellow	Red	Yellow	Yellow	Yellow	Yellow	Green	7%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Mining & quarrying	8%	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Yellow	7%	Green	Green	Green	Green	Green	Green	Yellow
Wholesale & retail trade	7%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	7%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Real estate	5%	Yellow	Yellow	Red	Yellow	Yellow	Yellow	Yellow	9%	Red	Red	Red	Yellow	Yellow	Yellow	Yellow
Professional, scientific & technical	3%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	2%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Construction	3%	Yellow	Yellow	Yellow	Red	Yellow	Yellow	Yellow	3%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Administrative & support service	3%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	3%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Transportation & storage	2%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	3%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Electricity, gas, steam & AC supply	2%	Green	Green	Green	Green	Green	Green	Red	1%	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Green
Accommodation & food service	2%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	3%	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Agriculture, forestry & fishing	1%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	2%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Human health & social work	1%	Yellow	Red	Yellow	Yellow	Yellow	Yellow	Green	1%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Arts, entertainment & recreation	1%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	0.5%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Water supply, sewerage & waste mgmt	1%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	0.4%	Green	Green	Green	Green	Green	Green	Green
Education	0.42%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	0.6%	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Other services	0.29%	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Green	0.1%	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Public administration & defence	0.01%	Green	Green	Green	Green	Green	Green	Yellow								
Households as employers	0.01%	Green	Green	Green	Green	Green	Green	Yellow								

Heterogeneity of Scores Across Countries



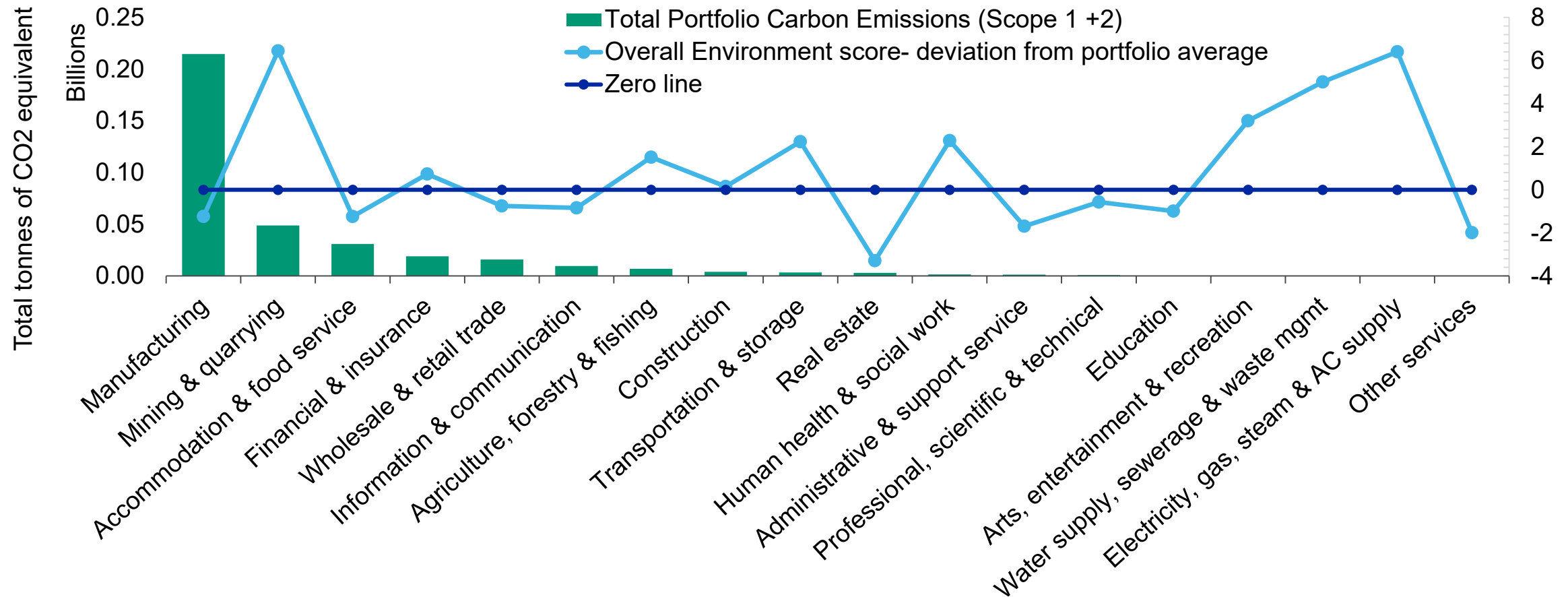
Deviation of Overall ESG score from full portfolio average, selected countries



Point-in-time & Forward-looking Analysis of Metrics



CO2 emissions and Overall Environment score for Africa subset

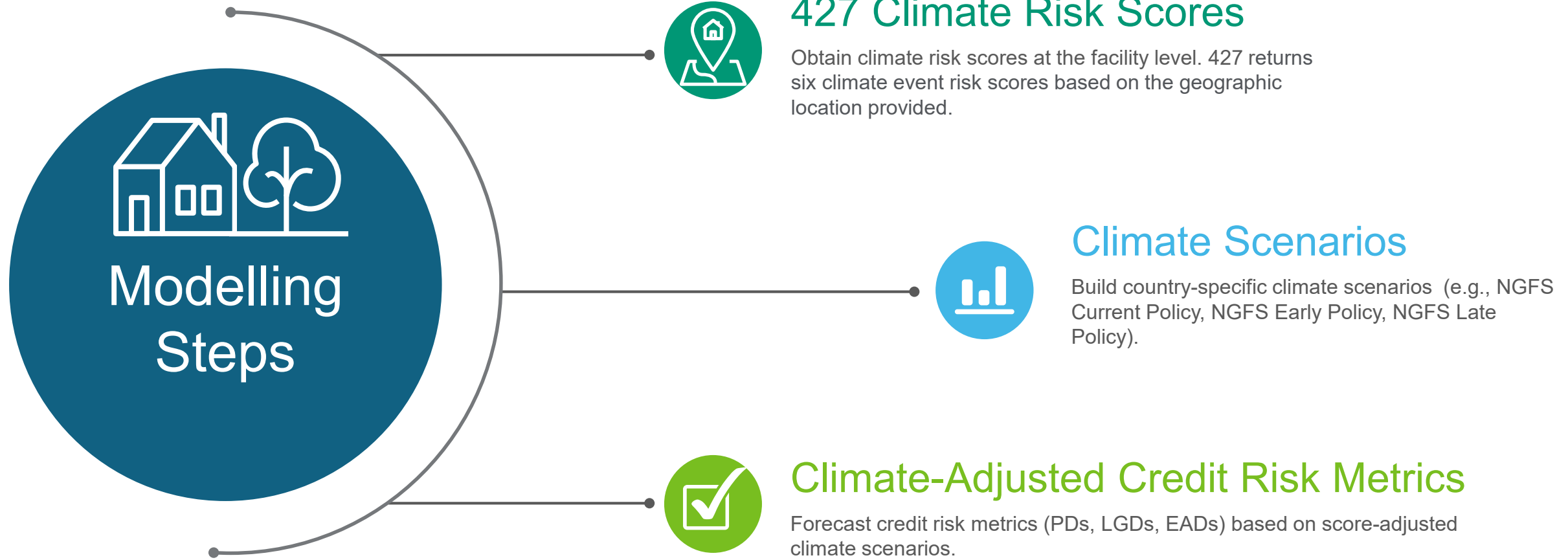


2

Climate Change Risk and Stress Testing

Location-Specific Climate Risk

Risk Assessment







427 Data – Physical Risk Score

On-Demand Scoring



Key Features of 427 Data

-  Score single assets or large portfolios via an interactive, browser-based application or API
-  Analyze data and underlying climate indicators via multiple visualizations
-  Score thousands of properties in minutes
-  Identify hotspots and analyze the detailed drivers of exposure to six physical climate hazards

Use Cases

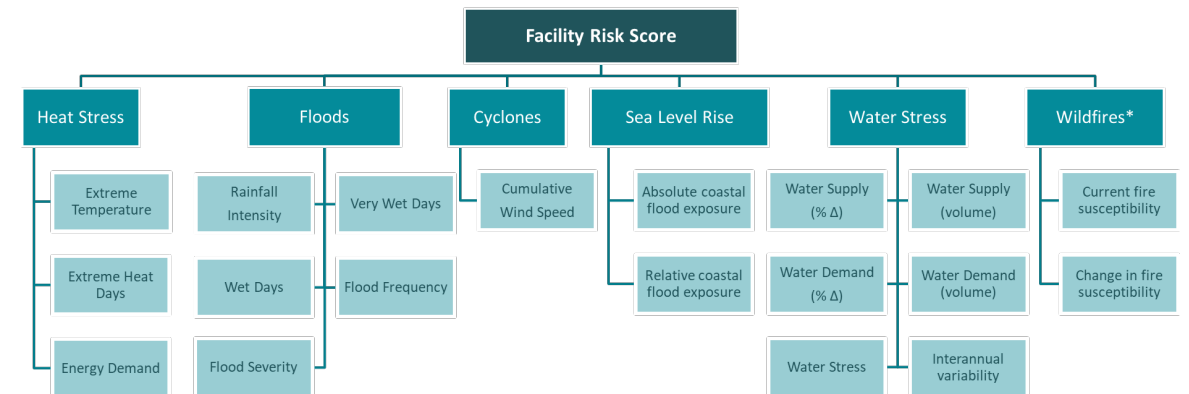


Asset Owners – evaluate the long-term risk exposure of your portfolio holdings and engage with asset operators to improve resilience and risk management

Portfolio Managers – enhance the analysis of your portfolio and monitor risk as portfolio holdings change over time. Screen assets for their exposure to climate hazards, pre-acquisition

Banks – identify the climate-related risks in commercial and residential mortgage portfolios. Incorporate climate risks into loan acquisition

Facility Risk Score



- » Best-in-class, peer-reviewed, publicly available climate models, supplemented by commercially available data.
- » Assessments on virtually **any property or corporate facility globally based on its exposure to key climate hazards**.
- » Ground-up climate risk scores for **real assets**, listed companies, REITs, U.S. municipalities and global sovereigns
- » Available through an API or online user interface for **real assets**.

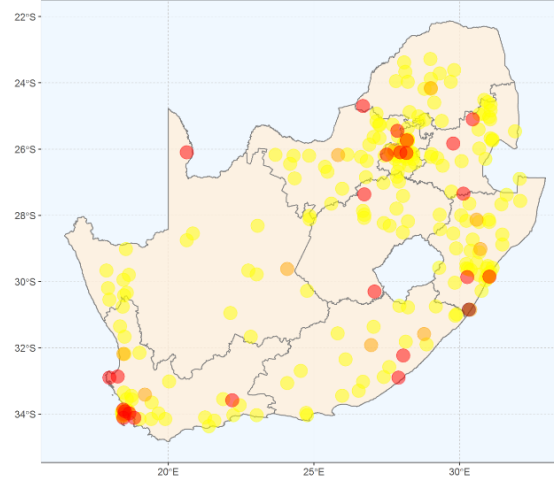
Physical Climate Risk Score

427 Data

- » 250 random names of the portfolio and ran the physical risk climate scores within the on-demand scoring application.
- » **Six climate hazards** assessed at the facility-level: floods, sea level rise, water stress, heat stress, wildfire, and hurricanes & typhons.
- » Majority of the portfolio is low risk but some material hotspots across specific climate hazards.
- » While few South Africa facilities may lead to Red Flags, **Floods and Heat Stress Risk** scores can easily double or triple, amplifying damages for local economies and assets.

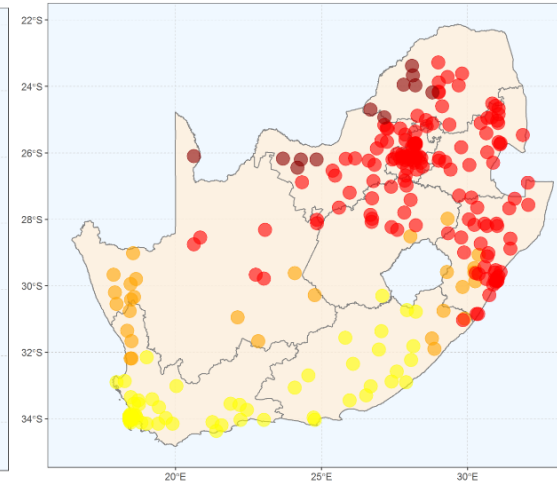
Floods Risk Score

South Africa - 250 random locations



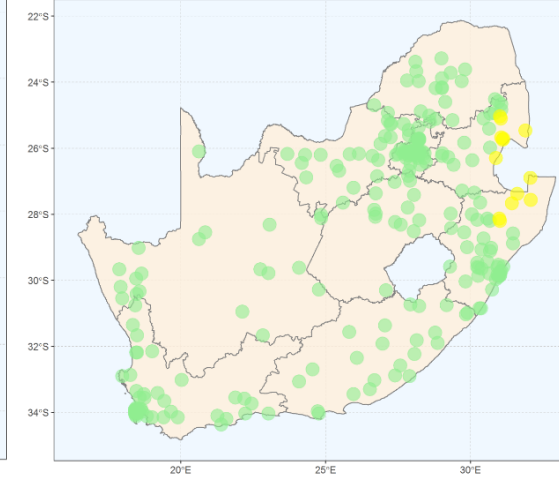
Heat Stress Risk Score

South Africa - 250 random locations



Hurricanes & Typhoons Risk Score

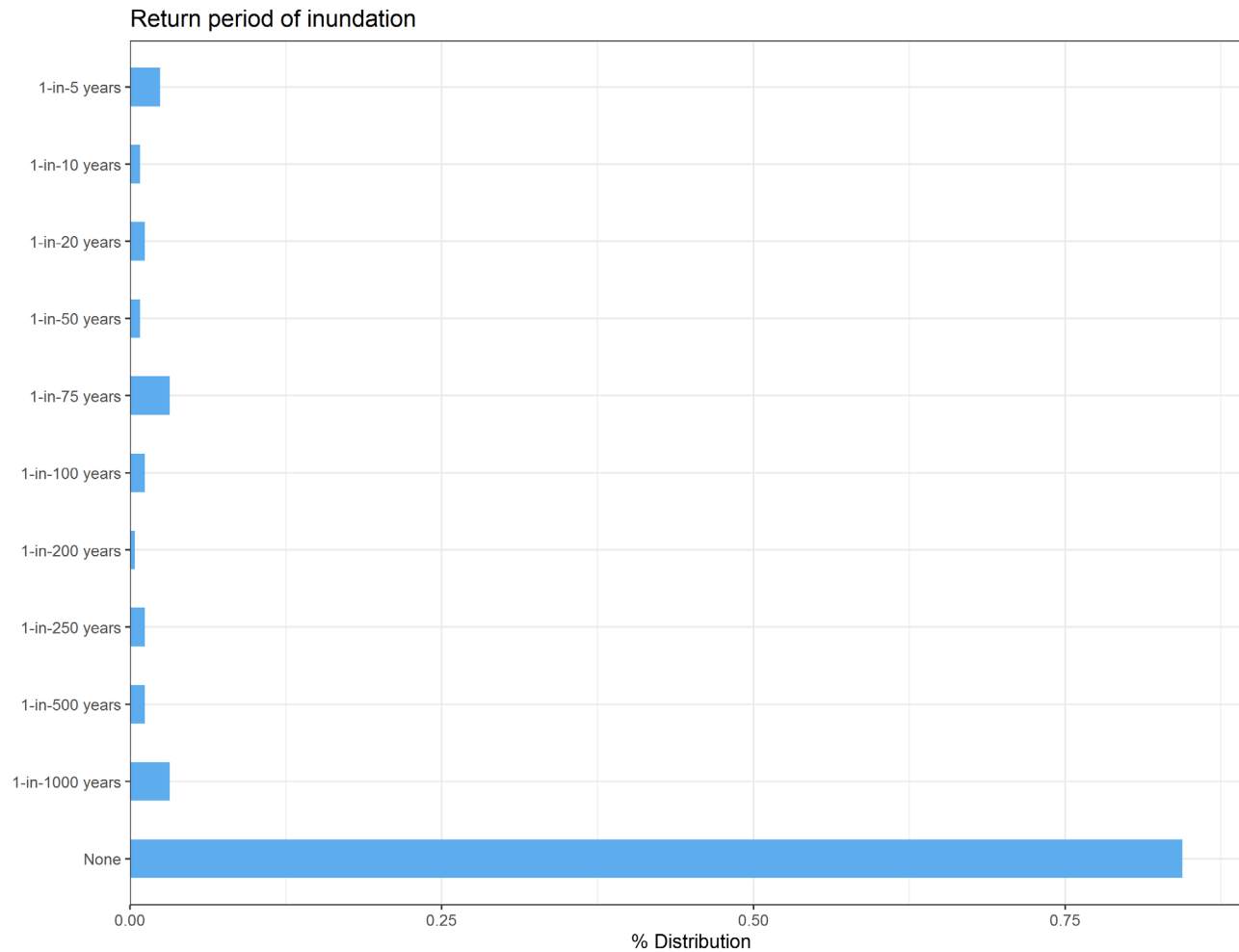
South Africa - 250 random locations



- 1. No Risk
- 2. Low Risk
- 3. Medium Risk
- 4. High Risk
- 5. Red Flag

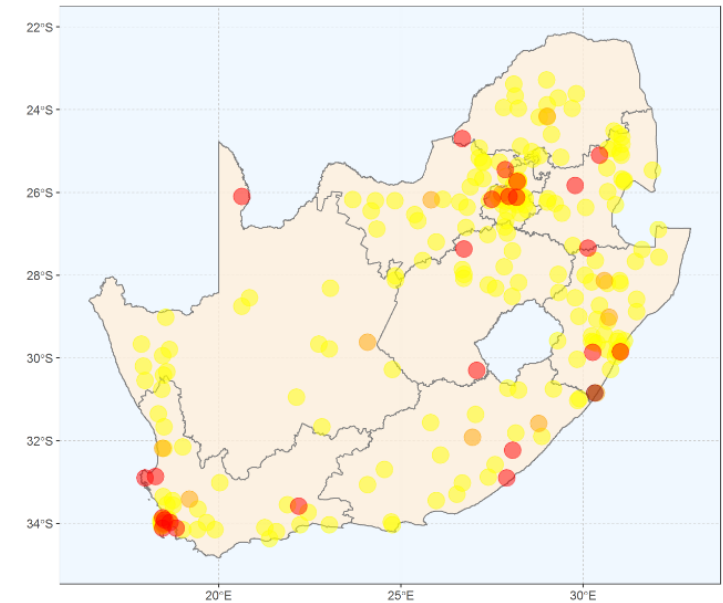
Physical Climate Risk Score (cont.)

South Africa Flood Frequency Based on 250 Random Locations



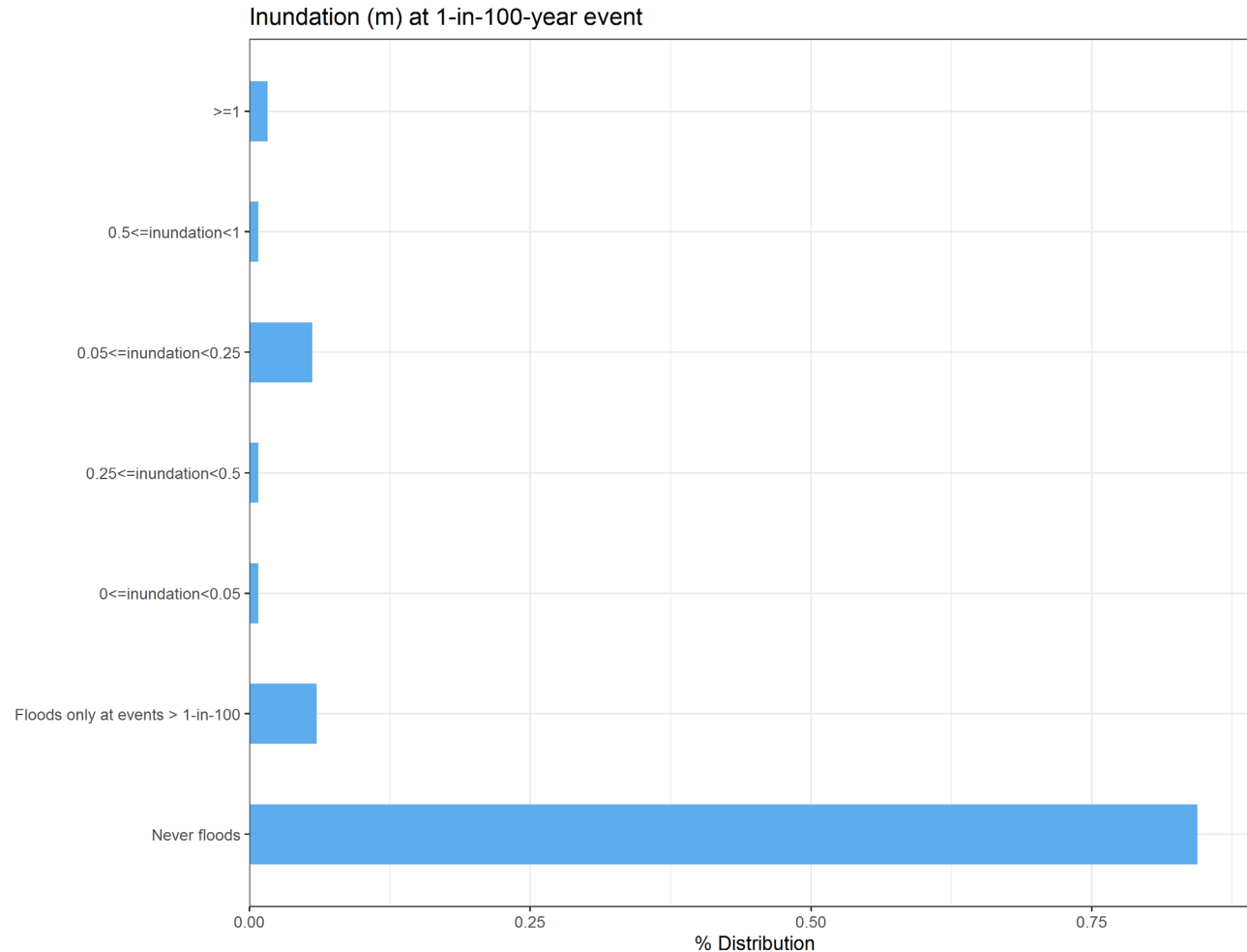
Floods Risk Score

South Africa - 250 random locations



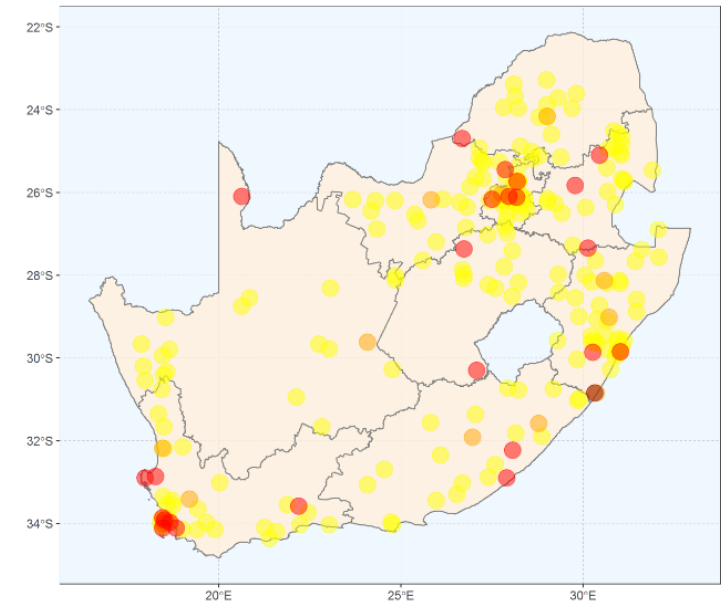
Physical Climate Risk Score (cont.)

South Africa Flood Severity Based on 250 Random Locations



Floods Risk Score

South Africa - 250 random locations



Climate Risk Scenarios



Climate Risk Variables

Physical Variables

Global & regional temperature pathways
 Climate-related perils (e.g. flood, subsidence)
 Longevity
 Agricultural productivity

Transition Variables

Carbon price pathways
 Emissions pathways
 Commodity & energy prices; energy mix

Macro-financial Variables

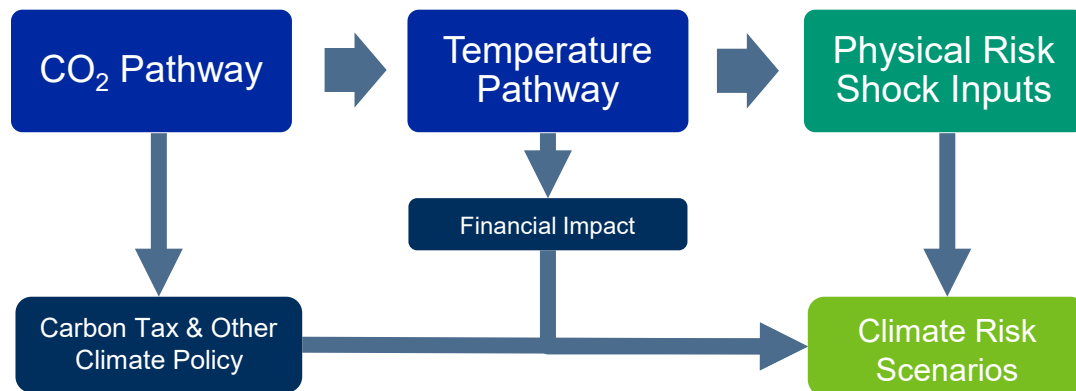
Macroeconomic Variables

GDP & unemployment
 Inflation & central bank rates
 Corporate profits & household income
 Residential & commercial property prices

Financial Market Variables

Government & corporate bond yields
 Equity indexes
 Exchange rates & bank rates

Start with parameters from regulators or clients and expand scenarios to populate additional variables using our Global Macro Model with climate risk components

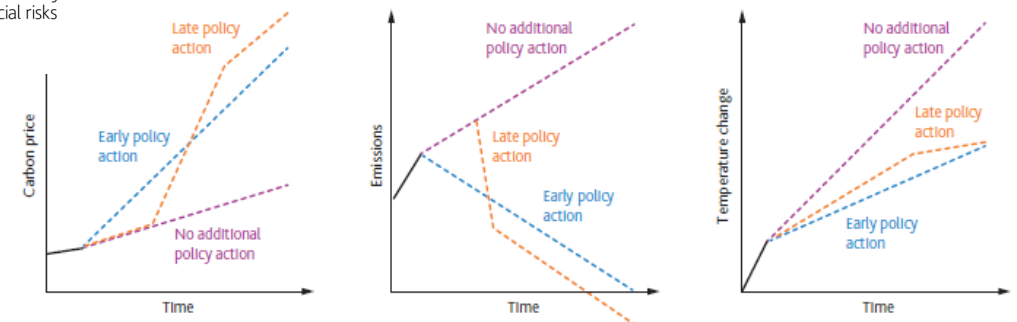


BANK OF ENGLAND

Financial Policy Committee
 Prudential Regulation Committee

Discussion Paper
 The 2021 biennial exploratory
 scenario on the financial risks
 from climate change
 December 2019

Illustrative Variable Pathways in each Scenario



Modelling Framework



Impact Channel

1. Sea level rise
2. Agricultural productivity
3. Heat stress effect on labor productivity
4. Human health effects
5. Tourism
6. Energy demand

Mnemonics

- FC\$_GEO*
- FPROD\$_POT_GEO*
- FPROD\$_POT_GEO*
- FPROD\$_POT_GEO*
- FNETEX\$_I_GEO*
- FCPIFICEBOIU_US*

Energy Consumption

1. Coal
2. Natural gas
3. Petroleum and other liquid

Mnemonics

- FCOALCONQ_IGEO*
- FNGASCONQ_IGEO*
- FPETCONQ_IGEO*

CO2 Taxes

1. Dividend dummy
2. Carbon tax dummy
3. Carbon tax rate
4. Carbon tax revenue
 - 4-i. Carbon tax revenue: Coal
 - 4-i. Carbon tax revenue: Natural gas

Mnemonics

- DUM_CARBDIV_IGEO*
- DUM_CARBONTAX_IGEO*
- FCARBONTAX_IGEO*
- FCARBONREV_IGEO*
- FCOALREV_IGEO*
- FNGASREV_IGEO*

CO2 Emissions

1. Coal
2. Natural gas
3. Oil and petroleum products

Mnemonics

- FCOALCO2EQ_IGEO*
- FNGASCO2EQ_IGEO*
- FPETCO2EQ_IGEO*

Energy Prices

1. Coal
2. Natural gas
3. Oil

Mnemonics

- FPCCOALDOM_IGEO*
- FPCNGASDOM_IGEO*
- FPCOILDOM_IGEO*

Government Finances

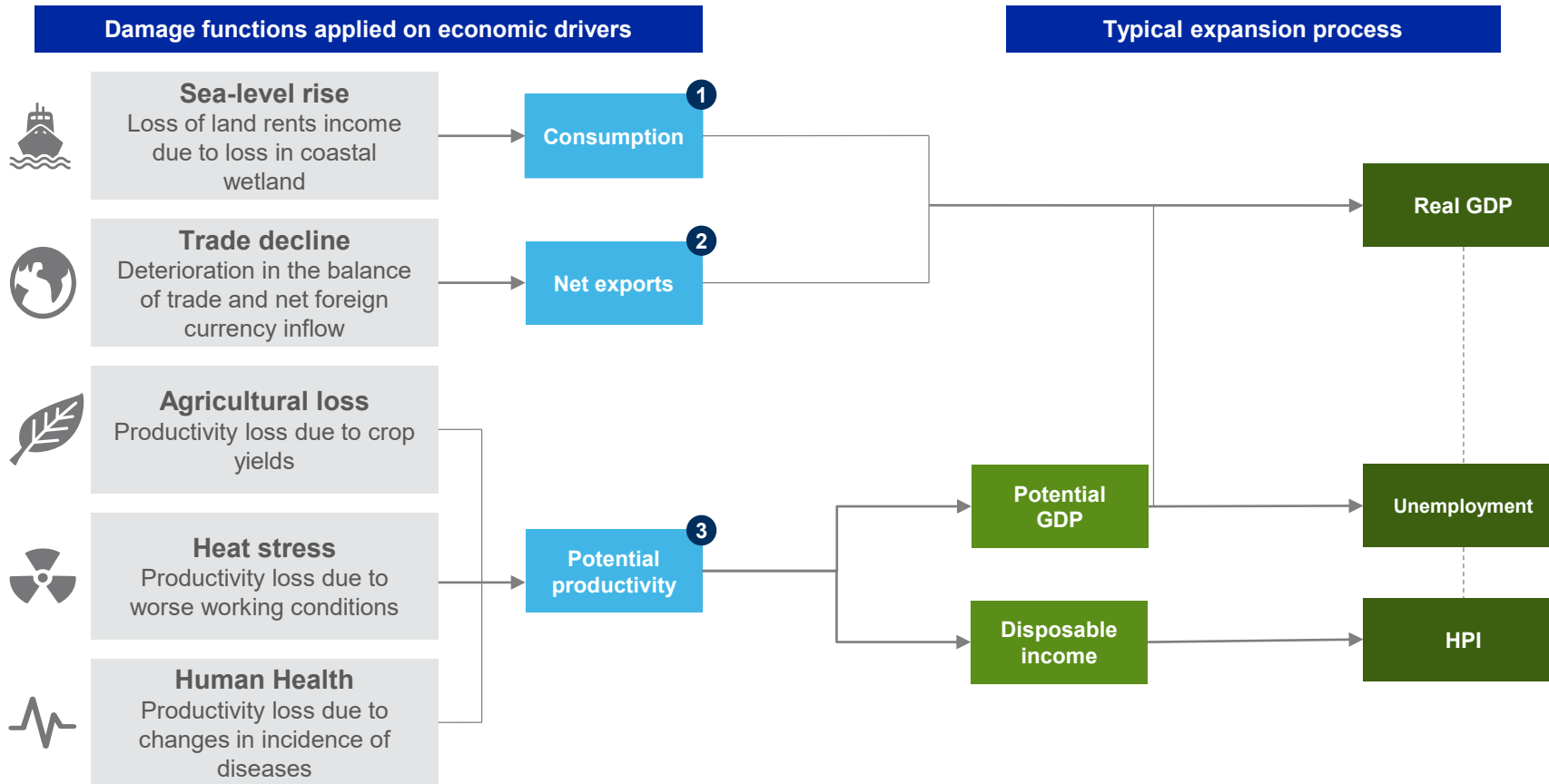
1. Total revenue
2. Total expense
3. Expenditure intermediate term
4. Expenditure residual

Mnemonics

- FGGREV_IGEO*
- FGGEXP_IGEO*
- FGGEXP_I_IGEO*
- FGGEXP_RESID_IGEO*

Physical Risk Impact Channels

Roson-Sartori Damage Function



3 economic drivers affected:

- **Consumption:** Sea-level rise causes a loss in productive lands on the coast and related rent income. This is translated into loss of income and consumption
- **Net Exports:** High increase in temperatures reduces tourism business and export services.
- **Potential productivity:** Labour productivity is affected by heat stress and diffusion of vector-borne diseases. Lower crop yield

Consumption and NX are GDP components having direct effect on the output. Productivity impacts disposable income and potential GDP.

Source: Moody's Analytics

Physical Risks: Health and Tourism



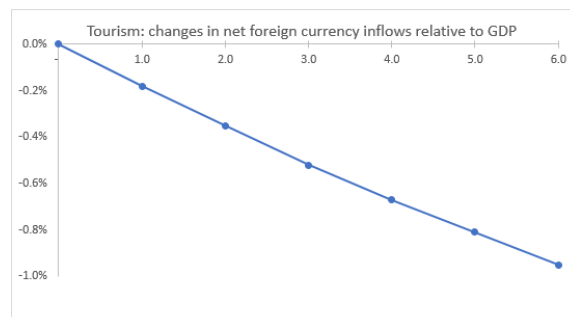
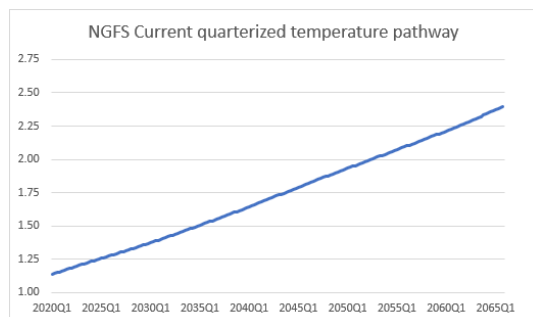
Quarterize Temperature Pathway

Create quarterly temperature path for the climate scenario to match the quarterly periodicity of the Moody's Analytics global model

Link impact estimates from Roson & Sartori (2016) to key economic variables



Roson and Sartori (2016) summarize climate change impacts from a series of meta-analyses that linked the impact channels to temperature fluctuations for all of the world's major countries. We connect these estimates to key economic variables including exports, energy prices, consumption and productivity



Source: Roson & Sartori (2016), Moody's Analytics

Impact Calculations

Change in Temperature		×	Pct Loss in Health Productivity		=	Health Impact on Total Productivity	
Year	Temp (°C)		Pct Loss	Total Productivity Impact			
2021Q2	1.17		-0.63%	-0.74%			
2021Q3	1.17		-0.63%	-0.74%			
2021Q4	1.18		-0.63%	-0.74%			
...			
2060Q1	2.21		-0.63%	-1.40%			
2060Q2	2.22		-0.63%	-1.40%			
2060Q3	2.23		-0.63%	-1.41%			
2060Q4	2.24		-0.63%	-1.41%			

Change in Temperature		→	% Change in GDP due to Tourism		×	Real GDP Forecast (Bil. 2010 ZAR)		=	Tourism Impact on Net Export	
Year	Temp (°C)		% Change	Real GDP Forecast		Net Export Impact				
2021Q2	1.17		-0.2%	2,610	-5.44					
2021Q3	1.17		-0.2%	2,963	-6.20					
2021Q4	1.18		-0.2%	2,963	-6.23					
...					
2060Q1	2.21		-0.4%	5,287	-20.43					
2060Q2	2.22		-0.4%	5,300	-20.55					
2060Q3	2.23		-0.4%	5,313	-20.67					
2060Q4	2.24		-0.4%	5,325	-20.78					

Chronic Physical Risk



Energy Demand



Tourism



Sea Level Rise



Heat & labour
Productivity



Human Health

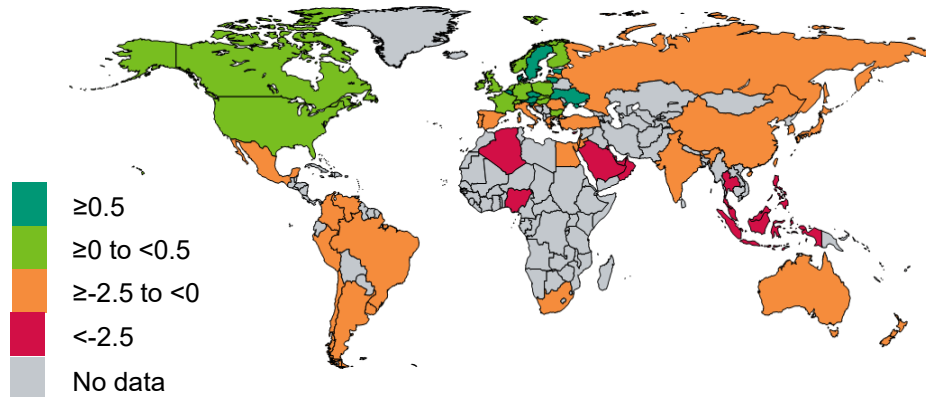


Agricultural
Productivity

Moody's Analytics physical risk assessment is based on:

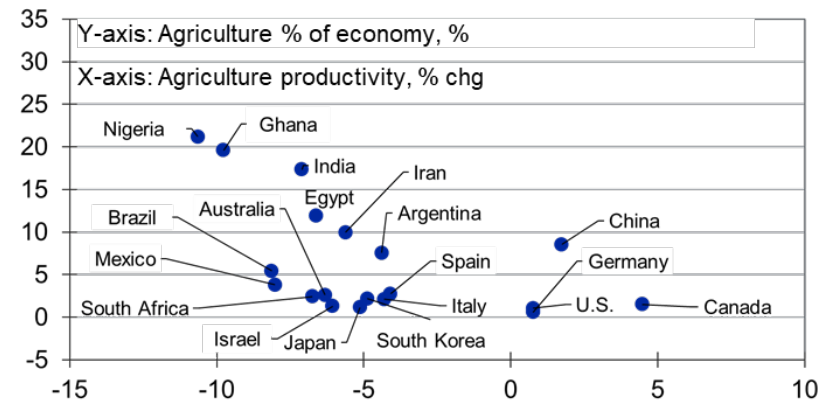
- » Combined output delta
- » Temperature pathways from NGFS Scenarios
- » Chronic physical risk (vs acute)
- » Forecasting horizon from 2050 to 2100
- » Transition risk added later
- » Moody's Global Macroeconomic Model.

GDP % deviation from baseline in 2048, RCP 8.5



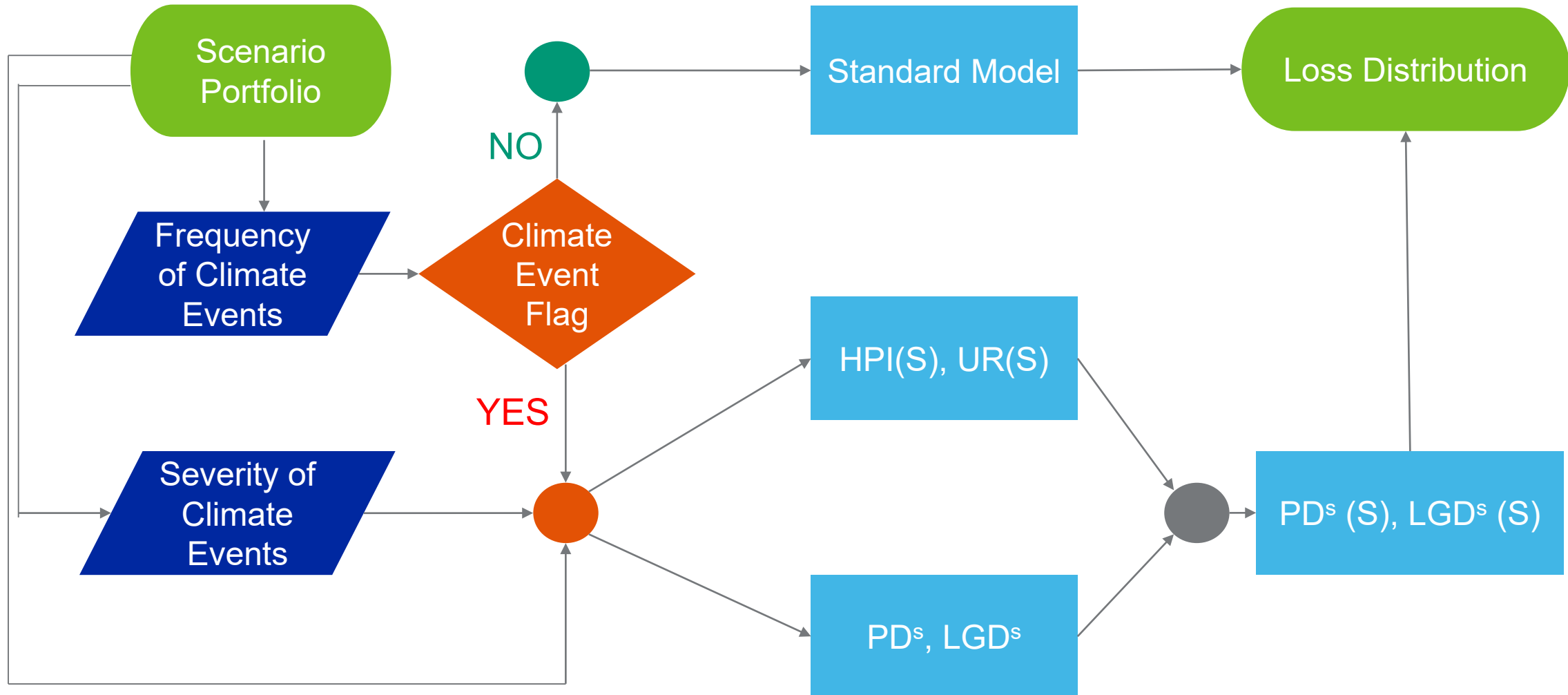
Possible outcome

Ag Hit to Hot, 3°C increase on Agriculture



Example

Climate-Adjusted Credit Risk Approach



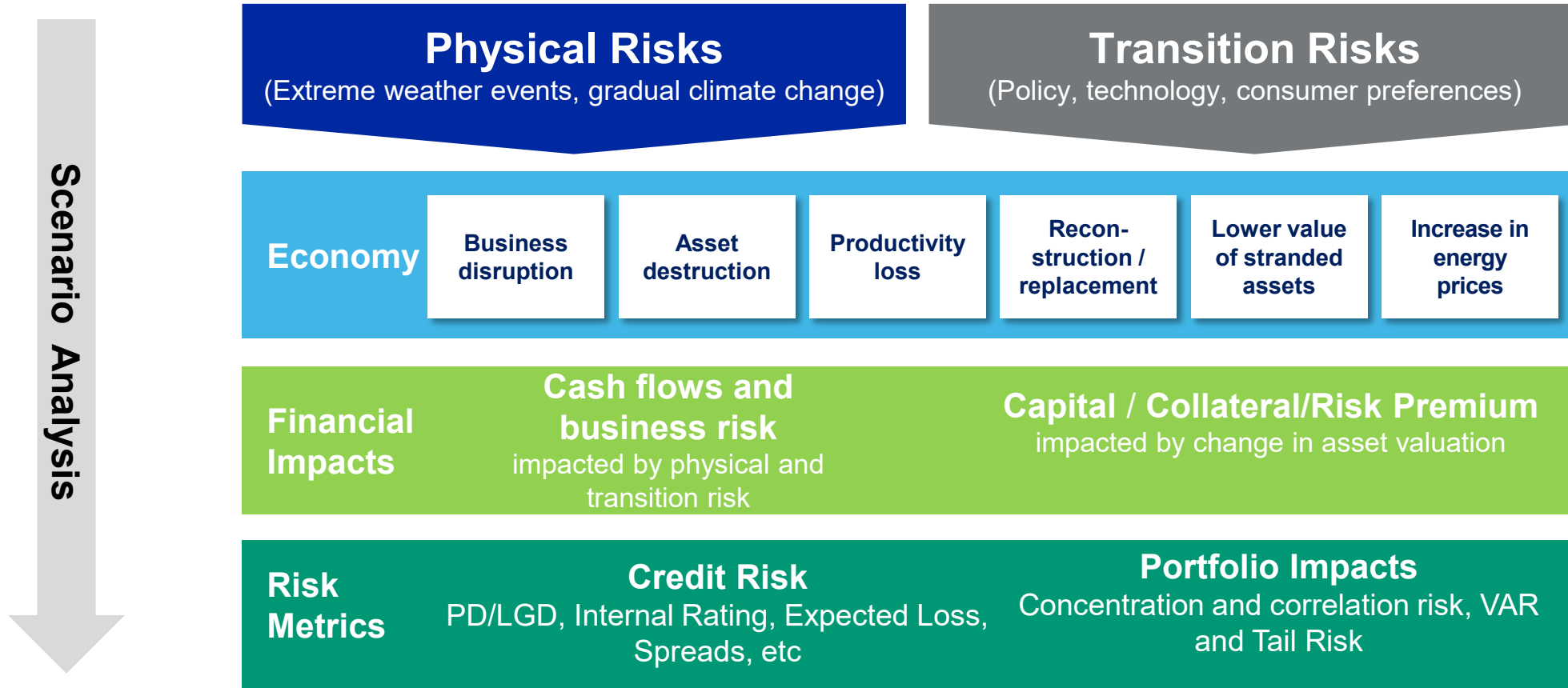
3

Climate Change and Corporate Credit Risk

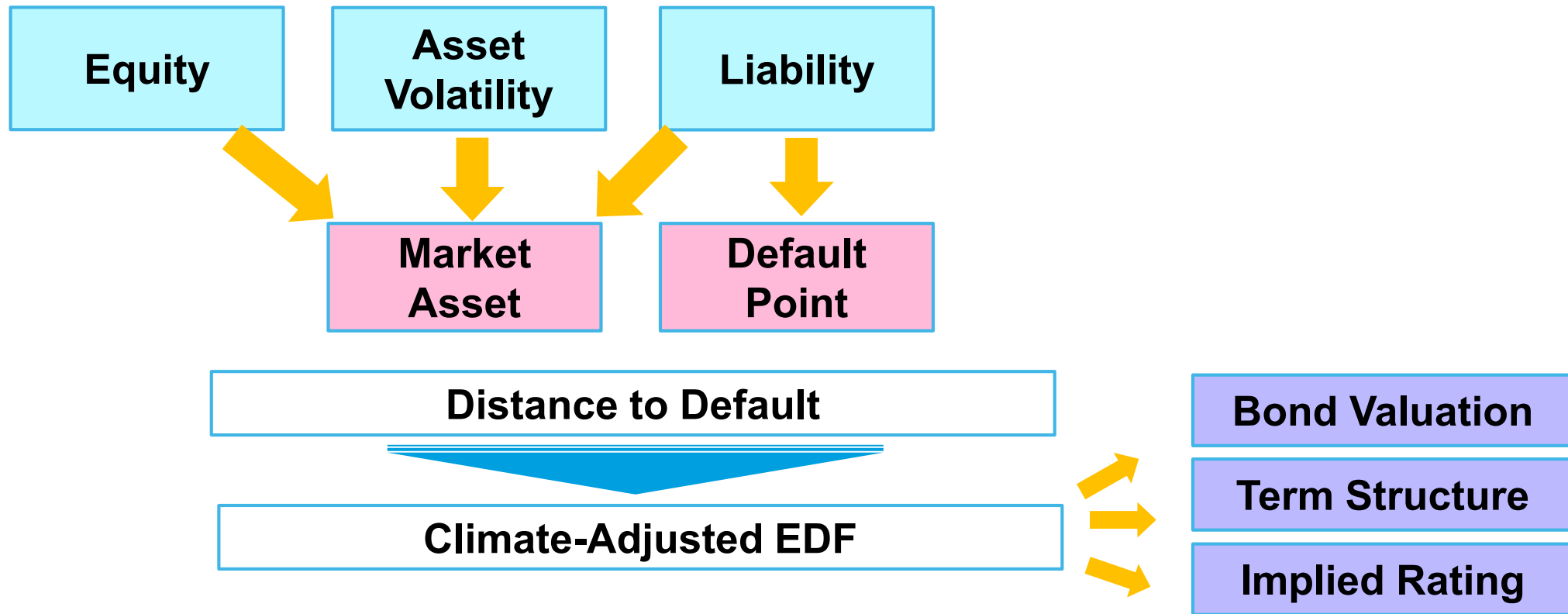
From Climate Risks to Financial Metrics



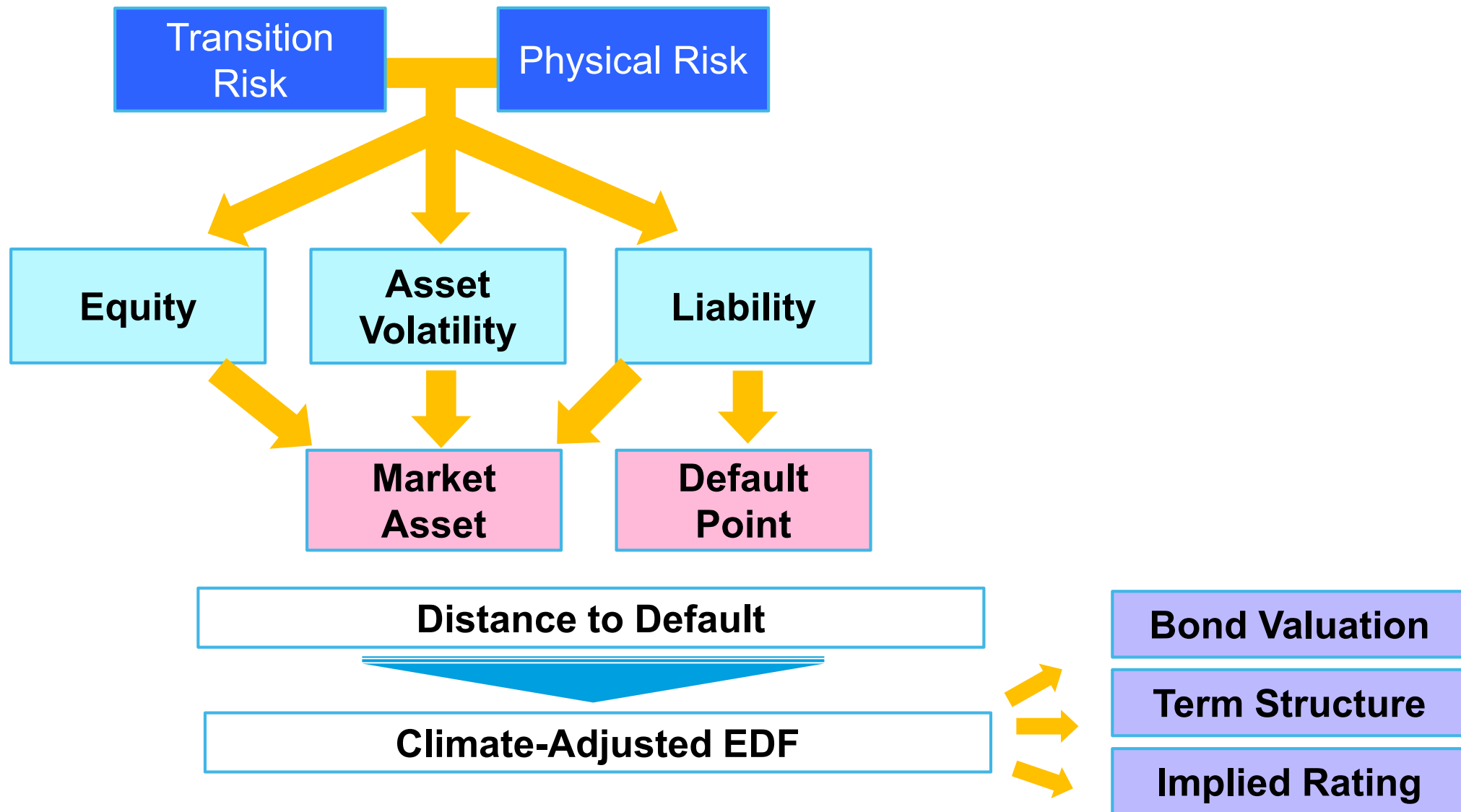
Our credit metrics will be part of a full-suite of scenario-conditioned data analytics:



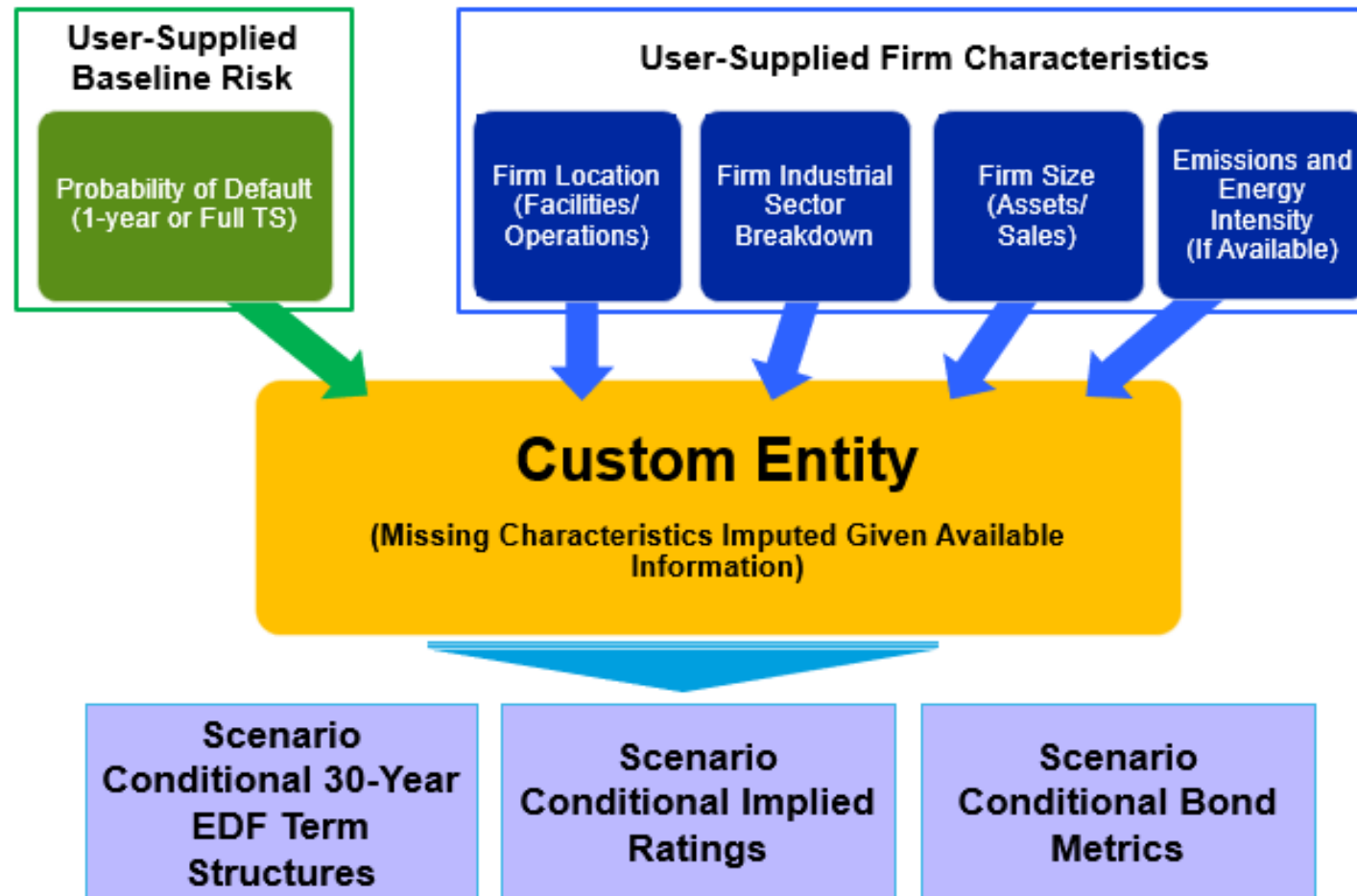
Public EDF Model Employs Market Data to Build a Structural Measure of Credit Risk



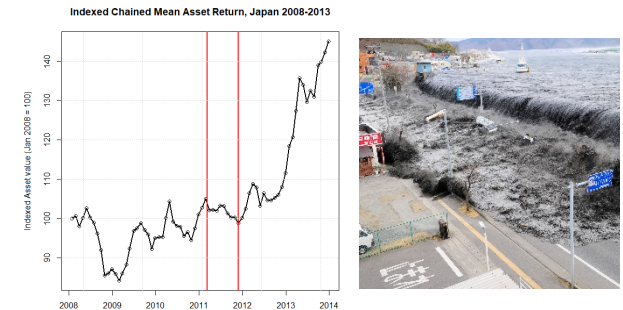
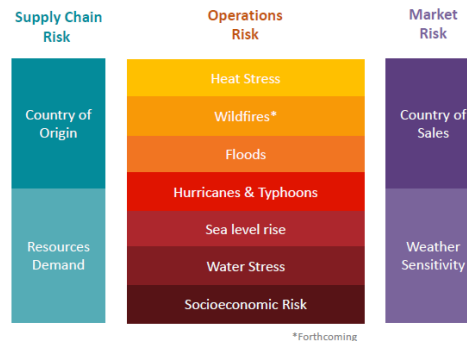
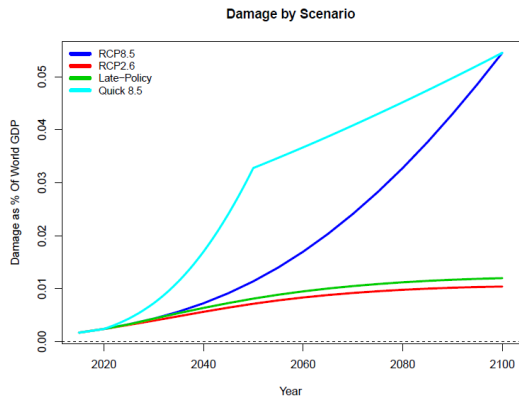
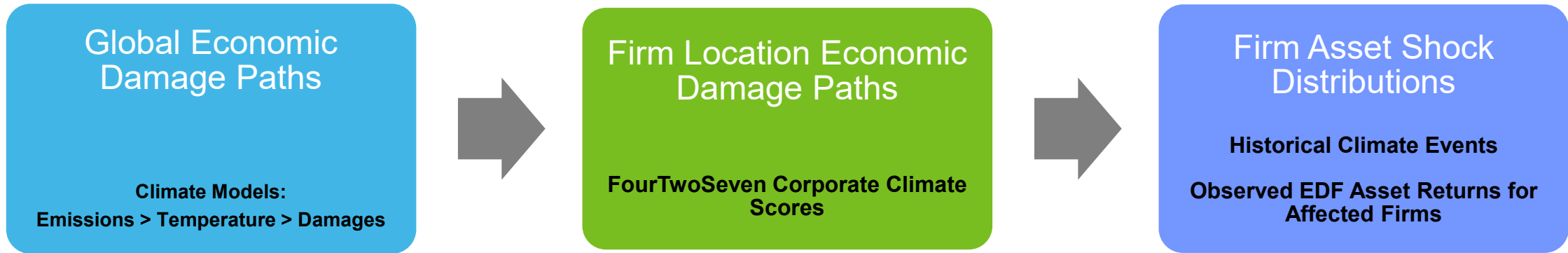
Climate Risk Affects the Drivers of the EDF Model



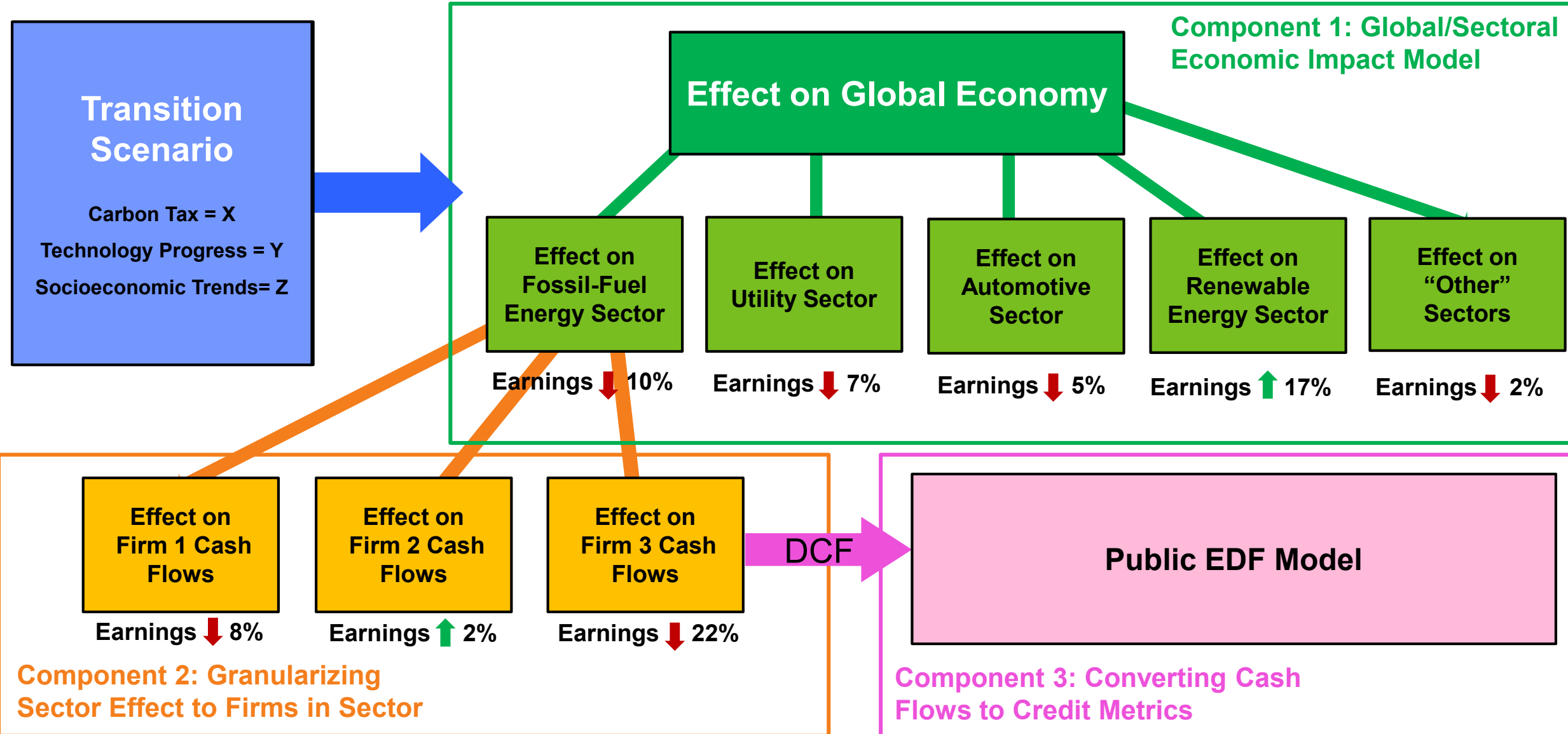
Climate PD Converter Module



Physical Risk: Quantifying Frequency and Magnitude of Climate-Related Asset Shocks



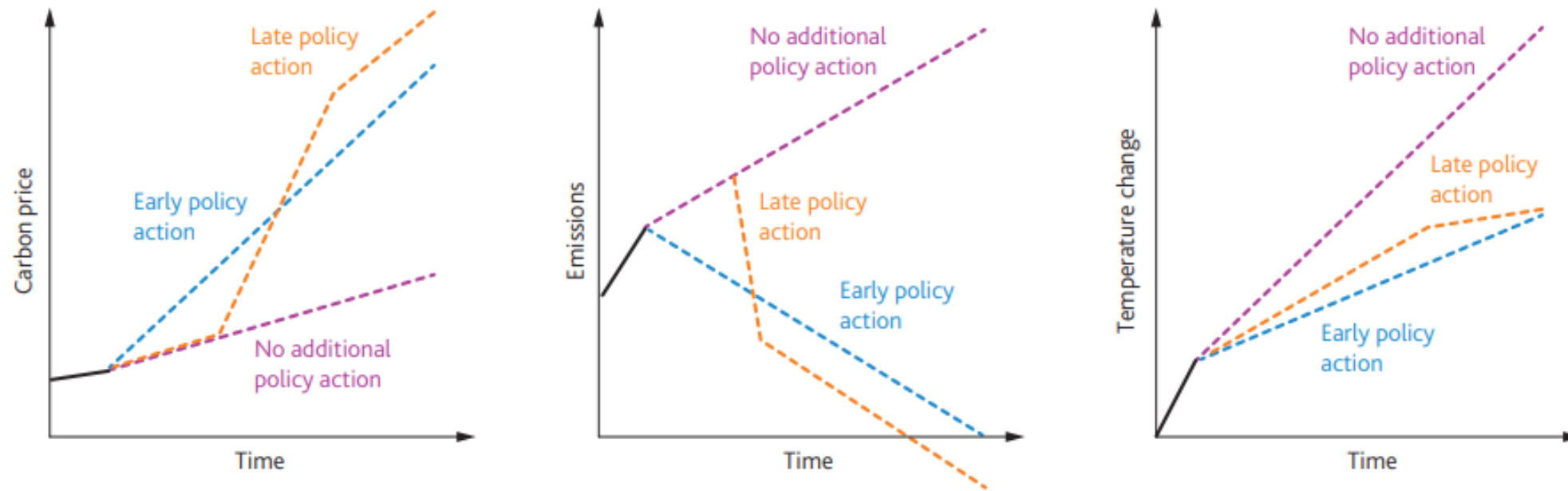
Transition Risk: Quantifying Scenario-Conditional Cash Flows



Which Climate Scenarios to Analyze?

- » One important set of climate scenarios are the NGFS scenarios, which have also been proposed for the 2021 BES exercise:

Figure 3.1 Illustrative variable pathways in each scenario



Investor Expectation Paths within Scenario Matter

Expectation Assumption: Uncertainty Until Policy is Announced



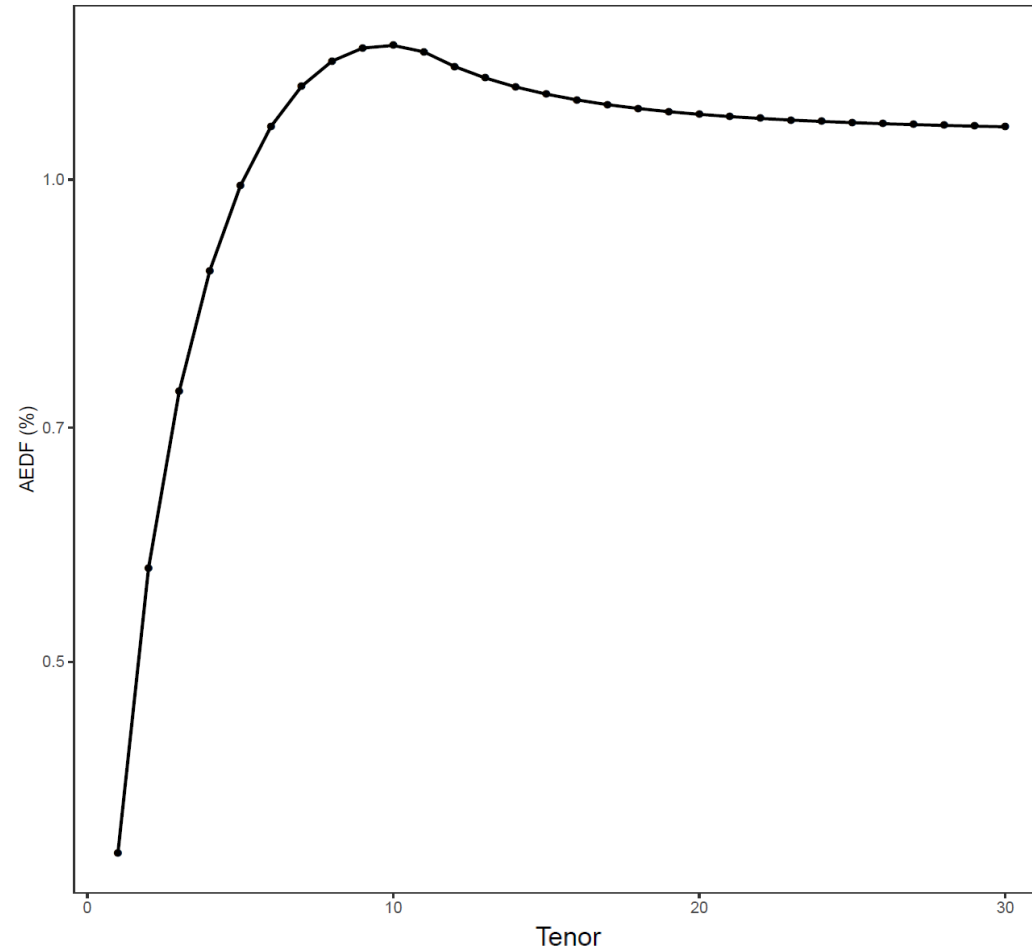
Year	Early Policy Path Expectations				Late Policy Path Expectations				No Policy Path Expectations			
	% Physical Risk Priced	Early Policy	Late Policy	No Policy	% Physical Risk Priced	Early Policy	Late Policy	No Policy	% Physical Risk Priced	Early Policy	Late Policy	No Policy
2020	0%	33%	33%	33%	0%	33%	33%	33%	0%	33%	33%	33%
2021	100%	100%	0%	0%	100%	0%	50%	50%	100%	0%	50%	50%
2022	100%	100%	0%	0%	100%	0%	50%	50%	100%	0%	50%	50%
2023	100%	100%	0%	0%	100%	0%	50%	50%	100%	0%	50%	50%
2024	100%	100%	0%	0%	100%	0%	50%	50%	100%	0%	50%	50%
2025	100%	100%	0%	0%	100%	0%	50%	50%	100%	0%	50%	50%
2026	100%	100%	0%	0%	100%	0%	50%	50%	100%	0%	50%	50%
2027	100%	100%	0%	0%	100%	0%	50%	50%	100%	0%	50%	50%
2028	100%	100%	0%	0%	100%	0%	50%	50%	100%	0%	50%	50%
2029	100%	100%	0%	0%	100%	0%	50%	50%	100%	0%	50%	50%
2030	100%	100%	0%	0%	100%	0%	50%	50%	100%	0%	50%	50%
2031	100%	100%	0%	0%	100%	0%	100%	0%	100%	0%	0%	100%
2032	100%	100%	0%	0%	100%	0%	100%	0%	100%	0%	0%	100%
2033	100%	100%	0%	0%	100%	0%	100%	0%	100%	0%	0%	100%
2034	100%	100%	0%	0%	100%	0%	100%	0%	100%	0%	0%	100%

Example of a Baseline PD Term Structure

Exxaro Resources LTD.



Baseline PD Term Structure
EXXARO RESOURCES LTD.

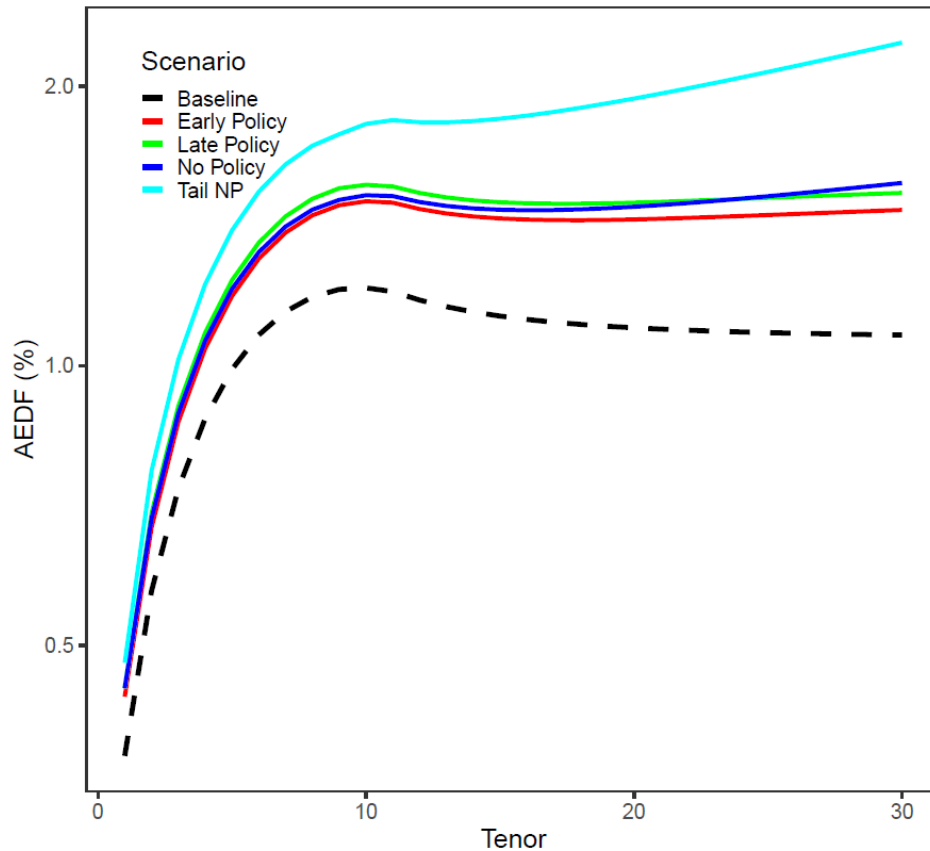


Effect of Physical Climate Risk on EDFs

Exxaro Resources LTD.

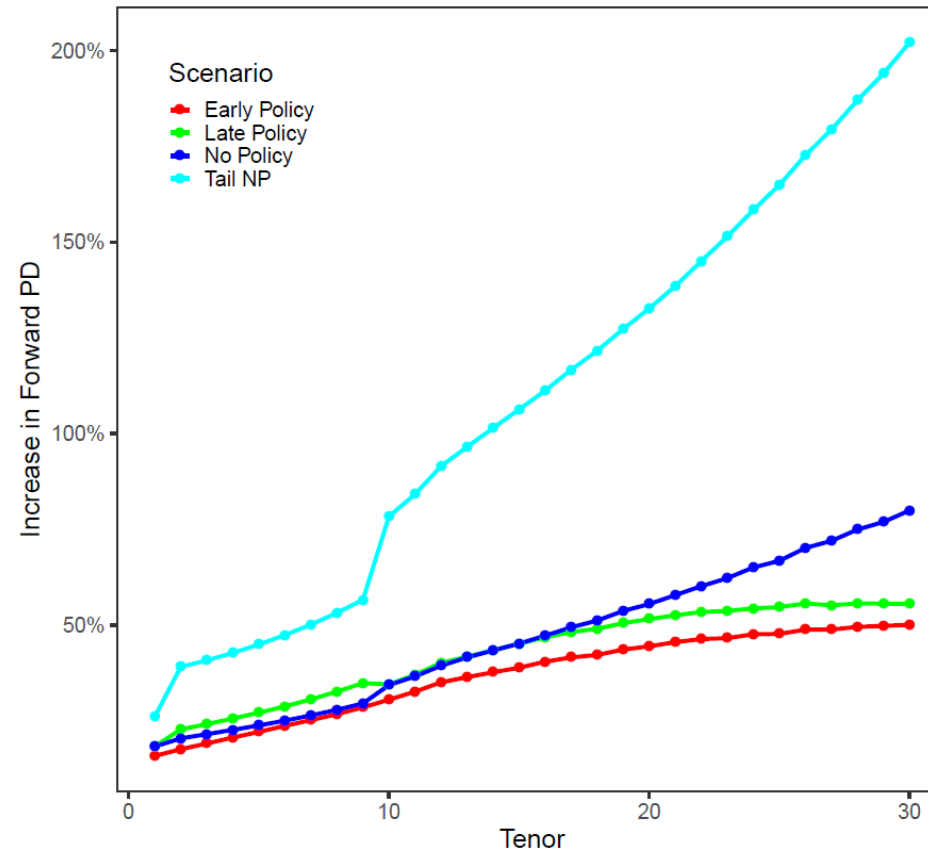
Physical Risk: PD Term Structure By Scenario

EXXARO RESOURCES LTD. | 427 Climate Score: 63



Physical Risk: Increase in PD by Tenor

EXXARO RESOURCES LTD. | 427 Climate Score: 63



427 Total Score

63

Investor Expectations Assumption: Physical Climate damages not currently priced, but perfect scenario foresight occurs when announced

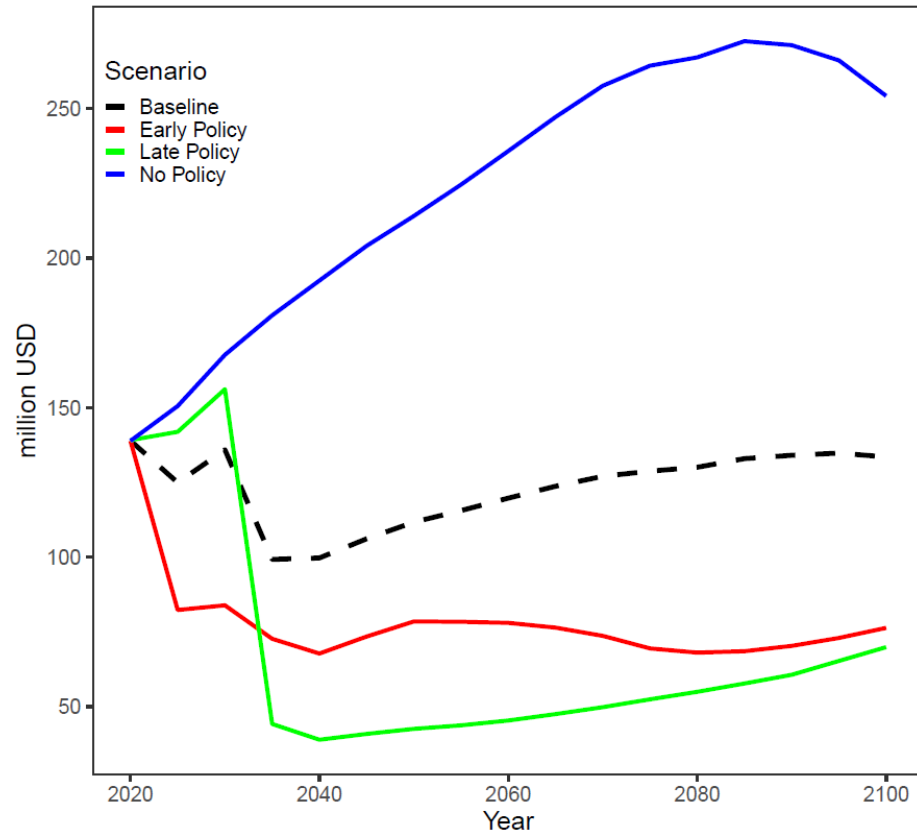
Effect of Transition Risk: Earnings and Asset Paths



Exxaro Resources LTD.

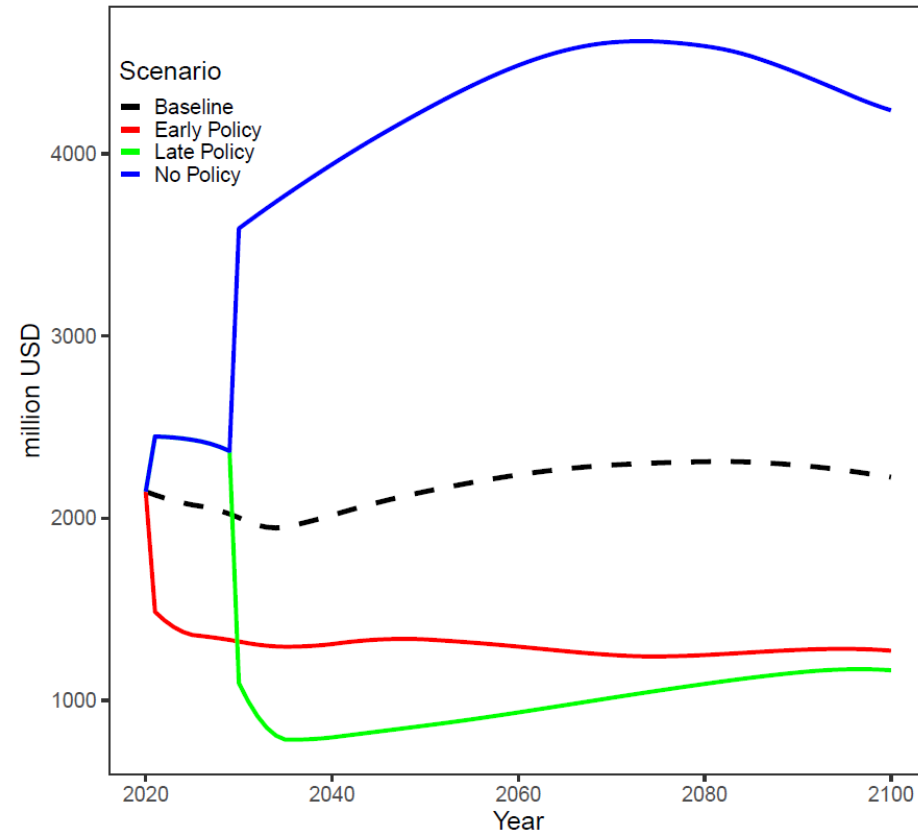
Transition Only Earnings Path

EXXARO RESOURCES LTD.



Transition Only Asset Path

EXXARO RESOURCES LTD.



Coal Extraction	82.02%
MINING	13.39%
UNASSIGNED	4.1%

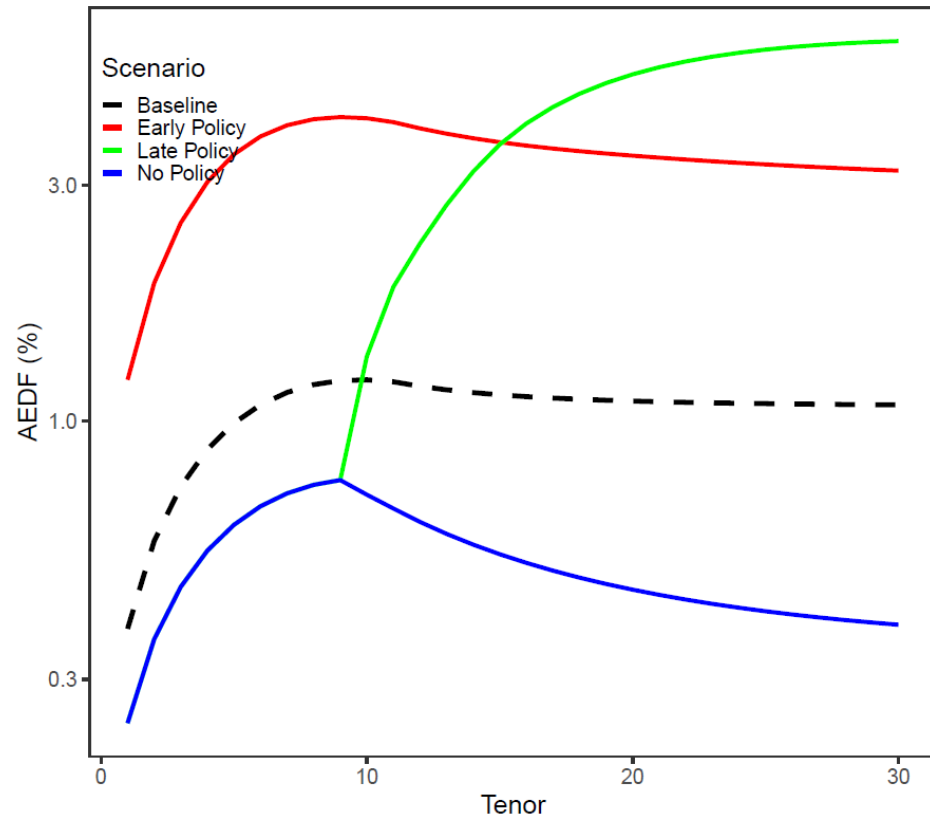
Investor Expectations Assumption: Perfect scenario foresight occurs when announced

Effect of Transition Risk on EDFs

Exxaro Resources LTD.

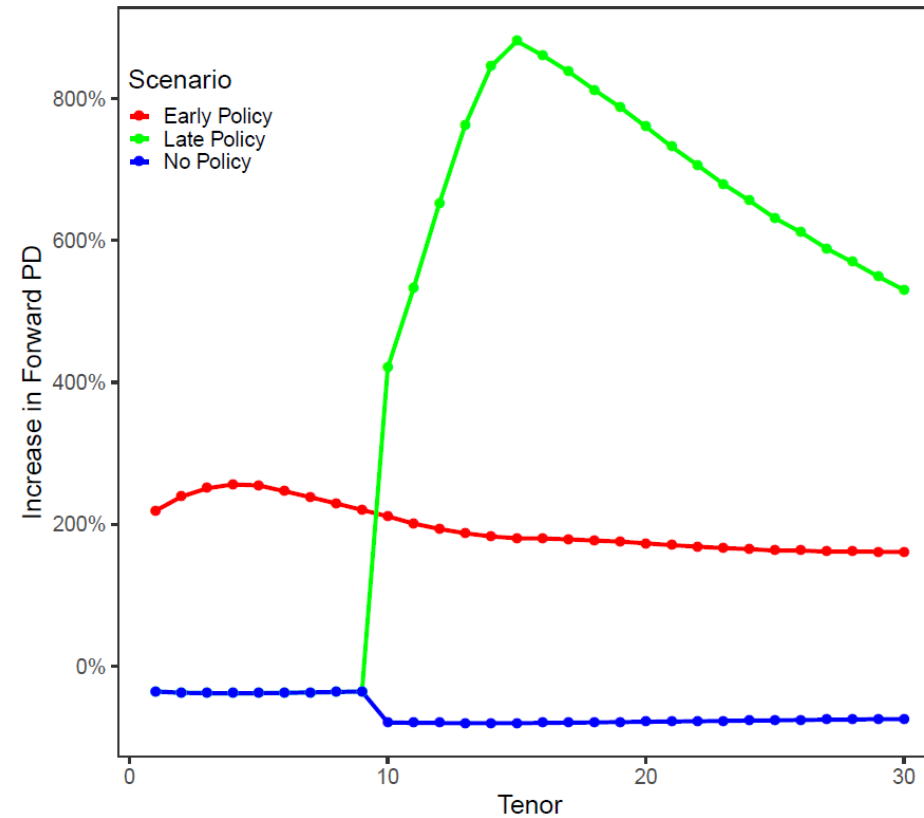
Transition Risk: PD Term Structure By Scenario

EXXARO RESOURCES LTD.
Total Carbon Emission (mTon): 8.7e+05



Transition Risk: Increase in PD by Tenor

EXXARO RESOURCES LTD.
Total Carbon Emission (mTon): 8.7e+05



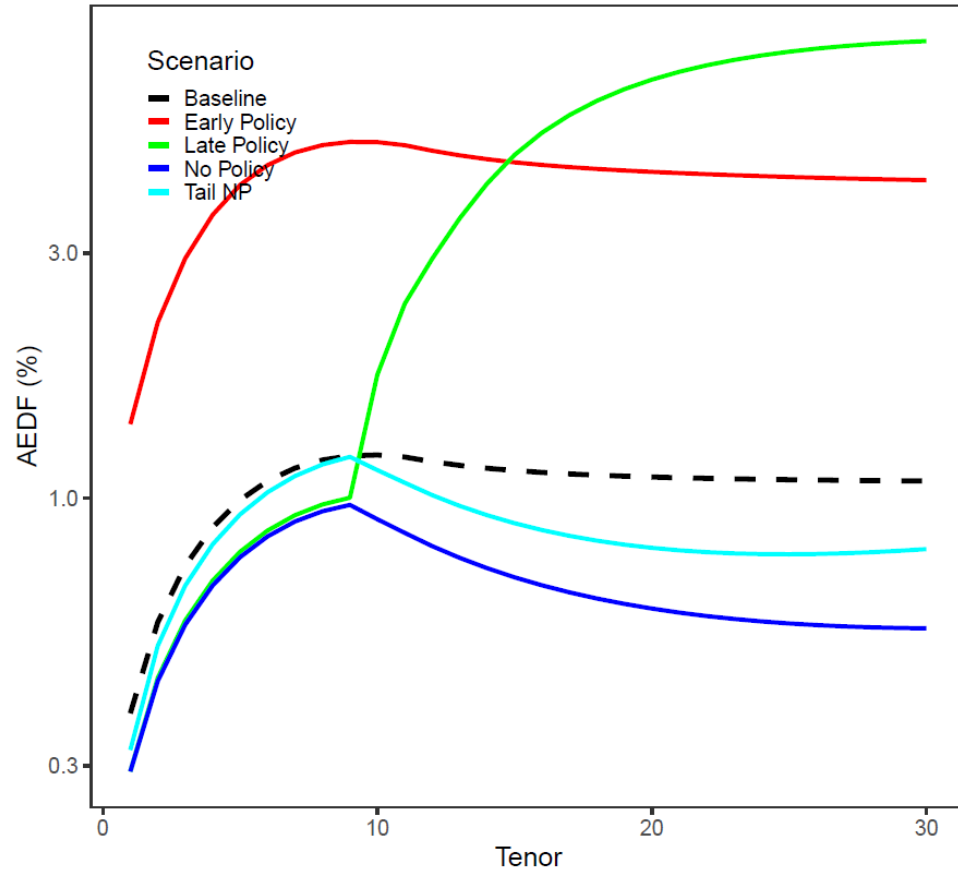
Investor Expectations Assumption: Perfect scenario foresight occurs when announced

Effect of Combined Climate Risk on EDFs

Exxaro Resources LTD.

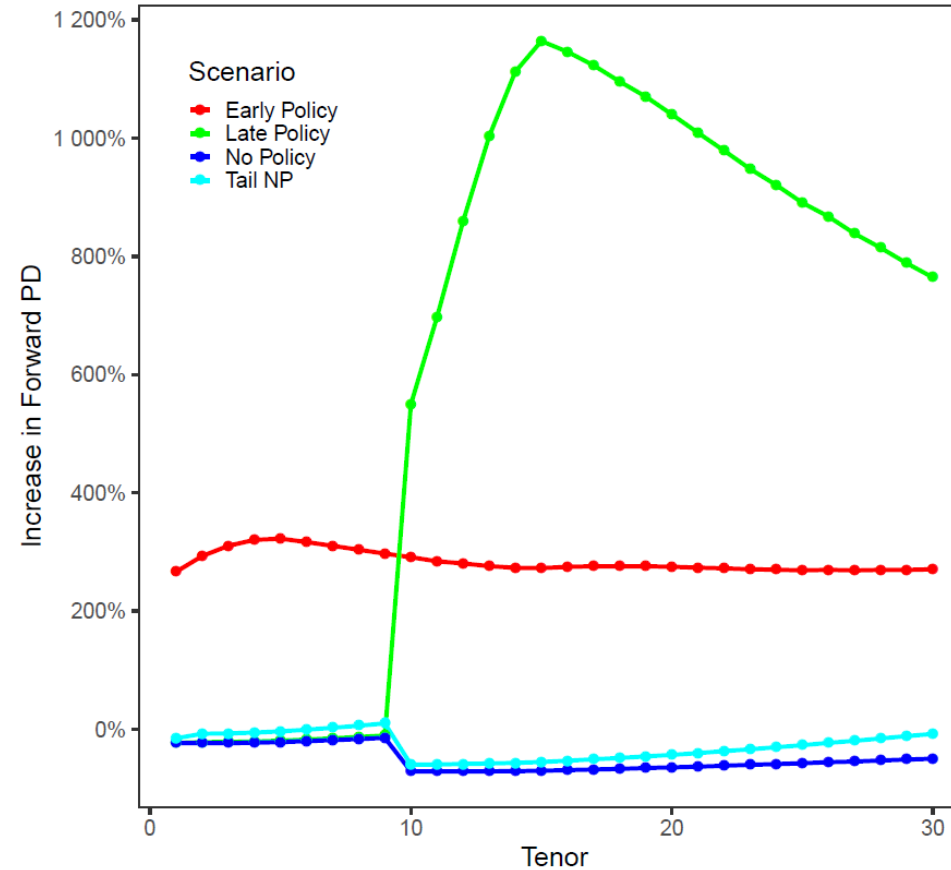
Combined Risk: PD Term Structure By Scenario

EXXARO RESOURCES LTD.



Combined Risk: Increase in PD by Tenor

EXXARO RESOURCES LTD.



Investor Expectations Assumption: Physical Climate damages not currently priced, but perfect scenario foresight occurs when announced

Analyzing Risk Across the Public Universe

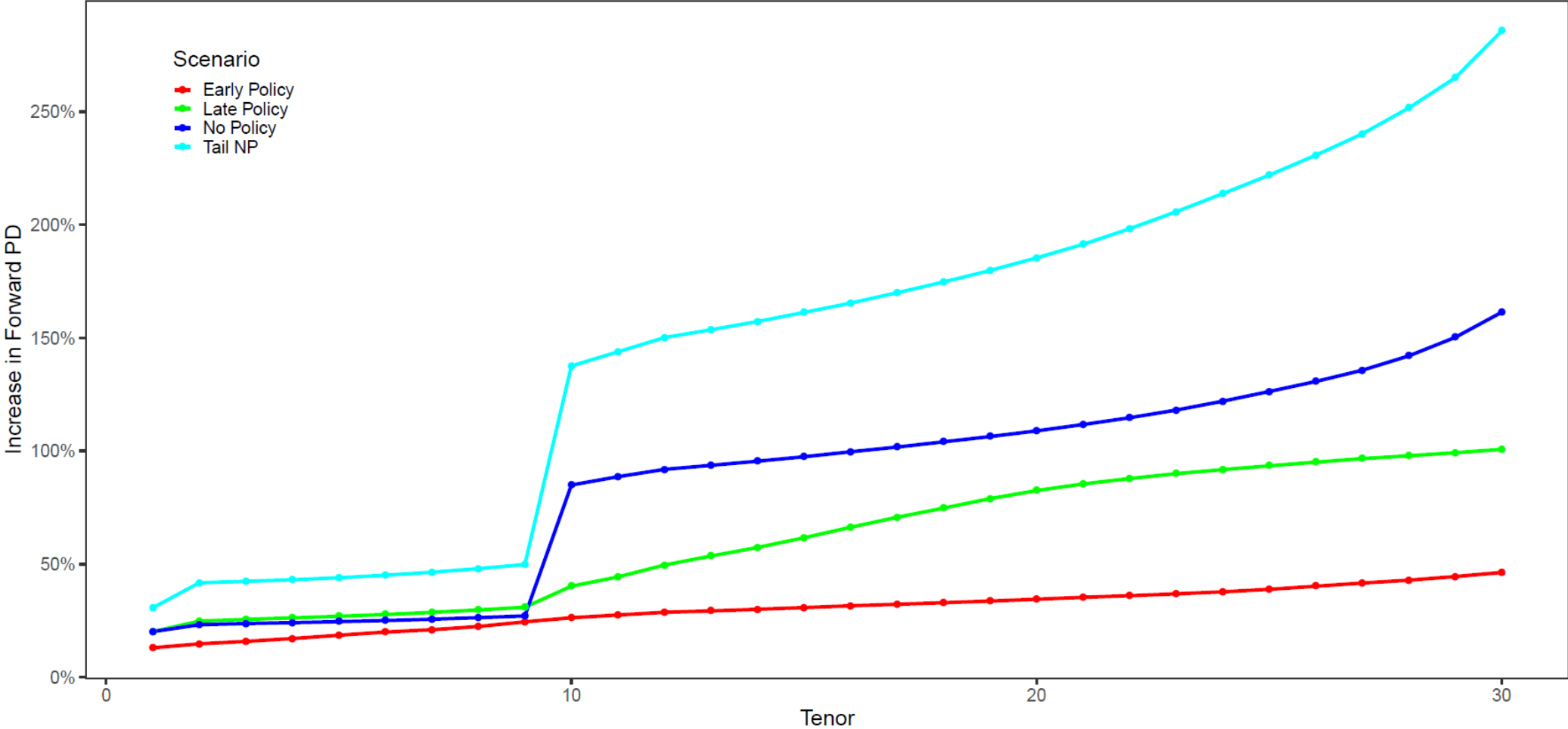


- » Within the Climate-Adjusted EDF Framework, analyze risk for the 40,000+ names in the Public EDF universe of global public companies
- » **Identify the overall distribution of climate-adjusted risk and the important drivers of relative risk worldwide**

Average Physical-Adjusted EDF Term Structures



Physical Risk: Mean Portfolio Increase in PD by Tenor

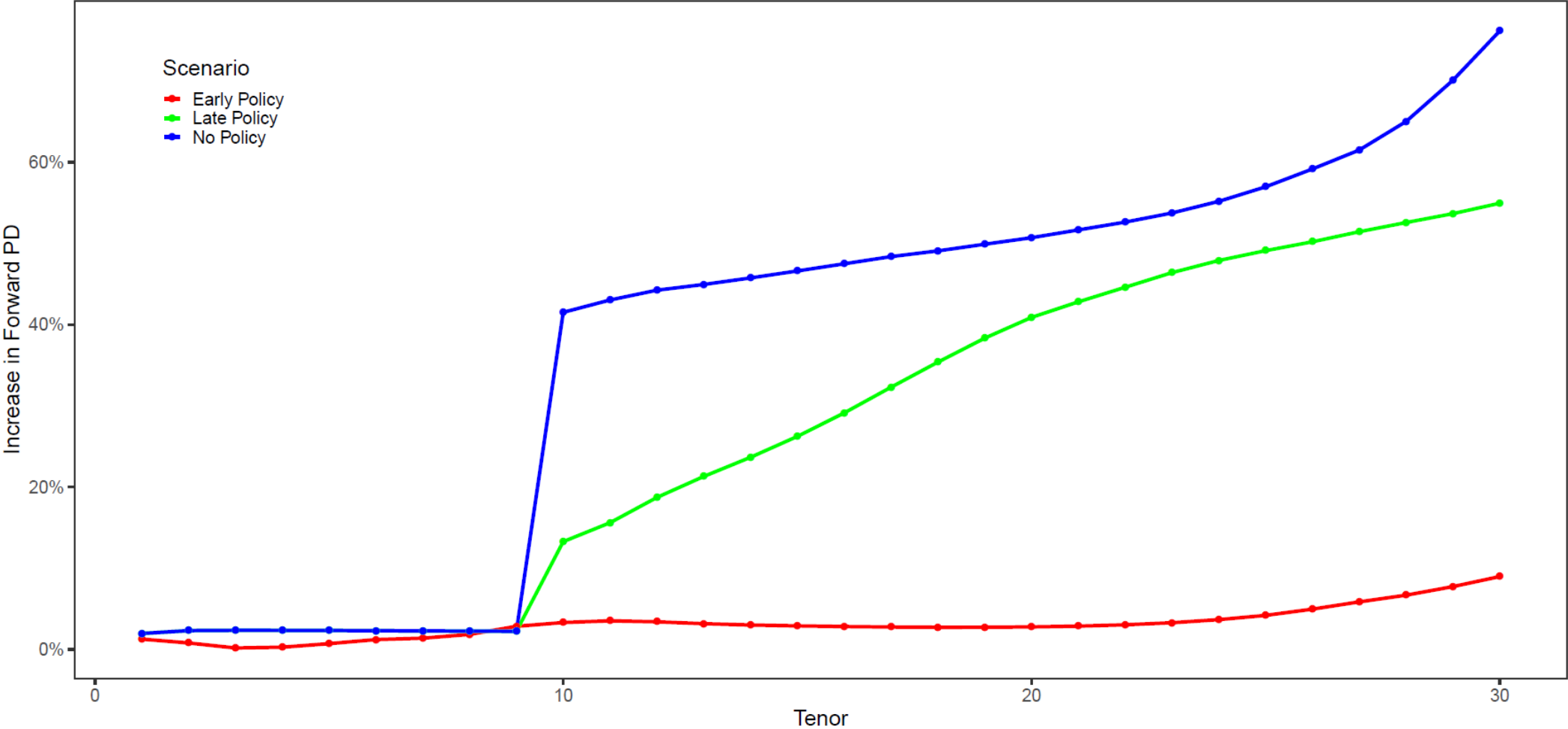


Investor Expectations Assumption: Perfect scenario foresight occurs when announced

Average Transition-Adjusted EDF Term Structures



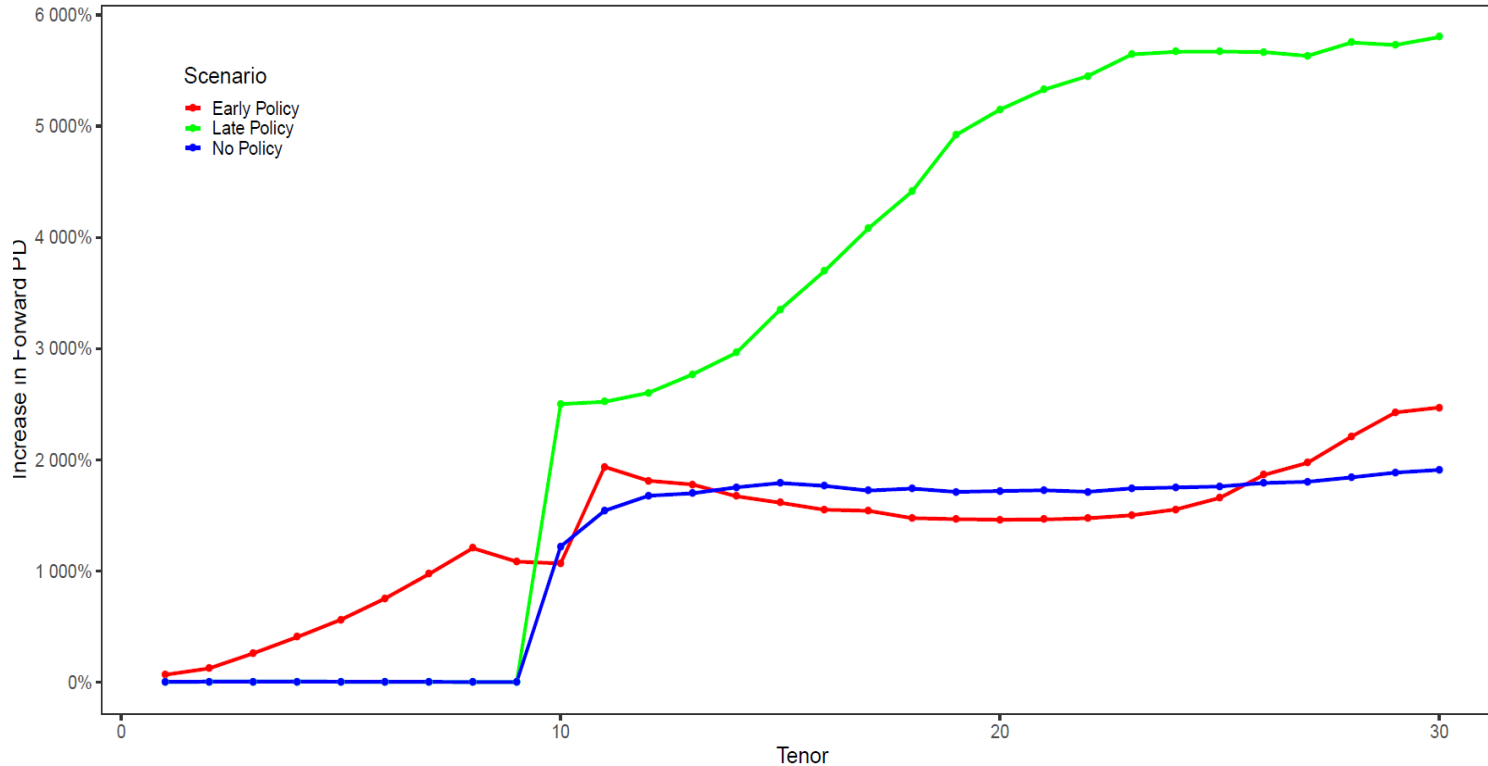
Transition Risk: Mean Portfolio Increase in PD by Tenor



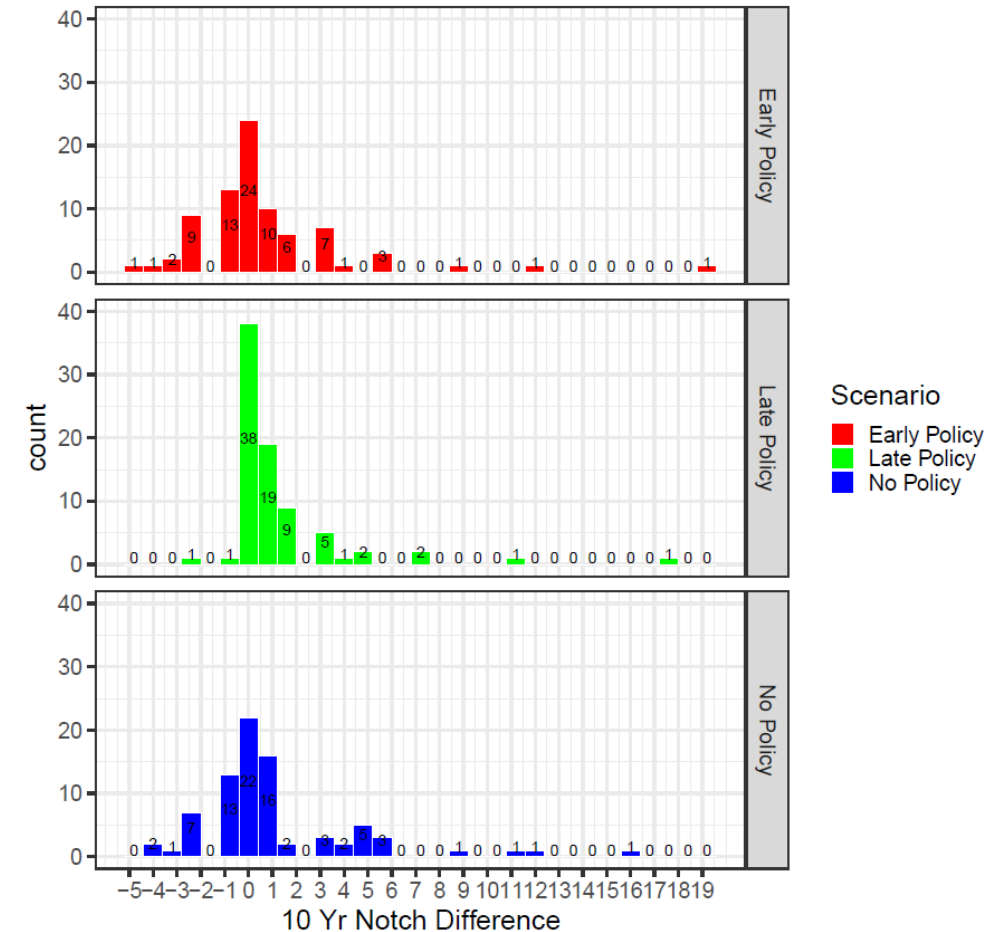
Investor Expectations Assumption: Perfect scenario foresight occurs when announced

Average Transition-Adjusted EDF – High Exposure Sector Portfolio

Transition Risk: Mean Portfolio Increase in PD by Tenor



Transition Risk: 10 Yr Notch Difference Over Portfolio

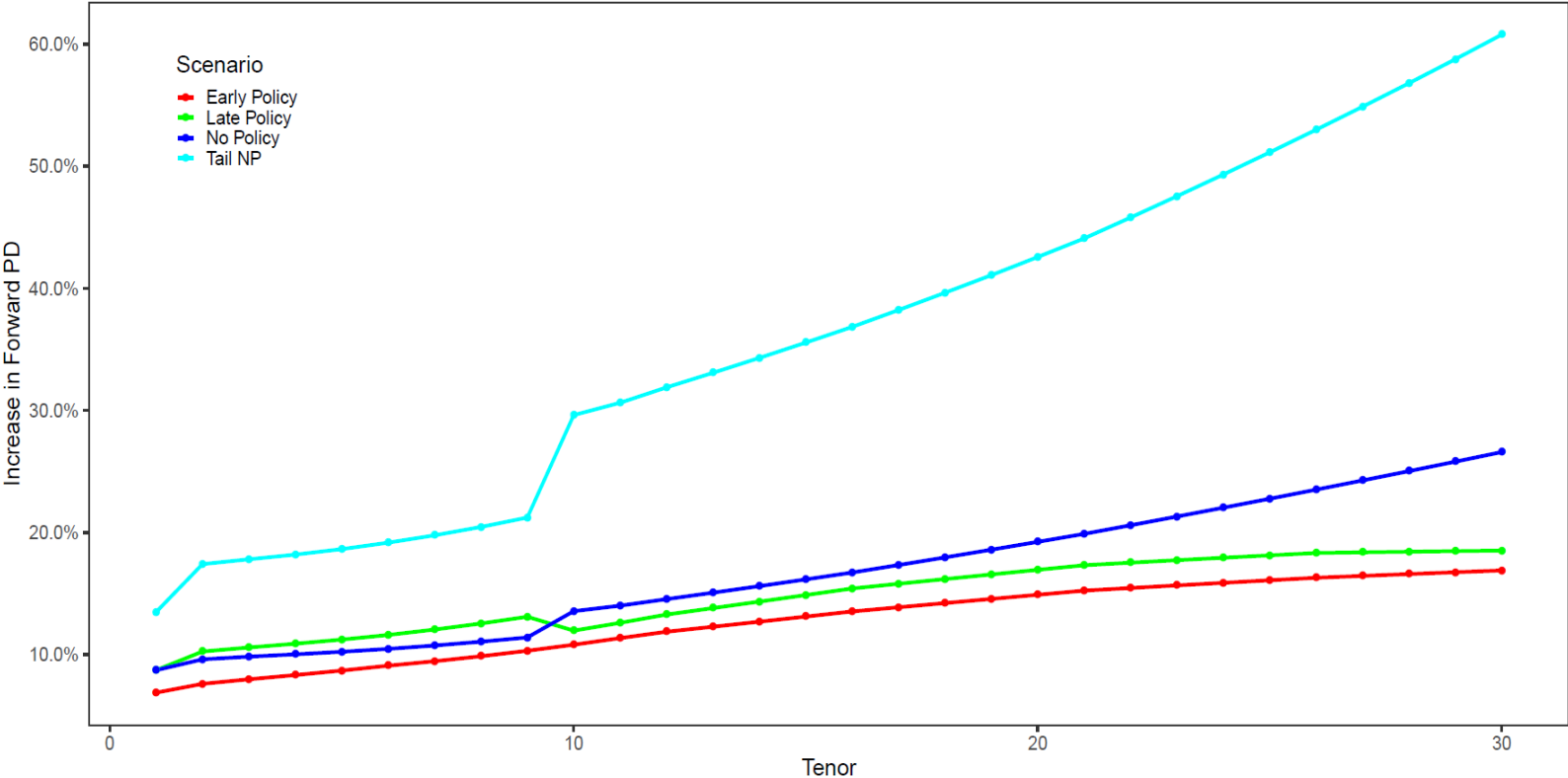


Investor Expectations Assumption: Perfect scenario foresight occurs when announced

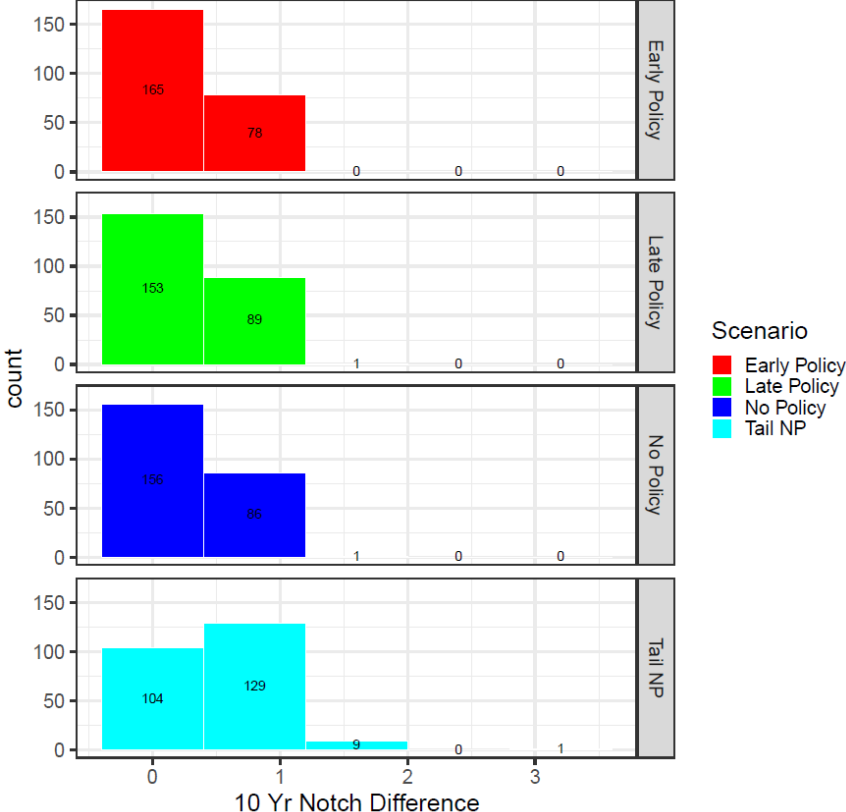
Average Physical-Adjusted EDF – South Africa Only



Physical Risk: Mean Portfolio Increase in PD by Tenor



Physical Risk: 10 Yr Notch Difference Over Portfolio

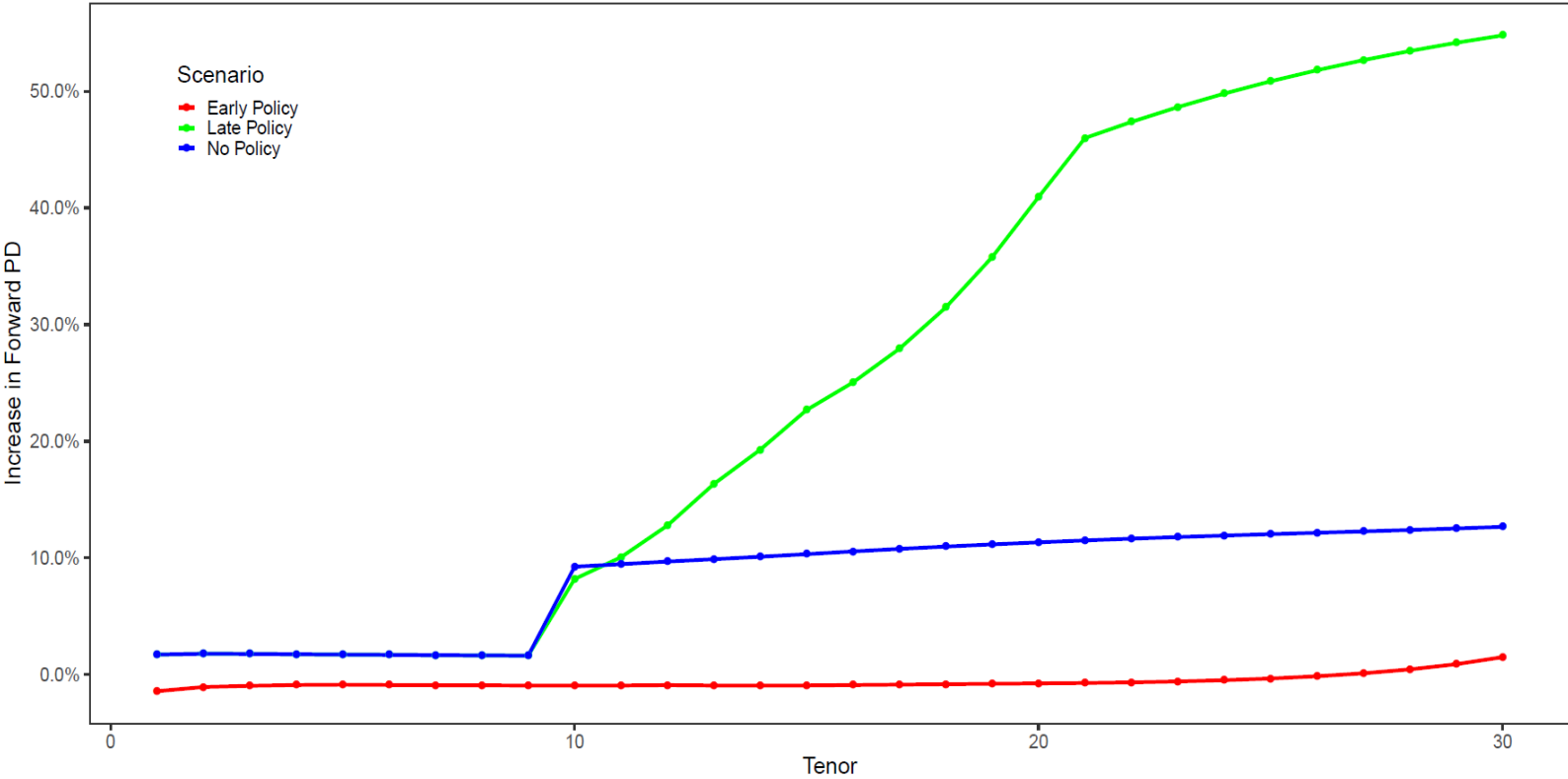


Investor Expectations Assumption: Perfect scenario foresight occurs when announced

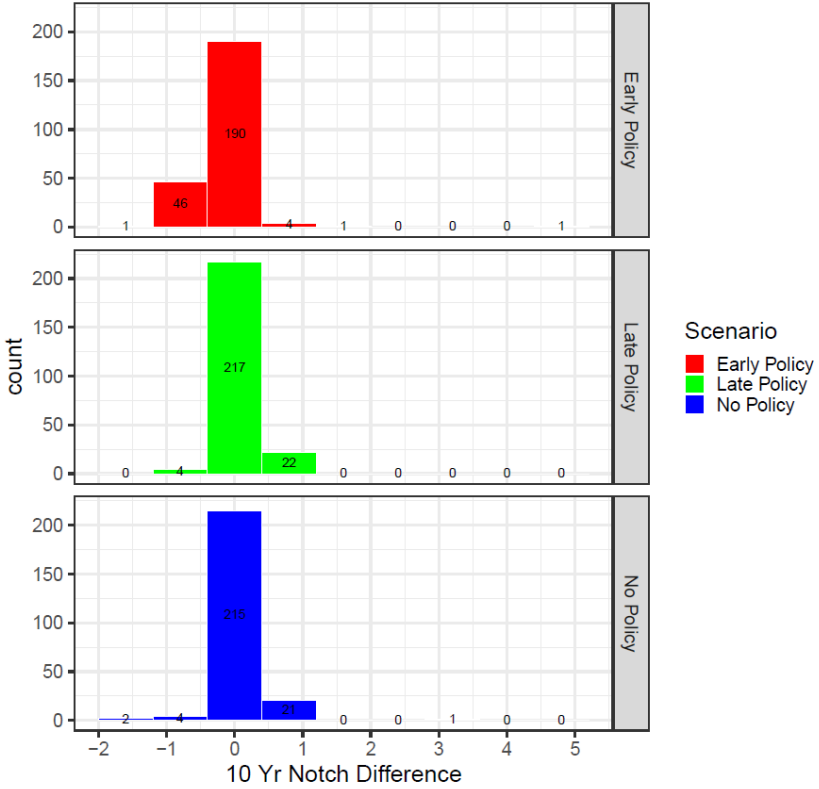
Average Transition-Adjusted EDF – South Africa Only



Transition Risk: Mean Portfolio Increase in PD by Tenor



Transition Risk: 10 Yr Notch Difference Over Portfolio

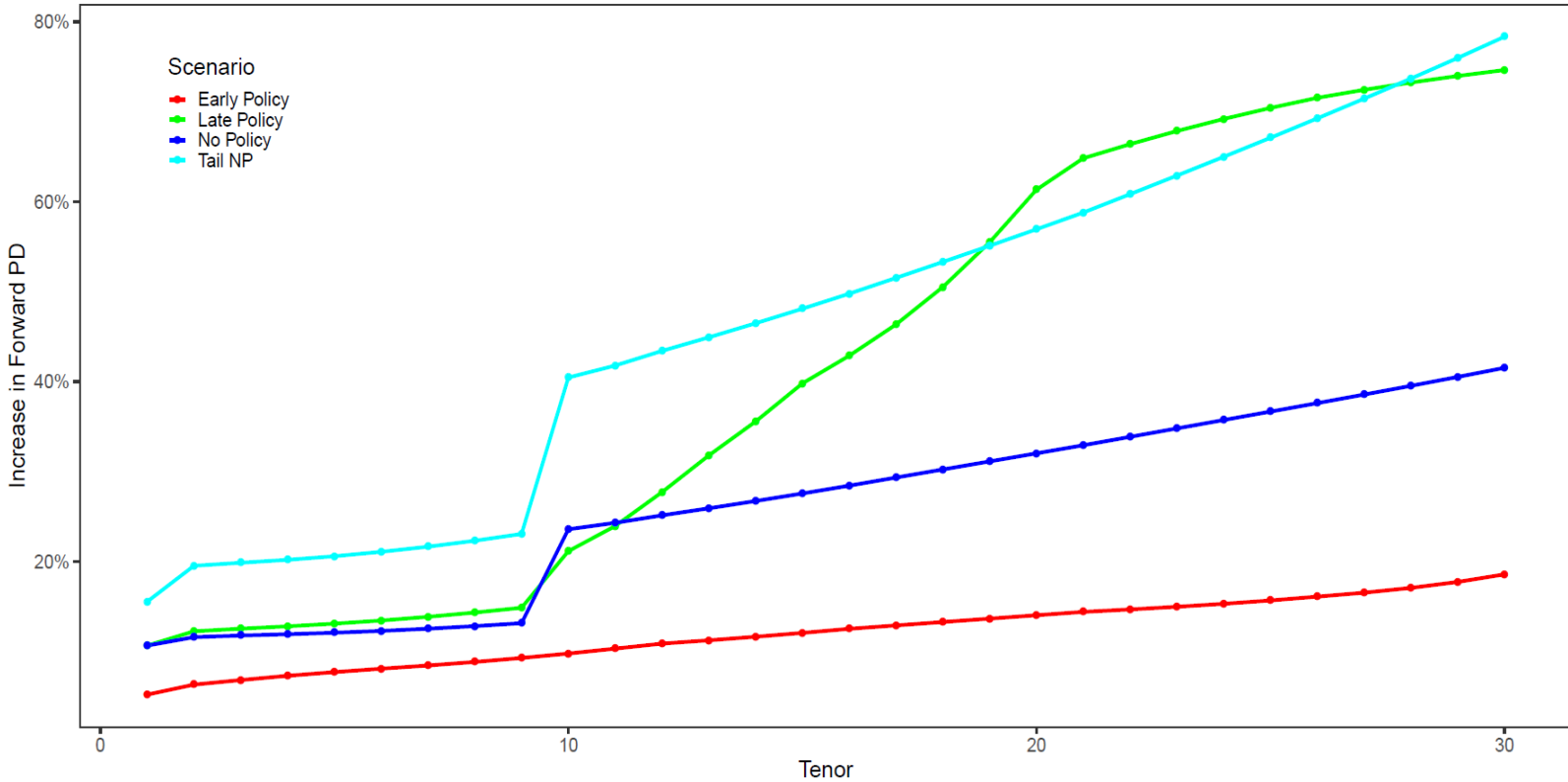


Investor Expectations Assumption: Perfect scenario foresight occurs when announced

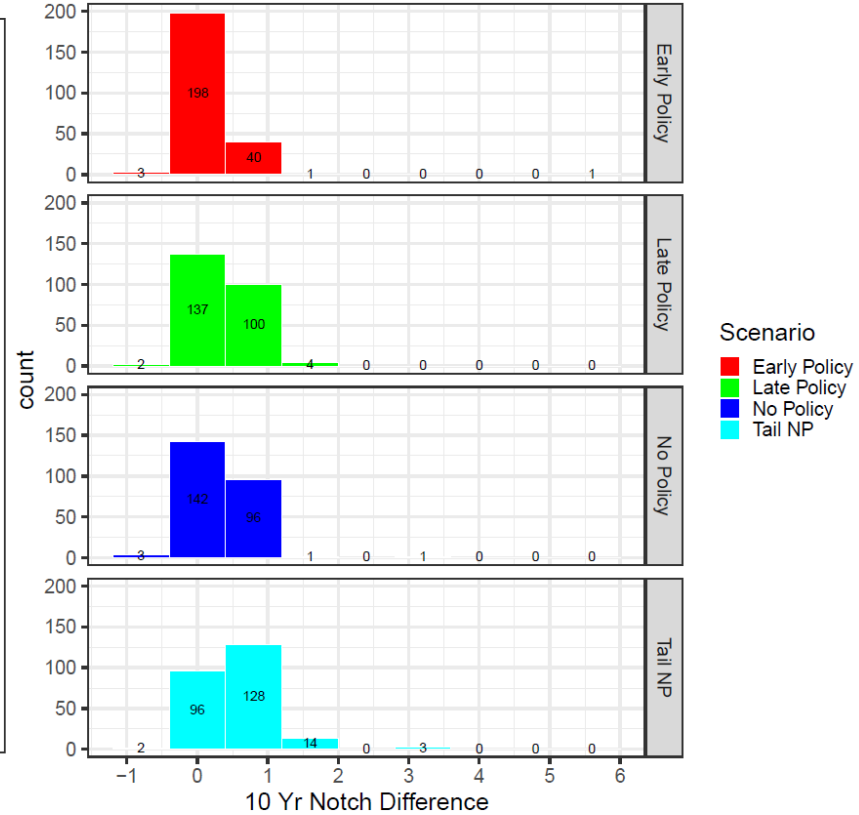
Average Combined-Adjusted EDF – South Africa Only



Combined Risk: Mean Portfolio Increase in PD by Tenor



Combined Risk: 10 Yr Notch Difference Over Portfolio

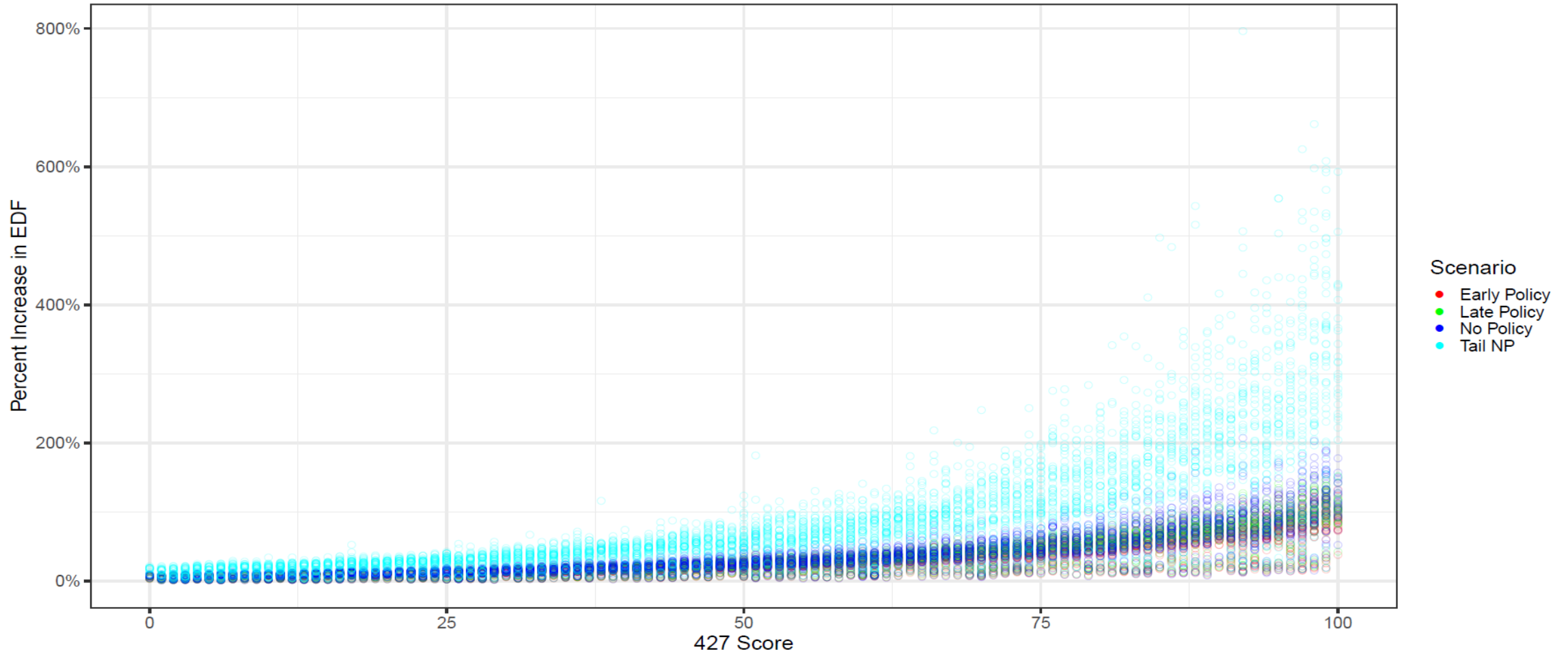


Investor Expectations Assumption: Perfect scenario foresight occurs when announced

Relationship between Physical Risk Scores and Increase in EDFs



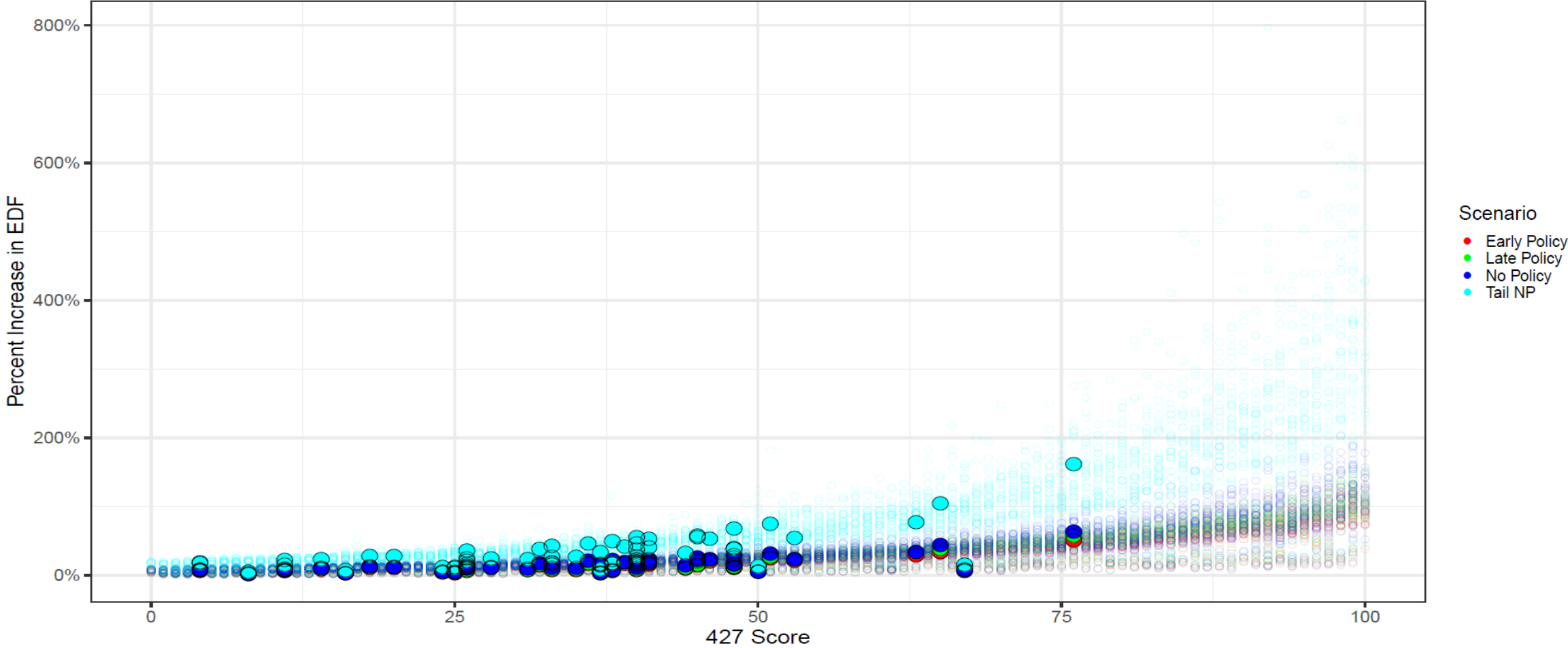
Physical Risk: Increase in 10Yr Forward PD by 427 Score



Relationship between Physical Risk Scores and Increase in EDFs (SA Names Highlighted)

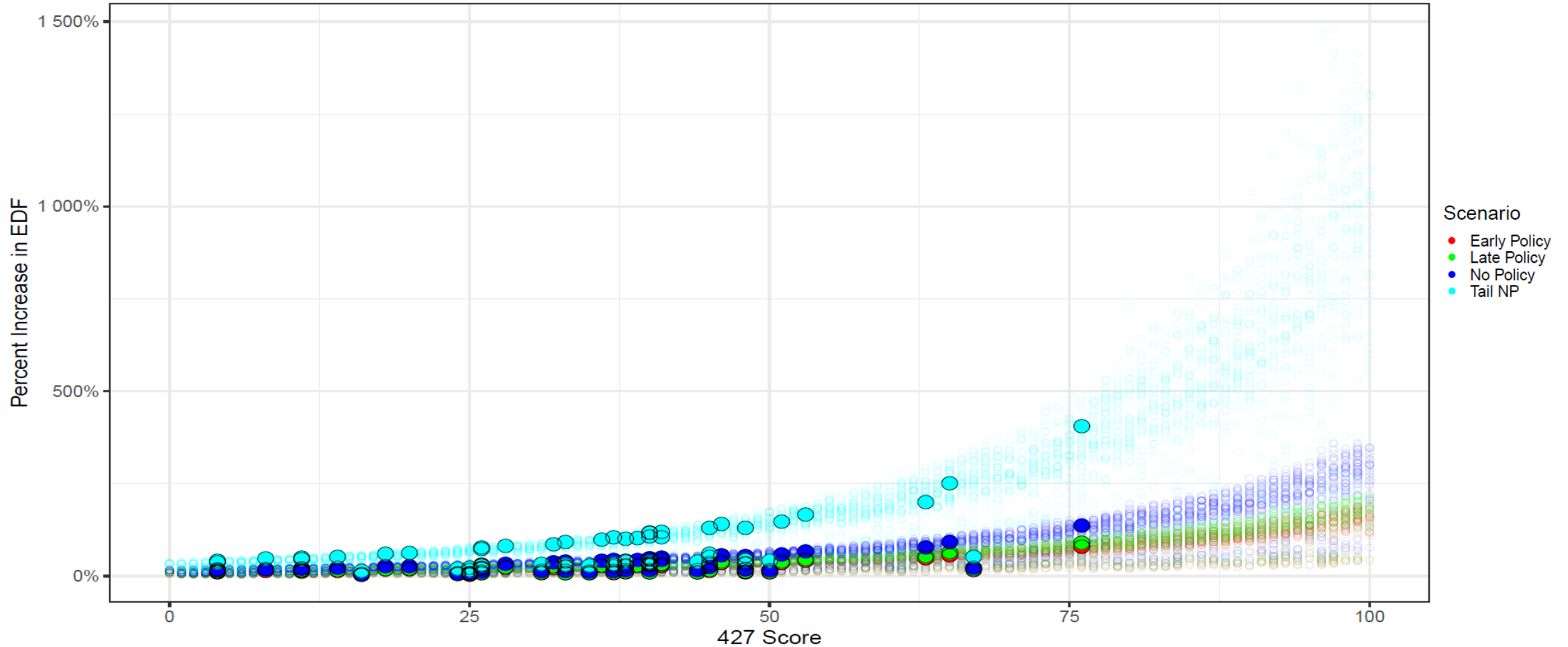


Physical Risk: Increase in 10Yr Forward PD by 427 Score



Relationship between Physical Risk Scores and Increase in EDFs (SA Names Highlighted)

Physical Risk: Increase in 30Yr Forward PD by 427 Score



Transition Risk Increases for High Exposure Sectors



	Sector Name	Mean of 1 Year PD Increase			Mean of 10 Year PD Increase		
		Early Policy	Late Policy	No Policy	Early Policy	Late Policy	No Policy
Strongly Energy-related Sectors	Coal to Liquid Refining	194.6%	-21.6%	-21.6%	2154.7%	2473.8%	-61.9%
	Gas Processing	194.6%	-21.6%	-21.6%	2154.7%	2473.8%	-61.9%
	Coal Extraction	353.5%	-36.5%	-36.5%	410.3%	882.0%	-76.0%
	Delivered Coal	131.9%	-16.7%	-16.7%	164.5%	161.9%	-40.7%
	Delivered Gas	449.4%	-4.1%	-4.1%	114.3%	434.4%	-50.2%
	Oil and Natural Gas Extraction	68.2%	-9.4%	-9.4%	55.4%	211.6%	-49.8%
	Oil Refining	16.6%	-5.6%	-5.6%	22.0%	120.3%	-39.0%
	Delivered Refined Liquids	14.2%	-4.2%	-4.2%	10.7%	44.4%	-20.2%
	Bicycle/Motorcycle Manufacturing	8.3%	-3.2%	-3.2%	6.8%	-2.8%	0.3%
	Automotive Manufacturing	7.4%	-3.3%	-3.3%	5.5%	2.4%	-6.3%
	Shipping	19.6%	-2.7%	-2.7%	4.3%	-0.1%	33.3%
	Rail Freight	3.6%	0.9%	0.9%	3.2%	-10.2%	37.8%
	Mass Passenger Transport	1.6%	0.6%	0.6%	1.1%	-4.0%	16.2%
	Aviation	0.1%	0.8%	0.8%	-2.1%	0.2%	8.8%
	Road Freight	-2.9%	1.6%	1.6%	-2.5%	-2.2%	9.0%
	Nuclear Fuel Generation	-6.9%	4.1%	4.1%	-6.9%	-39.5%	495.9%
	Fertilizer Production	-9.0%	11.6%	11.6%	-7.9%	-21.1%	149.7%
	Concrete Production	-17.0%	12.3%	12.3%	-11.8%	-55.1%	565.0%
	Electricity Production	-23.9%	18.5%	18.5%	-19.3%	-56.2%	1784.6%
	Delivered Electricity (Industrial)	-23.9%	18.5%	18.5%	-19.3%	-56.2%	1784.6%
	Delivered Electricity (Building)	-21.8%	19.2%	19.2%	-20.5%	-48.8%	1184.8%
	Delivered Electricity (Transportation)	-25.5%	23.7%	23.7%	-25.2%	-58.7%	1690.3%

Transition Risk Increases for Low Exposure Sectors



	sector name			Mean of 1 Year PD Increase			Mean of 10 Year PD Increase			sector name			Mean of 1 Year PD Increase			Mean of 10 Year PD Increase		
	Early Policy	Late Policy	No Policy	Early Policy	Late Policy	No Policy	Early Policy	Late Policy	No Policy	Early Policy	Late Policy	No Policy	Early Policy	Late Policy	No Policy	Early Policy	Late Policy	No Policy
Weakly Energy-related Sectors	UTILITIES NEC	2.0%	-0.9%	-0.9%	1.6%	29.8%	-20.3%	PLASTIC & RUBBER	-4.3%	2.3%	2.3%	-5.2%	-0.2%	6.0%				
	UTILITIES, GAS	-0.5%	1.2%	1.2%	0.9%	71.5%	-27.0%	FURNITURE & APPLIANCES	-4.3%	2.3%	2.3%	-5.3%	-1.2%	7.1%				
	MINING	0.1%	-0.1%	-0.1%	-0.2%	10.4%	-8.1%	MEDICAL SERVICES	-3.5%	1.9%	1.9%	-5.3%	-0.7%	6.7%				
	STEEL & METAL PRODUCTS	-0.3%	0.2%	0.2%	-0.9%	18.2%	-13.2%	PRINTING	-4.6%	2.5%	2.5%	-5.3%	-1.5%	7.5%				
	CHEMICALS	-1.3%	0.7%	0.7%	-2.1%	13.9%	-9.3%	FINANCE COMPANIES	-5.0%	2.8%	2.8%	-5.3%	-1.9%	8.4%				
	CONSTRUCTION MATERIALS	-1.8%	0.9%	0.9%	-2.4%	12.6%	-8.4%	CONSUMER SERVICES	-4.5%	2.4%	2.4%	-5.3%	-1.4%	7.5%				
	UNASSIGNED	-1.8%	1.0%	1.0%	-2.8%	3.8%	0.2%	LESSORS	-3.9%	2.1%	2.1%	-5.4%	-0.9%	7.2%				
	COMPUTER SOFTWARE	-2.7%	1.4%	1.4%	-3.9%	-1.0%	5.3%	MACHINERY & EQUIPMENT	-4.6%	2.4%	2.4%	-5.4%	-1.0%	7.0%				
	PHARMACEUTICALS	-2.5%	1.3%	1.3%	-3.9%	0.1%	4.1%	APPAREL & SHOES	-4.9%	2.6%	2.6%	-5.5%	-1.7%	7.9%				
	FINANCE NEC	-2.6%	1.4%	1.4%	-3.9%	-0.6%	5.3%	CONSUMER PRODUCTS	-3.7%	1.9%	1.9%	-5.5%	-1.3%	7.5%				
	LUMBER & FORESTRY	-3.0%	1.6%	1.6%	-4.0%	5.0%	-0.6%	PUBLISHING	-4.6%	2.5%	2.5%	-5.5%	-1.9%	8.3%				
	AGRICULTURE	-3.3%	1.7%	1.7%	-4.1%	1.5%	2.8%	CONSUMER DURABLES	-4.9%	2.6%	2.6%	-5.6%	-1.2%	7.8%				
	INVESTMENT MANAGEMENT	-2.2%	1.3%	1.3%	-4.2%	-1.3%	7.0%	HOTELS & RESTAURANTS	-4.5%	2.4%	2.4%	-5.6%	0.8%	5.4%				
	SEMICONDUCTORS	-3.1%	1.6%	1.6%	-4.2%	0.7%	3.8%	INSURANCE - PROP/CAS/HEALTH	-4.2%	2.4%	2.4%	-5.7%	-1.2%	8.5%				
	PAPER	-3.6%	1.9%	1.9%	-4.2%	7.7%	-2.7%	BUSINESS PRODUCTS WHSL	-5.5%	3.0%	3.0%	-5.8%	0.0%	6.6%				
	MEDICAL EQUIPMENT	-2.6%	1.4%	1.4%	-4.4%	-0.7%	5.5%	FOOD & BEVERAGE	-4.2%	2.3%	2.3%	-5.9%	1.6%	5.1%				
	BUSINESS SERVICES	-3.5%	1.9%	1.9%	-4.5%	-0.7%	5.6%	TELEPHONE	-4.5%	2.4%	2.4%	-6.0%	-1.3%	8.3%				
	SECURITY BROKERS & DEALERS	-4.2%	2.4%	2.4%	-4.6%	-1.7%	7.3%	CONSTRUCTION	-6.8%	3.8%	3.8%	-6.0%	-1.1%	8.7%				
	ELECTRONIC EQUIPMENT	-4.2%	2.2%	2.2%	-4.6%	-0.5%	5.6%	CONSUMER DURABLES RETL/WHSL	-5.3%	2.9%	2.9%	-6.1%	-1.5%	8.6%				
	TRANSPORTATION	-3.8%	2.0%	2.0%	-4.7%	5.9%	-0.7%	BROADCAST MEDIA	-4.9%	2.6%	2.6%	-6.2%	-2.0%	9.1%				
	ENTERTAINMENT & LEISURE	-3.9%	2.1%	2.1%	-4.7%	-1.3%	6.6%	CONSUMER PRODUCTS RETL/WHSL	-5.4%	2.9%	2.9%	-6.2%	-1.7%	8.9%				
	MEASURE & TEST EQUIPMENT	-3.1%	1.7%	1.7%	-4.8%	-0.9%	6.5%	AUTOMOTIVE	-5.8%	3.1%	3.1%	-6.3%	-1.0%	8.1%				
	REAL ESTATE INVESTMENT TRUSTS	-2.7%	1.4%	1.4%	-4.8%	0.2%	5.3%	TOBACCO	-3.1%	1.6%	1.6%	-6.4%	-0.6%	8.0%				
	TEXTILES	-5.6%	3.0%	3.0%	-4.8%	1.7%	3.7%	CABLE TV	-4.7%	2.5%	2.5%	-6.4%	-1.8%	9.3%				
	COMPUTER HARDWARE	-4.3%	2.3%	2.3%	-4.9%	-0.9%	6.4%	FOOD & BEVERAGE RETL/WHSL	-5.1%	2.8%	2.8%	-6.8%	-0.8%	8.7%				
	ELECTRICAL EQUIPMENT	-4.3%	2.3%	2.3%	-5.0%	-1.4%	7.4%	INSURANCE - LIFE	-9.9%	6.4%	6.4%	-9.4%	-2.8%	17.4%				
	AEROSPACE & DEFENSE	-3.9%	2.1%	2.1%	-5.0%	-1.4%	7.1%	BANKS AND S&LS	-10.3%	7.1%	7.1%	-10.8%	-3.0%	23.5%				
	REAL ESTATE	-3.8%	2.1%	2.1%	-5.0%	-0.6%	6.8%											

4

Conclusion

Key Takeaways

- » The assessment of ESG risk is possible either through direct company assessment or building score estimates if direct assessment is not available.
- » Quantitative methodologies can be applied especially when the data gaps are present and/or the number of companies in a portfolio is large.
- » Heat stress and flooding are greatest location-specific climate hazards in South Africa, while health and tourism are key factors at a macroeconomic level.
- » Climate Change has the potential for material credit effects for all corporate names in a portfolio
- » The magnitude of climate shocks varies widely across names, time horizons, and scenarios, and is concentrated in the most heavily affected firms and extreme outcomes.

Q&A



Additional questions? Email us at ma-webinars@moodys.com

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