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# Climate Risk Stress Testing: The Impacts on Credit and Market Risk Metrics

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# Agenda

- Physical Risk Modeling
- Transition Risk Modeling
- Summary Climate Risk Stress
- Climate Credit Risk Stress: Cumulative PD ( $1y \Rightarrow 15y$ )
- Annex: Designing and Implementing Climate Risk Analysis





Methodological Framework to Climate Physical & Transition Risk

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### Methodological Framework to Climate Physical & Transition Risk

End-to-end methodology aimed at incorporating the impacts of climate risks (physical and transition) on Non-Financial Corporate Credit Risk (PD, LGD, EL) and Market Risk (Fair Value) metrics. The methodology estimates the climate risk economic impacts on corporations considering both direct first-order impacts and indirect second-order impacts, due to the amplification effects and disruptions on supply chains. It is applied a bottom-up approach, based on microeconomic company-specific drivers and macroeconomic data. The modeling is very flexible, being applicable according with the level of information and data available, through a waterfall approach that envisages the use of proxies estimates and fallback solutions in case of lack of data.

Company-Specific Data	<b>Country-Sector Data</b>
<ul> <li>Accounting and management data related to individual companies.</li> <li>Company GHG Data.</li> <li>Business Line Break-down by Country &amp; Sector.</li> <li>Geo-Exposure: Break-down companies by the geographic location of their domicile or factories.</li> <li>Asset type, Location and Geocoding production sites or trading address.</li> <li>Production capacity, GVA (Gross Value Added), intermediate consumption, allocation of assets &amp; production.</li> <li>Company-specific country industry supply chain data.</li> </ul>	<ul> <li>Input-Output Matrix Model as a proxy to identify upstream industry and countries.</li> <li>GHG Sector Emission Path &amp; Carbon Price.</li> <li>Country data on Energy Consumption, Energy Mix, Energy Price.</li> <li>Green Investments.</li> <li>Country/sectoral economic damage on physical risk expressed as deviations from a baseline scenario, where there is no climate-related risk.</li> <li>Industry sector physical risk sensitivity.</li> <li>Natural Hazards Risk Map &amp; Scientific studies of Natural Hazards Data (Copernicus, ISPRA, JRC, Hanze, EM-DAT, NASA, UNDRR, CMIP6, FEMA).</li> <li>Climate scenarios data (IPCC, NGFS, IEA , IMF, Oxford Economics,etc.)</li> </ul>

### Projected Expected Annual Economic Impact

- Company-specific economic impacts include both first-order impacts (covering all kind of impacts directly affecting the company's plants and operations), and **second-order impacts** (covering all kind of indirect impacts affecting the company's supply chain).
- The relevance of first-order and second-order impacts mainly depends on the share of production performed directly by the company respect to the contribution of intermediate consumptions to the total production value.
- All expected economic impacts are considered netted of the effects that have already manifested themselves in some way and thus already recorded in the final reported values.

### Climate Risk Financial Assessment

- Climate financial valuation adjustment: estimate of the present value of climate risk economic impacts on the companies' cash flows and equity value.
- **Credit risk impact**: incorporation of climate risk impacts in PDs and LGDs through either structural credit risk models (e.g. *a là* Merton) or credit scoring models.
- The following empirical estimates are obtained by taking as a reference a model *a là* Merton (DRSK Bloomberg) and a scoring model (Altman's Z-Score model).
- **PD estimates refer to June-25** and consider the effects on **cumulated PDs up to 15 y** (in line with IFRS 9 provisioning purposes).



## Physical Risk Modeling

The methodology is aimed at catching all the main relevant drivers which can affect a company's physical risk exposure. The methodology splits the estimate of physical risk impacts into first and second order impacts, according with the company's business model and the way it organizes the production and distribution of its products/services. The methodology covers the estimate acute physical risks associated with extreme natural hazards; and chronic physical risks

the company's business model and the way it organizes the production and distribution of its products/services. The me associated with gradual and structural climate changes related with the global temperature increase.





The estimate of transition risk impacts is based on a differential approach between the economic projections made under a climate scenario of refence and a hypothetical inertial scenario (baseline) under which projections follow the dynamics and impacts implicit in the current trend in relation to technology and environmental policies (e.g. the Current Policies NGFS scenario). This allow us to exclude from Transition Risk all those impacts that the companies would have sustained in any case (i.e. increase in costs and investments), regardless from the transition process assumed in the reference climate scenario. The differential approach rules are applied uniformly for all the different variables involved, in order to ensure that coherence is maintained in the interdependencies between the different variables.





### **Energy Cost**

- Estimate of the future change in the company's operating costs related to the evolution of energy consumption and energy prices.
- The size and sign of this component is connected to the **degree of energy intensity of the company**, and to the expectations regarding the evolution of **energy prices**, which in turn are linked to the **energy mix** present in the different countries in which the company operates.

### **Investment Cost**

- Estimate of the future additional investments (Capex) for the transition from the current carbon-intensive production plants (i.e. "brown technologies") to the new and more efficient "green technologies" aimed at reducing the overall GHG emissions (S1+S2+S3).
- The higher investments involve an increase in Net Fixed Assets e relative depreciation, an increase of Debt and related Interest Expenses.

### **Browning Deterioration Effect**

- Estimate of the reduction in fossil fuel production associated with the expected decline in demand, relevant only for economic sectors structurally highly exposed to the transition and ancillary to them (Coal, Oil & Gas, Extraction, etc.).
- The effects at company-specific level involve a reduction in revenues and a corresponding reduction in costs connected to the progressive abandonment of the brown business line.
- The impact is an estimate of the future reductions in operating profits; the present value of all changes estimated in each period would represent the expected write-down to be applied to the value of **stranded assets** (assets subject to significant future value losses in relation to the transition to a low-carbon economy).

## Summary Climate Risk Stress

- The analysis shows, as one would logically expect, that the most significant impacts are associated with sectors with high carbon intensity (higher transition risks) and high capital intensity (higher physical risks).
- Automobile sectors in Altman's model), the impacts although they may seem relatively low still produce high levels of post climate stress risk.
- Comparison of impacts between different climate scenarios seems to show the following trends:
  - time horizon (2040 ->2050).
  - (particularly after 2040); we could say that the higher costs and investments related to the transition tend to be "repaid" with lower economic impacts related to physical risks.
- When evaluating the results, consider that they also depend on the calibration of the climate stress test, assumed to be at a central value (50th percentile). Obviously, assuming higher stress levels would change the results with a consequent increase in the impacts of physical risks and an increase in transition effects related to a potential increase in prices.
- Finally, keep in mind that the results obtained are a snapshot of what the impacts might be as of today; in a few years, even confirming the same implicit predictions of the estimates, the additional impacts might be significantly different, lead to increasingly pronounced differences in impacts (particularly in physical risks) between the different climate scenarios.



• When assessing the additional effects of climate risks on credit risk with the two models used, one must always keep in mind the starting values of pre-climate stress PDs; when these are already significant (as in the case of the Airlines and

⇒ The two scenarios considered (Delayed Transition and Net Zero 2050) often tend to have similar impacts when we consider the entire time horizon to 2050. In fact, in the Delayed Transition scenario, the lower impact of the transition, deferred over time, tends to be offset by the higher effects of physical risks in the later years; while in the Net Zero scenario, the earlier effect of the transition is offset by the lower impact of physical risks in the latter part of the

 $\Rightarrow$  If we compare the impacts between the two scenarios Net Zero and Delayed Transition vs. Current Policies (in which no impact of the transition was assumed) we can observe that excluding high carbon intensity sectors (in particular integreted oil and gas) in the other cases the impacts are quite similar. The reason for this tends to be related to the fact that in current policies there is no impact of the transition, but physical risks turn out to be much more significant

since a portion of the impacts will already be factored into the balance sheets of the companies and thus no longer be included in the forward-looking estimate of climate risks, and at the same time lengthening the horizon beyond 2050 would



### Climate Credit Risk Stress: Cumulative PD (1y⇒15y)



### **Integrated Chemicals**

Merton's Model (DRSK)



Altman's Z-Score Model



### **Automobile Manufacturers**

Merton's Model (DRSK)



Altman's Z-Score Model



### Climate Credit Risk Stress: Cumulative PD ( $1y \Rightarrow 15y$ )

Airlines Altman's Z-Score Model Merton's Model (DRSK) 25.60% . . . . . . . . . . . . . . . **27.20**% 12.80% lity (Log) (Log) 13.60% 6.40% 3.20% Defaul Prol 6.80% De 1.60% • Cumula Cumu 0.80% 3.40% 0.40% 0.20% 1.70% FY1 FY2 FY3 FY4 FY5 FY6 FY7 FY8 FY9 FY10 FY11 FY12 FY13 FY14 FY15 FY1 FY2 FY3 FY4 FY5 FY6 FY7 FY8 FY9 FY10 FY11 FY12 FY13 FY14 FY15 • • • Pre-Climate Stress • • • Delayed Transition • • • Pre-Climate Stress • • • Delayed Transition • • • Net Zero • • • Current Policies • • • Current Policies • • • Net Zero

#### **Manufacture Textiles**

Altman's Z-Score Model







### **IT Consulting & Other Services**

#### **Manufacture Tires & Rubber**

Altman's Z-Score Model



### Annex: Designing and Implementing Climate Risk Analysis

### **ANALYSIS DESCRIPTION**

- The stress testing analysis aims to estimate the impacts of climate risks and compare it with current market valuations and current credit risk estimates; the impact estimates take the time interval 2025-2050 as a reference.
- represented as average values at the GICS sector level.
- consider a 50th percentile stress.
- The analysis takes eight industrial sectors as a reference, according to the following scheme:
  - ⇒ Integrated Oil & Gas: includes major European companies (Shell, BP, ENI, Equinor, Snam,... etc.) operating in the fossil fuel sector in which mining and refining activities are prevalent. (No. 30 companies)
  - $\Rightarrow$  Electric Utilities: includes major European energy companies (Enel, Iberdrola, Endesa, EVN, ENBW, ...etc.) operating mainly in the power generation sector. (No. 20 companies)
  - ⇒ Integrated Chemicals: includes companies operating in the following GICS subsectors: Diversified Chemicals, Specialty Chemicals, Fertilizers & Agricultural Chemicals, Commodity Chemicals. (No. 30 companies)
  - ⇒ Automobile Manufacturers: includes major European car manufacturers including Stellantis, Renault, Mercedes, BMW, Volkswagen... etc. (No. 7 Companies)
  - $\Rightarrow$  Airlines: includes major European airlines including air France, Lufthansa, Raynair,... etc. (No. 10 Companies)
  - of climate risks should tend to be lower, both in terms of transitional and physical risks. (No. 20 Companies)
  - $\Rightarrow$  Manufacture Textiles: includes Italian companies with a turnover between 40 and 50 million operating in the sector. (No. 20 Companies)
  - $\Rightarrow$  Manufacture Tires & Rubber: includes Italian companies with a turnover between 40 and 50 million operating in the sector. (No. 20 Companies)

### **CREDIT RISK ESTIMATE**

Translation of economic impacts on PDs is obtained through two alternative credit risk models: Merton Model and Altman Z-Score. Both models were first used to estimate PDs without the impacts of physical risks, based on current data (Pre-Climate Stress PD). We then considered the effects of climate risks for both models and obtained the new climate risk-adjusted PDs for the different climate scenarios. Since, as is well known, the Z-Score model does not directly provide results in terms of PD but only a relative risk score; and the Bloomberg DRSK model only returns cumulative PD up to 5 years. In order to be able to compare the results of the two models in terms of cumulative PD over the long time horizon of the climate risk analysis (2050), we exploited the rating and Cumulative Average Default Rates tables of the rating agencies as a linking element, working as follows: the Z-Score was transformed into a PD through a dual conversion process: (1) with a conversion table developed by Altman the Z-Score is translated into an equivalent rating class (See Altman and Hotchkiss, 2006); subsequently, the cumulative default rates of the rating agency tables associated with the rating class were used to obtain the cumulative PDs at various maturities. In order to extend the duration of the PDs of the DRSK, we associated the PD 5yrs of the model with the corresponding rating taken from the tables of the rating agencies; and then we used the cumulative default rates corresponding to that rating class to complete the series of cumulative PDs on subsequent maturities up to 15 yrs.

### **MARKET RISK ESTIMATE**

For the group of listed companies belonging to the top six industries, the potential value reduction related to the effect of climate risks is estimated compared to current market values (June 2025). The haircut estimate is obtained as the present value of the impacts occurring in each individual period, assuming a cost of capital as a function of the reference climate scenario. In estimating this type of impact, keep in mind that what affects the result is not only the size of the impact but also the period in which it is realized.

• All estimates are obtained granularly at the individual company level, considering three alternative NGFS climate scenarios: Current Policies, Delayed Transition, and Net-Zero 2050. Results are • Estimation of the impacts of physical and transition risks predict a 50th percentile climate model calibration. Specifically, within the disaster risk models, both return times and associated damage functions

⇒ IT Consulting & Other Services: includes companies operating in the IT consulting sector, including Accenture, Reply, Capgemini... etc. This sector can be considered representative of service-related sectors, where the impact